ALLEN CAREER INSTITUTE
KOTA (RAJASTHAN)

JEE (MAIN)
JANUARY & APRIL 2019

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN) path to success

Chapter 01 Contents

JEE (MAIN) TOPICWISE TEST PAPERS JANUARY & APRIL 2019

PHYSICS

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

Chapter 01 Contents

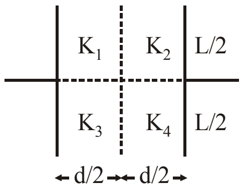
JEE (MAIN) TOPICWISE TEST PAPERS JANUARY & APRIL 2019

PHYSICS

JANUARY & APRIL 2019 ATTEMPT (PHYSICS)

CAPACITOR

1. A parallel plate capacitor with square plates is filled with four dielectrics of dielectric constants K_1, K_2, K_3, K_4 arranged as shown in the figure. The effective dielectric constant K will be :



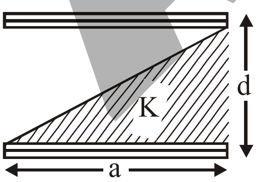
(1) $K = \dfrac{(K_1+K_2)(K_3+K_4)}{2(K_1+K_2+K_3+K_4)}$

(2) $K = \dfrac{(K_1+K_2)(K_3+K_4)}{(K_1+K_2+K_3+K_4)}$

(3) $K = \dfrac{(K_1+K_4)(K_2+K_3)}{2(K_1+K_2+K_3+K_4)}$

(4) $K = \dfrac{(K_1+K_3)(K_2+K_4)}{K_1+K_2+K_3+K_4}$

2. A parallel plate capacitor is made of two square plates of side 'a', separated by a distance d (d<<a). The lower triangular portion is filled with a dielectric of dielectric constant K, as shown in the figure.



Capacitance of this capacitor is :

(1) $\dfrac{1}{2}\dfrac{k\epsilon_0 a^2}{d}$ (2) $\dfrac{k\epsilon_0 a^2}{d}\ln K$

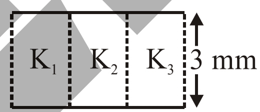
(3) $\dfrac{k\epsilon_0 a^2}{d(K-1)}\ln K$ (4) $\dfrac{k\epsilon_0 a^2}{2d(K+1)}$

3. A parallel plate capacitor having capacitance 12 pF is charged by a battery to a potential difference of 10 V between its plates. The charging battery is now disconnected and a porcelain slab of dielectric constant 6.5 is slipped between the plates the work done by the capacitor on the slab is :

(1) 692 pJ   (2) 60 pJ

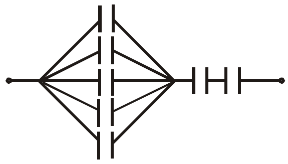
(3) 508 pJ   (4) 560 pJ

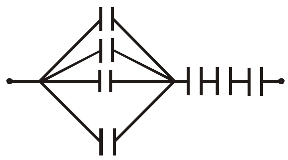
4. A parallel plate capacitor is of area 6 cm^2 and a separation 3 mm. The gap is filled with three dielectric materials of equal thickness (see figure) with dielectric constants K_1, = 10, K_2 = 12 and K_3 = 14. The dielectric constant of a material which when fully inserted in above capacitor, gives same capacitance would be :

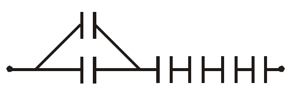


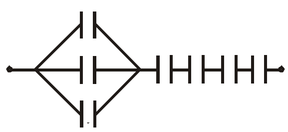
(1) 12   (2) 4   (3) 36   (4) 14

5. Seven capacitors, each of capacitance 2 μF, are to be connected in a configuration to obtain an effective capacitance of $\left(\dfrac{6}{13}\right)\mu F$. Which of the combinations, shown in figures below, will achieve the desired value ?

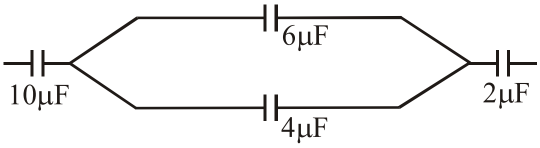
(1)


(2)


(3)


(4)


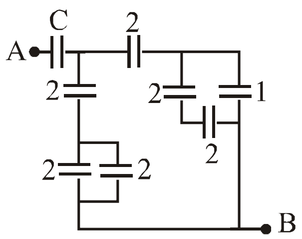
6. In the figure shown below, the charge on the left plate of the 10 μF capacitor is –30 μC. ? The charge on the right plate of the 6 μF capacitor is :



(1) –18 μC (2) –12 μC

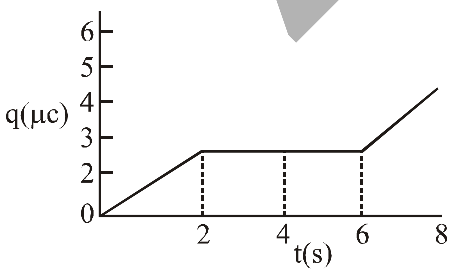
(3) +12 μC (4) +18 μC

7. In the circuit shown, find C if the effective capacitance of the whole circuit is to be 0.5 μF. All values in the circuit are in μF.



(1) $\frac{7}{10}$μF (2) $\frac{7}{11}$μF (3) $\frac{6}{5}$μF (4) 4μF

8. The charge on a capacitor plate in a circuit, as a function of time, is shown in the figure: What is the value of current at t = 4 s ?



(1) 3μA (2) 2μA

(3) zero (4) 1.5μA

9. A parallel plate capacitor with plates of area 1m^2 each, area t a separation of 0.1 m. If the electric field between the plates is 100 N/C, the magnitude of charge each plate is :-

(Take $\varepsilon_0 = 8.85\times10^{-12}\frac{C^2}{N-m^2}$)

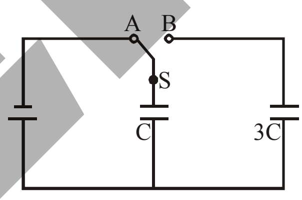
(1) 7.85×10^{-10} C

(2) 6.85×10^{-10} C

(3) 9.85×10^{-10} C

(4) 8.85×10^{-10} C

10. In the figure shown, after the switch 'S' is turned from position 'A' to position 'B', the energy dissipated in the circuit in terms of capacitance 'C' and total charge 'Q' is:



(1) $\frac{3}{8}\frac{Q^2}{C}$ (2) $\frac{3}{4}\frac{Q^2}{C}$

(3) $\frac{1}{8}\frac{Q^2}{C}$ (4) $\frac{5}{8}\frac{Q^2}{C}$

11. A parallel plate capacitor has 1μF capacitance. One of its two plates is given +2μC charge and the other plate, +4μC charge. The potential difference developed across the capacitor is:-

(1) 5V (2) 2V

(3) 3V (4) 1V

12. Voltage rating of a parallel plate capacitor is 500V. Its dielectric can withstand a maximum electric field of 10^6 V/m. The plate area is 10^{-4} m^2. What is the dielectric constant is the capacitance is 15 pF? (given $\epsilon_0 = 8.86 \times 10^{-12}$ C^2/Nm^2)

(1) 3.8 (2) 4.5

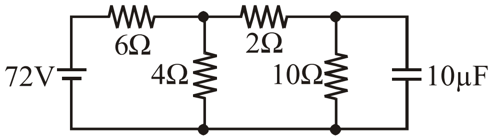
(3) 6.2 (4) 8.5

13. The parallel combination of two air filled parallel plate capacitors of capacitance C and nC is connected to a battery of voltage, V. When the capacitors are fully charged, the battery is removed and after that a dielectric material of dielectric constant K is placed between the two plates of the first capacitor. The new potential difference of the combined system is :-

(1) $\frac{V}{K+n}$ (2) V

(3) $\frac{(n+1)V}{(K+n)}$ (4) $\frac{nV}{K+n}$

14. Determine the charge on the capacitor in the following circuit :



(1) 2μC (2) 60μC

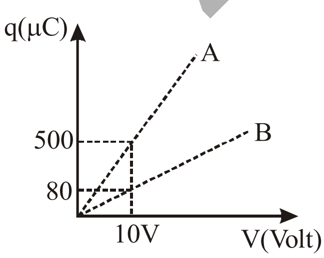
(3) 200μC (4) 10μC

15. A capacitor with capacitance 5μF is charged to 5μC. If the plates are pulled apart to reduce the capacitance to 2μF, how much work is done ?

(1) 3.75×10^{-6} J (2) 2.55×10^{-6} J

(3) 2.16×10^{-6} J (4) 6.25×10^{-6} J

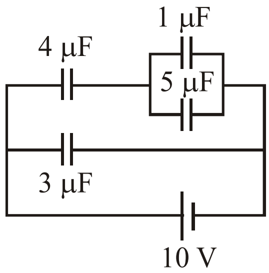
16. Figure shows charge (q) versus voltage (V) graph for series and parallel combination of two given capacitors. The capacitances are :



(1) 50 μF and 30 μF (2) 20 μF and 30 μF

(3) 60 μF and 40 μF (4) 40 μF and 10 μF

17. In the given circuit, the charge on 4 μF capacitor will be :

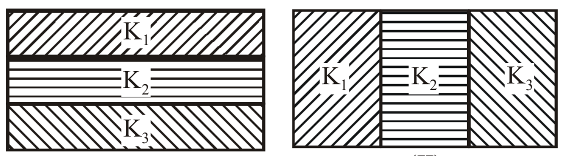


(1) 5.4 μC (2) 24 μC

(3) 13.4 μC (4) 9.6 μC

18. Two identical parallel plate capacitors, of capacitance C each, have plates of area A, separated by a distance d. The space between the plates of the two capacitors, is filled with three dielectrics, of equal thickness and dielectric constants K_1, K_2 and K_3. The first capacitor is filled as shown in fig. I, and the second one is filled as shown in fig. II.

If these two modified capacitors are charged by the same potential V, the ratio of the energy stored in the two, would be (E_1 refers to capacitor (I) and E_2 to capacitor (II)) :



(I) (II)

(1) $\frac{E_1}{E_2} = \frac{9K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

(2) $\frac{E_1}{E_2} = \frac{K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

(3) $\frac{E_1}{E_2} = \frac{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}{K_1K_2K_3}$

(4) $\frac{E_1}{E_2} = \frac{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}{9K_1K_2K_3}$

CIRCULAR MOTION

1. A body is projected at t = 0 with a velocity $10\ ms^{-1}$ at an angle of 60° with the horizontal. The radius of curvature of its trajectory at t = 1s is R. Neglecting air resistance and taking acceleration due to gravity $g = 10\ ms^{-2}$, the value of R is :

(1) 2.5 m (2) 10.3 m

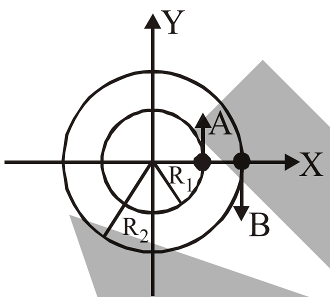
(3) 2.8 m (4) 5.1 m

2. A particle is moving along a circular path with a constant speed of $10\ ms^{-1}$. What is the magnitude of the change is velocity of the particle, when it moves through an angle of 60° around the centre of the circle?

(1) zero (2) 10 m/s

(3) $10\sqrt{3}$ m/s (4) $10\sqrt{2}$ m/s

3. Two particles A, B are moving on two concentric circles of radii R_1 and R_2 with equal angular speed ω. At t = 0, their positions and direction of motion are shown in the figure :

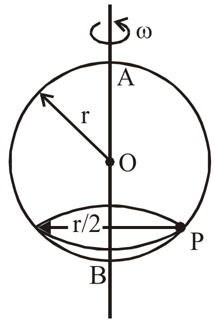


The relative velocity $\vec{\upsilon}_A - \vec{\upsilon}_B$ at $t = \frac{\pi}{2\omega}$ is given by :

(1) $-\omega(R_1 + R_2)\hat{i}$ (2) $\omega(R_1 + R_2)\hat{i}$

(3) $\omega(R_1 - R_2)\hat{i}$ (4) $\omega(R_2 - R_1)\hat{i}$

4. A smooth wire of length 2πr is bent into a circle and kept in a vertical plane. A bead can slide smoothly on the wire. When the circle is rotating with angular speed ω about the vertical diameter AB, as shown in figure, the bead is at rest with respect to the circular ring at position P as shown. Then the value of ω^2 is equal to :



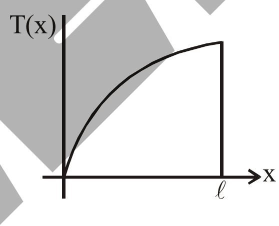
(1) $\left(g\sqrt{3}\right)/r$

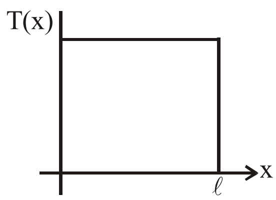
(2) $\frac{\sqrt{3}g}{2r}$

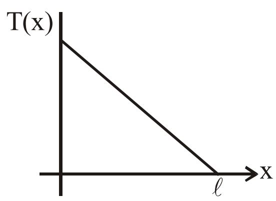
(3) 2g/r

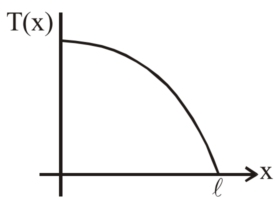
(4) $2g/\left(r\sqrt{3}\right)$

5. A uniform rod of length ℓ is being rotated in a horizontal plane with a constant angular speed about an axis passing through one of its ends. If the tension generated in the rod due to rotation is T(x) at a distance x from the axis, then which of the following graphs depicts it most closely?

(1)


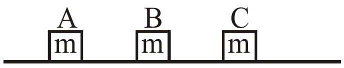
(2)


(3)


(4)


COM & COLLISION

1. Three blocks A, B and C are lying on a smooth horizontal surface, as shown in the figure. A and B have equal masses, m while C has mass M. Block A is given an brutal speed v towards B due to which it collides with B perfectly inelastically. The combined mass collides with C, also perfectly inelastically $\frac{5}{6}$ th of the initial kinetic energy is lost in whole process. What is value of M/m ?



(1) 4 (2) 5

(3) 3 (4) 2

2. A piece of wood of mass 0.03 kg is dropped from the top of a 100 m height building. At the same time, a bullet of mass 0.02 kg is fired vertically upward, with a velocity 100 ms^{-1}, from the ground. The bullet gets embedded in the wood. Then the maximum height to which the combined system reaches above the top of the building before falling below is : ($g = 10ms^{-2}$)

(1) 30 m (2) 10 m

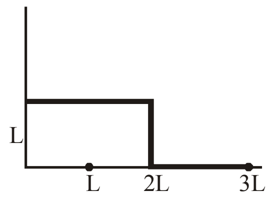
(3) 40 m (4) 20 m

3. A simple pendulum, made of a string of length l and a bob of mass m, is released from a small angle θ_0. It strikes a block of mass M, kept on a horizontal surface at its lowest point of oscillations, elastically. It bounces back and goes up to an angle θ_1. Then M is given by :

(1) $\frac{m}{2}\left(\frac{\theta_0-\theta_1}{\theta_0+\theta_1}\right)$ (2) $\frac{m}{2}\left(\frac{\theta_0+\theta_1}{\theta_0-\theta_1}\right)$

(3) $m\left(\frac{\theta_0+\theta_1}{\theta_0-\theta_1}\right)$ (4) $m\left(\frac{\theta_0-\theta_1}{\theta_0+\theta_1}\right)$

4. The position vector of the centre of mass $\vec{r}$ cm of an symmetric uniform bar of negligible area of cross-section as shown in figure is :



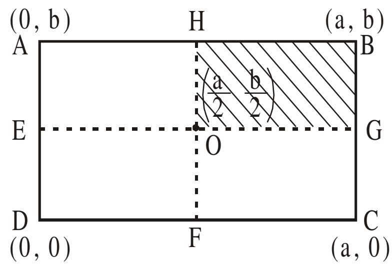
(1) $\vec{r}\,cm = \frac{13}{8}L\hat{x} + \frac{5}{8}L\hat{y}$

(2) $\vec{r}\,cm = \frac{11}{8}L\,\hat{x} + \frac{3}{8}L\hat{y}$

(3) $\vec{r}\,cm = \frac{3}{8}L\,\hat{x} + \frac{11}{8}L\hat{y}$

(4) $\vec{r}\,cm = \frac{5}{8}L\,\hat{x} + \frac{13}{8}L\hat{y}$

5. A uniform rectangular thin sheet ABCD of mass M has length a and breadth b, as shown in the figure. If the shaded portion HBGO is cut-off, the coordinates of the centre of mass of the remaining portion will be :-



(1) $\left(\frac{2a}{3},\frac{2b}{3}\right)$ (2) $\left(\frac{5a}{3},\frac{5b}{3}\right)$

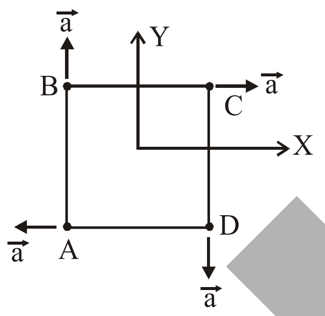
(3) $\left(\frac{3a}{4},\frac{3b}{4}\right)$ (4) $\left(\frac{5a}{12},\frac{5b}{12}\right)$

6. A body of mass m_1 moving with an unknown velocity of $v_1\hat{i}$, undergoes a collinear collision with a body of mass m_2 moving with a velocity $v_2\hat{i}$. After collision, m_1 and m_2 move with velocities of $v_3\hat{i}$ and $v_4\hat{i}$, respectively. If $m_2 = 0.5\ m_1$ and $v_3 = 0.5\ v_1$, then v_1 is :-

(1) $v_4 - \frac{v_2}{4}$ (2) $v_4 - \frac{v_2}{2}$

(3) $v_4 - v_2$ (4) $v_4 + v_2$

7. Four particles A, B, C and D with masses $m_A = m$, $m_B = 2m$, $m_C = 3m$ and $m_D = 4m$ are at the corners of a square. They have accelerations of equal magnitude with directions as shown. The acceleration of the centre of mass of the particles is :



(1) $\frac{a}{5}(\hat{i}-\hat{j})$ (2) $\frac{a}{5}(\hat{i}+\hat{j})$

(3) Zero (4) $a(\hat{i}+\hat{j})$

8. A particle of mass 'm' is moving with speed '2v' and collides with a mass '2m' moving with speed 'v' in the same direction. After collision, the first mass is stopped completely while the second one splits into two particles each of mass 'm', which move at angle 45° with respect to the origianl direction. The speed of each of the moving particle will be :-

(1) $v/(2\sqrt{2})$ (2) $2\sqrt{2}v$

(3) $\sqrt{2}v$ (4) $v/\sqrt{2}$

9. A wedge of mass M = 4m lies on a frictionless plane. A particle of mass m approaches the wedge with speed v. There is no friction between the particle and the plane or between the particle and the wedge. The maximum height climbed by the particle on the wedge is given by :-

(1) $\frac{2v^2}{7g}$ (2) $\frac{v^2}{g}$

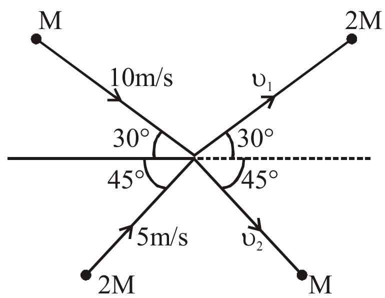
(3) $\frac{2v^2}{5g}$ (4) $\frac{v^2}{2g}$

10. A body of mass 2 kg makes an eleastic collision with a second body at rest and continues to move in the original direction but with one fourth of its original speed. What is the mass of the second body ?

(1) 1.8 kg (2) 1.2 kg

(3) 1.5 kg (4) 1.0 kg

11. Two particles, of masses M and 2M, moving, as shown, with speeds of 10 m/s and 5 m/s, collide elastically at the origin. After the collision, they move along the indicated directions with speeds υ_1 and υ_2, respectively. The values of υ_1 and υ_2 are nearly :



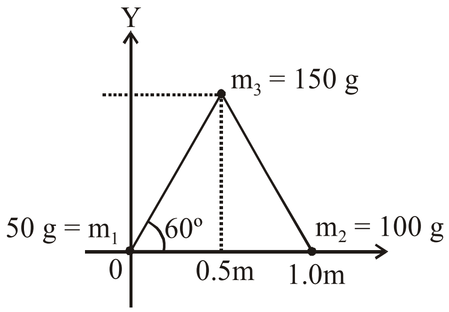
(1) 3.2 m/s and 6.3 m/s

(2) 3.2 m/s and 12.6 m/s

(3) 6.5 m/s and 6.3 m/s

(4) 6.5 m/s and 3.2 m/s

12. Three particles of masses 50 g, 100 g and 150g are placed at the vertices of an equilateral triangle of side 1 m (as shown in the figure). The (x, y) coordinates of the centre of mass will be :



(1) $\left(\frac{7}{12}\text{m}, \frac{\sqrt{3}}{8}\text{m}\right)$ (2) $\left(\frac{\sqrt{3}}{4}\text{m}, \frac{5}{12}\text{m}\right)$

(3) $\left(\frac{7}{12}\text{m}, \frac{\sqrt{3}}{4}\text{m}\right)$ (4) $\left(\frac{\sqrt{3}}{8}\text{m}, \frac{7}{12}\text{m}\right)$

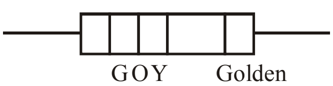
13. A man (mass = 50 kg) and his son (mass = 20 kg) are standing on a frictionless surface facing each other. The man pushes his son so that he starts moving at a speed of 0.70 ms^{-1} with respect to the man. The speed of the man with respect to the surface is :

(1) 0.20 ms^{-1} (2) 0.14 ms^{-1}

(3) 0.47 ms^{-1} (4) 0.28 ms^{-1}

CURRENT ELECTRICITY

1. A carbon resistance has a following colour code. What is the value of the resistance ?



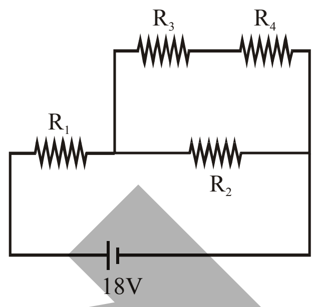
(1) 1.64 MΩ ± 5%

(2) 530 kΩ ± 5%

(3) 64 kΩ ± 10%

(4) 5.3 MΩ ± 5%

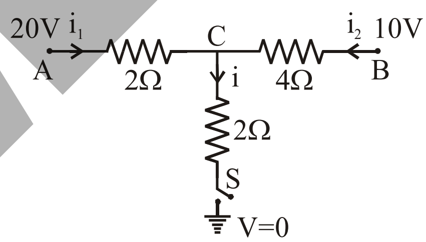
2. In the given circuit the internal resistance of the 18 V cell is negligible. If R_1 = 400 Ω, R_3 = 100 Ω and R_4 = 500 Ω and the reading of an ideal voltmeter across R_4 is 5V, then the value R_2 will be:



(1) 300 Ω (2) 230 Ω

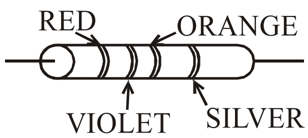
(3) 450 Ω (4) 550 Ω

3. When the switch S, in the circuit shown, is closed, then the value of current *i* will be :



(1) 3 A (2) 5 A (3) 4 A (4) 2 A

4. A resistance is shown in the figure. Its value and tolerance are given respectively by:



(1) 27 KΩ, 20% (2) 270 KΩ, 5%

(3) 270 KΩ, 10% (4) 27 KΩ, 10%

5. A copper wire is stretched to make it 0.5% longer. The percentage change in its electrical resistance if its volume remains unchanged is:

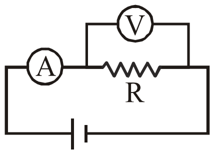
(1) 2.5% (2) 0.5%

(3) 1.0% (4) 2.0%

6. Drift speed of electrons, when 1.5 A of current flows in a copper wire of cross section 5 mm, is v. If the electron density in copper is 9×10^{28} /m^3 the value of v in mm/s is close to (Take charge of electron to be $= 1.6 \times 10^{-19}$C)

(1) 0.2 (2) 3 (3) 2 (4) 0.02

7. The actual value of resistance R, shown in the figure is 30Ω. This is measured in an experiment as shown using the standard formula $R = \frac{V}{I}$, where V and I are the readings of the voltmeter and ammeter, respectively. If the measured value of R is 5% less, then the internal resistance of the voltmeter is :



(1) 350Ω (2) 570Ω (3) 35 Ω (4) 600 Ω

8. A current of 2 mA was passed through an unknown resistor which dissipated a power of 4.4 W. Dissipated power when an ideal power supply of 11V is connected across it is :

(1) 11×10^{-5} W

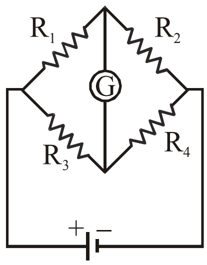
(2) 11×10^{-4} W

(3) 11×10^{5} W

(4) 11×10^{-3} W

9. The Wheatstone bridge shown in Fig. here, gets balanced when the carbon resistor used as R_1 has the colour code (Orange, Red, Brown). The resistors R_2 and R_4 are 80Ω and 40Ω, respectively.

Assuming that the colour code for the carbon resistors gives their accurate values, the colour code for the carbon resistor, used as R_3, would be :



(1) Red, Green, Brown

(2) Brown, Blue, Brown

(3) Grey, Black, Brown

(4) Brown, Blue, Black

10. A uniform metallic wire has a resistance of 18 Ω and is bent into an equilateral triangle. Then, the resistance between any two vertices of the triangle is :

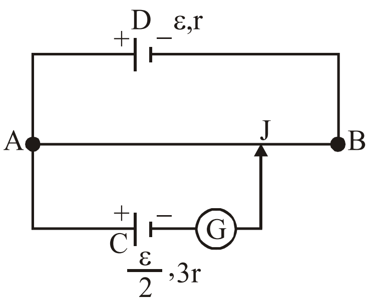
(1) 8 Ω (2) 12 Ω (3) 4 Ω (4) 2Ω

11. A 2 W carbon resistor is color coded with green, black, red and brown respectively. The maximum current which can be passed through this resistor is :

(1) 63 mA (2) 0.4 mA

(3) 100 mA (4) 20 mA

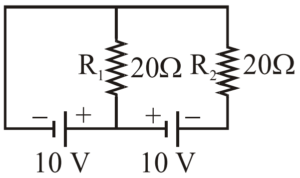
12. A potentiometer wire AB having length L and resistance 12 r is joined to a cell D of emf ε and internal resistance r. A cell C having emf ε/2 and internal resistance 3r is connected. The length AJ at which the galvanometer as shown in fig. shows no deflection is :



(1) $\frac{5}{12}$L (2) $\frac{11}{24}$L

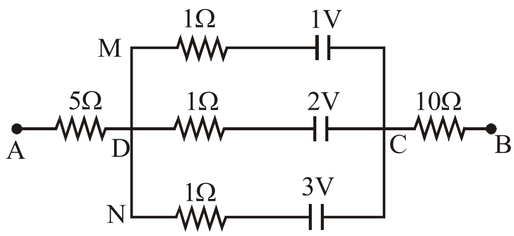
(3) $\frac{11}{12}$L (4) $\frac{13}{24}$L

13. In the given circuit the cells have zero internal resistance. The currents (in Amperes) passing through resistance R_1, and R_2 respectively, are:



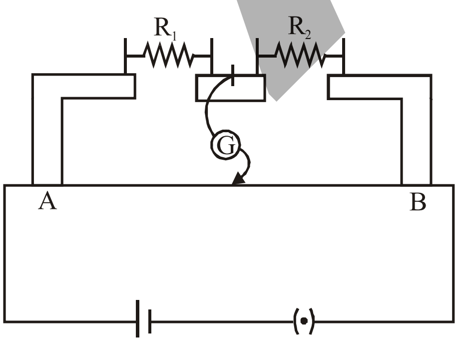
(1) 2, 2 (2) 0,1 (3) 1,2 (4) 0.5,0

14. In the circuit , the potential difference between A and B is :-



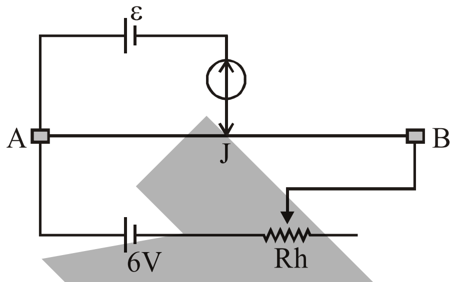
(1) 6 V (2) 1 V (3) 3 V (4) 2 V

15. In the experimental set up of metre bridge shown in the figure, the null point is obtained at a distance of 40 cm from A. If a 10Ω resistor is connected in series with R_1, the null point shifts by 10 cm. The resistance that should be connected in parallel with $(R_1 + 10)\Omega$ such that the null point shifts back to its initial position is



(1) 40 Ω (2) 60 Ω
(3) 20 Ω (4) 30Ω

16. The resistance of the meter bridge AB is given figure is 4Ω. With a cell of emf ε = 0.5 V and rheostat resistance R_h = 2 Ω the null point is obtained at some point J. When the cell is replaced by another one of emf $\varepsilon = \varepsilon_2$ the same null point J is found for R_h = 6 Ω. The emf ε_2 is;

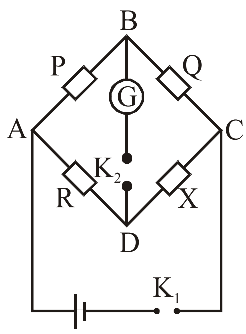


(1) 0.6 V (2) 0.5 V
(3) 0.3 V (4) 0.4 V

17. Two equal resistance when connected in series to a battery, consume electric power of 60 W. If these resistances are now connected in parallel combination to the same battery, the electric power consumed will be :

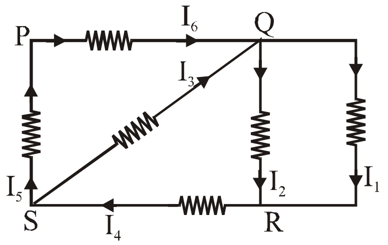
(1) 60 W (2) 240 W
(3) 30 W (4) 120 W

18. In a Wheatstone bridge (see fig.), Resistances P and Q are approximately equal. When R = 400 Ω, the bridge is equal. When R = 400 Ω, the bridge is balanced. On inter-changing P and Q, the value of R, for balance, is 405 Ω. The value of X is close to :



(1) 403.5 ohm (2) 404.5 ohm
(3) 401.5 ohm (4) 402.5 ohm

19. In the given circuit diagram, the currents, $I_1 = -0.3A$, $I_4 = 0.8$ A and $I_5 = 0.4$ A, are flowing as shown. The currents I_2, I_3 and I_6, respectively, are :



(1) 1.1 A, 0.4 A, 0.4 A

(2) –0.4 A, 0.4 A, 1.1 A

(3) 0.4 A, 1.1 A, 0.4 A

(4) 1.1 A,–0.4 A, 0.4 A

20. A galvanometer, whose resistance is 50 ohm, has 25 divisions in it. When a current of 4×10^{-4} A passes through it, its needle (pointer) deflects by one division. To use this galvanometer as a voltmeter of range 2.5 V, it should be connected to a resistance of:

(1) 6250 ohm (2) 250 ohm

(3) 200 ohm (4) 6200 ohm

21. Two electric bulbs, rated at (25 W, 220 V) and (100 W, 220 V), are connected in series across a 220 V voltage source. If the 25 W and 100 W bulbs draw powers P_1 and P_2 respectively, then:

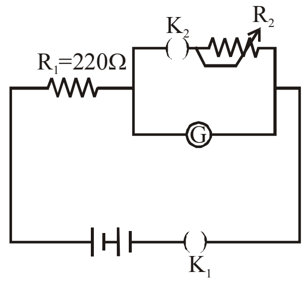
(1) P1 = 9 W, P_2 = 16 W

(2) P_1 = 4 W, P_2 = 16W

(3) P_1 = 16 W, P_2 = 4W

(4) P_1 16 W, P_2 = 9W

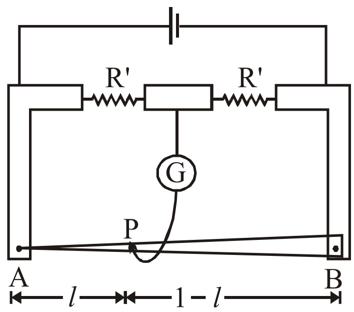
22. The galvanometer deflection, when key K_1 is closed but K_2 is open, equals θ_0 (see figure). On closing K_2 also and adjusting R_2 to 5Ω, the deflection in galvanometer becomes $\frac{\theta_0}{5}$. The resistance of the galvanometer is, then, given by [Neglect the internal resistance of battery]:



(1) 12Ω (2) 25Ω

(3) 5Ω (4) 22Ω

23. In a meter bridge, the wire of length 1 m has a non-uniform cross-section such that, the variation $\frac{dR}{d\ell}$ of its resistance R with length ℓ is $\frac{dR}{d\ell} \propto \frac{1}{\sqrt{\ell}}$. Two equal resistances are connected as shown in the figure. The galvanometer has zero deflection when the jockey is at point P. What is the length AP?



(1) 0.25 m (2) 0.3m

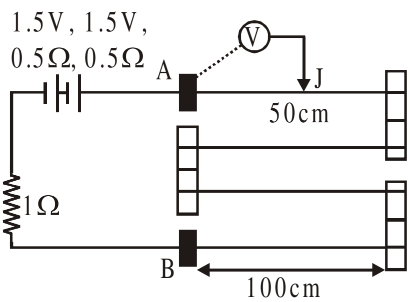
(3) 0.35 m (4) 0.2 m

24. An ideal battery of 4 V and resistance R are connected in series in the primary circuit of a potentiometer of length 1 m and resistance 5Ω. The value of R, to give a potential difference of 5 mV across 10 cm of potentiometer wire, is :

(1) 490 Ω (2) 480 Ω

(3) 395 Ω (4) 495 Ω

25. In the circuit shown, a four-wire potentiometer is made of a 400 cm long wire, which extends between A and B. The resistance per unit length of the potentiometer wire is r = 0.01 Ω/cm. If an ideal voltmeter is connected as shown with jockey J at 50 cm from end A, the expected reading of the voltmeter will be :-



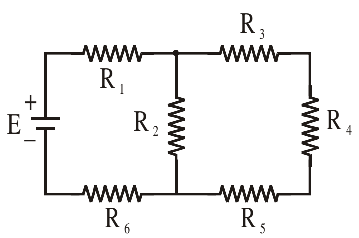
(1) 0.20 V (2) 0.25 V
(3) 0.75 V (4) 0.50V

26. A cell of internal resistance r drives current through an external resistance R. The power delivered by the cell to the external resistance will be maximum when :-

(1) R = 1000 r (2) R = 0.001 r
(3) R = 2r (4) R = r

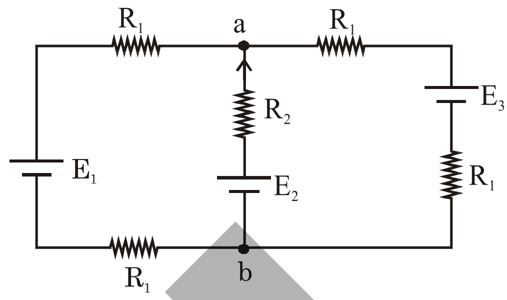
27. In the figure shown, what is the current (in Ampere) drawn from the battery ? You are given:

$R_1 = 15\Omega$, $R_2 = 10\ \Omega$, $R_3 = 20\ \Omega$, $R_4 = 5\Omega$, $R_5 = 25\Omega$, $R_6 = 30\ \Omega$, $E = 15$ V



(1) 7/18 (2) 13/24 (3) 9/32 (4) 20/3

28. For the circuit shown, with $R_1 = 1.0\Omega$, $R_2 = 2.0\ \Omega$, $E_1 = 2$ V and $E_2 = E_3 = 4$ V, the potential difference between the points 'a' and 'b' is approximately (in V) :



(1) 2.7 (2) 3.3
(3) 2.3 (4) 3.7

29. A 200 Ω resistor has a certain color code. If one replaces the red color by green in the code, the new resistance will be :

(1) 100 Ω (2) 400 Ω
(3) 500 Ω (4) 300 Ω

30. A metal wire of resistance 3 Ω is elongated to make a uniform wire of double its previous length. This new wire is now bent and the ends joined to make a circle. If two points on this circle make an angle 60° at the centre, the equivalent resistance between these two points will be :-

(1) $\frac{12}{5}\Omega$ (2) $\frac{5}{3}\Omega$

(3) $\frac{5}{2}\Omega$ (4) $\frac{7}{2}\Omega$

31. The resistance of a galvanometer is 50 ohm and the maximum current which can be passed through it is 0.002 A. What resistance must be connected to it in order to convert it into an ammeter of range 0 – 0.5 A ?

(1) 0.2 ohm (2) 0.002 ohm
(3) 0.02 ohm (4) 0.5 ohm

32. In a conductor, if the number of conduction electrons per unit volume is 8.5×10^{28} m^{-3} and mean free time is 25*f*s (femto second), it's approximate resistivity is :-

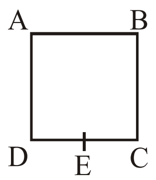
($m_e = 9.1 \times 10^{-31}$ kg)

(1) 10^{-5} Ωm (2) 10^{-6} Ωm

(3) 10^{-7} Ωm (4) 10^{-8} Ωm

33. A wire of resistance R is bent to form a square ABCD as shown in the figure. The effective resistance between E and C is :

(E is mid-point of arm CD)



(1) R (2) $\frac{1}{16}R$

(3) $\frac{7}{64}R$ (4) $\frac{3}{4}R$

34. A moving coil galvanometer has resistance 50Ω and it indicates full deflection at 4mA current. A voltmeter is made using this galvanometer and a 5 kΩ resistance. The maximum voltage, that can be measured using this voltmeter, will be close to :

(1) 10 V (2) 20 V

(3) 40 V (4) 15 V

35. Space between two concentric conducting spheres of radii a and b (b > a) is filled with a medium of resistivity ρ. The resistance between the two spheres will be :

(1) $\frac{\rho}{4\pi}\left(\frac{1}{a}-\frac{1}{b}\right)$ (2) $\frac{\rho}{2\pi}\left(\frac{1}{a}-\frac{1}{b}\right)$

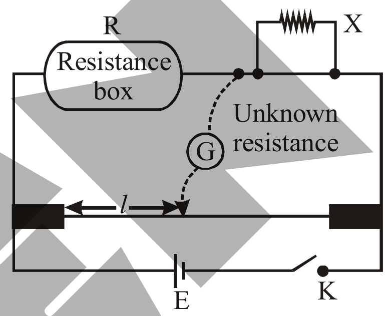
(3) $\frac{\rho}{2\pi}\left(\frac{1}{a}+\frac{1}{b}\right)$ (4) $\frac{\rho}{4\pi}\left(\frac{1}{a}+\frac{1}{b}\right)$

36. A current of 5 A passes through a copper conductor (resistivity = 1.7×10^{-8} Ωm) of radius of cross-section 5 mm. Find the mobility of the charges if their drift velocity is 1.1×10^{-3} m/s.

(1) 1.3 m^2/Vs (2) 1.5 m^2/Vs

(3) 1.8 m^2/Vs (4) 1.0 m^2/Vs

37. In a meter bridge experiment, the circuit diagram and the corresponding observation table are shown in figure

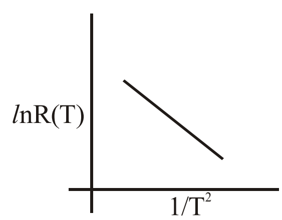


Sl. No.	R(Ω)	l(cm)
1.	1000	60
2.	100	13
3.	10	1.5
4.	1	1.0

Which of the readings is inconsistent?

(1) 4 (2) 1 (3) 2 (4) 3

38. In an experiment, the resistance of a material is plotted as a function of temperature (in some range). As shown in the figure, it is a straight line. One may conclude that :



(1) $R(T) = \frac{R_0}{T^2}$ (2) $R(T) = R_0 e^{-T^2/T_0^2}$

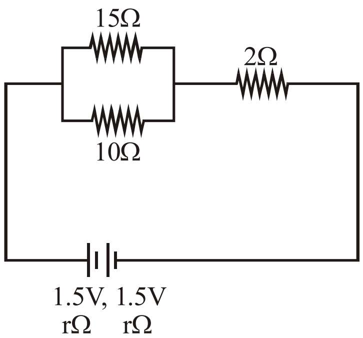
(3) $R(T) = R_0 e^{-T_0^2/T^2}$ (4) $R(T) = R_0 e^{T^2/T_0^2}$

39. A moving coil galvanometer allows a full scale current of 10^{-4}A. A series resistance of 2 MΩ is required to convert the above galvanometer into a voltmeter of range 0-5 V. Therefore the value of shunt resistance required to convert the above galvanometer into an ammeter of range 0-10 mA is :

(1) 200 Ω (2) 100 Ω

(3) 10 Ω (4) 500 Ω

40. In the given circuit, an ideal voltmeter connected across the 10Ω resistance reads 2V. The internal resistance r, of each cell is :



(1) 1Ω (2) 1.5Ω (3) 0Ω (4) 0.5Ω

41. A moving coil galvanometer, having a resistance G, produces full scale deflection when a current I_g flows through it. This galvanometer can be converted into (i) an ammeter of range 0 to I_0 ($I_0 > I_g$) by connecting a shunt resistance R_A to it and (ii) into a voltmeter of range 0 to V($V = GI_0$) by connecting a series resistance R_V to it. Then,

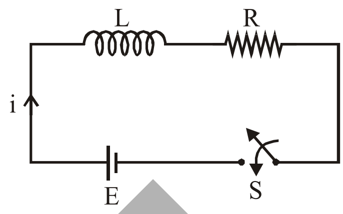
(1) $R_A R_V = G^2\left(\frac{I_g}{I_0 - I_g}\right)$ and $\frac{R_A}{R_V} = \left(\frac{I_0 - I_g}{I_g}\right)^2$

(2) $R_A R_V = G^2$ and $\frac{R_A}{R_V} = \left(\frac{I_g}{I_0 - I_g}\right)^2$

(3) $R_A R_V = G^2$ and $\frac{R_A}{R_V} = \frac{I_g}{(I_0 - I_g)}$

(4) $R_A R_V = G^2\left(\frac{I_0 - I_g}{I_g}\right)$ and $\frac{R_A}{R_V} = \left(\frac{I_g}{I_0 - I_g}\right)^2$

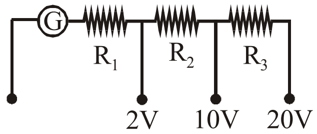
42. Consider the LR circuit shown in the figure. If the switch S is closed at t = 0 then the amount of charge that passes through the battery between t = 0 and t = $\frac{L}{R}$ is :



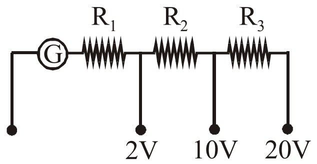
(1) $\frac{EL}{7.3R^2}$ (2) $\frac{EL}{2.7R^2}$

(3) $\frac{7.3EL}{R^2}$ (4) $\frac{2.7EL}{R^2}$

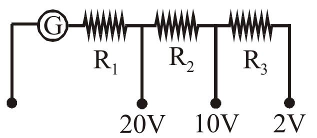
43. A galvanometer of resistance 100Ω has 50 divisions on its scale and has sensitivity of 20 μA/division. It is to be converted to a voltmeter with three ranges, of 0–2 V, 0–10 V and 0–20 V. The appropriate circuit to do so is :

(1) 

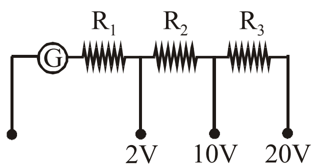
R_1 = 1900 Ω
R_2 = 9900 Ω
R_3 = 19900 Ω

(2) 

R_1 = 2000 Ω
R_2 = 8000 Ω
R_3 = 10000 Ω

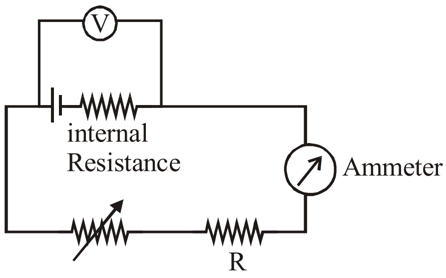
(3) 

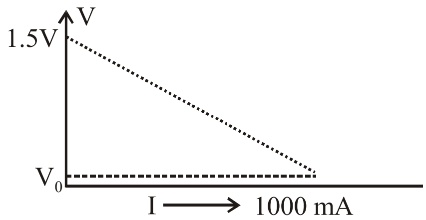
R_1 = 19900 Ω
R_2 = 9900 Ω
R_3 = 1900 Ω

(4) 

R_1 = 1900 Ω
R_2 = 8000 Ω
R_3 = 10000 Ω

44. To verify Ohm's law, a student connects the voltmeter across the battery as, shown in the figure. The measured voltage is plotted as a function of the current, and the following graph is obtained:





If V_0 is almost zero, identify the correct statement:

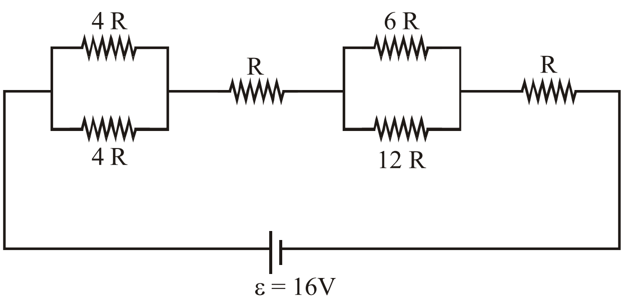
(1) The value of the resistance R is 1.5 Ω

(2) The emf of the battery is 1.5 V and the value of R is 1.5 Ω

(3) The emf of the battery is 1.5 V and its internal resistance is 1.5 Ω

(4) The potential difference across the battery is 1.5 V when it sends a current of 1000mA.

45. The resistive network shown below is connected to a D.C. source of 16V. The power consumed by the network is 4 Watt. The value of R is :



(1) 8Ω (2) 6Ω (3) 1Ω (4) 16Ω

ELECTROSTATICS

1. Two point charges $q_1(\sqrt{10}\ \mu C)$ and $q_2(-25\ \mu C)$ are placed on the x-axis at x = 1 m and x = 4 m respectively. The electric field (in V/m) at a point y = 3 m on y-axis is,

$$\left[\text{take } \frac{1}{4\pi\varepsilon_0} = 9\times10^9\ \text{Nm}^2\text{C}^{-2}\right]$$

(1) $(-63\hat{i}+27\hat{j})\times10^2$

(2) $(81\hat{i}-81\hat{j})\times10^2$

(3) $(63\hat{i}-27\hat{j})\times10^2$

(4) $(-81\hat{i}+81\hat{j})\times10^2$

2. Charge is distributed within a sphere of radius R with a volume charge density $\rho(r)=\frac{A}{r^2}e^{-2r/a}$, where A and a are constants. If Q is the total charge of this charge distribution, the radius R is :

(1) $\frac{a}{2}\log\left(1-\frac{Q}{2\pi aA}\right)$

(2) $a\log\left(1-\frac{Q}{2\pi aA}\right)$

(3) $a\log\left(\frac{1}{1-\frac{Q}{2\pi aA}}\right)$

(4) $\frac{a}{2}\log\left(\frac{1}{1-\frac{Q}{2\pi aA}}\right)$

3. Three charges +Q, q, + Q are placed respectively, at distance, 0, d/2 and d from the origin, on the x-axis. If the net force experienced by + Q, placed at x = 0, Ls zero, then value of q is :

(1) +Q/2 (2) –Q/2

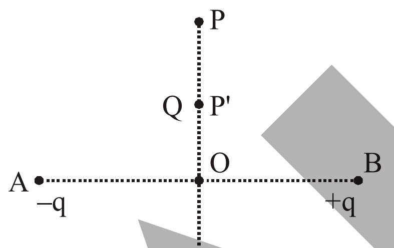
(3) –Q/4 (4) +Q/4

4. For a uniformly charged ring of radius R, the electric field on its axis has the largest magnitude at a distance h from its centre. Then value of h is :

(1) $\frac{R}{\sqrt{5}}$ (2) R

(3) $\frac{R}{\sqrt{2}}$ (4) $R\sqrt{2}$

5. Charges –q and +q located at A and B, respectively, constitute an electric dipole. Distance AB = 2a, O is the mid point of the dipole and OP is perpendicular to AB. A charge Q is placed at P where OP = y and y >> 2a. The charge Q experiences and electrostatic force F. If Q is now moved along the equatorial line to P' such that $OP' = \left(\frac{y}{3}\right)$, the force on Q will be close to : $\left(\frac{y}{3} >> 2a\right)$



(1) $\frac{F}{3}$ (2) 3F (3) 9F (4) 27F

6. Four equal point charges Q each are placed in the xy plane at (0, 2), (4, 2), (4, –2) and (0, –2). The work required to put a fifth charge Q at the origin of the coordinate system will be :

(1) $\frac{Q^2}{2\sqrt{2}\pi\varepsilon_0}$ (2) $\frac{Q^2}{4\pi\varepsilon_0}\left(1+\frac{1}{\sqrt{5}}\right)$

(3) $\frac{Q^2}{4\pi\varepsilon_0}\left(1+\frac{1}{\sqrt{3}}\right)$ (4) $\frac{Q^2}{4\pi\varepsilon_0}$

7. A charge Q is distributed over three concentric spherical shells of radii a, b, c (a < b < c) such that their surface charge densities are equal to one another. The total potential at a point at distance r from their common centre, where r < a, would be :

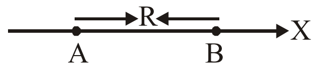
(1) $\frac{Q}{4\pi\varepsilon_0(a+b+c)}$

(2) $\frac{Q(a+b+c)}{4\pi\varepsilon_0(a^2+b^2+c^2)}$

(3) $\frac{Q}{12\pi\varepsilon_0}\frac{ab+bc+ca}{abc}$

(4) $\frac{Q}{4\pi\varepsilon_0}\frac{(a^2+b^2+c^2)}{(a^3+b^3+c^3)}$

8. Two electric dipoles, A, B with respective dipole moments $\vec{d}_A = -4qa\hat{i}$ and $\vec{d}_B = -2qa\hat{i}$ placed on the x-axis with a separation R, as shown in the figure



The distance from A at which both of them produce the same potential is :

(1) $\frac{\sqrt{2}R}{\sqrt{2}+1}$ (2) $\frac{R}{\sqrt{2}+1}$

(3) $\frac{\sqrt{2}R}{\sqrt{2}-1}$ (4) $\frac{R}{\sqrt{2}-1}$

9. An electric field of 1000 V/m is applied to an electric dipole at angle of 45°. The value of electric dipole moment is 10^{-29} C.m. What is the potential energy of the electric dipole ?

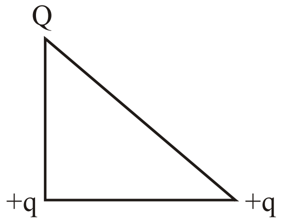
(1) -9×10^{-20} J

(2) -7×10^{-27} J

(3) -10×10^{-29} J

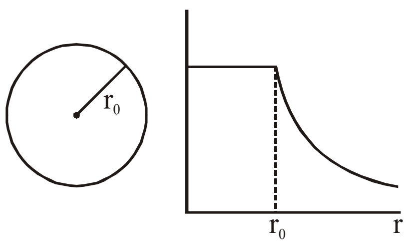
(4) -20×10^{-18} J

10. The charges Q + q and +q are placed at the vertices of a right-angle isosceles triangle as shown below. The net electrostatic energy of the configuration is zero, it the value of Q is:



(1) $\frac{-\sqrt{2}q}{\sqrt{2}+1}$ (2) –2q (3) $\frac{-q}{1+\sqrt{2}}$ (4) +q

11. The given graph shows variation (with distance r from centre) of :



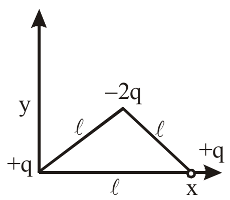
(1) Potential of a uniformly charged sphere

(2) Potential of a uniformly charged spherical shell

(3) Electric field of uniformly charged spherical shell

(4) Electric field of uniformly charged sphere

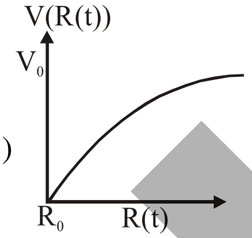
12. Determine the electric dipole moment of the system of three charges, placed on the vertices of an equilateral triangle, as shown in the figure:

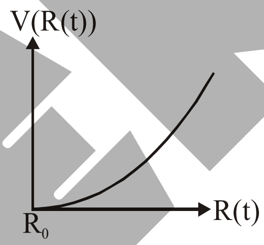


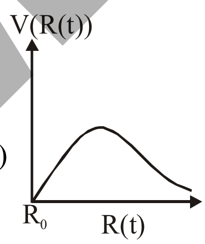
(1) $(q\ell)\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ (2) $\sqrt{3}q\ell\frac{\hat{j}-\hat{i}}{\sqrt{2}}$

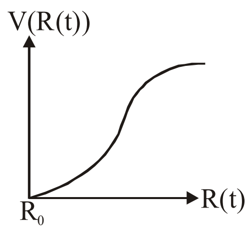
(3) $-\sqrt{3}q\ell\hat{j}$ (4) $2q\ell\hat{j}$

13. There is a uniform spherically symmetric surface charge density at a distance R_0 from the origin. The charge distribution is initially at rest and starts expanding because of mutual repulsion. The figure that represents best the speed V(R(t)) of the distribution as a function of its instantaneous radius R (t) is :

(1) 

(2) 

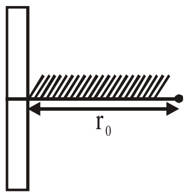
(3) 

(4) 

14. An electric dipole is formed by two equal and opposite charges q with separation d. The charges have same mass m. It is kept in a uniform electric field E. If it is slightly rotated from its equilibrium orientation, then its angular frequency ω is :-

(1) $\sqrt{\frac{qE}{2md}}$ (2) $2\sqrt{\frac{qE}{md}}$ (3) $\sqrt{\frac{2qE}{md}}$ (4) $\sqrt{\frac{qE}{md}}$

15. A positive point charge is released from rest at a distance r_0 from a positive line charge with uniform density. The speed (v) of the point charge, as a function of instantaneous distance r from line charge, is proportional to :-



(1) $v \propto e^{+r/r_0}$

(2) $v \propto \ell n\left(\frac{r}{r_0}\right)$

(3) $v \propto \left(\frac{r}{r_0}\right)$

(4) $v \propto \sqrt{\ell n\left(\frac{r}{r_0}\right)}$

16. The electric field in a region is given by $\vec{E} = (Ax + B)\hat{i}$, where E is in NC^{-1} and x is in metres. The values of constants are A = 20 SI unit and B = 10 SI unit. If the potential at x = 1 is V_1 and that at x = –5 is V_2, then $V_1 - V_2$ is :-

(1) –48 V

(2) –520 V

(3) 180 V

(4) 320 V

17. The bob of a simple pendulum has mass 2g and a charge of 5.0 μC. It is at rest in a uniform horizontal electric field of intensity 2000 V/m. At equilibrium, the angle that the pendulum makes with the vertical is : (take g = 10 m/s^2)

(1) $\tan^{-1}(5.0)$

(2) $\tan^{-1}(2.0)$

(3) $\tan^{-1}(0.5)$

(4) $\tan^{-1}(0.2)$

18. A solid conducting sphere, having a charge Q, is surrounded by an uncharged conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge of –4 Q, the new potential difference between the same two surfaces is :

(1) V (2) 2V

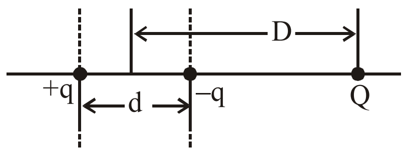
(3) –2V (4) 4V

19. Four point charges –q, +q, +q and –q are placed on y-axis at y = –2d, y = –d, y = +d and y = +2d, respectively. The magnitude of the electric field E at a point on the x-axis at x = D, with D >> d, will behave as :-

(1) $E \propto \frac{1}{D}$ (2) $E \propto \frac{1}{D^3}$

(3) $E \propto \frac{1}{D^2}$ (4) $E \propto \frac{1}{D^4}$

20. A system of three charges are placed as shown in the figure :



If D >> d, the potential energy of the system is best given by :

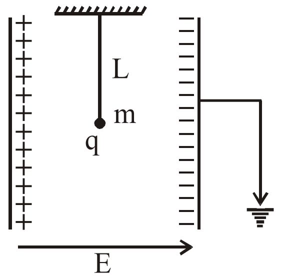
(1) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d} - \frac{qQd}{2D^2}\right]$

(2) $\frac{1}{4\pi\varepsilon_0}\left[+\frac{q^2}{d} + \frac{qQd}{D^2}\right]$

(3) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d} + \frac{2qQd}{D^2}\right]$

(4) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d} - \frac{qQd}{D^2}\right]$

21. A simple pendulum of length L is placed between the plates of a parallel plate capacitor having electric field E, as shown in figure. Its bob has mass m and charge q. The time period of the pendulum is given by :



(1) $2\pi\sqrt{\dfrac{L}{\sqrt{g^2+\left(\dfrac{qE}{m}\right)^2}}}$ (2) $2\pi\sqrt{\dfrac{L}{\left(g+\dfrac{qE}{m}\right)}}$

(3) $2\pi\sqrt{\dfrac{L}{\left(g-\dfrac{qE}{m}\right)}}$ (4) $2\pi\sqrt{\dfrac{L}{\sqrt{g^2-\dfrac{q^2E^2}{m^2}}}}$

22. In free space, a particle A of charge 1 μC is held fixed at a point P. Another particle B of the same charge and mass 4 μg is kept at a distance of 1 mm from P. if B is released, then its velocity at a distance of 9 mm from P is :

$\left[\text{Take } \dfrac{1}{4\pi\varepsilon_0}=9\times10^9\,\text{Nm}^2\,\text{C}^{-2}\right]$

(1) 2.0×10^3 m/s (2) 3.0×10^4 m/s

(3) 1.5×10^2 m/s (4) 1.0 m/s

23. A uniformly charged ring of radius 3a and total charge q is placed in xy-plane centred at origin. A point charge q is moving towards the ring along the z-axis and has speed u at z = 4a. The minimum value of u such that it crosses the origin is :

(1) $\sqrt{\dfrac{2}{m}}\left(\dfrac{1}{15}\dfrac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

(2) $\sqrt{\dfrac{2}{m}}\left(\dfrac{2}{15}\dfrac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

(3) $\sqrt{\dfrac{2}{m}}\left(\dfrac{4}{15}\dfrac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

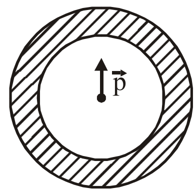
(4) $\sqrt{\dfrac{2}{m}}\left(\dfrac{1}{5}\dfrac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

24. Let a total charge 2Q be distributed in a sphere of radius R, with the charge density given by ρ(r) = kr, where r is the distance from the centre. Two charges A and B, of –Q each, are placed on diametrically opposite points, at equal distance, a, from the centre. If A and B do not experience any force, then :

(1) $a=\dfrac{3R}{2^{1/4}}$ (2) $a=R/\sqrt{3}$

(3) $a = 8^{-1/4}R$ (4) $a = 2^{-1/4}R$

25. Shown in the figure is a shell made of a conductor. It has inner radius a and outer radius b, and carries charge Q. At its centre is a dipole $\vec{p}$ as shown. In this case :



(1) Electric field outside the shell is the same as that of a point charge at the centre of the shell.

(2) Surface charge density on the inner surface of the shell is zero everywhere.

(3) Surface charge density on the inner surface is uniform and equal to $\dfrac{(Q/2)}{4\pi a^2}$.

(4) Surface charge density on the outer surface depends on $|\vec{p}|$

26. A point dipole $\vec{p} = -p_0\hat{x}$ is kept at the origin. The potential and electric field due to this dipole on the y-axis at a distance d are, respectively: (Take V = 0 at infinity) :

(1) $\frac{|\vec{p}|}{4\pi\varepsilon_0 d^2}, \frac{-\vec{p}}{4\pi\varepsilon_0 d^3}$ (2) $0, \frac{\vec{p}}{4\pi\varepsilon_0 d^3}$

(3) $\frac{|\vec{p}|}{4\pi\varepsilon_0 d^2}, \frac{\vec{p}}{4\pi\varepsilon_0 d^3}$ (4) $0, \frac{-\vec{p}}{4\pi\varepsilon_0 d^3}$

EMI & AC

1. A series AC circuit containing an inductor (20 mH), a capacitor (120 μF) and a resistor (60Ω) is driven by an AC source of 24V/50Hz. The energy dissipated in the circuit in 60 s is :

(1) 2.26×10^3 J (2) 3.39×10^3 J

(3) 5.65×10^2 J (4) 5.17×10^2 J

2. A power transmission line feeds input power at 2300 V to a step down transformer with its primary windings having 4000 turns. The output power is delivered at 230 V bv the transformer. If the current in the primary of the transformer is 5A and its efficiency is 90%, the output current would be :

(1) 25 A (2) 50 A

(3) 35 A (4) 45 A

3. The self induced emf of a coil is 25 volts. When the current in it is changed at uniform rate from 10 A to 25 A in 1s, the change in the energy of the inductance is :

(1) 437.5 J (2) 637.5 J

(3) 740 J (4) 540 J

4. A solid metal cube of edge length 2 cm is moving in a positive y direction at a constant speed of 6 m/s. There is a uniform magnetic field of 0.1 T in the positive z-direction. The potential difference between the two faces of the cube perpendicular to the x-axis, is :

(1) 6 mV (2) 1 mV (3) 12 mV (4) 2 mV

5. A copper wire is wound on a wooden frame, whose shape is that of an equilateral triangle. If the linear dimension of each side of the frame is increased by a factor of 3, keeping the number of turns of the coil per unit length of the frame the same, then the self inductance of the coil :

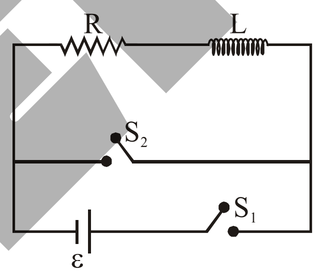
(1) Decreases by a factor of $9\sqrt{3}$

(2) Increases by a factor of 3

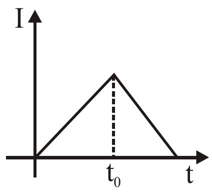
(3) Decreases by a factor of 9

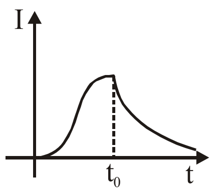
(4) Increases by a factor of 27

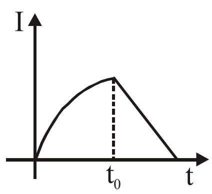
6. In the circuit shown,

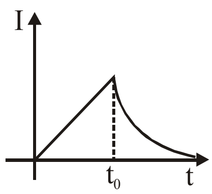


the switch S_1 is closed at time t = 0 and the switch S_2 is kept open. At some later time (t_0), the switch S_1 is opened and S_2 is closed. The behavious of the current I as a function of time 't' is given by :

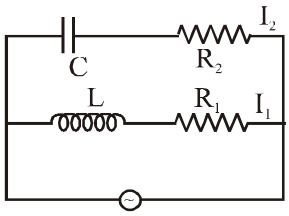
(1) 

(2) 

(3) 

(4) 

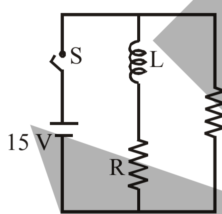
7.



In the above circuit, $C=\frac{\sqrt{3}}{2}\mu F$, $R_2 = 20\Omega$, $L=\frac{\sqrt{3}}{10}$ H and $R_1 = 10\Omega$. Current in L-R_1 path is I_1 and in C-R_2 path it is I_2. The voltage of A.C source is given by $V=200\sqrt{2}\sin(100t)$ volts. The phase difference between I_1 and I_2 is :

(1) 30° (2) 0° (3) 90° (4) 60°

8. In the figure shown, a circuit contains two identical resistors with resistance R = 5Ω and an inductance with L = 2mH. An ideal battery of 15 V is connected in the circuit. What will be the current through the battery long after the switch is closed?



(1) 6A (2) 7.5A (3) 5.5A (4) 3A

9. A circuit connected to an ac source of emf $e = e_0\sin(100t)$ with t in seconds, gives a phase difference of $\frac{\pi}{4}$ between the emf e and current i. Which of the following circuits will exhibit this ?

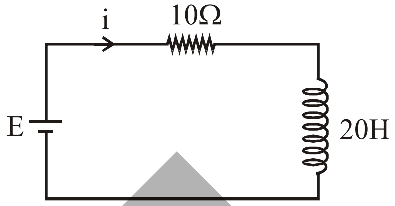
(1) RC circuit with R = 1 kΩ and C = 1μF

(2) RL circuit with R = 1kΩ and L = 1mH

(3) RL circuit with R = 1 kΩ and L = 10 mH

(4) RC circuit with R = 1kΩ and C = 10 μF

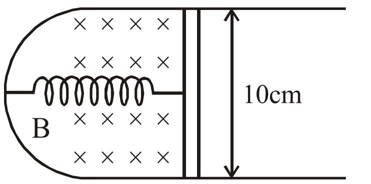
10. A 20 Henry inductor coil is connected to a 10 ohm resistance in series as shown in figure. The time at which rate of dissipation of energy (joule's heat) across resistance is equal to the rate at which magnetic energy is stored in the inductor is :



(1) $\frac{2}{\ell n2}$ (2) $\ell n2$

(3) $2\ell n2$ (4) $\frac{1}{2}\ell n2$

11. A thin strip 10 cm long is on a U shaped wire of negligible resistance and it is connected to a spring of spring constant 0.5 Nm^{-1} (see figure). The assembly is kept in a uniform magnetic field of 0.1 T. If the strip is pulled from its equilibrium position and released, the number of oscillation it performs before its amplitude decreases by a factor of e is N. If the mass of the strip is 50 grams, its resistance 10Ω and air drag negligible, N will be close to :



(1) 50000 (2) 5000

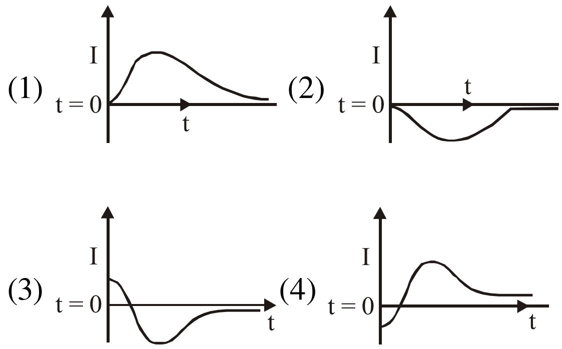
(3) 10000 (4) 1000

12. An alternating voltage v(t) = 220 sin 100 πt volt is applied to a purely resistance load of 50 Ω. The time taken for the current to rise from half of the peak value to the peak value is :

(1) 2.2 ms (2) 5 ms

(3) 3.3 ms (4) 7.2 ms

13. A very long solenoid of radius R is carrying current $I(t) = kte^{-\alpha t}(k > 0)$, as a function of time $(t \geq 0)$. counter clockwise current is taken to be positive. A circular conducting coil of radius 2R is placed in the equatorial plane of the solenoid and concentric with the solenoid. The current induced in the outer coil is correctly depicted, as a function of time, by :-



14. The total number of turns and cross-section area in a solenoid is fixed. However, its length L is varied by adjusting the separation between windings. The inductance of solenoid will be proportional to :

(1) $1/L^2$ (2) $1/L$

(3) L (4) L^2

15. A coil of self inductance 10 mH and resistance 0.1 Ω is connected through a switch to a battery of internal resistance 0.9 Ω. After the switch is closed, the time taken for the current to attain 80% of the saturation value is : (Take $ln5 = 1.6$)

(1) 0.103 s (2) 0.016 s

(3) 0.002 s (4) 0.324 s

16. A transformer consisting of 300 turns in the primary and 150 turns in the secondary gives output power of 2.2 kW. If the current in the secondary coil is 10A, then the input voltage and current in the primary coil are :

(1) 220 V and 10A

(2) 440 V and 5A

(3) 440 V and 20 A

(4) 220 V and 20 A

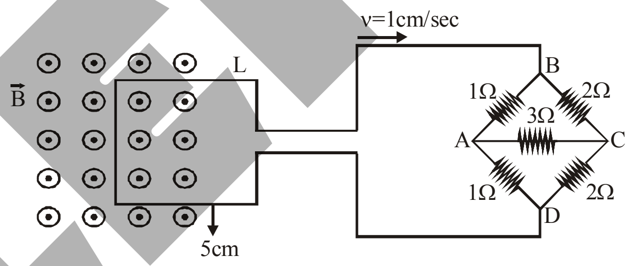
17. The displacement of a damped harmonic oscillator is given by

$x(t) = e^{-0.1t}\cos(10\pi t + \phi)$. Here t is in seconds.

The time taken for its amplitude of vibration to drop to half of its initial value is close to :

(1) 13 s (2) 7 s (3) 27 s (4) 4 s

18. The figure shows a square loop L of side 5 cm which is connected to a network of resistances. The whole setup is moving towards right with a constant speed of 1 cms^{-1}. At some instant, a part of L is in a uniform magnetic field of 1T, perpendicular to the plane of the loop. If the resistance of L is 1.7 Ω, the current in the loop at that instant will be close to :



(1) 115 μA (2) 170 μA

(3) 60 μA (4) 150 μA

EMW

1. The energy associated with electric field is (U_E) and with magnetic field is (U_B) for an electromagnetic wave in free space. Then :

(1) $U_E = \frac{U_B}{2}$ (2) $U_E < U_B$

(3) $U_E = U_B$ (4) $U_E > U_B$

2. A plane electromagnetic wave of frequency 50 MHz travels in free space along the positive x-direction. At a particular point in space and time, $\vec{E} = 6.3\hat{j}\,V/m$. The corresponding magnetic field $\vec{B}$, at that point will be:

(1) $18.9\times10^{-8}\hat{k}T$ (2) $6.3\times10^{-8}\hat{k}T$

(3) $2.1\times10^{-8}\hat{k}T$ (4) $18.9\times10^{8}\hat{k}T$

3. A conducting circular loop made of a thin wire, has area 3.5×10^{-3} m^2 and resistance 10Ω. It is placed perpendicular to a time dependent magnetic field $B(t) = (0.4T)\sin(50\pi t)$. The field is uniform in space. Then the net charge flowing through the loop during t = 0 s and t = 10 ms is close to :

(1) 14mC (2) 21 mC

(3) 6 mC (4) 7 mC

4. The electric field of a plane polarized electromagnetic wave in free space at time t= 0 is given by an expression

$\vec{E}(x,y) = 10\hat{j}\ \cos[(6x + 8z)]$

The magnetic field $\vec{B}$ (x, z, t) is given by : (c is the velocity of light)

(1) $\frac{1}{c}(6\hat{k}+8\hat{i})\cos[(6x-8z+10ct)]$

(2) $\frac{1}{c}(6\hat{k}-8\hat{i})\cos[(6x+8z-10ct)]$

(3) $\frac{1}{c}(6\hat{k}+8\hat{i})\cos[(6x+8z-10ct)]$

(4) $\frac{1}{c}(6\hat{k}-8\hat{i})\cos[(6x+8z+10ct)]$

5. If the magnetic field of a plane electromagnetic wave is given by (The speed of light = 3×10^8/m/s)

$B = 100 \times 10^{-6} \sin\left[2\pi\times 2\times 10^{15}\left(t-\frac{x}{c}\right)\right]$ then

the maximum electric field associated with it is :

(1) 4×10^4 N/C

(2) 4.5×10^4 N/C

(3) 6×10^4 N/C

(4) 3×10^4 N/C

6. A 27 mW laser beam has a cross-sectional area of 10 mm^2. The magnitude of the maximum electric field in this electromagnetic wave is given by [Given permittivity of space $\in_0 = 9 \times 10^{-12}$ SI units, Speed of light $c = 3 \times 10^8$ m/s]:-

(1) 1 kV/m (2) 2 kV/m

(3) 1.4 kV/m (4) 0.7 kV/m

7. An electromagnetic wave of intensity 50 Wm^{-2} enters in a medium of refractive index 'n' without any loss. The ratio of the magnitudes of electrric fields, and the ratio of the magnitudes of magnetic fields of the wave before and after entering into the medium are respectively, given by :

(1) $\left(\frac{1}{\sqrt{n}},\frac{1}{\sqrt{n}}\right)$ (2) $\left(\sqrt{n},\frac{1}{\sqrt{n}}\right)$

(3) $\left(\sqrt{n},\sqrt{n}\right)$ (4) $\left(\frac{1}{\sqrt{n}},\sqrt{n}\right)$

8. The mean intensity of radiation on the surface of the Sun is about 10^8 W/m^2. The rms value of the corresponding magnetic field is closest to :

(1) 10^2T (2) 10^{-4}T (3) 1T (4) 10^{-2}T

9. The magnetic field of an electromagnetic wave is given by :-

$$\vec{B} = 1.6\times 10^{-6}\cos(2\times 10^7 z + 6\times 10^{15} t)(2\hat{i}+\hat{j})\frac{Wb}{m^2}$$

The associated electric field will be :-

(1) $\vec{E} = 4.8\times 10^2\cos(2\times 10^7 z + 6\times 10^{15} t)(\hat{i}-2\hat{j})\frac{V}{m}$

(2) $\vec{E} = 4.8\times 10^2\cos(2\times 10^7 z - 6\times 10^{15} t)(2\hat{i}+\hat{j})\frac{V}{m}$

(3) $\vec{E} = 4.8\times 10^2\cos(2\times 10^7 z - 6\times 10^{15} t)(-2\hat{j}+\hat{i})\frac{V}{m}$

(4) $\vec{E} = 4.8\times 10^2\cos(2\times 10^7 z + 6\times 10^{15} t)(-\hat{i}+2\hat{j})\frac{V}{m}$

10. A plane electromagnetic wave travels in free space along the x-direction. The electric field component of the wave at a particular point of space and time is $E = 6\ V\ m^{-1}$ along y-direction. Its corresponding magnetic field component, B would be :

(1) 6×10^{-8} T along z-direction

(2) 6×10^{-8} T along x-direction

(3) 2×10^{-8} T along z-direction

(4) 2×10^{-8} T along y-direction

11. The magnetic field of a plane electromagnetic wave is given by :

$\vec{B} = B_0\hat{i}[\cos(kz - \omega t)] + B_1\hat{j}\cos(kz + \omega t)$ where $B_0 = 3 \times 10^{-5}$ T and $B_1 = 2 \times 10^{-6}$ T. The rms value of the force experienced by a stationary charge $Q = 10^{-4}$ C at z = 0 is closest to :

(1) 0.9 N (2) 0.1 N

(3) 3×10^{-2} N (4) 0.6 N

12. The electric field of a plane electromagnetic wave is given by

$\vec{E} = E_0\hat{i}\cos(kz)\cos(\omega t)$

The corresponding magnetic field $\vec{B}$ is then given by :

(1) $\vec{B} = \frac{E_0}{C}\hat{j}\sin(kz)\cos(\omega t)$

(2) $\vec{B} = \frac{E_0}{C}\hat{j}\sin(kz)\sin(\omega t)$

(3) $\vec{B} = \frac{E_0}{C}\hat{k}\sin(kz)\cos(\omega t)$

(4) $\vec{B} = \frac{E_0}{C}\hat{j}\cos(kz)\sin(\omega t)$

13. A plane electromagnetic wave having a frequency $\nu = 23.9$ GHz propagates along the positive z-direction in free space. The peak value of the electric field is 60 V/m. Which among the following is the acceptable magnetic field component in the electromagnetic wave ?

(1) $\vec{B} = 2\times10^{7}\sin(0.5\times10^{3}z + 1.5\times10^{11}t)\hat{i}$

(2) $\vec{B} = 2\times10^{-7}\sin(1.5\times10^{2}x + 0.5\times10^{11}t)\hat{j}$

(3) $\vec{B} = 2\times10^{-7}\sin(0.5\times10^{3}z - 1.5\times10^{11}t)\hat{i}$

(4) $\vec{B} = 60\sin(0.5\times10^{3}x + 1.5\times10^{11}t)\hat{k}$

14. An electromagnetic wave is represented by the electric field

$\vec{E} = E_0\hat{n}\sin[\omega t + (6y - 8z)]$. Taking unit vectors in x, y and z directions to be $\hat{i}, \hat{j}, \hat{k}$, the direction of propogation $\hat{s}$, is :

(1) $\hat{s} = \frac{4\hat{j} - 3\hat{k}}{5}$ (2) $\hat{s} = \frac{3\hat{i} - 4\hat{j}}{5}$

(3) $\hat{s} = \left(\frac{-3\hat{j} + 4\hat{k}}{5}\right)$ (4) $\hat{s} = \frac{-4\hat{k} + 3\hat{j}}{5}$

ERROR & MEASUREMENT

1. The pitch and the number of divisions, on the circular scale, for a given screw gauge are 0.5 mm and 100 respectively. When the screw gauge is fully tightened without any object, the zero of its circular scale lies 3 divisions below the mean line.

The readings of the main scale and the circular scale, for a thin sheet, are 5.5 mm and 48 respectively, the thickness of this sheet is :

(1) 5.755 m (2) 5.725 mm

(3) 5.740 m (4) 5.950 mm

2. The diameter and height of a cylinder are measured by a meter scale to be 12.6 ± 0.1 cm and 34.2 ± 0.1 cm, respectively. What will be the value of its volume in appropriate significant figures ?

(1) 4260 ± 80 cm^3

(2) 4300 ± 80 cm^3

(3) 4264.4 ± 81.0 cm^3

(4) 4264 ± 81 cm^3

3. The least count of the main scale of a screw gauge is 1 mm. The minimum number of divisions on its circular scale required to measure 5μm diameter of wire is :

(1) 50 (2) 100 (3) 200 (4) 500

4. In a simple pendulum experiment for determination of acceleration due to gravity (g), time taken for 20 oscillations is measured by using a watch of 1 second least count. The mean value of time taken comes out to be 30 s. The length of pendulum is measured by using a meter scale of least count 1 mm and the value obtained is 55.0 cm. The percentage error in the determination of g is close to :-

(1) 0.7% (2) 0.2%

(3) 3.5% (4) 6.8%

5. The area of a square is 5.29 cm^2. The area of 7 such squares taking into account the significant figures is :-

(1) 37 cm^2 (2) 37.0 cm^2

(3) 37.03 cm^2 (4) 37.030 cm^2

6. In the density measurement of a cube, the mass and edge length are measured as (10.00 ± 0.10) kg and (0.10 ± 0.01) m, respectively. The error in the measurement of density is :

(1) 0.10 kg/m^3 (2) 0.31 kg/m^3

(3) 0.07 kg/m^3 (4) 0.01 kg/m^3

FLUIDS MECHANICS

1. The top of a water tank is open to air and its water level is maintained. It is giving out 0.74 m^3 water per minute through a circular opening of 2 cm radius in its wall. The depth of the centre of the opening from the level of water in the tank is close to :

(1) 9.6 m (2) 4.8 m

(3) 2.9 m (4) 6.0 m

2. A cylindrical plastic bottle of negligible mass is filled with 310 ml of water and left floating in a pond with still water. If pressed downward slightly and released, it starts performing simple harmonic motion at angular frequency ω. If the radius of the bottle is 2.5 cm then ω close to : (density of water = 10^3 kg / m^3)

(1) 5.00 rad s^{-1}

(2) 1.25 rad s^{-1}

(3) 3.75 rad s^{-1}

(4) 2.50 rad s^{-1}

3. Water flows into a large tank with flat bottom at the rate of 10^{-4} m^3s^{-1}. Water is also leaking out of a hole of area 1 cm^2 at its bottom. If the height of the water in the tank remains steady, then this height is:

(1) 4 cm (2) 2.9 cm

(3) 1.7 cm (4) 5.1 cm

4. A liquid of density ρ is coming out of a hose pipe of radius a with horizontal speed v and hits a mesh. 50% of the liquid passes through the mesh unaffected. 25% looses all of its momentum and 25% comes back with the same speed. The resultant pressure on the mesh will be :

(1) ρv^2 (2) $\frac{3}{4}\rho v^2$

(3) $\frac{1}{2}\rho v^2$ (4) $\frac{1}{4}\rho v^2$

5. A load of mass M kg is suspended from a steel wire of length 2 m and radius 1.0 mm in Searle's apparatus experiment. The increase in length produced in the wire is 4.0 mm. Now the load is fully immersed in a liquid of relative density 2. The relative density of the material of load is 8. The new value of increase in length of the steel wire is :

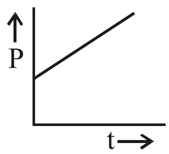
(1) 4.0mm (2) 3.0mm

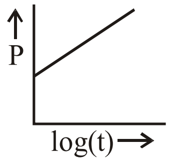
(3) 5.0mm (4) zero

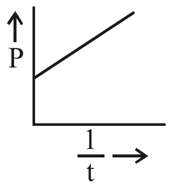
6. A long cylindrical vessel is half filled with a liquid. When the vessel is rotated about its own vertical axis, the liquid rises up near the wall. If the radius of vessel is 5 cm and its rotational speed is 2 rotations per second, then the difference in the heights between the centre and the sides, in cm, will be:

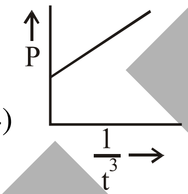
(1) 1.2 (2) 0.1 (3) 2.0 (4) 0.4

7. A soap bubble, blown by a mechanical pump at the mouth of a tube, increases in volume, with time, at a constant rate. The graph that correctly depicts the time dependence of pressure inside the bubble is given by :-

(1) 

(2) 

(3) 

(4) 

8. Water from a pipe is coming at a rate of 100 litres per minute. If the radius of the pipe is 5 cm, the Reynolds number for the flow is of the order of : (density of water = 1000 kg/m^3, coefficient of viscosity of water = 1mPas)

(1) 10^6 (2) 10^3
(3) 10^4 (4) 10^2

9. A wooden block floating in a bucket of water has $\frac{4}{5}$ of its volume submerged. When certain amount of an oil is poured into the bucket, it is found that the block is just under the oil surface with half of its volume under water and half in oil. The density of oil relative to that of water is :-

(1) 0.5 (2) 0.7 (3) 0.6 (4) 0.8

10. If 'M' is the mass of water that rises in a capillary tube of radius 'r', then mass of water which will rise in a capillary tube of radius '2r' is :

(1) 4M (2) M (3) 2M (4) $\frac{M}{2}$

11. A submarine experiences a pressure of 5.05×10^6 Pa at a depth of d_1 in a sea. When it goes further to a depth of d_2, it experiences a pressure of 8.08×10^6 Pa., Then $d_2 - d_1$ is approximately (density of water = 10^3 kg/m^3 and acceleration due to gravity = 10 ms^{-2})

(1) 500 m (2) 400 m
(3) 300 m (4) 600 m

12. Water from a tap emerges vertically downwards with an initial speed of 1.0 ms^{-1}. The cross-sectional area of the tap is 10^{-4} m^2. Assume that the pressure is constant throughout the stream of water and that the flow is streamlined. The cross-sectional area of the stream, 0.15 m below the tap would be: (Take g = 10 ms^{-2})

(1) 1×10^{-5} m^2 (2) 5×10^{-5} m^2
(3) 2×10^{-5} m^2 (4) 5×10^{-4} m^2

13. A cubical block of side 0.5 m floats on water with 30% of its volume under water. What is the maximum weight that can be put on the block without fully submerging it under water? (Take density of water = 10^3 kg/m^3)

(1) 65.4 kg (2) 87.5 kg
(3) 30.1 kg (4) 46.3 kg

14. The radtio of surface tensions of mercury and water is given to be 7.5 while the ratio of thier densities is 13.6. Their contact angles, with glass, are close to 135° and 0°, respectively. It is observed that mercury gets depressed by an amount h in a capillary tube of radius r_1, while water rises by the same amount h in a capillary tube of radius r_2. The ratio, (r_1/r_2), is then close to :

(1) 2/3 (2) 3/5
(3) 2/5 (4) 4/5

15. A solid sphere, of radius R acquires a terminal velocity v_1 when falling (due to gravity) through a viscous fluid having a coefficient of viscosity η. The sphere is broken into 27 identical solid spheres. If each of these spheres acquires a terminal velocity, v_2, when falling through the same fluid, the ratio (v_1/v_2) equals:
(1) 1/27 (2) 1/9 (3) 27 (4) 9

GEOMETRICAL OPTICS

1. Two plane mirrors arc inclined to each other such that a ray of light incident on the first mirror (M_1) and parallel to the second mirror (M_2) is finally reflected from the second mirror (M_2) parallel to the first mirror (M_1). The angle between the two mirrors will be :
(1) 90° (2) 45° (3) 75° (4) 60°

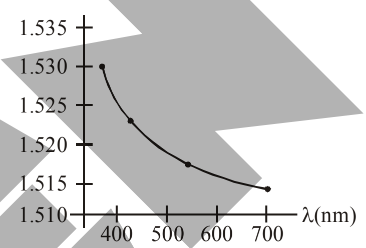
2. A convex lens is put 10 cm from a light source and it makes a sharp image on a screen, kept 10 cm from the lens. Now a glass block (refractive index 1.5) of 1.5 cm thickness is placed in contact with the light source. To get the sharp image again, the screen is shifted by a distance d. Then d is :
(1) 0.55 cm away from the lens
(2) 1.1 cm away from the lens
(3) 0.55 cm towards the lens
(4) 0

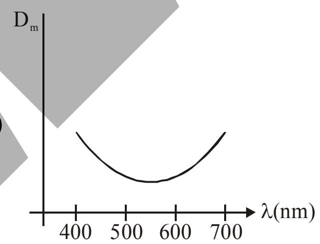
3. The eye can be regarded as a single refracting surface . The radius of curvature of this surface is equal to that of cornea (7.8 mm). This surface separates two media of refractive indices 1 and 1.34. Calculate the distance from the refracting surface at which a parallel beam of light will come to focus.
(1) 2 cm (2) 1 cm
(3) 3.1 cm (4) 4.0 cm

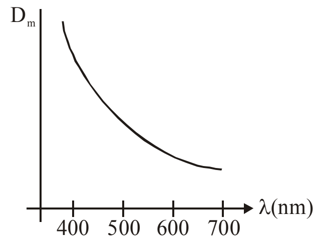
4. A plano convex lens of refractive index μ_1 and focal length f_1 is kept in contact with another plano concave lens of refractive index μ_2 and focal length f_2. If the radius of curvature of their spherical faces is R each and $f_1 = 2f_2$, then μ_1 and μ_2 are related as :
(1) $\mu_1 + \mu_2 = 3$ (2) $2\mu_1 - \mu_2 = 1$
(3) $2\mu_2 - \mu_1 = 1$ (4) $3\mu_2 - 2\mu_1 = 1$

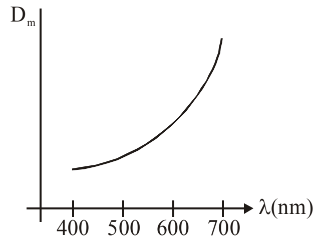
5. A monochromatic light is incident at a certain angle on an equilateral triangular prism and suffers minimum deviation. If the refractive index of the material of the prism is $\sqrt{3}$, then the angle of incidence is :-
(1) 30° (2) 45° (3) 90° (4) 60°

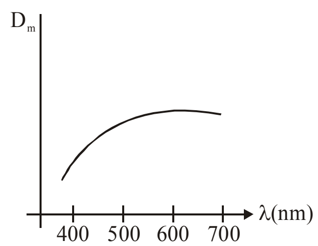
6. The variation of refractive index of a crown glass thin prism with wavelength of the incident light is shown. Which of the following graphs is the correct one, if D_m is the angle of minimum deviation?



(1)


(2)


(3)


(4)


7. An object is at a distacen of 20 m from a convex lens of focal length 0.3 m. The lens forms an image of the object. If the object moves away from the lens at a speed of 5 m/s, the speed and direction of the image will be :

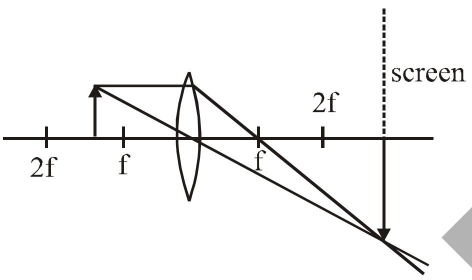
(1) 0.92×10^{-3} m/s away from the lens

(2) 2.26×10^{-3} m/s away from the lens

(3) 1.16×10^{-3} m/s towards the lens

(4) 3.22×10^{-3} m/s towards the lens

8. Formation of real image using a biconvex lens is shown below :



If the whole set up is immersed in water without disturbing the object and the screen position, what will one observe on the screen ?

(1) Image disappears

(2) No change

(3) Erect real image

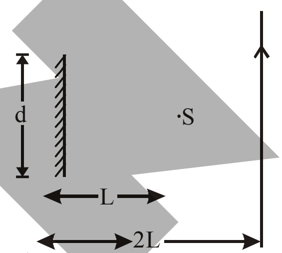
(4) Magnified image

9. A plano-convex lens (focal length f_2, refractive index μ_2, radius of curvature R) fits exactly into a plano-concave lens (focal length f_1, refractive index μ_1, radius of curvature R). Their plane surfaces are parallel to each other. Then, the focal length of the combination will be :

(1) $f_1 - f_2$ (2) $f_1 + f_2$

(3) $\dfrac{R}{\mu_2 - \mu_1}$ (4) $\dfrac{2f_1f_2}{f_1 + f_2}$

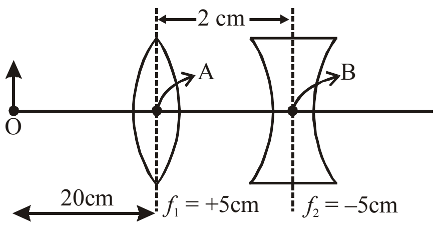
10. A point source of light, S is placed at a distance L in front of the centre of plane mirror of width d which is hanging vertically on a wall. A man walks in front of the mirror along a line parallel to the mirror, at a distance 2L as shown below. The distance over which the man can see the image of the light source in the mirror is :



(1) 3d (2) $\dfrac{d}{2}$

(3) d (4) 2d

11. What is the position and nature of image formed by lens combination shown in figure? (f_1, f_2 are focal lengths)



(1) 70 cm from point B at left; virtual

(2) 40 cm from point B at right; real

(3) $\dfrac{20}{3}$ cm from point B at right , real

(4) 70 cm from point B at right, real

12. A convex lens (of focal length 20 cm) and a concave mirror, having their principal axes along the same lines, are kept 80 cm apart from each other. The concave mirror is to the right of the convex lens. When an object is kept at a distance of 30 cm to the left of the convex lens, its image remains at the same position even if the concave mirror is removed. The maximum distance of the object for which this concave mirror, by itself would produce a virtual image would be :-

(1) 20 cm (2) 10 cm (3) 25 cm (4) 30 cm

13. An upright object is placed at a distance of 40 cm in front of a convergent lens of focal length 20 cm. A convergent mirror of focal length 10 cm is placed at a distance of 60 cm on the other side of the lens. The position and size of the final image will be :

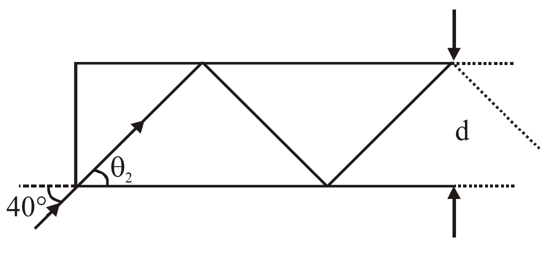
(1) 40 cm from the convergent mirror, same size as the object

(2) 20 cm from the convergent mirror, same size as the object

(3) 20 cm from the convergent mirror, twice the size of the object

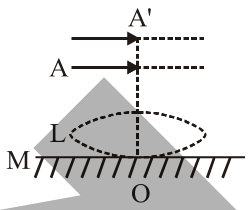
(4) 40 cm from the convergent lens, twice the size of the object

14. In figure, the optical fiber is $\ell = 2$m long and has a diameter of d = 20 μm. If a ray of light is incident on one end of the fiber at angle $\theta_1 = 40°$, the number of reflection it makes before emerging from the other end is close to: (refractive index of fibre is 1.31 and sin 40° = 0.64)



(1) 55000 (2) 57000
(3) 66000 (4) 45000

15. A thin convex lens L (refractive index = 1.5) is placed on a plane mirror M. When a pin is placed at A, such that OA = 18 cm, its real inverted image is formed at A itself, as shown in figure. When a liquid of refractive index μ_1 is put between the lens and the mirror, The pin has to be moved to A', such that OA' = 27 cm, to get its inverted real image at A' itself. The value of μ_1 will be :-



(1) $\sqrt{2}$ (2) $\frac{4}{3}$ (3) $\sqrt{3}$ (4) $\frac{3}{2}$

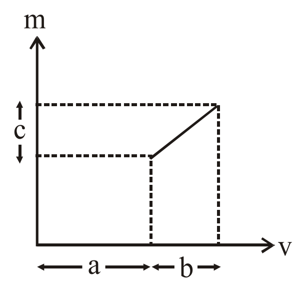
16. A convex lens of focal length 20 cm produces images of the same magnification 2 when an object is kept at two distances x_1 and x_2 ($x_1 > x_2$) from the lens. The ratio of x_1 and x_2 is:-

(1) 5 : 3 (2) 2 : 1
(3) 4 : 3 (4) 3 : 1

17. A concave mirror for face viewing has focal length of 0.4 m. The distance at which you hold the mirror from your face in order to see your image upright with a magnification of 5 is :

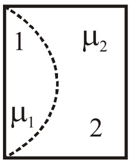
(1) 1.60 m (2) 0.24 m
(3) 0.16 m (4) 0.32 m

18. The graph shows how the magnification m produced by a thin lens varies with image distance v. What is the focal length of the lens used ?



(1) $\frac{b^2c}{a}$ (2) $\frac{b^2}{ac}$ (3) $\frac{a}{c}$ (4) $\frac{b}{c}$

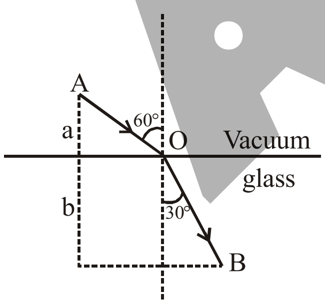
19. One plano-convex and one plano-concave lens of same radius of curvature 'R' but of different materials are joined side by side as shown in the figure. If the refractive index of the material of 1 is μ_1 and that of 2 is μ_2, then the focal length of the combination is :



(1) $\frac{R}{2-(\mu_1-\mu_2)}$ (2) $\frac{2R}{\mu_1-\mu_2}$

(3) $\frac{R}{2(\mu_1-\mu_2)}$ (4) $\frac{R}{\mu_1-\mu_2}$

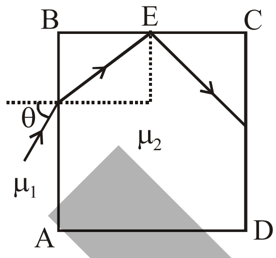
20. A ray of light AO in vacuum is incident on a glass slab at angle 60° and refracted at angle 30° along OB as shown in the figure. The optical path length of light ray from A to B is:



(1) 2a + 2b (2) $2a+\frac{2b}{3}$

(3) $\frac{2\sqrt{3}}{a}+2b$ (4) $2a+\frac{2b}{\sqrt{3}}$

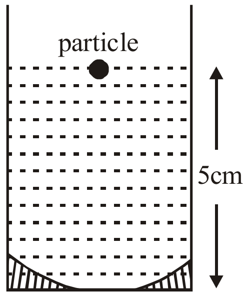
21. A transparent cube of side d, made of a material of refractive index μ_2, is immersed in a liquid of refractive index $\mu_1(\mu_1 < \mu_2)$. A ray is incident on the face AB at an angle θ(shown in the figure). Total internal reflection takes place at point E on the face BC. The θ must satisfy :



(1) $\theta < \sin^{-1}\frac{\mu_1}{\mu_2}$ (2) $\theta < \sin^{-1}\sqrt{\frac{\mu_2^2}{\mu_1^2}-1}$

(3) $\theta > \sin^{-1}\frac{\mu_1}{\mu_2}$ (4) $\theta > \sin^{-1}\sqrt{\frac{\mu_2^2}{\mu_1^2}-1}$

22. A concave mirror has radius of curvature of 40 cm. It is at the bottom of a glass that has water filled up to 5 cm (see figure). If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d is close to : (Refractive index of water = 1.33)



(1) 8.8 cm (2) 11.7 cm

(3) 6.7 cm (4) 13.4 cm

GRAVITATION

1. The energy required to take a satellite to a height 'h' above Earth surface (radius of Earth $= 6.4 \times 10^3$ km) is E_1 and kinetic energy required for the satellite to be in a circular orbit at this height is E_2. The value of h for which E_1 and E_2 are equal, is:

(1) 1.28×10^4 km (2) 6.4×10^3 km

(3) 3.2×10^3 km (4) 1.6×10^3 km

2. If the angular momentum of a planet of mass m, moving around the Sun in a circular orbit is L, about the center of the Sun, its areal velocity is :

(1) $\frac{4L}{m}$ (2) $\frac{L}{m}$ (3) $\frac{L}{2m}$ (4) $\frac{2L}{m}$

3. Two stars of masses 3×10^{31} kg each, and at distance 2×10^{11}m rotate in a plane about their common centre of mass O. A meteorite passes through O moving perpendicular to the star's rotation plane. In order to escape from the gravitational field of this double star, the minimum speed that meteorite should have at O is : (Take Gravitational constant $G = 6.67 \times 10^{-11}$ Nm^2 kg^{-2})

(1) 1.4×10^5 m/s

(2) 24×10^4 m/s

(3) 3.8×10^4 m/s

(4) 2.8×10^5 m/s

4. A satellite is moving with a constant speed v in circular orbit around the earth. An object of mass 'm' is ejected from the satellite such that it just escapes from the gravitational pull of the earth. At the time of ejection, the kinetic energy of the object is :

(1) $\frac{3}{2}mv^2$ (2) mv^2

(3) $2mv^2$ (4) $\frac{1}{2}mv^2$

5. The mass and the diameter of a planet are three times the respective values for the Earth. The period of oscillation of a simple pendulum on the Earth is 2s. The period of oscillation of the same pendulum on the planet would be :-

(1) $\frac{2}{\sqrt{3}}$s (2) $2\sqrt{3}$ s

(3) $\frac{\sqrt{3}}{2}$s (4) $\frac{3}{2}$s

6. A satellite is revolving in a circular orbit at a height h from the earth surface, such that h << R where R is the radius of the earth. Assuming that the effect of earth's atmosphere can be neglected the minimum increase in the speed requried so that the satellite could escapte from the gravitational field of earth is:

(1) $\sqrt{gR}\left(\sqrt{2}-1\right)$ (2) $\sqrt{2gR}$

(3) $\sqrt{gR}$ (4) $\sqrt{\frac{gR}{2}}$

7. Two satellites, A and B, have masses m and 2m respectively. A is in a circular orbit of radius R, and B is in a circular orbit of radius 2R around the earth. The ratio of their kinetic energies, T_A/T_B, is:

(1) 2 (2) $\sqrt{\frac{1}{2}}$ (3) 1 (4) $\frac{1}{2}$

8. A straight rod of length L extends from x = a to x=L + a. The gravitational force is exerts on a point mass 'm' at x = 0, if the mass per unit length of the rod is $A + Bx^2$, is given by:

(1) $Gm\left[A\left(\frac{1}{a+L}-\frac{1}{a}\right)-BL\right]$

(2) $Gm\left[A\left(\frac{1}{a}-\frac{1}{a+L}\right)+BL\right]$

(3) $Gm\left[A\left(\frac{1}{a+L}-\frac{1}{a}\right)+BL\right]$

(4) $Gm\left[A\left(\frac{1}{a}-\frac{1}{a+L}\right)-BL\right]$

9. A satellite of mass M is in a circular orbit of radius R about the centre of the earth. A meteorite of the same mass, falling towards the earth, collides with the satellite completely inelastically. The speeds of the satellite and the meteorite are the same, just before the collision. The subsequent motion of the combined body will be :

(1) in a circular orbit of a different radius

(2) in the same circular orbit of radius R

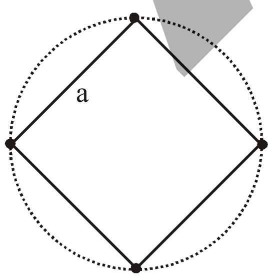
(3) in an elliptical orbit

(4) such that it escapes to infinity

10. A rocket has to be launched from earth in such a way that it never returns. If E is the minimum energy delivered by the rocket launcher, what should be the minimum energy that the launcher should have if the same rocket is to be launched from the surface of the moon ? Assume that the density of the earth and the moon are equal and that the earth's volume is 64 times the volume of the moon :-

(1) $\frac{E}{4}$ (2) $\frac{E}{16}$ (3) $\frac{E}{32}$ (4) $\frac{E}{64}$

11. Four identical particles of mass M are located at the corners of a square of side 'a'. What should be their speed if each of them revolves under the influence of other's gravitational field in a circular orbit circumscribing the square?



(1) $1.21\sqrt{\frac{GM}{a}}$ (2) $1.41\sqrt{\frac{GM}{a}}$

(3) $1.16\sqrt{\frac{GM}{a}}$ (4) $1.35\sqrt{\frac{GM}{a}}$

12. A test particle is moving in a circular orbit in the gravitational field produced by a mass density $\rho(r) = \frac{K}{r^2}$. Identify the correct relation between the radius R of the particle's orbit and its period T :

(1) T/R^2 is a constant

(2) TR is a constant

(3) T^2/R^3 is a constant

(4) T/R is a constant

13. A solid sphere of mass 'M' and radius 'a' is surrounded by a uniform concentric spherical shell of thickness 2a and mass 2M. The gravitational field at distance '3a' from the centre will be :

(1) $\frac{2GM}{9a^2}$ (2) $\frac{GM}{3a^2}$

(3) $\frac{GM}{9a^2}$ (4) $\frac{2GM}{3a^2}$

14. A spaceship orbits around a planet at a height of 20 km from its surface. Assuming that only gravitational field of the planet acts on the spaceship, what will be the number of complete revolutions made by the spaceship in 24 hours around the planet ?

[Given : Mass of planet = 8×10^{22} kg ;

Radius of planet = 2×10^6 m,

Gravitational constant $G = 6.67 \times 10^{-11}$ Nm^2/kg^2]

(1) 9 (2) 11 (3) 13 (4) 17

15. The value of acceleration due to gravity at Earth's surface is 9.8 ms^{-2}. The altitude above its surface at which the acceleration due to gravity decreases to 4.9 ms^{-2}, is close to : (Radius of earth = 6.4×10^6 m)

(1) 1.6×10^6 m (2) 6.4×10^6 m

(3) 9.0×10^6 m (4) 2.6×10^6 m

16. The ratio of the weights of a body on the Earth's surface to that on the surface of a planet is 9 : 4. The mass of the planet is $\frac{1}{9}$th of that of the Earth. If 'R' is the radius of the Earth, what is the radius of the planet ? (Take the planets to have the same mass density)

(1) $\frac{R}{3}$ (2) $\frac{R}{2}$

(3) $\frac{R}{4}$ (4) $\frac{R}{9}$

HEAT & THERMODYNAMICS

1. A 15 g mass of nitrogen gas is enclosed in a vessel at a temperature 27°C. Amount of heat transferred to the gas, so that rms velocity of molecules is doubled, is about :

[Take R = 8.3 J/ K mole]

(1) 10 kJ

(2) 0.9 kJ

(3) 6 kJ

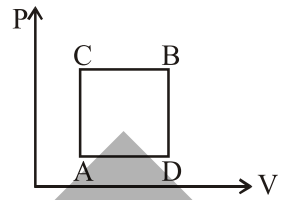
(4) 14 kJ

2. Two Carrnot engines A and B are operated in series. The first one, A, receives heat at T_1(= 600 K) and rejects to a reservoir at temperature T_2. The second engine B receives heat rejected by the first engine and, in turn, rejects to a heat reservoir at T_3(= 400 K). Calculate the temperature T_2 if the work outputs of the two engines are equal :

(1) 400 K (2) 600 K

(3) 500 K (4) 300 K

3. A gas can be taken from A to B via two different processes ACB and ADB. When path ACB is used 60 J of heat flows into the system and 30 J of work is done by the system. If path ADB is used work done by the system is 10 J. The heat Flow into the system in path ADB is:



(1) 80 J (2) 20 J

(3) 100 J (4) 40 J

4. A mixture of 2 moles of helium gas (atomic mass = 4 u), and 1 mole of argon gas (atomic mass = 40 u) is kept at 300 K in a container. The ratio of their rms speeds $\left[\frac{V_{rms}(\text{helium})}{V_{rms}((\text{argon}))}\right]$, is close to:

(1) 2.24 (2) 0.45

(3) 0.32 (4) 3.16

5. A rod, of length L at room temperature and uniform area of cross section A, is made of a metal having coefficient of linear expansion α/°C. It is observed that an external compressive force F, is applied on each of its ends, prevents any change in the length of the rod, when its temperature rises by ΔT K. Young's modulus, Y, for this metal is :

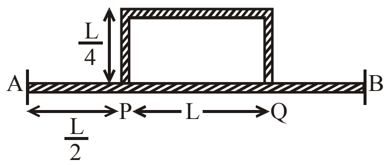
(1) $\frac{F}{2A\alpha\Delta T}$

(2) $\frac{F}{A\alpha(\Delta T - 273)}$

(3) $\frac{F}{A\alpha\Delta T}$

(4) $\frac{2F}{A\alpha\Delta T}$

6. Temperature difference of 120°C is maintained between two ends of a uniform rod AB of length 2L. Another bent rod PQ, of same cross-section as AB and length $\frac{3L}{2}$, is connected across AB (See figure). In steady state, temperature difference between P and Q will be close to :



(1) 60ºC (2) 75ºC (3) 35ºC (4) 45ºC

7. An unknown metal of mass 192 g heated to a temperature of 100ºC was immersed into a brass calorimeter of mass 128 g containing 240 g of water a temperature of 8.4ºC Calculate the specific heat of the unknown metal if water temperature stabilizes at 21.5ºC (Specific heat of brass is 394 J kg^{-1} K^{-1})

(1) 1232 J kg^{-1} K^{-1}

(2) 458 J kg^{-1} K^{-1}

(3) 654 J kg^{-1} K^{-1}

(4) 916 J kg^{-1} K^{-1}

8. Half mole of an ideal monoatomic gas is heated at constant pressure of 1atm from 20 ºC to 90ºC. Work done by gas is close to : (Gas constant R = 8.31 J /mol.K)

(1) 73 J (2) 291 J

(3) 581 J (4) 146 J

9. Two kg of a monoatomic gas is at a pressure of 4×10^4 N/m^2 . The density of the gas is 8 kg /m^3. What is the order of energy of the gas due to its thermal motion ?

(1) 10^3 J (2) 10^5 J

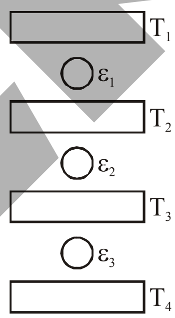
(3) 10^6 J (4) 10^4 J

10. A heat source at T= 10^3 K is connected to another heat reservoir at T=10^2 K by a copper slab which is 1 m thick. Given that the thermal conductivity of copper is 0.1 WK^{-1} m^{-1}, the energy flux through it in the steady state is :

(1) 90 Wm^{-2} (2) 200 Wm^{-2}

(3) 65 Wm^{-2} (4) 120 Wm^{-2}

11. Three Carnot engines operate in series between a heat source at a temperature T_1 and a heat sink at temperature T_4 (see figure). There are two other reservoirs at temperature T_2, and T_3, as shown, with $T_2 > T_2 > T_3 > T_4$. The three engines are equally efficient if:



(1) $T_2 = \left(T_1^2 T_4\right)^{1/3}; T_3 = \left(T_1 T_4^2\right)^{1/3}$

(2) $T_2 = \left(T_1 T_4^2\right)^{1/3}; T_3 = \left(T_1^2 T_4\right)^{1/3}$

(3) $T_2 = \left(T_1^3 T_4\right)^{1/4}; T_3 = \left(T_1 T_4^3\right)^{1/4}$

(4) $T_2 = (T_1 T_4)^{1/2}; T_3 = (T_1^2 T_4)^{1/3}$

12. Two rods A and B of identical dimensions are at temperature 30°C. If A is heated upto 180°C and B upto T°C, then the new lengths are the same. If the ratio of the coefficients of linear expansion of A and B is 4 : 3, then the value of T is :-

(1) 270°C (2) 230°C

(3) 250°C (4) 200°C

13. When 100 g of a liquid A at 100°C is added to 50 g of a liquid B at temperature 75°C, the temperature of the mixture becomes 90°C. The temperature of the mixture, if 100 g of liquid A at 100°C is added to 50 g of liquid B at 50°C, will be :-

(1) 80°C (2) 60°C
(3) 70°C (4) 85°C

14. A thermometer graduated according to a linear scale reads a value x_0 when in contact with boiling water, and $x_0/3$ when in contact with ice.

What is the temperature of an object in 0 °C, if this thermometer in the contact with the object reads $x_0/2$?

(1) 35 (2) 25
(3) 60 (4) 40

15. In a process, temperature and volume of one mole of an ideal monoatomic gas are varied according to the relation VT = K, where K is a constant. In this process the temperature of the gas is incresed by ΔT. The amount of heat absorbed by gas is (R is gas constant) :

(1) $\frac{1}{2}R\Delta T$ (2) $\frac{3}{2}R\Delta T$

(3) $\frac{1}{2}KR\Delta T$ (4) $\frac{2K}{3}\Delta T$

16. A metal ball of mass 0.1 kg is heated upto 500°C and dropped into a vessel of heat capacity 800 JK^{-1} and containing 0.5 kg water. The initial temperature of water and vessel is 30°C. What is the approximate percentage increment in the temperature of the water ? [Specific Heat Capacities of water and metal are, respectively, 4200 $Jkg^{-1}K^{-1}$ and 400 $JKg^{-1}K^{-1}$]

(1) 30% (2) 20%
(3) 25% (4) 15%

17. A rigid diatomic ideal gas undergoes an adiabatic process at room temperature. The relation between temperature and volume of this process is TV^x = constant, then x is :

(1) $\frac{5}{3}$ (2) $\frac{2}{5}$ (3) $\frac{2}{3}$ (4) $\frac{3}{5}$

18. The gas mixture constists of 3 moles of oxygen and 5 moles of argon at temperature T. Considering only translational and rotational modes, the total inernal energy of the system is:

(1) 12 RT (2) 20 RT
(3) 15 RT (4) 4 RT

19. Ice at –20° C os added tp 50 g of water at 40°C. When the temperature of the mixture reaches 0°C, it is found that 20 g of ice is still unmelted. The amount of ice added to the water was close to

(Specific heat of water = 4.2 J/g/°C)

Specific heat of Ice = 2.1 J/g/°C

Heat of fusion of water at 0°C = 334 J/g)

(1) 50 g (2) 40 g
(3) 60 g (4) 100 g

20. A vertical closed cylinder is separated into two parts by a frictionless piston of mass m and of negligible thickness. The piston is free to move along the length of the cylinder. The length of the cylinder above the piston is ℓ_1, and that below the piston is ℓ_2, such that $\ell_1 > \ell_2$. Each part of the cylinder contains n moles of an ideal gas at equal temperature T. If the piston is stationary, its mass, m, will be given by :

(R is universal gas constant and g is the acceleration due to gravity)

(1) $\frac{nRT}{g}\left[\frac{1}{\ell_2}+\frac{1}{\ell_1}\right]$ (2) $\frac{nRT}{g}\left[\frac{\ell_1-\ell_2}{\ell_1\ell_2}\right]$

(3) $\frac{RT}{g}\left[\frac{2\ell_1+\ell_2}{\ell_1\ell_2}\right]$ (4) $\frac{RT}{ng}\left[\frac{\ell_1-3\ell_2}{\ell_1\ell_2}\right]$

21. An ideal gas is enclosed in a cylinder at pressure of 2 atm and temperature, 300 K. The mean time between two successive collisions is 6×10^{-8} s. If the pressure is doubled and temperature is increased to 500 K, the mean time between two successive collisions will be close to:

(1) 4×10^{-8}s (2) 3×10^{-6}s

(3) 2×10^{-7}s (4) 0.5×10^{-8}s

22. A cylinder of radius R is surrounded by a cylindrical shell of inner radius R and outer radius 2R. The thermal conductivity of the material of the inner cylinder is K_1 and that of the outer cylinder is K_2. Assuming no loss of heat, the effective thermal conductivity of the system for heat flowing along the length of the cylinder is:

(1) $K_1 + K_2$ (2) $\frac{K_1+K_2}{2}$

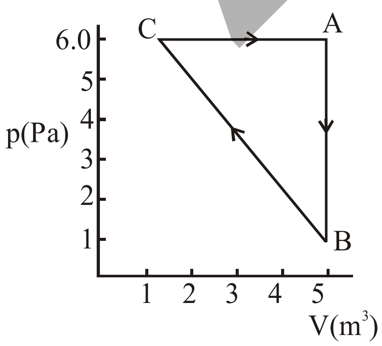
(3) $\frac{2K_1+3K_2}{5}$ (4) $\frac{K_1+3K_2}{4}$

23. An ideal gas occupies a volume of $2m^3$ at a pressure of 3×10^6 Pa. The energy of the gas is:

(1) 3×10^2 (2) 10^8 J

(3) 6×10^4 J (4) 9×10^6 J

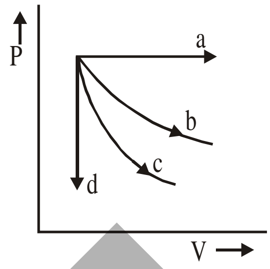
24. For the given cyclic process CAB as shown for a gas, the work done is :



(1) 1 J (2) 5 J

(3) 10 J (4) 30 J

25. The given diagram shows four processes i.e., isochoric, isobaric, isothermal and adiabatic. The correct assignment of the processes, in the same order is given by :-



(1) d a c b (2) a d c b

(3) a d b c (4) d a b c

26. The temperature, at which the root mean square velocity of hydrogen molecules equals their escape velocity from the earth, is closest to :

[Boltzmann Constant $k_B = 1.38 \times 10^{-23}$ J/K

Avogadro Number $N_A = 6.02 \times 10^{26}$ /kg

Radius of Earth : 6.4×10^6 m

Gravitational acceleration on Earth = $10ms^{-2}$]

(1) 650 K (2) 3×10^5 K

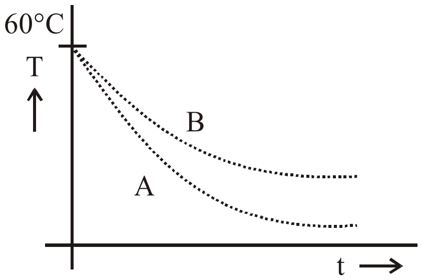
(3) 10^4 K (4) 800 K

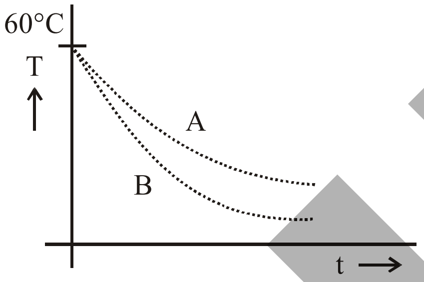
27. A boy's catapult is made of rubber cord which is 42 cm long, with 6 mm diameter of cross-section and of negligible mass. The boy keeps a stone weighing 0.02kg on it and stretches the cord by 20 cm by applying a constant force. When released, the stone flies off with a velocity of 20 ms^{-1}. Neglect the change in the area of cross-section of the cord while stretched. The Young's modulus of rubber is closest to:

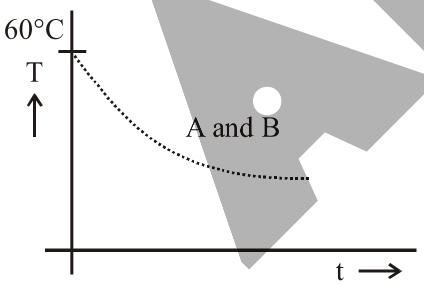
(1) 10^4 Nm^{-2} (2) 10^8 Nm^{-2}

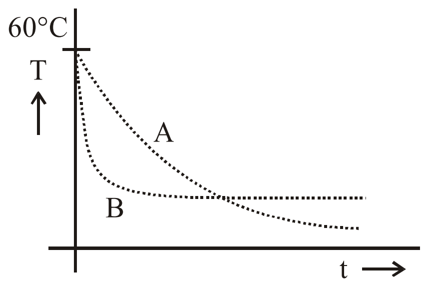
(3) 10^6 Nm^{-2} (4) 10^3 Nm^{-2}

28. Two identical breakers A and B contain equal volumes of two different liquids at 60°C each and left to cool down. Liquid in A has density of 8×10^2 kg/m^3 and specific heat of 2000 J kg^{-1} K^{-1} while liquid in B has density of 10^3 kg m^{-3} and specific heat of 4000 J kg^{-1} K^{-1}. Which of the following best describes their temperature versus time graph schematically? (assume the emissivity of both the beakers to be the same)

(1) 

(2) 

(3) 

(4) 

29. A steel wire having a radius of 2.0 mm, carrying a load of 4 kg, is hanging from a ceiling. Given that $g = 3.1\ \pi$ ms^{-2}, what will be the tensile stress that would be developed in the wire ?

(1) 4.8×10^6 Nm^{-2}

(2) 5.2×10^6 Nm^{-2}

(3) 6.2×10^6 Nm^{-2}

(4) 3.1×10^6 Nm^{-2}

30. A thermally insulated vessel contains 150g of water at 0°C. Then the air from the vessel is pumped out adiabatically. A fraction of water turns into ice and the rest evaporates at 0°C itself. The mass of evaporated water will be closest to :

(Latent heat of vaporization of water = 2.10×10^6 J kg^{-1} and Latent heat of Fusion of water = 3.36×10^5 J kg^{-1})

(1) 130 g (2) 35 g

(3) 20 g (4) 150 g

31. If 10^{22} gas molecules each of mass 10^{-26} kg collide with a surface (perpendicular to it) elastically per second over an area 1 m^2 with a speed 10^4 m/s, the pressure exerted by the gas molecules will be of the order of :

(1) 10^8 N/m^2 (2) 10^4 N/m^2

(3) 10^3 N/m^2 (4) 10^{16} N/m^2

32. A massless spring (k = 800 N/m), attached with a mass (500 g) is completely immersed in 1 kg of water. The spring is stretched by 2 cm and released so that it starts vibrating. What would be the order of magnitude of the change in the temperature of water when the vibrations stop completely ? (Assume that the water container and spring receive negligible heat and specific heat of mass = 400 J/kg K, specific heat of water = 4184 J/kg K)

(1) 10^{-3}K (2) 10^{-4} K

(3) 10^{-1} K (4) 10^{-5}K

33. The specific heats, C_P and C_V of a gas of diatomic molecules, A, are given (in units of J mol^{-1} K^{-1}) by 29 and 22, respectively. Another gas of diatomic molecules, B, has the corresponding values 30 and 21. If they are treated as ideal gases, then :-

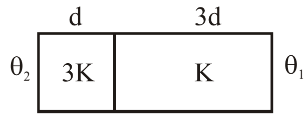
(1) A has one vibrational mode and B has two

(2) Both A and B have a vibrational mode each

(3) A is rigid but B has a vibrational mode

(4) A has a vibrational mode but B has none

34. Two materials having coefficients of thermal conductivity '3K' and 'K' and thickness 'd' and '3d', respectively, are joined to form a slab as shown in the figure. The temperatures of the outer surfaces are 'θ_2' and 'θ_1' respectively, $(\theta_2 > \theta_1)$. The temperature at the interface is :-



(1) $\frac{\theta_2 + \theta_1}{2}$ (2) $\frac{\theta_1}{10} + \frac{9\theta_2}{10}$

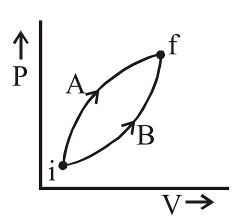
(3) $\frac{\theta_1}{3} + \frac{2\theta_2}{3}$ (4) $\frac{\theta_1}{6} + \frac{5\theta_2}{6}$

35. An HCl molecule has rotational, translational and vibrational motions. If the rms velocity of HCl molecules in its gaseous phase is $\overline{v}$, m is its mass and k_B is Boltzmann constant, then its temperature will be :

(1) $\frac{m\overline{v}^2}{6k_B}$ (2) $\frac{m\overline{v}^2}{5k_B}$

(3) $\frac{m\overline{v}^2}{3k_B}$ (4) $\frac{m\overline{v}^2}{7k_B}$

36. Following figure shows two processes A and B for a gas. If ΔQ_A and ΔQ_B are the amount of heat absorbed by the system in two cases, and ΔU_A and ΔU_B are changes in internal energies, respectively, then :



(1) $\Delta Q_A = \Delta Q_B$; $\Delta U_A = \Delta U_B$

(2) $\Delta Q_A > \Delta Q_B$; $\Delta U_A = \Delta U_B$

(3) $\Delta Q_A > \Delta Q_B$; $\Delta U_A > \Delta U_B$

(4) $\Delta Q_A < \Delta Q_B$; $\Delta U_A < \Delta U_B$

37. For a given gas at 1 atm pressure, rms speed of the molecule is 200 m/s at 127°C. At 2 atm pressure and at 227°C, the rms speed of the molecules will be :

(1) 80 m/s (2) $100\sqrt{5}$ m/s

(3) $80\sqrt{5}$ m/s (4) 100 m/s

38. The elastic limit of brass is 379 MPa. What should be the minimum diameter of a brass rod if it is to support a 400 N load without exceeding its elastic limit ?

(1) 1.16 mm (2) 0.90 mm

(3) 1.36 mm (4) 1.00 mm

39. When heat Q is supplied to a diatomic gas of rigid molecules, at constant volume its temperature increases by ΔT. The heat required to produce the same change in temperature, at a constant pressure is :

(1) $\frac{7}{5}Q$ (2) $\frac{3}{2}Q$ (3) $\frac{5}{3}Q$ (4) $\frac{2}{3}Q$

40. In an experiment, bras and steel wires of length 1m each with areas of cross section 1 mm^2 are used. teh wires are connected in series and one end of the combined wire is connected to a rigid support and other end is subjected to elongation. The stress required to produce a net elongation of 0.2 mm is :

(Given, the Young's Modulus for steel and brass are respectively, 120×10^9 N/m^2 and 60×10^9 N/m^2)

(1) 0.2×10^6 N/m^2 (2) 4.0×10^6 N/m^2

(3) 1.8×10^6 N/m^2 (4) 1.2×10^6 N/m^2

41. One mole of an ideal gas passes through a process where pressure and volume obey the relation $P = P_o\left[1-\frac{1}{2}\left(\frac{V_0}{V}\right)^2\right]$. Here P_o and V_o are constants. Calculate the change in the temperature of the gas if its volume changes from V_o to $2V_o$.

(1) $\frac{1}{2}\frac{P_oV_o}{R}$ (2) $\frac{3}{4}\frac{P_oV_o}{R}$

(3) $\frac{5}{4}\frac{P_oV_o}{R}$ (4) $\frac{1}{4}\frac{P_oV_o}{R}$

42. A cylinder with fixed capacity of 67.2 lit contains helium gas at STP. The amount of heat needed to raise the temperature of the gas by 20°C is : [Given that R = 8.31 J mol^{-1} K^{-1}]

(1) 748 J (2) 374 J

(3) 350 J (4) 700 J

43. A 25×10^{-3} m^3 volume cylinder is filled with 1 mol of O_2 gas at room temperature (300K). The molecular diameter of O_2, and its root mean square speed, are found to be 0.3 nm, and 200 m/s, respectively. What is the average collision rate (per second) for an O_2 molecule ?

(1) $\sim 10^{11}$ (2) $\sim 10^{13}$

(3) $\sim 10^{10}$ (4) $\sim 10^{12}$

44. n moles of an ideal gas with constant volume heat capcity C_V undergo an isobaric expansion by certain volume. The ratio of the work done in the process, to the heat supplied is :

(1) $\frac{4nR}{C_V - nR}$ (2) $\frac{nR}{C_V - nR}$

(3) $\frac{nR}{C_V + nR}$ (4) $\frac{4nR}{C_V + nR}$

45. One kg of water, at 20ºC, is heated in an electric kettle whose heating element has a mean (temperature averaged) resistance of 20 Ω. The rms voltage in the mains is 200 V. Ignoring heat loss from the kettle, time taken for water to evaporate fully, is close to :

[Specific heat of water = 4200 J/kg ºC), Latent heat of water = 2260 kJ/kg]

(1) 3 minutes

(2) 22 minutes

(3) 10 minutes

(4) 16 minutes

46. The number density of molecules of a gas depends on their distance r from the origin as, $n(r) = n_0 e^{-\alpha r^4}$. Then the total number of molecules is proportional to :

(1) $n_0\alpha^{1/4}$ (2) $n_0\alpha^{-3}$

(3) $n_0\alpha^{-3/4}$ (4) $\sqrt{n_0}\,\alpha^{1/2}$

47. A Carnot engine has an efficiency of 1/6. When the temperature of the sink is reduced by 62ºC, its efficiency is doubled. The temperatures of the source and the sink are, respectively

(1) 124ºC, 62ºC

(2) 37ºC, 99ºC

(3) 62ºC, 124ºC

(4) 99ºC, 37ºC

48. A diatomic gas with rigid molecules does 10 J of work when expanded at constant pressure. What would be the heat energy absorbed by the gas, in this process ?

(1) 35 J (2) 40 J

(3) 25 J (4) 30 J

49. A uniform cylindrical rod of length L and radius r, is made from a material whose Young's modulus of Elasticity equals Y. When this rod is heated by temperature T and simultaneously subjected to a net longitudinal compressional force F, its length remains unchanged. The coefficient of volume expansion, of the material of the rod, is (nearly) equals to :

(1) $F/(3\pi r^2YT)$ (2) $3F/(\pi r^2YT)$

(3) $6F/(\pi r^2YT)$ (4) $9F/(\pi r^2YT)$

50. When M_1 gram of ice at –10°C (specific heat = 0.5 cal $g^{-1}{}^{\circ}C^{-1}$) is added to M_2 gram of water at 50°C, finally no ice is left and the water is at 0°C. The value of latent heat of ice, in cal g^{-1} is:

(1) $\frac{5M_1}{M_2}-50$ (2) $\frac{50M_2}{M_1}$

(3) $\frac{50M_2}{M_1}-5$ (4) $\frac{5M_2}{M_1}-5$

51. Two moles of helium gas is mixed with three moles of hydrogen molecules (taken to be rigid). What is the molar specific heat of mixture at constant volume ? (R = 8.3 J/mol K)

(1) 21.6 J/mol K (2) 19.7 J/mol K

(3) 17.4 J/mol K (4) 15.7 J/mol K

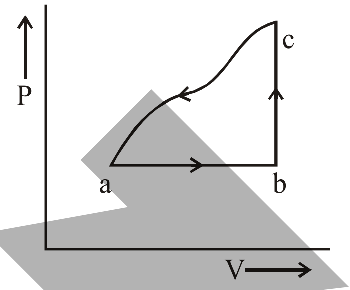
52. At 40°C, a brass wire of 1 mm radius is hung from the ceiling. A small mass, M is hung from the free end of the wire. When the wire is cooled down from 40°C to 20°C it regains its original length of 0.2 m. The value of M is close to :

(Coefficient of linear expansion and Young's modulus of brass are 10^{-5}/°C and 10^{11} N/m^2, respectively; g = 10 ms^{-2})

(1) 1.5 kg (2) 9 kg

(3) 0.9 kg (4) 0.5 kg

53. A sample of an ideal gas is taken through the cyclic process abca as shown in the figure. The change in the internal energy of the gas along the path ca is –180J. The gas absorbs 250 J of heat along the path ab and 60 J along the path bc. The work done by the gas along the path abc is :



(1) 100 J (2) 120 J

(3) 140 J (4) 130 J

KINEMATICS

1. The position co-ordinates of a particle moving in a 3-D coordinate system is given by

$x = a\cos\omega t$

$y = a\sin\omega t$

and $z = a\omega t$

The speed of the particle is :

(1) $a\omega$ (2) $\sqrt{3}\,a\omega$

(3) $\sqrt{2}\,a\omega$ (4) $2a\omega$

2. In a car race on straight road, car A takes a time t less than car B at the finish and passes finishing point with a speed 'v' more than that of car B. Both the cars start from rest and travel with constant acceleration a_1 and a_2 respectively. Then 'v' is equal to :

(1) $\frac{a_1+a_2}{2}t$ (2) $\sqrt{2a_1a_2}\,t$

(3) $\frac{2a_1a_2}{a_1+a_2}t$ (4) $\sqrt{a_1a_2}\,t$

3. A particle is moving with a velocity $\vec{v} = K(y\hat{i} + x\hat{j})$, where K is a constant. The general equation for its path is:

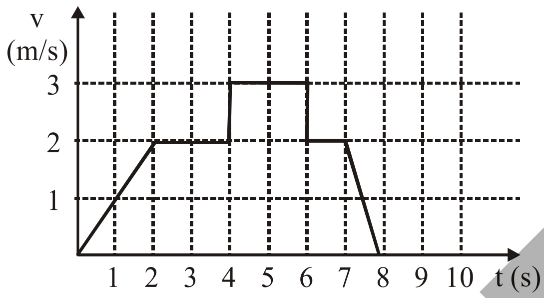
(1) xy = constant

(2) $y^2 = x^2$ + constant

(3) $y = x^2$ + constant

(4) $y^2 = x$ + constant

4. A particle starts from the origin at time t = 0 and moves along the positive x-axis. The graph of velocity with respect to time is shown in figure. What is the position of the particle at time t = 5s ?



(1) 6 m (2) 9 m (3) 3 m (4) 10 m

5. Two guns A and B can fire bullets at speeds 1 km/s and 2 km/s respectively. From a point on a horizontal ground, they are fired in all possible directions. The ratio of maximum areas covered by the bullets fired by the two guns, on the ground is :

(1) 1 : 2 (2) 1 : 4 (3) 1 : 8 (4) 1 : 16

6. A particle moves from the point $(2.0\hat{i} + 4.0\hat{j})$ m, at t = 0, with an initial velocity $(5.0\hat{i} + 4.0\hat{j})$ ms^{-1}. It is acted upon by a constant force which produces a constant acceleration $(4.0\hat{i} + 4.0\hat{j})$ ms^{-2}. What is the distance of the particle from the origin at time 2 s ?

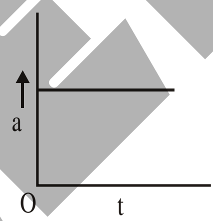
(1) $20\sqrt{2}$ m (2) $10\sqrt{2}$ m

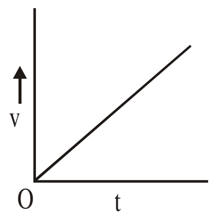
(3) 5 m (4) 15 m

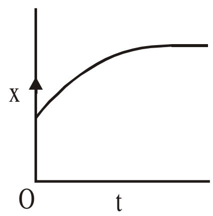
7. A passenger train of length 60m travels at a speed of 80 km/hr. Another freight train of length 120 m travels at a speed of 30 km/hr. The ratio of times taken by the passenger train to completely cross the freight train when : (i) they are moving in the same direction, and (ii) in the opposite directions is :

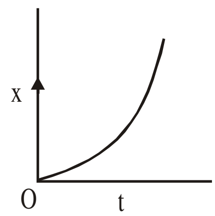
(1) $\frac{5}{2}$ (2) $\frac{25}{11}$ (3) $\frac{3}{2}$ (4) $\frac{11}{5}$

8. A particle starts from origin O from rest and moves with a uniform acceleration along the positive x-axis. Identify all figures that correctly represent the motion qualitatively. (a = acceleration, v = velocity, x = displacement, t = time)

(A) 

(B) 

(C) 

(D) 

(1) (A), (B), (C) (2) (A)

(3) (A), (B), (D) (4) (B), (C)

9. Ship A is sailing towards north-east with velocity $\vec{v} = 30\hat{i} + 50\hat{j}$ km/hr where $\hat{i}$ points east and $\hat{j}$, north. Ship B is at a distance of 80 km east and 150 km north of Ship A and is sailing towards west at 10 km/hr. A will be at minimum distance from B in :

(1) 4.2 hrs. (2) 2.2 hrs.

(3) 3.2 hrs. (4) 2.6 hrs.

10. The position of a particle as a function of time t, is given by

$x(t) = at + bt^2 - ct^3$

where a, b and c are constants. When the particle attains zero acceleration, then its velocity will be :

(1) $a + \frac{b^2}{4c}$ (2) $a + \frac{b^2}{c}$

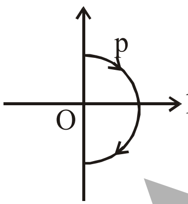
(3) $a + \frac{b^2}{2c}$ (4) $a + \frac{b^2}{3c}$

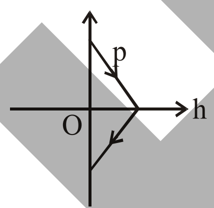
11. The position vector of a particle changes with time according to the relation $\vec{r}(t) = 15t^2\hat{i} + (4 - 20t^2)\hat{j}$. What is the magnitude of the acceleration at t = 1 ?

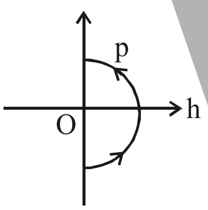
(1) 40 (2) 100

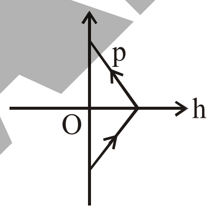
(3) 25 (4) 50

12. A ball is thrown vertically up (taken as +z-axis) from the ground. The correct momentum-height (p-h) diagram is :

(1) 

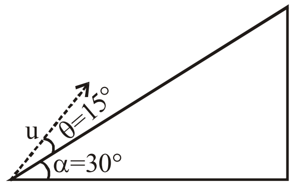
(2) 

(3) 

(4) 

13. A plane is inclined at an angle $\alpha = 30°$ with a respect to the horizontal. A particle is projected with a speed $u = 2\ ms^{-1}$ from the base of the plane, making an angle $\theta = 15°$ with respect to the plane as shown in the figure. The distance from the base, at which the particle hits the plane is close to :

(Take $g = 10\ ms^{-2}$)



(1) 14 cm (2) 20 cm

(3) 18 cm (4) 26 cm

14. A particle is moving with speed $v = b\sqrt{x}$ along positive x-axis. Calculate the speed of the particle at time $t = \tau$ (assume that the particle is at origin at t = 0).

(1) $\frac{b^2\tau}{4}$ (2) $\frac{b^2\tau}{2}$

(3) $b^2\tau$ (4) $\frac{b^2\tau}{\sqrt{2}}$

15. Two particles are projected from the same point with the same speed u such that they have the same range R, but different maximum heights, h_1 and h_2. Which of the following is correct ?

(1) $R^2 = 2h_1h_2$ (2) $R^2 = 16h_1h_2$

(3) $R^2 = 4h_1h_2$ (4) $R^2 = h_1h_2$

16. The trajectory of a projectile near the surface of the earth is given as $y = 2x - 9x^2$. If it were launched at an angle θ_0 with speed v_0 then ($g = 10\ ms^{-2}$) :

(1) $\theta_0 = \cos^{-1}\left(\frac{1}{\sqrt{5}}\right)$ and $v_0 = \frac{5}{3}ms^{-1}$

(2) $\theta_0 = \sin^{-1}\left(\frac{1}{\sqrt{5}}\right)$ and $v_0 = \frac{5}{3}ms^{-1}$

(3) $\theta_0 = \sin^{-1}\left(\frac{2}{\sqrt{5}}\right)$ and $v_0 = \frac{3}{5}ms^{-1}$

(4) $\theta_0 = \cos^{-1}\left(\frac{2}{\sqrt{5}}\right)$ and $v_0 = \frac{3}{5}ms^{-1}$

17. A shell is fired from a fixed artillery gun with an initial speed u such that it hits the target on the ground at a distance R from it. If t_1 and t_2 are the values of the time taken by it to hit the target in two possible ways, the product t_1t_2 is :

(1) R/g (2) R/4g

(3) 2R/g (4) R/2g

MEC

1. One of the two identical conducting wires of length L is bent in the form of a circular loop and the other one into a circular coil of N identical turns. If the same current is passed in both, the ratio of the magnetic field at the central of the loop (B_L) to that at the centre of the coil (B_C), i.e. R $\frac{B_L}{B_C}$ will be :

(1) $\frac{1}{N}$ (2) N^2

(3) $\frac{1}{N^2}$ (4) N

2. A particle having the same charge as of electron moves in a circular path of radius 0.5 cm under the influence of a magnetic field of 0.5 T. If an electric field of 100 V/m makes it to move in a straight path, then the mass of the particle is (Given charge of electron $=1.6 \times 10^{-19}$C)

(1) 2.0×10^{-24} kg

(2) 1.6×10^{-19} kg

(3) 1.6×10^{-27} kg

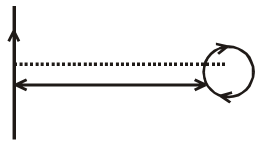
(4) 9.1×10^{-31} kg

3. A bar magnet is demagnetized by inserting it inside a solenoid of length 0.2 m, 100 turas, and carrying a current of 5.2 A. The coercivitv of the bar magnet is :

(1) 1200 A/m (2) 2600 A/m

(3) 520 A/jm (4) 285 A/m

4. An infinitely long current carrying wire and a small current carrying loop are in the plane of the paper as shown. The radius of the loop is a and distance of its centre from the wire is d (d»a). If the loop applies a force F on the wire then :



(1) $F \propto \left(\frac{a^2}{d^3}\right)$ (2) $F \propto \left(\frac{a}{d}\right)$

(3) $F \propto \left(\frac{a}{d}\right)^2$ (4) F = 0

5. At some location on earth the horizontal component of earth's magnetic field is 18×10^{-6}T. At this location, magnetic neeedle of length 0.12 m and pole strength 1.8 Am is suspended from its mid-point using a thread, it makes 45° angle with horizontal in equilibrium. To keep this needle horizontal, the vertical force that should be applied at one of its ends is :

(1) 3.6×10^{-5} N (2) 6.5×10^{-5} N

(3) 1.3×10^{-5} N (4) 1.8×10^{-5} N

6. A hoop and a solid cylinder of same mass and radius are made of a permanent magnetic material with their magnetic moment parallel to their respective axes. But the magnetic moment of hoop is twice of solid cylinder. They are placed in a uniform magnetic field in such a manner that their magnetic moments make a small angle with the field. If the oscillation periods of hoop and cylinder are T_h and T_c respectively, then :

(1) $T_h = 0.5\ T_c$

(2) $T_h = 2\ T_c$

(3) $T_h = 1.5\ T_c$

(4) $T_h = T_c$

7. A magnet of total magnetic moment $10^{-2}\,\hat{i}$ A-m^2 is placed in a time varying magnetic field, $B\hat{i}(\cos\omega t)$ where B = 1 Tesla and $\omega = 0.125$ rad/s. The work done for reversing the direction of the magnetic moment at t = 1 second, is :

(1) 0.007 J

(2) 0.014 J

(3) 0.01 J

(4) 0.028 J

8. An insulating thin rod of length ℓ has a x linear charge density $p(x) = \rho_0 \dfrac{x}{\ell}$ on it. The rod is rotated about an axis passing through the origin (x = 0) and perpendicular to the rod. If the rod makes n rotations per second, then the time averaged magnetic moment of the rod is :

(1) $\dfrac{\pi}{4} n\rho\ell^3$ (2) $n\rho\ell^3$

(3) $\pi n\rho\ell^3$ (4) $\dfrac{\pi}{3} n\rho\ell^3$

9. A paramagnetic substance in the form of a cube with sides 1 cm has a magnetic dipole moment of 20×10^{-6} J/T when a magnetic intensity of 60×10^3 A/m is applied. Its magnetic susceptibility is :-

(1) 2.3×10^{-2}

(2) 3.3×10^{-2}

(3) 3.3×10^{-4}

(4) 4.3×10^{-2}

10. A galvanometer having a resistance of 20 Ω and 30 divisions on both sides has figure of merit 0.005 ampere/division. The resistance that should be connected in series such that it can be used as a voltmeter upto 15 volt, is :-

(1) 80 Ω (2) 120 Ω

(3) 125 Ω (4) 100 Ω

11. The region between y = 0 and y = d contains a magnetic field $\vec{B} = B\hat{z}$. A particle of mass m and charge q enters the region with a velocity $\vec{v} = v\hat{i}$. If $d = \dfrac{mv}{2qB}$, the acceleration of the charged particle at the point of its emergence at the other side is :-

(1) $\dfrac{qvB}{m}\left(\dfrac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

(2) $\dfrac{qvB}{m}\left(\dfrac{1}{2}\hat{i}-\dfrac{\sqrt{3}}{\sqrt{2}}\hat{j}\right)$

(3) $\dfrac{qvB}{m}\left(\dfrac{-\hat{j}+\hat{i}}{\sqrt{2}}\right)$

(4) $\dfrac{qvB}{m}\left(\dfrac{\sqrt{3}}{2}\hat{i}+\dfrac{1}{2}\hat{j}\right)$

12. A particle of mass m and charge q is in an electric and magnetic field given by

$\vec{E} = 2\hat{i}+3\hat{j}$; $\vec{B} = 4\hat{j}+6\hat{k}$.

The charged particle is shifted from the origin to the point P(x = 1 ; y = 1) along a straight path. The magnitude of the total work done is :-

(1) (0.35)q (2) (0.15)q

(3) (2.5)q (4) 5q

13. There are two long co-axial solenoids of same length *l*. the inner and outer coils have radii r_1 and r_2 and number of turns per unit length n_1 and n_2 respectively. The rate of mutual inductance to the self-inductance of the inner-coil is :

(1) $\dfrac{n_2}{n_1}\cdot\dfrac{r_2^2}{r_1^2}$ (2) $\dfrac{n_2}{n_1}\cdot\dfrac{r_1}{r_2}$ (3) $\dfrac{n_1}{n_2}$ (4) $\dfrac{n_2}{n_1}$

14. In an experiment electrons are accelerated, from rest, by applying a voltage of 500 V. Calculate the radius of the path if a magnetic field 100 mT is then applied.

[Charge of the electron = 1.6×10^{-19} C

Mass of the electron = 9.1×10^{-31} kg]

(1) 7.5×10^{-4} m

(2) 7.5×10^{-3} m

(3) 7.5 m

(4) 7.5×10^{-2} m

15. A paramagnetic material has 10^{28} atoms/m^3. Its magnetic susceptibility at temperature 350 K is 2.8×10^{-4}. Its susceptibility at 300 K is :

(1) 3.672×10^{-4}

(2) 3.726×10^{-4}

(3) 3.267×10^{-4}

(4) 2.672×10^{-4}

16. A 10 m long horizontal wire extends from North East to South West. It is falling with a speed of 5.0ms^{-1}, at right angles to the horizontal component of the earth's magnetic field, of 0.3×10^{-4}Wb/m^2. The value of the induced emf in wire is :

(1) 2.5×10^{-3}V

(2) 1.1×10^{-3}V

(3) 0.3×10^{-3}V

(4) 1.5×10^{-3}V

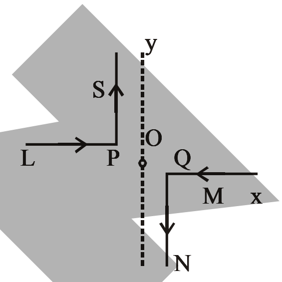
17. A proton and an α-particle (with their masses in the ratio of 1:4 and charges in the ratio of 1:2) are accelerated from rest through a potential difference V. If a uniform magnetic field (B) is set up perpendicular to their velocities, the ratio of the radii $r_p : r_\alpha$ of the circular paths described by them will be :

(1) $1:\sqrt{2}$ (2) 1 : 2

(3) 1 : 3 (4) $1:\sqrt{3}$

18. As shown in the figure, two infinitely long, identical wires are bent by 90° and placed in such a way that the segments LP and QM are along the x-axis, while segments PS and QN are parallel to the y-axis. If OP = OQ = 4cm, and the magnitude of the magnetic field at O is 10^{-4} T, and the two wires carry equal currents (see figure), the magnitude of the current in each wire and the direction of the magnetic field at O will be

($\mu_0 = 4\pi \times 10^{-7}$ NA^{-2}) :



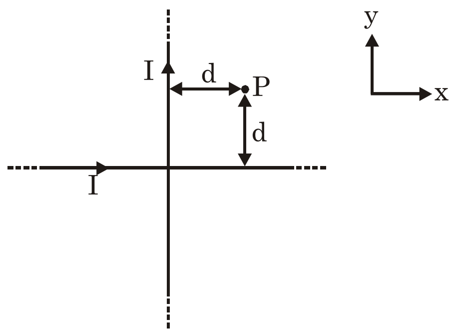
(1) 40 A, perpendicular into the page

(2) 40 A, perpendicular out of the page

(3) 20 A, perpendicular out of the page

(4) 20 A, perpendicular into the page

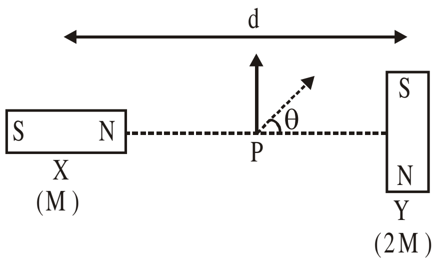
19. Two very long, straight, and insulated wires are kept at 90° angle from each other in xy-plane as shown in the figure. These wires carry currents of equal magnitude I, whose directions are shown in the figure. The net magnetic field at point P will be :



(1) Zero (2) $\frac{+\mu_0 I}{\pi d}(\hat{z})$

(3) $-\frac{\mu_0 I}{2\pi d}(\hat{x}+\hat{y})$ (4) $\frac{\mu_0 I}{2\pi d}(\hat{x}+\hat{y})$

20. Two magnetic dipoles X and Y are placed at a separation d, with their axes perpendicular to each other. The dipole moment of Y is twice that of X. A particle of charge q is passing, through their midpoint P, at angle $\theta = 45°$ with the horizontal line, as shown in figure. What would be the magnitude of force on the particle at that instant ? (d is much larger than the dimensions of the dipole)



(1) $\sqrt{2}\left(\frac{\mu_0}{4\pi}\right)\frac{M}{(d/2)^3}\times qv$

(2) $\left(\frac{\mu_0}{4\pi}\right)\frac{2M}{(d/2)^3}\times qv$

(3) $\left(\frac{\mu_0}{4\pi}\right)\frac{M}{(d/2)^3}\times qv$

(4) 0

21. A circular coil having N turns and radius r carries a current I. It is held in the XZ plane in a magnetic field $B\hat{i}$. The torque on the coil due to the magnetic field is :

(1) $B\pi r^2 IN$ (2) $\frac{Br^2 I}{\pi N}$

(3) Zero (4) $\frac{B\pi r^2 I}{N}$

22. Two coils 'P' and 'Q' are separated by some distance. When a current of 3 A flows through coil 'P', a magnetic flux of 10^{-3} Wb passes through 'Q'. No current is passed through 'Q'. When no current passes through 'P' and a current of 2 A passes through 'Q', the flux through 'P' is :-

(1) 6.67×10^{-3} Wb

(2) 6.67×10^{-4} Wb

(3) 3.67×10^{-4} Wb

(4) 3.67×10^{-3} Wb

23. A moving coil galvanometer has a coil with 175 turns and area 1 cm^2. It uses a torsion band of torsion constant 10^{-6} N-m/rad. The coil is placed in a maganetic field B parallel to its plane. The coil deflects by 1° for a current of 1 mA. The value of B (in Tesla) is approximately:-

(1) 10^{-3} (2) 10^{-1}

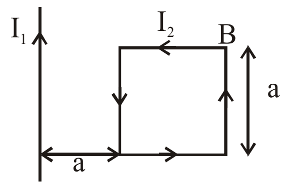
(3) 10^{-4} (4) 10^{-2}

24. The stream of a river is flowing with a speed of 2km/h. A swimmer can swim at a speed of 4km/h. What should be the direction of the swimmer with respect to the flow of the river to cross the river straight ?

(1) 60° (2) 150°

(3) 90° (4) 120°

25. A rigid square loop of side 'a' and carrying current I_2 is lying on a horizontal surface near a long current I_1 carrying wire in the same plane as shown in figure. The net force on the loop due to wire will be :



(1) Attractive and equal to $\frac{\mu_0 I_1 I_2}{3\pi}$

(2) Repulsive and equal to $\frac{\mu_0 I_1 I_2}{4\pi}$

(3) Repulsive and equal to $\frac{\mu_0 I_1 I_2}{2\pi}$

(4) Zero

26. A rectangular coil (Dimension 5 cm × 2.5 cm) with 100 turns, carrying a current of 3 A in the clock-wise direction is kept centered at the origin and in the X-Z plane. A magnetic field of 1 T is applied along X-axis. If the coil is tilted through 45° about Z-axis, then the torque on the coil is :

(1) 0.55 Nm

(2) 0.27 Nm

(3) 0.38 Nm

(4) 0.42 Nm

27. The magnitude of the magnetic field at the center of an equilateral triangular loop of side 1m which is carrying a current of 10 A is :
[Take $\mu_0 = 4\pi \times 10^{-7}$ NA^{-2}]

(1) 18 μT (2) 3 μT

(3) 1 μT (4) 9 μT

28. A square loop is carrying a steady current I and the magnitude of its magnetic dipole moment is m. If this square loop is changed to a circular loop and it carries the same current, the magnitude of the magnetic dipole moment of circular loop will be :

(1) $\frac{3m}{\pi}$ (2) $\frac{4m}{\pi}$

(3) $\frac{2m}{\pi}$ (4) $\frac{m}{\pi}$

29. In the formula $X = 5YZ^2$, X and Z have dimensions of capacitance and magnetic field, respectively. What are the dimensions of Y in SI units ?

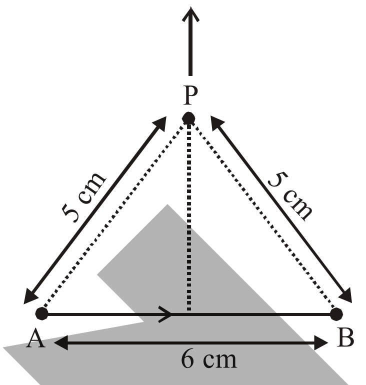
(1) $[M^{-2} L^{-2} T^{6} A^{3}]$

(2) $[M^{-1} L^{-2} T^{4} A^{2}]$

(3) $[M^{-3} L^{-2} T^{8} A^{4}]$

(4) $[M^{-2} L^{0} T^{-4} A^{-2}]$

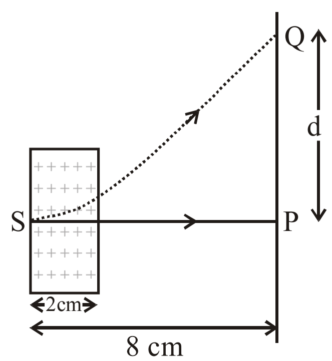
30. Find the magnetic field at point P due to a straight line segment AB of length 6 cm carrying a current of 5 A. (See figure)
($\mu_0 = 4\pi \times 10^{-7}$ N-A^{-2})



(1) 3.0×10^{-5} T (2) 2.5×10^{-5} T

(3) 2.0×10^{-5} T (4) 1.5×10^{-5} T

31. An electron, moving along the x-axis with an initial energy of 100 eV, enters a region of magnetic field $\vec{B} = (1.5 \times 10^{-3} T)\hat{k}$ at S (See figure). The field extends between x = 0 and x = 2 cm. The electron is detected at the point Q on a screen placed 8 cm away from the point S. The distance d between P and Q (on the screen) is :
(electron's charge = 1.6×10^{-19} C, mass of electron = 9.1×10^{-31} kg)



(1) 12.87 cm (2) 1.22 cm

(3) 11.65 cm (4) 2.25 cm

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32. A thin ring of 10 cm radius carries a uniformly distributed charge. The ring rotates at a constant angular speed of 40 π rad s^{-1} about its axis, perpendicular to its plane. If the magnetic field at its centre is 3.8×10^{-9} T, then the charge carried by the ring is close to

($\mu_0 = 4\pi \times 10^{-7}$ N/A^2) :

(1) 2×10^{-6} C (2) 3×10^{-5} C

(3) 4×10^{-5} C (4) 7×10^{-6} C

33. A magnetic compass needle oscillates 30 times per minute at a place where the dip is 45º, and 40 times per minute where the dip is 30º. If B_1 and B_2 are respectively the total magnetic field due to the earth at the two places, then the ratio B_1/B_2 is best given by :

(1) 2.2 (2) 1.8 (3) 0.7 (4) 3.6

MODERN PHYSICS

1. At a given instant, say t = 0, two radioactive substances A and B have equal activities. The ratio $\frac{R_B}{R_A}$ of their activities after time t itself decays with time t as e^{-3t}. If the half-life of A is ℓn2, the half-life of B is :

(1) $\frac{ln2}{2}$ (2) 2ln2

(3) $\frac{ln2}{4}$ (4) 4ln2

2. The magnetic field associated with a light wave is given, at the origin, by

$B = B_0 [\sin(3.14 \times 10^7)ct + \sin(6.28 \times 10^7)ct]$.

If this light falls on a silver plate having a work function of 4.7 eV, what will be the maximum kinetic energy of the photo electrons ?

($c = 3 \times 10^8 ms^{-1}$, $h = 6.6 \times 10^{-34}$ J-s)

(1) 7.72 eV (2) 8.52 eV

(3) 12.5 eV (4) 6.82 eV

3. A sample of radioactive material A, that has an activity of 10 mCi(1 Ci = 3.7×10^{10} decays/s), has twice the number of nuclei as another sample of a different radioactive maternal B which has an activity of 20 mCi. The correct choices for hall-lives of A and B would then be respectively :

(1) 20 days and 5 days

(2) 20 days and 10 days

(3) 5 days and 10 days

(4) 10 days and 40 days

4. Surface of certain metal is first illuminated with light of wavelength λ_1 =350 nm and then, by light of wavelength λ_2=540 nm. It is found that the maximum speed of the photo electrons in the two cases differ by a factor of 2. The work function of the metal (in eV) is close to:

(Energjr of photon = $\frac{1240}{\lambda(\text{in nm})}$eV)

(1) 1.8 (2) 1.4 (3) 2.5 (4) 5.6

5. Condiser the nuclear fission

$Ne^{20} \rightarrow 2He^4 + C^{12}$

Given that the binding energy/nucleon of Ne^{20}, He^4 and C^{12} are, respectively, 8.03 MeV, 7.07 MeV and 7.86 MeV, identify the correct statement :

(1) 8.3 MeV energy will be released

(2) energy of 12.4 MeV will be supplied

(3) energy of 11.9 MeV has to be supplied

(4) energy of 3.6 MeV will be released

6. A metal plate of area 1×10^{-4} m^2 is illuminated by a radiation of intensity 16 mW/m^2.The work function of the metal is 5eV. The energy of the incident photons is 10 eV and only 10% of it produces photo electrons. The number of emitted photo electrons per second and their maximum energy, respectively, will be : [1 eV = 1.6×10^{-19}J]

(1) 10^{10} and 5 eV (2) 10^{14} and 10 eV

(3) 10^{12} and 5 eV (4) 10^{11} and 5 eV

7. Using a nuclear counter the count rate of emitted particles from a radioactive source is measured. At t = 0 it was 1600 counts per second and t = 8 seconds it was 100 counts per second. The count rate observed, as counts per second, at t = 6 seconds is close to :

(1) 150 (2) 360

(3) 200 (4) 400

8. In an electron microscope, the resolution that can be achieved is of the order of the wavelength of electrons used. To resolve a width of 7.5×10^{-12}m, the minimum electron energy required is close to :

(1) 100 keV (2) 500 keV

(3) 25 keV (4) 1 keV

9. In a hydrogen like atom, when an electron jumps from the M - shell to the L - shell, the wavelength of emitted radiation is λ. If an electron jumps from N-shell to the L-shell, the wavelength of emitted radiation will be :-

(1) $\frac{27}{20}\lambda$ (2) $\frac{16}{25}\lambda$ (3) $\frac{20}{27}\lambda$ (4) $\frac{25}{16}\lambda$

10. In a photoelectric experiment, the wavelength of the light incident on a metal is changed from 300 nm to 400 nm. The decrease in the stopping potential is close to :

$\left(\frac{hc}{e} = 1240\,\text{nm} - V\right)$

(1) 0.5 V (2) 1.0 V

(3) 2.0 V (4) 1.5 V

11. A hydrogen atom, initially in the ground state is excited by absorbing a photon of wavelength 980Å. The radius of the atom in the excited state, it terms of Bohr radius a_0, will be :

(h_c = 12500 eV – Å)

(1) $9a_0$ (2) $25a_0$

(3) $4a_0$ (4) $16a_0$

12. If the deBronglie wavelenght of an electron is equal to 10^{-3} times the wavelength of a photon of frequency 6×10^{14} Hz, then the speed of electron is equal to :

(Speed of light = 3×10^8 m/s

Planck's constant = 6.63×10^{-34} J.s

Mass of electron = 9.1×10^{-31} kg)

(1) 1.45×10^6 m/s (2) 1.7×10^6 m/s

(3) 1.8×10^6 m/s (4) 1.1×10^6 m/s

13. When a certain photosensistive surface is illuminated with monochromatic light of frequency ν, the stopping potential for the photo current is $-V_0/2$. When the surface is illuminated by monochromatic light of frequency ν/2, the stopping potential is $-V_0$. The threshold frequency for photoelectric emission is:

(1) $\frac{3\nu}{2}$ (2) 2ν (3) $\frac{4}{3}\nu$ (4) $\frac{5\nu}{3}$

14. In a radioactive decay chain, the initial nucleus is ${}^{232}_{90}Th$. At the end there are 6 α-particles and 4 β-particles which are emitted. If the end nucleus, If ${}^{A}_{Z}X$, A and Z are given by :

(1) A = 208; Z = 80 (2) A = 202; Z = 80

(3) A = 200; Z = 81 (4) A = 208; Z = 82

15. An alpha-particle of mass m suffers 1-dimensional elastic coolision with a nucleus at rest of unknown mass. It is scattered directly backwards losing, 64% of its initial kinetic energy. The mass of the nucleus is :-

(1) 4 m (2) 3.5 m (3) 2 m (4) 1.5 m

16. In a Frank-Hertz experiment, an electron of energy 5.6 eV passes through mercury vapour and emerges with an energy 0.7 eV. The minimum wavelength of photons emitted by mercury atoms is close to :-

(1) 2020 nm (2) 220 nm

(3) 250 nm (4) 1700 nm

17. A particle of mass m moves in a circular orbit in a central potential field $U(r) = \frac{1}{2}kr^2$. If Bohr's quantization conditions are applied, radii of possible orbitals and energy levels vary with quantum number n as:

(1) $r_n \propto n^2$, $E_n \propto \frac{1}{n^2}$ (2) $r_n \propto \sqrt{n}, E_n \propto \frac{1}{n}$

(3) $r_n \propto n$, $E_n \propto n$ (4) $r_n \propto \sqrt{n}$, $E_n \propto n$

18. A particle A of mass 'm' and charge 'q' is accelerated by a potential difference of 50 V. Another particle B of mass '4 m' and charge 'q' is accelerated by a potential difference of 2500 V. The ratio of de-Broglie wavelengths $\frac{\lambda_A}{\lambda_B}$ is close to :

(1) 10.00 (2) 14.14

(3) 4.47 (4) 0.07

19. The ratio of mass densities of nuclei of ^{40}Ca and ^{16}O is close to :-

(1) 1 (2) 2

(3) 0.1 (4) 5

20. A damped harmonic oscillator has a frequency of 5 oscillations per second. The amplitude drops to half its value for every 10 oscillations. The time it will take to drop to $\frac{1}{1000}$ of the original amplitude is close to :-

(1) 100 s (2) 20 s (3) 10 s (4) 50 s

21. A nucleus A, with a finite de-broglie wavelength λ_A, undergoes spontaneous fission into two nuclei B and C of equal mass. B flies in the same direction as that of A, while C flies in the opposite direction with a velocity equal to half of that of B. The de-Broglie wavelengths λ_B and λ_C of B and C are respectively :-

(1) $2\lambda_A, \lambda_A$ (2) $\lambda_A, 2\lambda_A$

(3) $\lambda_A, \frac{\lambda_A}{2}$ (4) $\frac{\lambda_A}{2}, \lambda_A$

22. Radiation coming from transitions n = 2 to n = 1 of hydrogen atoms fall on He^+ ions in n = 1 and n = 2 states. The possible transition of helium ions as they absorb energy from the radiation is :

(1) $n = 1 \rightarrow n = 4$

(2) $n = 2 \rightarrow n = 4$

(3) $n = 2 \rightarrow n = 5$

(4) $n = 2 \rightarrow n = 3$

23. Two particles move at right angle to each other. Their de-Broglie wavelengths are λ_1 and λ_2 respectively. The particles suffer perfectly inelastic collision. The de-Broglie wavelength λ, of the final particle, is given by :

(1) $\lambda = \frac{\lambda_1 + \lambda_2}{2}$ (2) $\frac{2}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

(3) $\lambda = \sqrt{\lambda_1\lambda_2}$ (4) $\frac{1}{\lambda^2} = \frac{1}{\lambda_1^2} + \frac{1}{\lambda_2^2}$

24. A particle 'P' is formed due to a completely inelastic collision of particles 'x' and 'y' having de-Broglie wavelengths 'λ_x' and 'λ_y' respectively. If x and y were moving in opposite directions, then the de-Broglie wavelength of 'P' is :-

(1) $\lambda_x + \lambda_y$ (2) $\frac{\lambda_x\lambda_y}{\lambda_x + \lambda_y}$

(3) $\frac{\lambda_x\lambda_y}{|\lambda_x - \lambda_y|}$ (4) $\lambda_x - \lambda_y$

25. 50 W/m^2 energy density of sunlight is normally incident on the surface of a solar panel. Some part of incident energy (25%) is reflected from the surface and the rest is absorbed. The force exerted on 1m^2 surface area will be close to ($c = 3 \times 10^8$ m/s) :-

(1) 15×10^{-8} N (2) 35×10^{-8} N

(3) 10×10^{-8} N (4) 20×10^{-8} N

26. A He^+ ion is in its first excited state. Its ionization energy is :-

(1) 6.04 eV (2) 13.60 eV

(3) 54.40 eV (4) 48.36 eV

27. The electric field of light wave is given as

$$\vec{E} = 10^{-3}\cos\left(\frac{2\pi x}{5\times10^{-7}} - 2\pi\times6\times10^{14}t\right)\hat{x}\frac{N}{C}$$ .This

light falls on a metal plate of work function 2eV. The stopping potential of the photo-electrons is :

Given, E (in eV) = $\frac{12375}{\lambda(\text{in Å})}$

(1) 0.48 V (2) 2.0 V

(3) 2.48 V (4) 0.72 V

28. Taking the wavelength of first Balmer line in hydrogen spectrum (n = 3 to n = 2) as 660 nm, the wavelength of the 2^{nd} Balmer line (n = 4 to n = 2) will be :

(1) 889.2 nm (2) 642.7 nm

(3) 488.9 nm (4) 388.9 nm

29. Light is incident normally on a completely absorbing surface with an energy flux of 25 Wcm^{-2}. if the surface has an area of 25 cm^{-2}, the momentum transferred to the surface in 40 min time duration will be :

(1) 5.0×10^{-3} Ns (2) 3.5×10^{-6} Ns

(3) 1.4×10^{-6} Ns (4) 6.3×10^{-4} Ns

30. A 2 mW laser operates at a wavelength of 500 nm. The number of photons that will be emitted per second is :

[Given Planck's constant h = 6.6×10^{-34} Js, speed of light c = 3.0×10^8 m/s]

(1) 2×10^{16} (2) 1.5×10^{16}

(3) 5×10^{15} (4) 1×10^{16}

31. In Li^{++}, electron in first Bohr orbit is excited to a level by a radiation of wavelength λ. when the ion gets deexcited to the ground state in all possible ways (including intermediate emissions), a total of six spectral lines are observed. What is the value of λ ?

(Given : h = 6.63×10^{-34} Js; c = 3×10^8 ms^{-1})

(1) 9.4 nm (2) 12.3 nm

(3) 10.8 nm (4) 11.4 nm

32. Two radioactive substances A and B have decay constants 5λ and λ respectively. At t = 0, a sample has the same number of the two nuclei. The time taken for the ratio of the number of nuclei to become $\left(\frac{1}{e}\right)^2$ will be :

(1) 1 / 4λ (2) 1 / λ

(3) 1 / 2λ (4) 2 / λ

33. A proton, an electron, and a Helium nucleus, have the same energy. They are in circular orbits in a plane due to magnetic field perpendicualr to the plane. Let r_p, r_e and r_{He} be their respective radii, then,

(1) $r_e > r_p > r_{He}$ (2) $r_e < r_p < r_{He}$

(3) $r_e < r_p = r_{He}$ (4) $r_e > r_p = r_{He}$

34. In a photoelectric effect experiment the threshold wavelength of the light is 380 nm. If the wavelentgh of incident light is 260 nm, the maximum kinetic energy of emitted electrons will be: Given E (in eV) = $\frac{1237}{\lambda(\text{in nm})}$

(1) 1.5 eV (2) 4.5 eV

(3) 15.1 eV (4) 3.0 eV

35. Two radioactive materials A and B have decay constants 10λ and λ, respectively. It initially they have the same number of nuclei, then the ratio of the number of nuclei of A to that of B will be 1/e after a time :

(1) $\frac{11}{10\lambda}$ (2) $\frac{1}{9\lambda}$ (3) $\frac{1}{10\lambda}$ (4) $\frac{1}{11\lambda}$

36. The electron in a hydrogen atom first jumps from the third excited state to the second excited state and subsequently to the first excited state. The ratio of the respective wavelengths, λ_1/λ_2, of the photons emitted in this process is :

(1) 9/7 (2) 7/5

(3) 27/5 (4) 20/7

37. Consider an electron in a hydrogen atom, revolving in its second excited state (having radius 4.65Å). The de-Broglie wavelength of this electron is :

(1) 12.9 Å (2) 3.5 Å

(3) 9.7 Å (4) 6.6 Å

38. Half lives of two radioactive nuclei A and B are 10 minutes and 20 minutes, respectively. If, initially a sample has equal number of nuclei, then after 60 minutes, the ratio of decayed numbers of nuclei A and B will be :

(1) 9 : 8 (2) 1 : 8

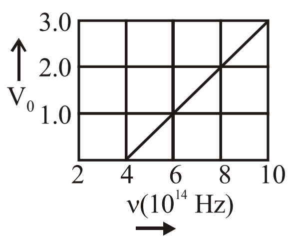
(3) 8 : 1 (4) 3 : 8

39. The stopping potential V_0 (in volt) as a function of frequency (ν) for a sodium emitter, is shown in the figure. The work function of sodium, from the data plotted in the figure, will be :

(Given : Planck's constant

(h) = 6.63×10^{-34} Js, electron

charge e = 1.6×10^{-19} C)



(1) 1.95 eV (2) 1.82 eV

(3) 1.66 eV (4) 2.12 eV

40. An excited He^+ ion emits two photons in succession, with wavelengths 108.5 nm and 30.4 nm, in making a transition to ground state. The quantum number n, corresponding to its initial excited state is (for photon of wavelength λ, energy $E = \dfrac{1240\text{eV}}{\lambda(\text{in nm})}$) :

(1) n = 5 (2) n = 4

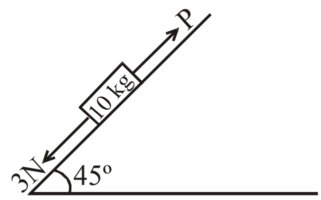
(3) n = 6 (4) n = 7

NLM & FRICTION

1. A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the rope at some point, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is (g = 10 ms $^{-2}$)

(1) 200 N (2) 100 N (3) 140 N (4) 70 N

2. A block of mass 10 kg is kept on a rough inclined plane as shown in the figure. A force of 3 N is applied on the block. The coefficient of static friction between the plane and the block is 0.6. What should be the minimum value of force P, such that the block doesnot move downward ? (take g = 10 ms^{-2})

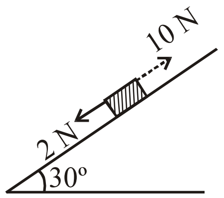


(1) 32 N (2) 25 N (3) 23 N (4) 18 N

3. A particle of mass m is moving in a straight line with momentum p. Starting at time t = 0, a force F = kt acts in the same direction on the moving particle during time interval T so that its momentum changes from p to 3p. Here k is a constant. The value of T is :-

(1) $2\sqrt{\dfrac{p}{k}}$ (2) $\sqrt{\dfrac{2p}{k}}$ (3) $\sqrt{\dfrac{2k}{p}}$ (4) $2\sqrt{\dfrac{k}{p}}$

4. A block kept on a rough inclined plane, as shown in the figure, remaias at rest upto a maximum force 2 N down the inclined plane. The maximum external force up the inclined plane that does not move the block is 10 N. The coefficient of static friction betwreen the block and the plane is : [Take g = 10 m/s^2]



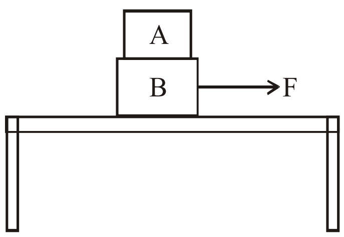
(1) $\frac{2}{3}$ (2) $\frac{\sqrt{3}}{2}$ (3) $\frac{\sqrt{3}}{4}$ (4) $\frac{1}{2}$

5. A bullet of mass 20 g has an initial speed of 1 ms^{-1}, just before it starts penetrating a mud wall of thickness 20 cm. if the wall offers a mean resistance of 2.5×10^{-2} N, the speed of the bullet after emerging from the other side of the wall is close to :

(1) 0.4 ms^{-1} (2) 0.1 ms^{-1}

(3) 0.3 ms^{-1} (4) 0.7 ms^{-1}

6. Two blocks A and B of masses m_A = 1 kg and m_B = 3 kg are kept on the table as shown in figure. The coefficient of friction between A and B is 0.2 and between B and the surface of the table is also 0.2. The maximum force F that can be applied on B horizontally, so that the block A does not slide over the block B is: (Take g = 10 m/s^2)



(1) 16 N (2) 40 N (3) 12 N (4) 8 N

7. A ball is thrown upward with an initial velocity V_0 from the surface of the earth. The motion of the ball is affected by a drag force equal to $m\gamma\upsilon^2$ (where m is mass of the ball, υ is its instantaneous velocity and γ is a constant). Time taken by the ball to rise to its zenith is :

(1) $\frac{1}{\sqrt{\gamma g}}\sin^{-1}\left(\sqrt{\frac{\gamma}{g}}V_0\right)$

(2) $\frac{1}{\sqrt{\gamma g}}\tan^{-1}\left(\sqrt{\frac{\gamma}{g}}V_0\right)$

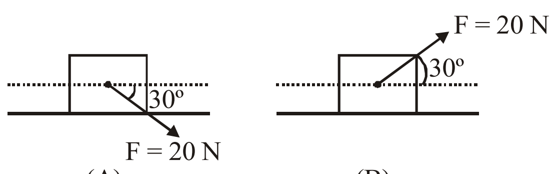
(3) $\frac{1}{\sqrt{2\gamma g}}\tan^{-1}\left(\sqrt{\frac{2\gamma}{g}}V_0\right)$

(4) $\frac{1}{\sqrt{\gamma g}}\ln\left(1+\sqrt{\frac{\gamma}{g}}V_0\right)$

8. A spring whose unstretched length is l has a force constant k. The spring is cut into two pieces of unstretched lengths l_1 and l_2 where, $l_1 = nl_2$ and n is an integer. The ratio k_1/k_2 of the corresponding force constants, k_1 and k_2 will be :

(1) $\frac{1}{n^2}$ (2) n^2 (3) $\frac{1}{n}$ (4) n

9. A block of mass 5 kg is (i) pushed in case (A) and (ii) pulled in case (B), by a force F = 20 N, making an angle of 30º with the horizontal, as shown in the figures. The coefficient of friction between the block and floor is μ = 0.2. The difference between the accelerations of the block, in case (B) and case (A) will be : (g = 10 ms^{-2})



(1) 0 ms^{-2} (2) 0.8 ms^{-2}

(3) 0.4 ms^{-2} (4) 3.2 ms^{-2}

POC

1. In a communication system operating at wavelength 800 nm, only one percent of source frequency is available as signal bandwidth. The number of channels accomodated for transmitting TV signals of band width 6 MHz are (Take velocity of light c = 3×10^8m/s, h = 6.6×10^{-34} J-s)

(1) 3.75×10^6 (2) 4.87×10^5

(3) 3.86×10^6 (4) 6.25×10^5

2. The modulation frequency of an AM radio station is 250 kHz, which is 10% of the carrier wave. If another AM station approaches you for license what broadcast frequency will you allot ?

(1) 2750 kHz (2) 2000 kHz

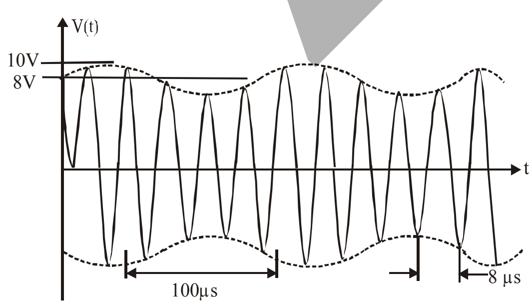
(3) 2250 kHz (4) 2900 kHz

3. A TV transmission tower has a height of 140 m and the height of the receiving antenna is 40 m. What is the maximum distance upto which signals can be broadcasted from this tower in LOS(Line of Sight) mode ?

(Given : radius of earth = 6.4×10^6m).

(1) 80 km (2) 48 km (3) 40 km (4) 65 km

4. An amplitude modulated signal is plotted below :-



Which one of the following best describes the above signal ?

(1) $(9 + \sin(2.5\pi \times 10^5\ t))\sin(2\pi \times 10^4 t)$V

(2) $(9 + \sin(4\pi \times 10^4\ t))\sin(5\pi \times 10^5 t)$V

(3) $(1 + 9\sin(2\pi \times 10^4\ t))\sin(2.5\pi \times 10^5 t)$V

(4) $(9 + \sin(2\pi \times 10^4\ t))\sin(2.5\pi \times 10^5 t)$V

5. An amplitude modulated signal is given by $V(t) = 10[1 + 0.3\cos(2.2 \times 10^4 t)]\sin(5.5 \times 10^5 t)$. Here t is in seconds. The sideband frequencies (in kHz) are, [Given π = 22/7]

(1) 1785 and 1715 (2) 892.5 and 857.5

(3) 89.25 and 85.75 (4) 178.5 and 171.5

6. To double the coverging range of a TV transmittion tower, its height should be multiplied by :-

(1) $\frac{1}{\sqrt{2}}$ (2) 4

(3) $\sqrt{2}$ (4) 2

7. A 100 V carrier wave is made to vary between 160 V and 40 V by a modulating signal. What is the modulation index?

(1) 0.6 (2) 0.5

(3) 0.3 (4) 0.4

8. In a line of sight radio communication, a distance of about 50 km is kept between the transmitting and receiving antennas. If the height of the receiving antenna is 70m, then the minimum height of the transmitting antenna should be : (Radius of the Earth = 6.4×10^6 m).

(1) 40 m (2) 51 m (3) 32 m (4) 20 m

9. The physical sizes of the transmitter and receiver antenna in a communication system are :-

(1) proportional to carrier frequency

(2) inversely proportional to modulation frequency

(3) inversely proportional to carrier frequency

(4) independent of both carrier and modulation frequency

10. A signal Acosωt is transmitted using $\nu_0 \sin \omega_0 t$ as carrier wave. The correct amplitude modulated (AM) signal is :

(1) $\nu_0 \sin \omega_0 t + A \cos \omega t$

(2) $\nu_0 \sin \omega_0 t + \frac{A}{2}\sin(\omega_0 - \omega)t + \frac{A}{2}\sin(\omega_0 + \omega)t$

(3) $(\nu_0 + A)\cos \omega t \sin \omega_0 t$

(4) $\nu_0 \sin[\omega_0(1 + 0.01A \sin \omega t)t]$

11. A message signal of frequency 100 MHz and peak voltage 100 V is used to execute amplitude modulation on a carrier wave of frequency 300 GHz and peak voltage 400 V. The modulation index and difference between the two side band frequencies are :

(1) 4; 1×10^8 Hz (2) 0.25; 1×10^8 Hz

(3) 4; 2×10^8 Hz (4) 0.25; 2×10^8 Hz

12. Given below in the the left column are different modes of communication using the kinds of waves given the right column.

A.	Optical Fibre communication	P.	Ultrasound
B.	Radar	Q.	Infrared Light
C.	Sonar	R.	Microwaves
D.	Mobile Phones	S.	Radio Waves

(1) A-S, B-Q, C-R, D-P

(2) A-R, B-P, C-S, D-Q

(3) A-Q, B-S, C-R, D-P

(4) A-Q, B-S, C-P, D-R

13. In an amplitude modulator circuit, the carrier wave is given by,

$C(t) = 4 \sin(20000\,\pi t)$ while modulating signal is given by, $m(t) = 2 \sin(2000\,\pi t)$. The values of modulation index and lower side band frequency are :

(1) 0.5 and 9 kHz (2) 0.5 and 10 kHz

(3) 0.3 and 9 kHz (4) 0.4 and 10 kHz

14. The wavelength of the carrier waves in a modern optical fiber communication network is close to :

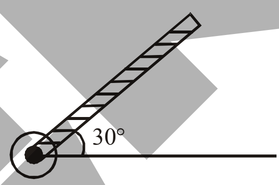
(1) 600 nm (2) 900 nm

(3) 2400 nm (4) 1500 nm

ROTATIONAL MECHANICS

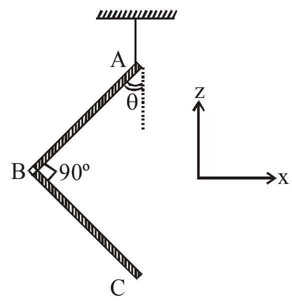
1. A rod of length 50cm is pivoted at one end. It is raised such that if makes an angle of 30° from the horizontal as shown and released from rest. Its angular speed when it passes through the horizontal (in rad s^{-1}) will be

$(g = 10ms^{-2})$



(1) $\sqrt{30}$ (2) $\sqrt{\frac{30}{2}}$ (3) $\frac{\sqrt{30}}{2}$ (4) $\frac{\sqrt{20}}{3}$

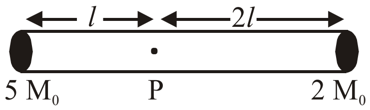
2. An L-shaped object, made of thin rods of uniform mass density, is suspended with a string as shown in figure. If AB = BC, and the angle made by AB with downward vertical is θ, then :



(1) $\tan\theta = \frac{2}{\sqrt{3}}$ (2) $\tan\theta = \frac{1}{3}$

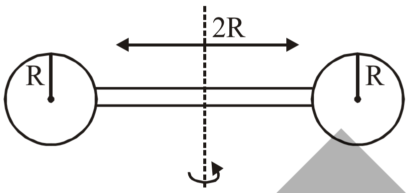
(3) $\tan\theta = \frac{1}{2}$ (4) $\tan\theta = \frac{1}{2\sqrt{3}}$

3. A rigid massless rod of length $3l$ has two masses attached at each end as shown in the figure. The rod is pivoted at point P on the horizontal axis (see figure). When released from initial horizontal position, its instantaneous angular acceleration will be :



(1) $\frac{g}{2l}$ (2) $\frac{7g}{3l}$ (3) $\frac{g}{13l}$ (4) $\frac{g}{3l}$

4. Two identical spherical balls of mass M and radius R each are stuck on two ends of a rod of length 2R and mass M (see figure). The moment of inertia of the system about the axis passing perpendicularly through the centre of the rod is :



(1) $\frac{152}{15}MR^2$ (2) $\frac{17}{15}MR^2$

(3) $\frac{137}{15}MR^2$ (4) $\frac{209}{15}MR^2$

5. To mop-clean a floor, a cleaning machine presses a circular mop of radius R vertically down with a total force F and rotates it with a constant angular speed about its axis. If the force F is distributed uniformly over the mop and if coefficient of friction between the mop and the floor is μ, the torque, applied by the machine on the mop is :

(1) $\frac{2}{3}\mu FR$ (2) $\mu FR/3$

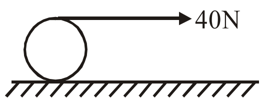
(3) $\mu FR/2$ (4) $\mu FR/6$

6. A homogeneous solid cylindrical roller of radius R and mass M is pulled on a cricket pitch by a horizontal force. Assuming rolling without slipping, angular acceleration of the cylinder is :

(1) $\frac{3F}{2m\,R}$ (2) $\frac{F}{3m\,R}$

(3) $\frac{2F}{3m\,R}$ (4) $\frac{F}{2m\,R}$

7. A string is wound around a hollow cylinder of mass 5 kg and radius 0.5 m. If the string is now pulled with a horizontal force of 40 N, and the cylinder is rolling without slipping on a horizontal surface (see figure), then the angular acceleration of the cylinder will be (Neglect the mass and thickness of the string):-



(1) 12 rad/s^2 (2) 16 rad/s^2

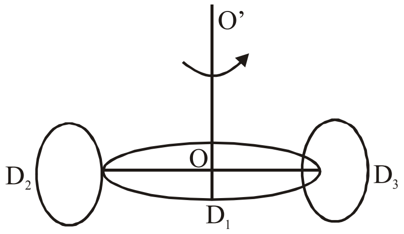
(3) 10 rad/s^2 (4) 20 rad/s^2

8. The magnitude of torque on a particle of mass 1kg is 2.5 Nm about the origin. If the force acting on it is 1 N, and the distance of the particle from the origin is 5m, the angle between the force and the position vector is (in radians) :-

(1) $\frac{\pi}{8}$ (2) $\frac{\pi}{6}$

(3) $\frac{\pi}{4}$ (4) $\frac{\pi}{3}$

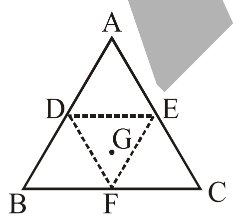
9. A circular disc D_1 of mass M and radius R has two identical discs D_2 and D_3 of the same mass M and radius R attached rigidly at its opposite ends (see figure). The moment of inertia of the system about the axis OO', passing through the centre of D_1, as shown in the figure, will be:-



(1) $3MR^2$ (2) $\frac{2}{3}MR^2$

(3) MR^2 (4) $\frac{4}{5}MR^2$

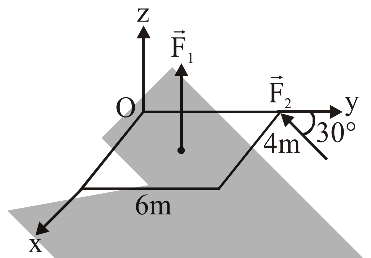
10. An equilateral triangle ABC is cut from a thin solid sheet of wood. (see figure) D, E and F are the mid-points of its sides as shown and G is the centre of the triangle. The moment of inertia of the triangle about an axis passing through G and perpendicular to the plane of the triangle is I_0. It the smaller triangle DEF is removed from ABC, the moment of inertia of the remaining figure about the same axis is I. Then:



(1) $I = \frac{9}{16}I_0$ (2) $I = \frac{3}{4}I_0$

(3) $I = \frac{I_0}{4}$ (4) $I = \frac{15}{16}I_0$

11. A slob is subjected to two forces $\vec{F}_1$ and $\vec{F}_2$ of same magnitude F as shown in the figure. Force $\vec{F}_2$ is in XY-plane while force F_1 acts along z-axis at the point $(2\vec{i} + 3\vec{j})$. The moment of these forces about point O will be :



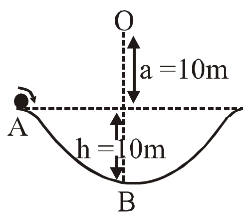
(1) $(3\hat{i} - 2\hat{j} - 3\hat{k})F$

(2) $(3\hat{i} + 2\hat{j} + 3\hat{k})F$

(3) $(3\hat{i} + 2\hat{j} - 3\hat{k})F$

(4) $(3\hat{i} - 2\hat{j} + 3\hat{k})F$

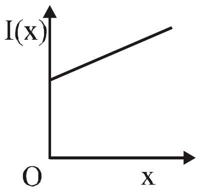
12. A particle of mass 20 g is released with an initial velocity 5 m/s along the curve from the point A, as shown in the figure. The point A is at height h from point B. The particle slides along the frictionless surface. When the particle reaches point B, its angular momentum about O will be : (Take g= 10 m/s^2)

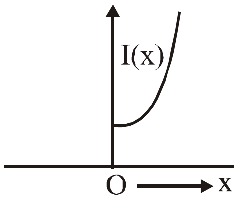


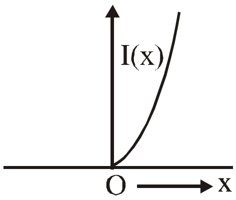
(1) 8kg-m^2/s (2) 6kg-m^2/s

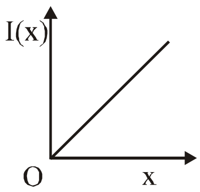
(3) 3kg-m^2/s (4) 2kg-m^2/s

13. The moment of inertia of a solid sphere, about an axis parallel to its diameter and at a distance of x from it, is I(x)'. Which one of the graphs represents the variation of I(x) with x correctlv?

(1) 

(2) 

(3) 

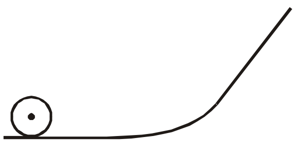
(4) 

14. Let the moment of inertia of a hollow cylinder of length 30 cm (inner radius 10 cm and outer radius 20 cm), about its axis be I. The radius of a thin cylinder of the same mass such that its moment of inertia about its axis is also I, is:

(1) 12 cm (2) 18 cm

(3) 16 cm (4) 14 cm

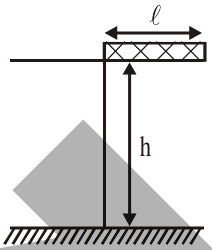
15. A solid sphere and solid cylinder of identical radii approach an incline with the same linear velocity (see figure). Both roll without slipping all throughout. The two climb maximum heights h_{sph} and h_{cyl} on the incline. The ratio $\frac{h_{sph}}{h_{cyl}}$ is given by :-



(1) $\frac{14}{15}$ (2) $\frac{4}{5}$

(3) 1 (4) $\frac{2}{\sqrt{5}}$

16. A rectangular solid box of length 0.3 m is held horizontally, with one of its sides on the edge of a platform of height 5m. When released, it slips off the table in a very short time $\tau = 0.01$s, remaining essentially horizontal. The angle by which it would rotate when it hits the ground will be (in radians) close to :-



(1) 0.02 (2) 0.28 (3) 0.5 (4) 0.3

17. A thin circular plate of mass M and radius R has its density varying as $\rho(r) = \rho_0 r$ with ρ_0 as constant and r is the distance from its centre. The moment of Inertia of the circular plate about an axis perpendicular to the plate and passing through its edge is $I = aMR^2$. The value of the coefficient a is :

(1) $\frac{3}{2}$ (2) $\frac{1}{2}$ (3) $\frac{3}{5}$ (4) $\frac{8}{5}$

18. Moment of inertia of a body about a given axis is 1.5 kg m^2. Initially the body is at rest. In order to produce a rotational kinetic energy of 1200 J, the angular accleration of 20 rad/s^2 must be applied about the axis for a duration of :-

(1) 2 s (2) 5s (3) 2.5 s (4) 3 s

19. A thin smooth rod of length L and mass M is rotating freely with angular speed ω_0 about an axis perpendicular to the rod and passing through its center. Two beads of mass m and negligible size are at the center of the rod initially. The beads are free to slide along the rod. The angular speed of the system, when the beads reach the opposite ends of the rod, will be :-

(1) $\frac{M\omega_0}{M+3m}$ (2) $\frac{M\omega_0}{M+m}$

(3) $\frac{M\omega_0}{M+2m}$ (4) $\frac{M\omega_0}{M+6m}$

20. The following bodies are made to roll up (without slipping) the same inclined plane from a horizontal plane. : (i) a ring of radius R, (ii) a solid cylinder of radius $\frac{R}{2}$ and (iii) a solid sphere of radius $\frac{R}{4}$. If in each case, the speed of the centre of mass at the bottom of the incline is same, the ratio of the maximum heights they climb is :

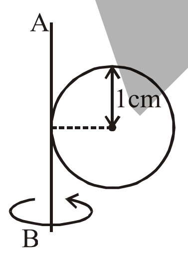
(1) 4 : 3 : 2 (2) 14 : 15 : 20

(3) 10 : 15 : 7 (4) 2 : 3 : 4

21. A stationary horizontal disc is free to rotate about its axis. When a torque is applied on it, its kinetic energy as a function of θ, where θ is the angle by which it has rotated, is given as $k\theta^2$. If its moment of inertia is I then the angular acceleration of the disc is :

(1) $\frac{k}{2I}\theta$ (2) $\frac{k}{I}\theta$ (3) $\frac{k}{4I}\theta$ (4) $\frac{2k}{I}\theta$

22. A metal coin of mass 5 g and radius 1 cm is fixed to a thin stick AB of negligible mass as shown in the figure. The system is initially at rest. The constant torque, that will make the system rotate about AB at 25 rotations per second in 5 s, is close to :



(1) 4.0×10^{-6} Nm

(2) 2.0×10^{-5} Nm

(3) 1.6×10^{-5} Nm

(4) 7.9×10^{-6} Nm

23. The time dependence of the position of a particle of mass m = 2 is given by $\vec{r}(t) = 2t\hat{i} - 3t^2\hat{j}$. Its angular momentum, with respect to the origin, at time t = 2 is :

(1) $36\hat{k}$ (2) $-34(\hat{k}-\hat{i})$

(3) $48(\hat{i}+\hat{j})$ (4) $-48\hat{k}$

24. A solid sphere of mass M and radius R is divided into two unequal parts. The first part has a mass of $\frac{7M}{8}$ and is converted into a uniform disc of radius 2R. The second part is converted into a uniform solid sphere. Let I_1 be the moment of inertia of the disc about its axis and I_2 be the moment of inertia of the new sphere about its axis. The ratio I_1/I_2 is given by :

(1) 185 (2) 65 (3) 285 (4) 140

25. A thin disc of mass M and radius R has mass per unit area $\sigma(r) = kr^2$ where r is the distance from its centre. Its moment of inertia about an axis going through its centre of mass and perpendicular to its plane is :

(1) $\frac{MR^2}{6}$ (2) $\frac{MR^2}{3}$

(3) $\frac{2MR^2}{3}$ (4) $\frac{MR^2}{2}$

26. Two coaxial discs, having moments of inertia I_1 and $\frac{I_1}{2}$, are rotating with respective angular velocities ω_1 and $\frac{\omega_1}{2}$, about their common axis. They are brought in contact with each other and thereafter they rotate with a common angular velocity. If E_f and E_i are the final and initial total energies, then $(E_f - E_i)$ is :

(1) $\frac{I_1\omega_1^2}{12}$ (2) $\frac{3}{8}I_1\omega_1^2$

(3) $\frac{I_1\omega_1^2}{6}$ (4) $\frac{I_1\omega_1^2}{24}$

27. A particle of mass m is moving along a trajectory given by

$x = x_0 + a\cos\omega_1 t$

$y = y_0 + b\sin\omega_2 t$

The torque, acting on the particle about the origin, at t = 0 is :

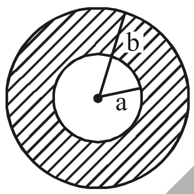
(1) $m(-x_0 b + y_0 a)\omega_1^2\hat{k}$

(2) $+my_0 a\omega_1^2\hat{k}$

(3) $-m(x_0 b\omega_2^2 - y_0 a\omega_1^2)\hat{k}$

(4) Zero

28. A circular disc of radius b has a hole of radius a at its centre (see figure). If the mass per unit area of the disc varies as $\left(\frac{\sigma_0}{r}\right)$, then the radius of gyration of the disc about its axis passing through the centre is :



(1) $\frac{a+b}{2}$ (2) $\frac{a+b}{3}$

(3) $\sqrt{\frac{a^2+b^2+ab}{2}}$ (4) $\sqrt{\frac{a^2+b^2+ab}{3}}$

29. A person of mass M is, sitting on a swing of length L and swinging with an angular amplitude θ_0. If the person stands up when the swing passes through its lowest point, the work done by him, assuming that his centre of mass moves by a distance ℓ ($\ell << L$), is close to :

(1) $Mg\ell$

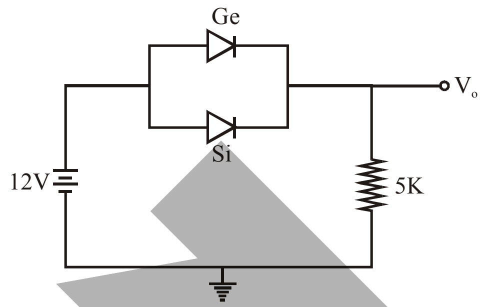
(2) $Mg\ell(1+\theta_0^2)$

(3) $Mg\ell(1-\theta_0^2)$

(4) $Mg\ell\left(1+\frac{\theta_0^2}{2}\right)$

SEMICONDUCTOR

1. Ge and Si diodes start conducting at 0.3 V and 0.7 V respectively. In the following figure if Ge diode connection are reversed, the value of V_o changes by : (assume that the Ge diode has large breakdown voltage)



(1) 0.6 V (2) 0.8 V

(3) 0.4 V (4) 0.2 V

2. Mobility of electrons in a semiconductor is defined as the ratio of their drift velocity to the applied electric field. If, for an n-type semiconductor, the density of electrons is $10^{19} m^{-3}$ and their mobility is $1.6\ m^2/(V.s)$ then the resistivity of the semiconductor (since it is an n-type semiconductor contribution of holes is ignored) is close to:

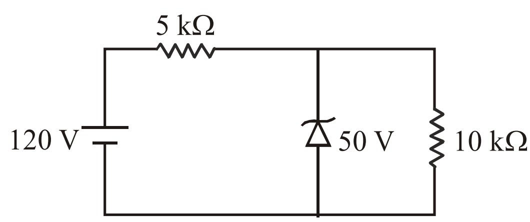
(1) 2Ωm

(2) 0.4Ωm

(3) 4Ωm

(4) 0.2Ωm

3. For the circuit shown below, the current through the Zener diode is :



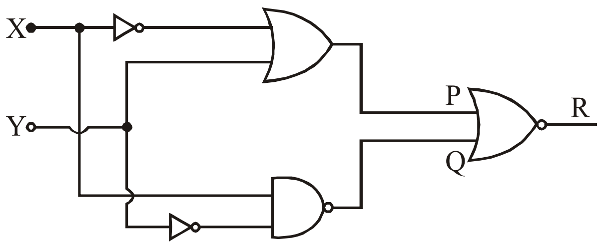
(1) 5 mA

(2) Zero

(3) 14 mA

(4) 9 mA

4. To get output '1' at R, for the given logic gate circuit the input values must be :



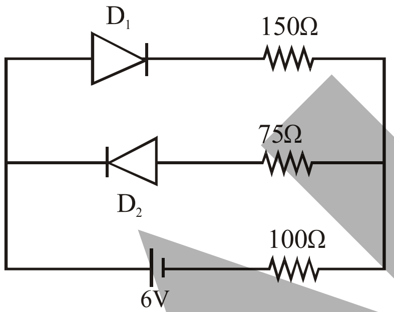
(1) X = 0, Y = 1

(2) X =1 , Y = 1

(3) X = 0, Y = 0

(4) X = 1, Y = 0

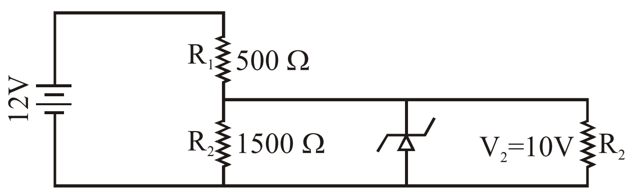
5. The circuit shown below contains two ideal diodes, each with a forward resistance of 50Ω. If the battery voltage is 6 V, the current through the 100 Ω resistance (in Amperes) is :-



(1) 0.027 (2) 0.020

(3) 0.030 (4) 0.036

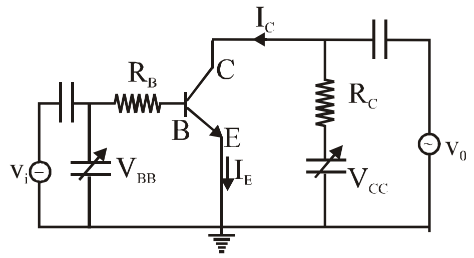
6. In the given circuit the current through Zener Diode is close to :



(1) 6.0 mA (2) 4.0 mA

(3) 6.7 mA (4) 0.0 mA

7.



In the figure, given that V_{BB} supply can vary from 0 to 5.0 V, V_{CC} = 5V, β_{dc} = 200, R_B = 100 kΩ, R_C=1 kΩ and V_{BE}=1.0 V, The minimum base current and the input voltage at which the transistor will go to saturation, will be, respectively :

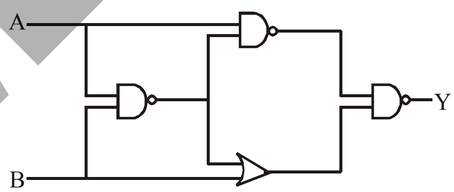
(1) 20μA and 3.5V

(2) 25μA and 3.5V

(3) 25μA and 2.8V

(4) 20μA and 2.8V

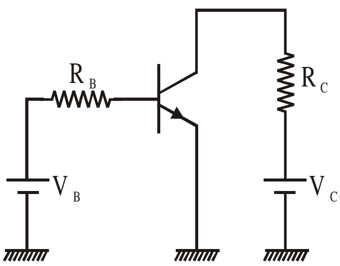
8. The output of the given logic circuit is :



(1) $\bar{A}B$ (2) $A\bar{B}$

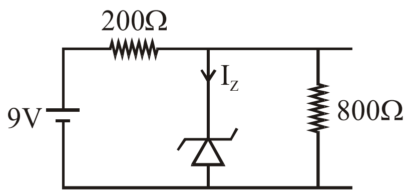
(3) $AB+\overline{AB}$ (4) $A\bar{B}+\bar{A}B$

9. A common emitter amplifier circuit, built using an npn transistor, is shown in the figure. Its dc current gain is 250, R_C = 1kΩ and V_{CC} = 10 V. What is the minimum base current for V_{CE} to reach saturation ?



(1) 100 μA (2) 7 μA (3) 40 μA (4) 10μA

10. The reverse breakdown voltage of a Zener diode is 5.6 V in the given circuit.

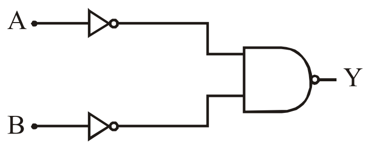


The current I_Z through the Zener is :

(1) 7 mA (2) 17 mA

(3) 10 mA (4) 15mA

11. The logic gate equivalent to the given logic circuit is :-



(1) OR (2) AND

(3) NOR (4) NAND

12. An NPN transistor is used in common emitter configuration as an amplifier with 1 kΩ load resistance. Signal voltage of 10 mV is applied across the base-emitter. This produces a 3 mA change in the collector current and 15μA change in the base current of the amplifier. The input resistance and voltage gain are :

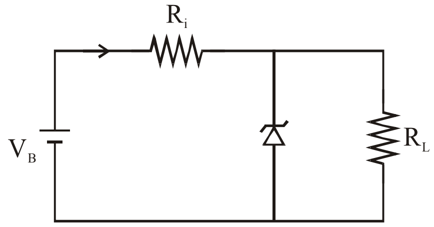
(1) 0.33 kΩ, 1.5

(2) 0.67 kΩ, 200

(3) 0.33 kΩ, 300

(4) 0.67 kΩ, 300

13. The figure represents a voltage regulator circuit using a Zener diode. The breakdown voltage of the Zener diode is 6V and the load resistance is R_L = 4 kΩ. The series resistance of the circuit is R_i = 1 kΩ. If the battery voltage V_B varies from 8V to 16V, what are the minimum and maximum values of the current through Zener diode ?



(1) 0.5 mA ; 6 mA

(2) 0.5 mA ; 8.5 mA

(3) 1.5 mA ; 8.5 mA

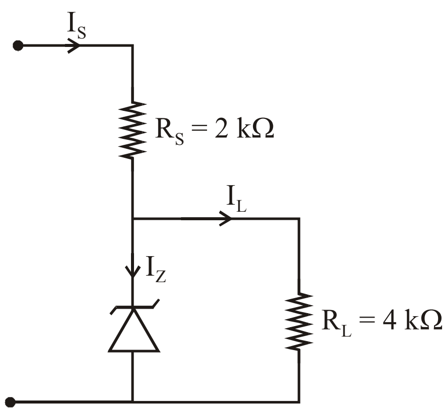
(4) 1 mA ; 8.5 mA

14. An npn transistor operates as a common emitter amplifier, with a power gain of 60 dB. The input circuit resistance is 100Ω and the output load resistance is 10 kΩ. The common emitter current gain β is :

(1) 60 (2) 10^4

(3) 6×10^2 (4) 10^2

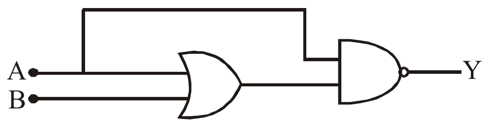
15. Figure shown a DC voltage regulator circuit, with a Zener diode of breakdown voltage = 6V. If the unregulated input voltage varies between 10 V to 16 V, then what is the maximum Zener current ?



(1) 2.5 mA (2) 3.5 mA

(3) 7.5 mA (4) 1.5 mA

16. The truth table for the circuit given in the fig. is:



(1)

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0

(2)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

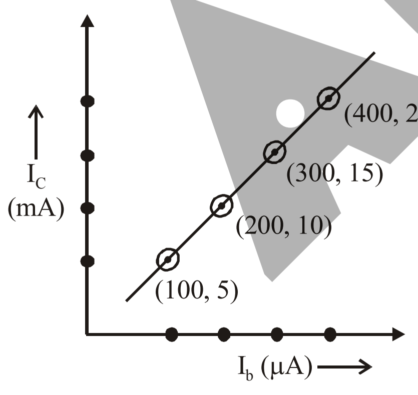
(3)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

(4)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	1

17. The transfer characteristic curve of a transistor, having input and output resistance 100 Ω and 100 kΩ respectively, is shown in the figure. The Voltage and Power gain, are respectively:



(1) 5×10^4, 5×10^5
(2) 5×10^4, 5×10^6
(3) 5×10^4, 2.5×10^6
(4) 2.5×10^4, 2.5×10^6

SHM

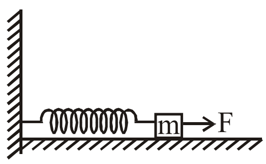
1. A rod of mass 'M' and length '2L' is suspended at its middle by a wire. It exhibits torsional oscillations; If two masses each of 'm' are attached at distance 'L/2' from its centre on both sides, it reduces the oscillation frequency by 20%. The value of ratio m/M is close to :

(1) 0.17 (2) 0.37
(3) 0.57 (4) 0.77

2. A particle is executing simple harmonic motion (SHM) of amplitude A, along the x-axis, about x = 0. When its potential Energy (PE) equals kinetic energy (KE), the position of the particle will be :

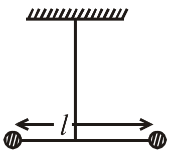
(1) $\frac{A}{2}$ (2) $\frac{A}{2\sqrt{2}}$
(3) $\frac{A}{\sqrt{2}}$ (4) A

3. A block of mass m, lying on a smooth horizontal surface, is attached to a spring (of negligible mass) of spring constant k. The other end of the spring is fixed, as shown in the figure. The block is initally at rest in its equilibrium position. If now the block is pulled with a constant force F, the maximum speed of the block is :



(1) $\frac{\pi F}{\sqrt{mk}}$ (2) $\frac{2F}{\sqrt{mk}}$
(3) $\frac{F}{\sqrt{mk}}$ (4) $\frac{F}{\pi\sqrt{mk}}$

4. Two masses m and $\frac{m}{2}$ are connected at the two ends of a massless rigid rod of length l. The rod is suspended by a thin wire of torsional constant k at the centre of mass of the rod-mass system(see figure). Because of torsional constant k, the restoring torque is $\tau=k\theta$ for angular displacement 0. If the rod is rota ted by θ_0 and released, the tension in it when it passes through its mean position will be:



(1) $\frac{3k\theta_0^2}{l}$ (2) $\frac{k\theta_0^2}{2l}$

(3) $\frac{2k\theta_0^2}{l}$ (4) $\frac{k\theta_0^2}{l}$

5. A particle executes simple harmonic motion with an amplitude of 5 cm. When the particle is at 4 cm from the mean position, the magnitude of its velocity in SI units is equal to that of its acceleration. Then, its periodic time in seconds is :

(1) $\frac{7}{3}\pi$ (2) $\frac{3}{8}\pi$

(3) $\frac{4\pi}{3}$ (4) $\frac{8\pi}{3}$

6. A simple pendulum of length 1 m is oscillating with an angular frequency 10 rad/s. The support of the pendulum starts oscillating up and down with a small angular frequency of 1 rad/s and an amplitude of 10^{-2} m. The relative change in the angular frequency of the pendulum is best given by :-

(1) 10^{-3} rad/s (2) 10^{-1} rad/s

(3) 1 rad/s (4) 10^{-5} rad/s

7. A pendulum is executing simple harmonic motion and its maximum kinetic energy is K_1. If the length of the pendulum is doubled and it performs simple harmonic motion with the same amplitude as in the first case, its maximum kinetic energy is K_2. Then :-

(1) $K_2 = \frac{K_1}{4}$

(2) $K_2 = \frac{K_1}{2}$

(3) $K_2 = 2K_1$

(4) $K_2 = K_1$

8. A particle undergoing simple harmonic motion has time dependent displacement given by $x(t) = A\sin\frac{\pi t}{90}$. The ratio of kinetic to potential energy of this particle at t = 210 s will be :

(1) 2 (2) $\frac{1}{9}$

(3) 3 (4) 1

9. A simple harmonic motion is represented by:

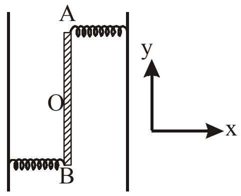
$y = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$ cm

The amplitude and time period of the motion are:

(1) 5cm, $\frac{3}{2}$s (2) 5cm, $\frac{2}{3}$s

(3) 10cm, $\frac{3}{2}$s (4) 10cm, $\frac{2}{3}$s

10. Two light identical springs of spring constant k are attached horizontally at the two ends of a uniform horizontal rod AB of length ℓ and mass m. The rod is pivoted at its centre 'O' and can rotate freely in horizontal plane. The other ends of the two springs are fixed to rigid supports as shown in figure. The rod is gently pushed through a small angle and released. The frequency of resulting oscillation is:



(1) $\frac{1}{2\pi}\sqrt{\frac{6k}{m}}$

(2) $\frac{1}{2\pi}\sqrt{\frac{2k}{m}}$

(3) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$

(4) $\frac{1}{2\pi}\sqrt{\frac{3k}{m}}$

11. A simple pendulum oscillating in air has period T. The bob of the pendulum is completely immersed in a non-viscous liquid. The density of the liquid is $\frac{1}{16}$ th of the material of the bob. If the bob is inside liquid all the time, its period of oscillation in this liquid is :

(1) $4T\sqrt{\frac{1}{15}}$ (2) $2T\sqrt{\frac{1}{10}}$

(3) $4T\sqrt{\frac{1}{14}}$ (4) $2T\sqrt{\frac{1}{14}}$

UNIT & DIMENSION

1. Expression for time in terms of G (universal gravitational constant), h (Planck constant) and c (speed of light) is proportional to :

(1) $\sqrt{\frac{Gh}{c^3}}$ (2) $\sqrt{\frac{hc^5}{G}}$

(3) $\sqrt{\frac{c^3}{Gh}}$ (4) $\sqrt{\frac{Gh}{c^5}}$

2. The density of a material in SI units is 128 kg m^{-3}. In certain units in which the unit of length is 25 cm and the unit of mass is 50 g, the numerical value of density of the material is :

(1) 410 (2) 640 (3) 16 (4) 40

3. If speed (V), acceleration (A) and force (F) are considered as fundamental units, the dimension of Young's modulus will be :-

(1) $V^{-2} A^2F^2$ (2) $V^{-4}A^2F$

(3) $V^{-4}A^{-2}F$ (4) $V^{-2}A^2F^{-2}$

4. The force of interaction between two atoms is given by $F = \alpha\beta\exp\left(-\frac{x^2}{\alpha kt}\right)$; where x is the distance, k is the Boltzmann constant and T is temperature and α and β are two constants. The dimension of β is :

(1) $M^2L^2T^{-2}$ (2) M^2LT^{-4}

(3) $M^0L^2T^{-4}$ (4) MLT^{-2}

5. Let ℓ, r, c and v represent inductance, resistance, capacitance and voltage, respectively. The dimension of $\frac{\ell}{rcv}$ in SI units will be:

(1) [LTA] (2) $[LA^{-2}]$

(3) $[A^{-1}]$ (4) $[LT^2]$

6. If surface tension (S), Moment of inertia (I) and Planck's constant (h), were to be taken as the fundamental units, the dimensional formula for linear momentum would be :-

(1) $S^{3/2}I^{1/2}h^0$ (2) $S^{1/2}I^{1/2}h^0$

(3) $S^{1/2}I^{1/2}h^{-1}$ (4) $S^{1/2}I^{3/2}h^{-1}$

7. In SI units, the dimesions of $\sqrt{\frac{\epsilon_0}{\mu_0}}$ is :

(1) $A^{-1} TML^3$ (2) $A^2T^3M^{-1}L^{-2}$

(3) $AT^2M^{-1}L^{-1}$ (4) $AT^{-3}ML^{3/2}$

8. Which of the following combinations has the dimension of electrical resistance (ε_0 is the permittivity of vacuum and μ_0 is the permeability of vacuum) ?

(1) $\sqrt{\frac{\varepsilon_0}{\mu_0}}$ (2) $\frac{\mu_0}{\varepsilon_0}$

(3) $\sqrt{\frac{\mu_0}{\varepsilon_0}}$ (4) $\frac{\varepsilon_0}{\mu_0}$

VECTOR

1. Two forces P and Q of magnitude 2F and 3F, respectively, are at an angle θ with each other. If the force Q is doubled, then their resultant also gets doubled. Then, the angle is :

(1) 30º (2) 60º

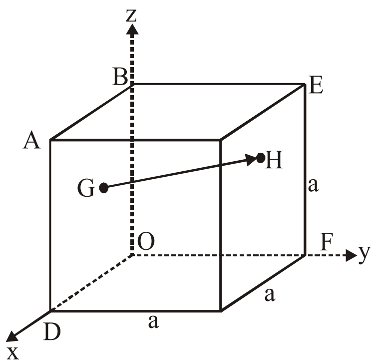
(3) 90º (4) 120º

2. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. The magnitude of $(\vec{A}+\vec{B})$ is 'n' times the magnitude of $(\vec{A}-\vec{B})$. The angle between $\vec{A}$ and $\vec{B}$ is :

(1) $\sin^{-1}\left[\frac{n^2-1}{n^2+1}\right]$ (2) $\cos^{-1}\left[\frac{n-1}{n+1}\right]$

(3) $\cos^{-1}\left[\frac{n^2-1}{n^2+1}\right]$ (4) $\sin^{-1}\left[\frac{n-1}{n+1}\right]$

3. In the cube of side 'a' shown in the figure, the vector from the central point of the face ABOD to the central point of the face BEFO will be:



(1) $\frac{1}{2}a(\hat{i}-\hat{k})$ (2) $\frac{1}{2}a(\hat{j}-\hat{i})$

(3) $\frac{1}{2}a(\hat{k}-\hat{i})$ (4) $\frac{1}{2}a(\hat{j}-\hat{k})$

4. Let $|\vec{A}_1|=3$, $|\vec{A}_2|=5$ and $|\vec{A}_1+\vec{A}_2|=5$. The value of $(2\vec{A}_1+3\vec{A}_2).(3\vec{A}_1-2\vec{A}_2)$ is :-

(1) –112.5 (2) –106.5

(3) –118.5 (4) –99.5

WAVE MOTION

1. A musician using an open flute of length 50 cm produces second harmonic sound waves. A person runs towards the musician from another end of a hall at a speed of 10 km/h. If the wave speed is 330 m/s, the frequency heard by the running person shall be close to :

(1) 753 Hz (2) 500 Hz

(3) 333 Hz (4) 666 Hz

2. Two coherent sources produce waves of different intensities which interfere. After interference, the ratio of the maximum intensity to the minimum intensity is 16. The intensity of the waves are in the ratio:

(1) 4 : 1 (2) 25 : 9

(3) 16 : 9 (4) 5 : 3

3. A heavy ball of mass M is suspended from the ceiling of a car by a light string of mass m (m<<M). When the car is at rest, the speed of transverse waves in the string is 60 ms^{-1}. When the car has acceleration a, the wave-speed increases to 60.5 ms^{-1}. The value of a, in terms of gravitational acceleration g, is closest to :

(1) $\frac{g}{5}$ (2) $\frac{g}{20}$ (3) $\frac{g}{10}$ (4) $\frac{g}{30}$

4. A closed organ pipe has a fundamental frequency of 1.5 kHz. The number of overtones that can be distinctly heard by a person with this organ pipe will be :

(Assume that the highest frequency a person can hear is 20,000 Hz)

(1) 7 (2) 5 (3) 6 (4) 4

5. A string of length 1 m and mass 5 g is fixed at both ends. The tension in the string is 8.0 N. The siring is set into vibration using an external vibrator of frequency 100 Hz. The separation between successive nodes on the string is close to :

(1) 16.6 cm (2) 20.0 cm
(3) 10.0 cm (4) 33.3 cm

6. A train moves towards a stationary observer with speed 34 m/s. The train sounds a whistle and its frequency registered by the observer is f_1. If the speed of the train is reduced to 17 m/s, the frequency registered is f_2. If speed of sound is 340 m/s, then the ratio f_1/f_2 is :

(1) 18/17 (2) 19/18 (3) 20/19 (4) 21/20

7. Equation of travelling wave on a stretched string of linear density 5 g/m is

$y = 0.03 \sin(450\,t - 9x)$

where distance and time are measured is SI units. The tension in the string is :

(1) 10 N (2) 12.5 N (3) 7.5 N (4) 5 N

8. A resonance tube is old and has jagged end. It is still used in the laboratory to determine velocity of sound in air. A tuning fork of frequency 512 Hz produces first resonance when the tube is filled with water to a mark 11 cm below a reference mark, near the open end of the tube. The experiment is repeated with another fork of frequency 256 Hz which produces first resonance when water reaches a mark 27 cm below the reference mark. The velocity of sound in air, obtained in the experiment, is close to:

(1) $328 ms^{-1}$ (2) $322 ms^{-1}$
(3) $341 ms^{-1}$ (4) $335 ms^{-1}$

9. A travelling harmonic wave is represented by the equation $y(x, t) = 10^{-3} \sin(50\,t + 2x)$, where x and y are in meter and t is in seconds. Which of the following is a correct statement about the wave?

The wave is propagating along the

(1) negative x-axis with speed $25 ms^{-1}$

(2) The wave is propagating along the positive x-axis with speed $25 ms^{-1}$

(3) The wave is propagating along the positive x-axis with speed $100 ms^{-1}$

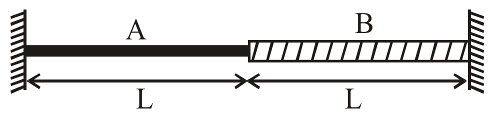
(4) The wave is propagating along the negative x-axis with speed $100 ms^{-1}$

10. A person standing on an open ground hears the sound of a jet aeroplane, coming from north at an angle 60° with ground level. But he finds the aeroplane right vertically above his position. If υ is the speed of sound, speed of the plane is :

(1) $\frac{2\upsilon}{\sqrt{3}}$ (2) υ

(3) $\frac{\upsilon}{2}$ (4) $\frac{\sqrt{3}}{2}\upsilon$

11. A wire of length 2L, is made by joining two wires A and B of same length but different radii r and 2r and made of the same material. It is vibrating at a frequency such that the joint of the two wires forms a node. If the number of antinodes in wire A is p and that in B is q then the ratio p : q is :



(1) 4 : 9 (2) 3 : 5
(3) 1 : 4 (4) 1 : 2

12. A string 2.0 m long and fixed at its ends is driven by a 240 Hz vibrator. The string vibrates in its third harmonic mode. The speed of the wave and its fundamental frequency is :-

(1) 320m/s, 120 Hz (2) 180m/s, 80 Hz

(3) 180m/s, 120 Hz (4) 320m/s, 80 Hz

13. The pressure wave, P = 0.01 sin [1000t – 3x] Nm^{-2}, corresponds to the sound produced by a vibrating blade on a day when atmospheric temperature is 0°C. On some other day, when temperature is T, the speed of sound produced by the same blade and at the same frequency is found to be 336 ms^{-1}. Approximate value of T is :

(1) 15°C (2) 12°C

(3) 4°C (4) 11°C

14. A string is clamped at both the ends and it is vibrating in its 4^{th} harmonic. The equation of the stationary wave is Y = 0.3 sin(0.157x) cos(200πt). The length of the string is : (All quantities are in SI units.)

(1) 20 m (2) 80 m

(3) 60 m (4) 40 m

15. A source of sound S is moving with a velocity of 50 m/s towards a stationary observer. The observer measures the frequency of the source as 1000 Hz. What will be the apparent frequency of the source when it is moving away from the observer after crossing him ? (Take velocity of sound in air is 350 m/s)

(1) 857 Hz (2) 807 Hz

(3) 750 Hz (4) 1143 Hz

16. A stationary source emits sound waves of frequency 500 Hz. Two observers moving along a line passing through the source detect sound to be of frequencies 480 Hz and 530Hz. Their respective speeds are, in ms^{-1},

(Given speed of sound = 300 m/s)

(1) 16, 14 (2) 12, 18

(3) 12, 16 (4) 8, 18

17. A tuning fork of frequency 480 Hz is used in an experiment for measuring speed of sound (ν) in air by resonance tube method. Resonance is observed to occur at two successive lengths of the air column, l_1 = 30 cm and l_2 = 70 cm. Then ν is equal to :

(1) 332 ms^{-1} (2) 379 ms^{-1}

(3) 384 ms^{-1} (4) 338 ms^{-1}

18. Two sources of sound S_1 and S_2 produce sound waves of same frequency 660 Hz. A listener is moving from source S_1 towards S_2 with a constant speed u m/s and he hears 10 beats/s. The velocity of sound is 330 m/s. Then, u equals :

(1) 2.5 m/s (2) 15.0 m/s

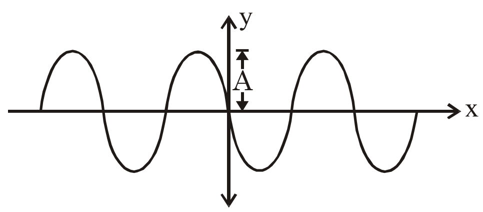
(3) 5.5 m/s (4) 10.0 m/s

19. A small speaker delivers 2 W of audio output. At what distance from the speaker will one detect 120 dB intensity sound ? [Given reference intensity of sound as $10^{-12} W/m^2$]

(1) 10 cm (2) 30 cm

(3) 40 cm (4) 20 cm

20. A progressive wave travelling along the positive x-direction is represented by y(x, t) = A sin (kx – ωt + φ). Its snapshot at t = 0 is given in the figure:



For this wave, the phase φ is :

(1) 0 (2) $-\frac{\pi}{2}$ (3) π (4) $\frac{\pi}{2}$

21. A submarine (A) travelling at 18 km/hr is being chased along the line of its velocity by another submarine (B) travelling at 27 km/hr. B sends a sonar signal of 500 Hz to detect A and receives a reflected sound of frequency ν. The value of ν is close to :

(Speed of sound in water = 1500 ms^{-1})

(1) 499 Hz (2) 502 Hz

(3) 507 Hz (4) 504 Hz

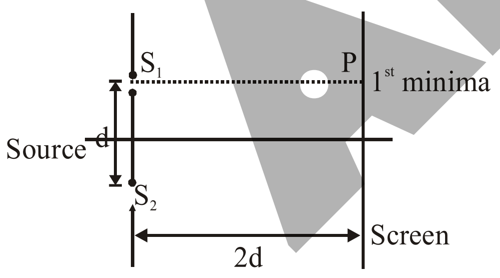
WAVE OPTICS

1. In a Young's double slit experiment, the slits are placed 0.320 mm apart. Light of wavelength λ = 500 nm is incident on the slits. The total number of bright fringes that are observed in the angular range $-30° \le \theta \le 30°$ is:

(1) 320 (2) 641

(3) 321 (4) 640

2. Consider a Young's double slit experiment as shown in figure. What should be the slit separation d in terms of wavelength λ such that the first minima occurs directly in front of the slit (S_1) ?



(1) $\frac{\lambda}{2(5-\sqrt{2})}$ (2) $\frac{\lambda}{(5-\sqrt{2})}$

(3) $\frac{\lambda}{(\sqrt{5}-2)}$ (4) $\frac{\lambda}{2(\sqrt{5}-2)}$

3. In a Young's double slit experiment with slit separation 0.1 mm, one observes a bright fringe at angle $\frac{1}{40}$ rad by using light of wavelength λ_1. When the light of wavelength λ_2 is used a bright fringe is seen at the same angle in the same set up. Given that λ_1 and λ_2 are in visible range (380 nm to 740 nm), their values are :

(1) 380 nm, 500 nm

(2) 625 nm, 500 nm

(3) 380 nm, 525 nm

(4) 400 nm, 500 nm

4. In a double-slit experiment, green light (5303 Å) falls on a double slit having a separation of 19.44 μm and a width of 4.05 μm. The number of bright fringes between the first and the second diffraction minima is :-

(1) 09 (2) 10

(3) 04 (4) 05

5. In a Young's double slit experiment, the path different, at a certain point on the screen, between two interfering waves is $\frac{1}{8}$th of wavelength. The ratio of the intensity at this point to that at the centre of a brigth fringe is close to :

(1) 0.94 (2) 0.74

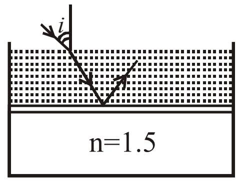
(3) 0.85 (4) 0.80

6. A light wave is incident normally on a glass slab of refractive index 1.5. If 4% of light gets reflected and the amplitude of the electric field of the incident light is 30V/m, then the amplitude of the electric field for the wave propogating in the glass medium will be:

(1) 10 V/m (2) 24 V/m

(3) 30 V/m (4) 6 V/m

7. Consider a tank made of glass(reiractive index 1.5) with a thick bottom. It is filled with a liquid of refractive index μ,. A student finds that, irrespective of what the incident angle *i* (see figure) is for a beam of light entering the liquid, the light reflected from the liquid glass interface is never completely polarized. For this to happen, the minimum value of μ is :



(1) $\frac{3}{\sqrt{5}}$ (2) $\frac{5}{\sqrt{3}}$

(3) $\sqrt{\frac{5}{3}}$ (4) $\frac{4}{3}$

8. Young's moduli of two wires A and B are in the ratio 7 : 4. Wire A is 2 m long and has radius R. Wire B is 1.5 m long and has radius 2 mm. If the two wires stretch by the same length for a given load, then the value of R is close to :-

(1) 1.9 mm

(2) 1.7 mm

(3) 1.5 mm

(4) 1.3 mm

9. In an interference experiment the ratio of amplitudes of coherent waves is $\frac{a_1}{a_2} = \frac{1}{3}$. The ratio of maximum and minimum intensities of fringes will be :

(1) 4 (2) 2

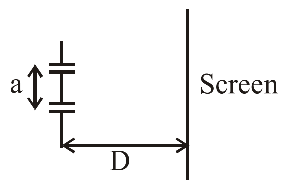
(3) 9 (4) 18

10. Two cars A and B are moving away from each other in opposite directions. Both the cars are moving with a speed of 20 ms^{-1} with respect to the ground. If an observer in car A detects a frequency 2000 Hz of the sound coming from car B, what is the natural frequency of the sound source in car B ? (speed of sound in air = 340 ms^{-1}) :-

(1) 2250 Hz (2) 2060 Hz

(3) 2150 Hz (4) 2300 Hz

11. The figure shows a Young's double slit experimental setup. It is observed that when a thin transparent sheet of thickness t and refractive index μ is put in front of one of the slits, the central maximum gest shifted by a distance equal to n fringe widths. If the wavelength of light used is λ, t will be :



(1) $\frac{2D\lambda}{a(\mu-1)}$ (2) $\frac{D\lambda}{a(\mu-1)}$

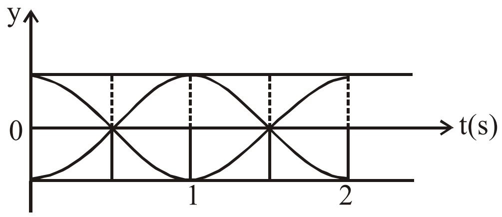
(3) $\frac{2nD\lambda}{a(\mu-1)}$ (4) $\frac{nD\lambda}{a(\mu-1)}$

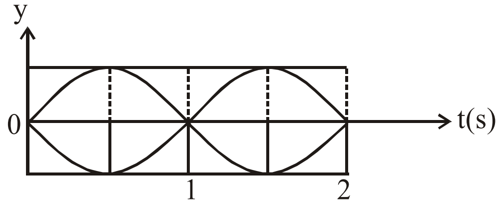
12. In a Young's doubble slit experiment, the ratio of the slit's width is 4 : 1. The ratio of the intensity of maxima to minima, close to the central fringe on the screen, will be :

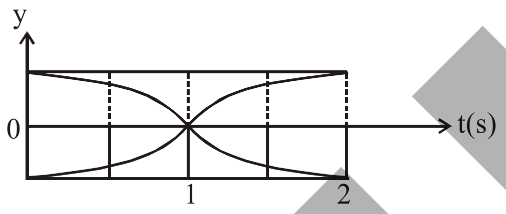
(1) $(\sqrt{3}+1)^4 : 16$ (2) 9 : 1

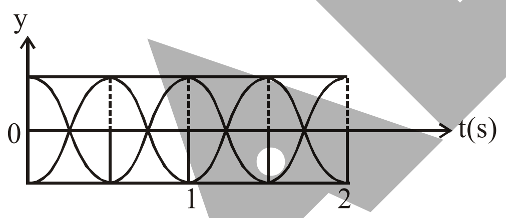
(3) 4 : 1 (4) 25 : 9

13. The correct figure that shows, schematically, the wave pattern produced by superposition of two waves of frequencies 9 Hz and 11 Hz is :

(1) 

(2) 

(3) 

(4) 

14. A system of three polarizers P_1, P_2, P_3 is set up such that the pass axis of P_3 is crossed with respect to that of P_1. The pass axis of P_2 is inclined at 60º to the pass axis of P_3. When a beam of unpolarized light of intensity I_0 is incident on P_1, the intensity of light transmitted by the three polarizers is I. The ratio (I_0/I) equals (nearly) :

(1) 16.00 (2) 1.80
(3) 5.33 (4) 10.67

15. In a double slit experiment, when a thin film of thickness t having refractive index μ is introduced in front of one of the slits, the maximum at the centre of the fringe pattern shifts by one fringe width. The value of t is (λ is the wavelength of the light used) :

(1) $\frac{\lambda}{2(\mu-1)}$ (2) $\frac{\lambda}{(2\mu-1)}$

(3) $\frac{2\lambda}{(\mu-1)}$ (4) $\frac{\lambda}{(\mu-1)}$

16. Calculate the limit of resolution of a telescope objective having a diameter of 200 cm, if it has to detect light of wavelength 500 nm coming from a star :-

(1) 305×10^{-9} radian
(2) 152.5×10^{-9} radian
(3) 610×10^{-9} radian
(4) 457.5×10^{-9} radian

17. Diameter of the objective lens of a telescope is 250 cm. For light of wavelength 600nm. coming from a distant object, the limit of resolution of the telescope is close to :-

(1) 1.5×10^{-7} rad (2) 2.0×10^{-7} rad
(3) 3.0×10^{-7} rad (4) 4.5×10^{-7} rad

18. The value of numerical aperature of the objective lens of a microscope is 1.25. If light of wavelength 5000 Å is used, the minimum separation between two points, to be seen as distinct, will be :

(1) 0.24 μm (2) 0.48 μm
(3) 0.12 μm (4) 0.38 μm

WORK, POWER & ENERGY

1. A force acts on a 2 kg object so that its position is given as a function of time as $x = 3t^2 + 5$. What is the work done by this force in first 5 seconds ?

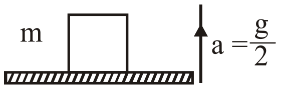
(1) 850 J (2) 900 J
(3) 950 J (4) 875 J

2. A particle which is experiencing a force, given by $\vec{F} = 3\vec{i} - 12\vec{j}$, undergoes a displacement of $\vec{d} = 4\vec{i}$. If the particle had a kinetic energy of 3 J at the beginning of the displacement, what is its kinetic energy at the end of the displacement ?

(1) 15 J (2) 10 J

(3) 12 J (4) 9 J

3. A block of mass m is kept on a platform which starts from rest with constant acceleration g/2 upward, as shown in fig. Work done bv normal reaction on block in time t is :



(1) 0 (2) $\frac{3mg^2t^2}{8}$

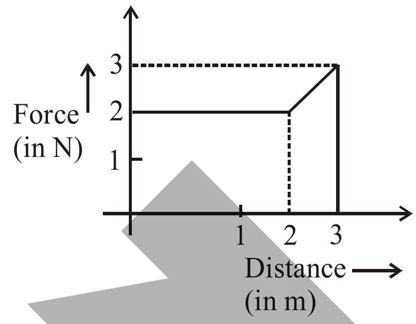
(3) $-\frac{mg^2t^2}{8}$ (4) $\frac{mg^2t^2}{8}$

4. A body of mass 1 kg falls freely from a height of 100 m on a platform of mass 3 kg which is mounted on a spring having spring constant k = 1.25 × 10^6 N/m. The body sticks to the platform and the spring's maximum compression is found to be x. Given that g = 10 ms^{-2}, the value of x will be close to :

(1) 4 cm (2) 8 cm

(3) 80 cm (4) 40 cm

5. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled 3m is :



(1) 6.5 J (2) 2.5 J

(3) 4 J (4) 5 J

6. A uniform cable of mass 'M' and length 'L' is placed on a horizontal surface such that its $\left(\frac{1}{n}\right)^{th}$ part is hanging below the edge of the surface. To lift the hanging part of the cable upto the surface, the work done should be :

(1) $\frac{MgL}{n^2}$ (2) $\frac{MgL}{2n^2}$

(3) $\frac{2MgL}{n^2}$ (4) nMgL

ANSWER KEY

CAPACITOR

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	Bonus	3	3	1	4	4	2	3	4	1
Que.	11	12	13	14	15	16	17	18		
Ans.	4	4	3	3	1	4	2	1		

CIRCULAR MOTION

Que.	1	2	3	4	5
Ans.	3	2	4	4	4

COM & COLLISION										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	3	3	1	4	3	1	2	3	2
Que.	11	12	13							
Ans.	3	3	1							

CURRENT ELECTRICITY										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	2	1	2	4	3	4	2	1	2	3
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	4	4	4	4	2	3	2	4	1	3
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	3	4	1	3	2	4	3	2	3	2
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	1	4	3	2	1	4	1	3	Bonus	4
Que.	41	42	43	44	45					
Ans.	2	2	4	3	1					

ELECTROSTATICS										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	4	3	3	4	2	2	3	2	1
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	1	3	4	3	3	1	4	4
Que.	21	22	23	24	25	26				
Ans.	1	1	2	3	1	4				

EMI & AC										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	4	1	3	2	2	3	1	4	3
Que.	11	12	13	14	15	16	17	18		
Ans.	2	3	4	2	2	2	2	2		

EMW										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	3	1	2	4	3	2	2	4	3
Que.	11	12	13	14						
Ans.	4	2	3	3						

ERROR & MEASUREMEMNT							
Que.	1	2	3	4	5	6	
Ans.	2	1	3	4	2	Allen : (Bonus) NTA : (2)	

FLUIDS MECHANICS										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	2	Bonus	4	2	2	3	Bonus	3	3	3
Que.	11	12	13	14	15					
Ans.	3	2	2	3	4					

GEOMETRICAL OPTICS										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	1	3	2	4	2	3	1	3	1
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	4	2	Allen : (Bonus) NTA : (2)	Allen : (1) or (2) NTA : (2)	2	4	4	4	4	1
Que.	21	22								
Ans.	2	1								

GRAVITATION										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	3	4	2	2	1	3	2	3	2
Que.	11	12	13	14	15	16				
Ans.	3	4	2	2	4	2				

HEAT & THERMODYNAMICS										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	3	4	4	3	4	4	2	4	1
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	1	2	1	2	1	2	2	3	2	2
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	1	4	4	3	4	3	3	1	4	3
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	Allen : (Bonus) NTA : (3)	4	4	2	3	2	2	1	1	Allen : (Bonus) NTA : (2)
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	3	1	Allen : (3) NTA : (4)	3	2	3	4	1	2	3
Que.	51	52	53							
Ans.	3	2	4							

KINEMATICS										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	4	2	2	4	1	4	3	4	4
Que.	11	12	13	14	15	16	17			
Ans.	4	1	2	2	2	1	3			

MEC										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	3	1	2	3	2	4	2	1	3	1
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	Bonus	4	4	1	3	2	1	4	1	4
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	1	2	1	4	2	2	1	2	3	4
Que.	**31**	**32**	**33**							
Ans.	1	2	3							

MODERN PHYSICS										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	3	1	1	1	3	4	3	3	3	2
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	1	Bonus	4	1	3	4	2	1	2
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	4	2	4	3	4	2	1	3	1	3
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	3	3	3	1	2	4	3	1	3	1

NLM & FRICTION										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
Ans.	2	1	1	2	4	1	2	3	2	

POC										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	4	2	4	4	3	2	1	3	3	2
Que.	**11**	**12**	**13**	**14**						
Ans.	4	4	1	4						

ROTATIONAL MECHANICS										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	1	2	3	3	1	3	2	2	1	4
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	2	2	3	1	3	4	1	4	2
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	
Ans.	4	2	4	4	3	4	2	4	2	

SEMICONDUCTOR										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	3	2	4	4	2	4	2	2	3	3
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**			
Ans.	1	4	2	4	2	1	3			

SHM										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	3	3	4	4	1	2	3	4	1
Que.	**11**									
Ans.	1									

UNIT & DIMENSION									
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Ans.	4	4	2	2	3	2	2	3	

VECTOR					
Que.	**1**	**2**	**3**	**4**	
Ans.	4	3	2	3	

WAVE MOTION										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	4	2	1	1	2	2	2	1	1	3
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	4	3	2	3	2	3	1	3	3
Que.	**21**									
Ans.	2									

WAVE OPTICS										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	4	2	4	3	2	1	2	1	1
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**		
Ans.	Allen : (Bonus) NTA : (4)	2	4	4	4	1	3	1		

WORK, POWER & ENERGY							
Que.	**1**	**2**	**3**	**4**	**5**	**6**	
Ans.	2	1	2	Bonus	1	2	

IMPORTANT NOTES

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

Chapter 02 Contents

JEE (MAIN) TOPICWISE TEST PAPERS JANUARY & APRIL 2019

CHEMISTRY

PHYSICAL CHEMISTRY

ORGANIC CHEMISTRY

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN) path to success

Chapter 02 Contents

JEE (MAIN) TOPICWISE TEST PAPERS JANUARY & APRIL 2019

ORGANIC CHEMISTRY

INORGANIC CHEMISTRY

JANUARY & APRIL 2019 ATTEMPT (PC)

ATOMIC STRUCTURE

1. What is the work function of the metal if the light of wavelength 4000 Å generates photoelectrons of velocity 6×10^5 ms^{-1} form it ?

(Mass of electron = 9×10^{-31} kg

Velocity of light = 3×10^8 ms^{-1}

Planck's constant = 6.626×10^{-34} Js

Charge of electron = 1.6×10^{-19} JeV^{-1})

(1) 0.9 eV (2) 4.0 eV

(3) 2.1 eV (4) 3.1 eV

2. If the de Broglie wavelength of the electron in nth Bohr orbit in a hydrogenic atom is equal to $1.5\ \pi a_0$(a_0 is Bohr radius), then the value of n/z is :

(1) 1.0 (2) 0.75

(3) 0.40 (4) 1.50

3. The upper stratosphere consisting of the ozone layer protects us from the sun's radiation that falls in the wavelength region of :

(1) 600-750 nm (2) 0.8-1.5 nm

(3) 400-550 nm (4) 200-315 nm

4. Heat treatment of muscular pain involves radiation of wavelength of about 900 nm. Which spectral line of H-atom is suitable for this purpose ?

[$R_H = 1 \times 10^5$ cm^{-1}, h = 6.6×10^{-34} Js, c = 3×10^8 ms^{-1}]

(1) Paschen, $5 \rightarrow 3$

(2) Paschen, $\infty \rightarrow 3$

(3) Lyman, $\infty \rightarrow 1$

(4) Balmer, $\infty \rightarrow 2$

5. The de Broglie wavelength (λ) associated with a photoelectron varies with the frequency (v) of the incident radiation as, [v_0 is thershold frequency] :

(1) $\lambda \propto \dfrac{1}{(v-v_0)^{\frac{3}{2}}}$ (2) $\lambda \propto \dfrac{1}{(v-v_0)^{\frac{1}{2}}}$

(3) $\lambda \propto \dfrac{1}{(v-v_0)^{\frac{1}{4}}}$ (4) $\lambda \propto \dfrac{1}{(v-v_0)}$

6. The ground state energy of hydrogen atom is –13.6 eV. The energy of second excited state He^+ ion in eV is :

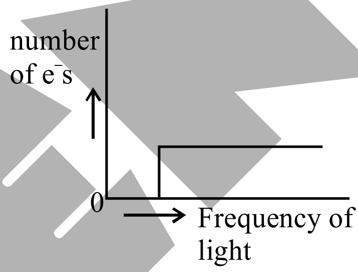
(1) –6.04 (2) –27.2

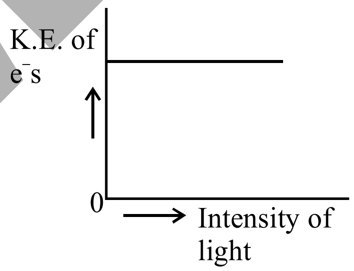
(3) –54.4 (4) –3.4

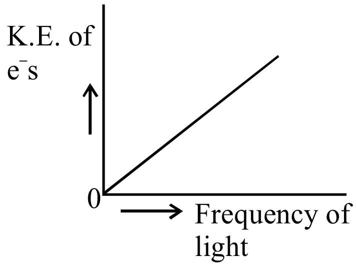
7. Among the following, the energy of 2s orbital is lowest in :

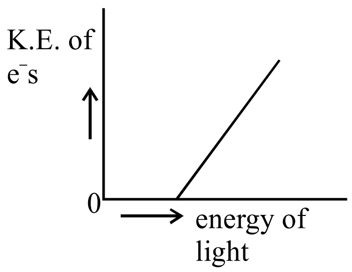
(1) K (2) Na (3) Li (4) H

8. Which of the graphs shown below does not represent the relationship between incident light and the electron ejected form metal surface ?

(1)


(2)


(3)


(4)


9. Which of the following combination of statements is true regarding the interpretation of the atomic orbitals ?

(a) An electron in an orbital of high angular momentum stays away from the nucleus than an electron in the orbital of lower angular momentum.

(b) For a given value of the principal quantum number, the size of the orbit is inversely proportional to the azimuthal quantum number.

(c) According to wave mechanics, the ground state angular momentum is equal to $\frac{h}{2\pi}$.

(d) The plot of ψ Vs r for various azimuthal quantum numbers, shows peak shifting towards higher r value.

(1) (b), (c) (2) (a), (d)
(3) (a), (b) (4) (a), (c)

10. For emission line of atomic hydrogen from $n_i = 8$ to $n_f = n$ the plot of wave number $(\bar{v})$ against $\left(\frac{1}{n^2}\right)$ will be (The Rydberg constant, R_H is in wave number unit).

(1) Linear with slope - R_H
(2) Linear with intercept - R_H
(3) Non linear
(4) Linear with slope R_H

11. If p is the momentum of the fastest electron ejected from a metal surface after the irradiation of light having wavelength λ, then for 1.5 p momentum of the photoelectron, the wavelength of the light should be:
(Assume kinetic energy of ejected photoelectron to be very high in comparison to work function)

(1) $\frac{1}{2}\lambda$ (2) $\frac{3}{4}\lambda$
(3) $\frac{2}{3}\lambda$ (4) $\frac{4}{9}\lambda$

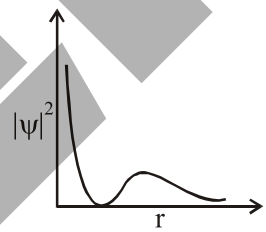
12. For any given series of spectral lines of atomic hydrogen, let $\Delta\bar{v} = \bar{v}_{max} - \bar{v}_{min}$ be the difference in maximum and minimum frequencies in cm^{-1}. The ratio $\Delta\bar{v}_{Lyman}/\Delta\bar{v}_{Balmer}$ is :

(1) 27 : 5 (2) 4 : 1
(3) 5 : 4 (4) 9 : 4

13. Which one of the following about an electron occupying the 1s orbital in a hydrogen atom is incorrect ?
(The Bohr radius is represented by a_0)

(1) The electron can be found at a distance $2a_0$ from the nucleus
(2) The probability density of finding the electron is maximum at the nucleus.
(3) The magnitude of potential energy is double that of its kinetic energy on an average.
(4) The total energy of the electron is maximum when it is at a distance a_0 from the nucleus.

14. The graph betweeen $|\psi|^2$ and r(radial distance) is shown below. This represents :-

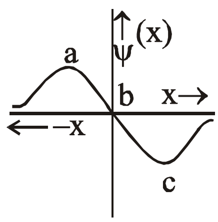


(1) 3s orbital (2) 1s orbital
(3) 2p orbital (4) 2s orbital

15. The ratio of the shortest wavelength of two spectral series of hydrogen spectrum is found to be about 9. The spectral series are:

(1) Paschen and P fund
(2) Lyman and Paschen
(3) Brackett and Piund
(4) Balmer and Brackett

16. The electrons are more likely to be found



(1) in the region a and b
(2) in the region a and c
(3) only in the region c
(4) only in the region a

CHEMICAL KINETICS

1. Decomposition of X exhibits a rate constant of 0.05 µg/year. How many years are required for the decomposition of 5 µg of X into 2.5 µg ?

(1) 50 (2) 25
(3) 20 (4) 40

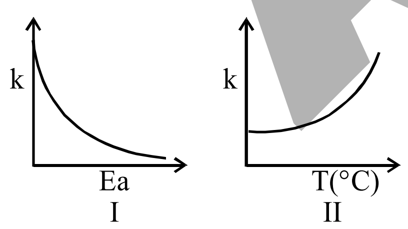
2. If a reaction follows the Arrhenius equation, the plot lnk vs $\frac{1}{(RT)}$ gives straight line with a gradient (–y) unit. The energy required to activate the reactant is :

(1) y unit (2) –y unit
(3) yR unit (4) y/R unit

3. The reaction $2X \rightarrow B$ is a zeroth order reaction. If the initial concentration of X is 0.2 M, the half-life is 6 h. When the initial concentration of X is 0.5 M, the time required to reach its final concentration of 0.2 M will be :-

(1) 18.0 h (2) 7.2 h
(3) 9.0 h (4) 12.0 h

4. Consider the given plots for a reaction obeying Arrhenius equation (0°C < T < 300°C) : (k and E_a are rate constant and activation energy, respectively)



Choose the correct option :

(1) Both I and II are wrong
(2) I is wrong but II is right
(3) Both I and II are correct
(4) I is right but II is wrong

5. For an elementary chemical reaction,

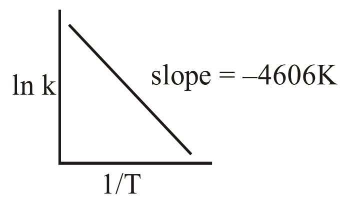
$A_2 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2A$, the expression for $\frac{d[A]}{dt}$ is :

(1) $2k_1[A_2]–k_{-1}[A]^2$
(2) $k_1[A_2]–k_{-1}[A]^2$
(3) $2k_1[A_2]–2k_{-1}[A]^2$
(4) $k_1[A_2]+k_{-1}[A]^2$

6. For the reaction, $2A + B \rightarrow$ products, when the concentrations of A and B both wrere doubled, the rate of the reaction increased from 0.3 mol $L^{-1}s^{-1}$ to 2.4 mol L^{-1} s^{-1}. When the concentration of A alone is doubled, the rate increased from 0.3 mol $L^{-1}s^{-1}$ to0.6 mol $L^{-1}s^{-1}$ Which one of the following statements is correct ?

(1) Order of the reaction with respect to Bis2
(2) Order of the reaction with respect to Ais2
(3) Total order of the reaction is 4
(4) Order of the reaction with respect to B is 1

7. For a reaction, consider the plot of ln k versus 1/T given in the figure. If the rate constant of this reaction at 400 K is 10^{-5} s^{-1}, then the rate constant at 500 K is :



(1) 2×10^{-4} s^{-1} (2) 10^{-4} s^{-1}
(3) 10^{-6} s^{-1} (4) 4×10^{-4} s^{-1}

8. The following results were obtained during kinetic studies of the reaction :

$2A + B \rightarrow$ Products

Experment	[A] (in mol L^{-1})	[B] (in mol L^{-1})	Initial Rate of reaction (in mol L^{-1} min^{-1})
(I)	0.10	0.20	6.93×10^{-3}
(II)	0.10	0.25	6.93×10^{-3}
(III)	0.20	0.30	1.386×10^{-2}

The time (in minutes) required to consume half of A is :

(1) 10 (2) 5 (3) 100 (4) 1

9. For the reaction $2A + B \rightarrow C$, the values of initial rate at different reactant concentrations are given in the table below. The rate law for the reaction is :

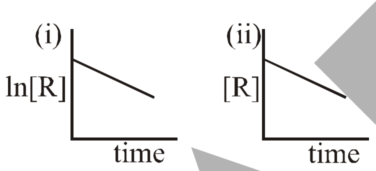
[A] (mol L^{-1})	[B] (mol L^{-1})	Initial Rate (mol $L^{-1}s^{-1}$)
0.05	0.05	0.045
0.10	0.05	0.090
0.20	0.10	0.72

(1) Rate = k [A][B]
(2) Rate = k $[A]^2[B]^2$
(3) Rate = k $[A][B]^2$
(4) Rate = k $[A]^2[B]$

10. For a reaction scheme $A \xrightarrow{k_1} B \xrightarrow{k_2} C$, if the rate of formation of B is set to be zero then the concentration of B is given by :

(1) $\left(\frac{k_1}{k_2}\right)[A]$ (2) $(k_1 + k_2)$ [A]
(3) $k_1k_2[A]$ (4) $(k_1 - k_2)$ [A]

11. The given plots represent the variation of the concentration of a reactant R with time for two different reactions (i) and (ii). The respective orders of the reactions are :



(1) 1,0 (2) 1,1 (3) 0,1 (4) 0,2

12. For the reaction of H_2 with I_2, the rate constant is $2.5\times10^{-4} dm^3 mol^{-1} s^{-1}$ at 327°C and 1.0 $dm^3 mol^{-1} s^{-1}$ at 527°C. The activation energy for the reaction, in kJ mol^{-1} is:
($R=8.314 J K^{-1} mol^{-1}$)

(1) 72 (2) 166 (3) 150 (4) 59

13. In the following reaction; $xA \rightarrow yB$

$$\log_{10}\left[-\frac{d[A]}{dt}\right] = \log_{10}\left[\frac{d[B]}{dt}\right] + 0.3010$$

'A' and 'B' respectively can be :
(1) n-Butane and Iso-butane
(2) C_2H_4 and C_4H_8
(3) N_2O_4 and NO_2
(4) C_2H_2 and C_6H_6

14. NO_2 required for a reaction is produced by the decomposition of N_2O_5 in CCl_4 as per the equation

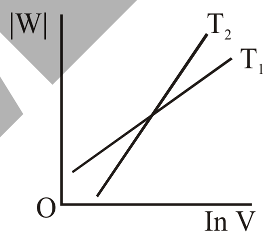
$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$.

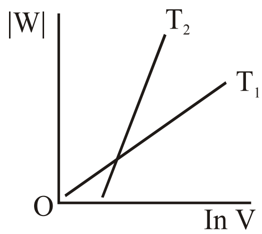
The initial concentration of N_2O_5 is 3.00 mol L^{-1} and it is 2.75 mol L^{-1} after 30 minutes. The rate of formation of NO_2 is :

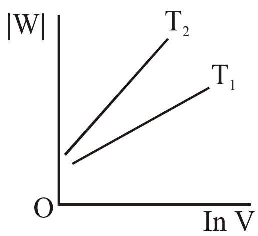
(1) 2.083×10^{-3} mol L^{-1} min^{-1}
(2) 4.167×10^{-3} mol L^{-1} min^{-1}
(3) 8.333×10^{-3} mol L^{-1} min^{-1}
(4) 1.667×10^{-2} mol L^{-1} min^{-1}

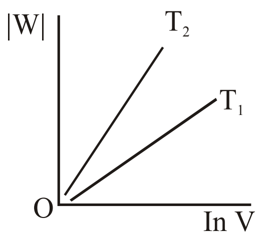
THERMODYNAMICS-01

1. Consider the reversible isothermal expansion of an ideal gas in a closed system at two different temperatures T_1 and T_2 ($T_1 < T_2$). The correct graphical depiction of the dependence of work done (w) on the final volume (V) is:

(1) 

(2) 

(3) 

(4) 

2. An ideal gas undergoes isothermal compression from 5 m^3 to 1 m^3 against a constant external pressure of 4 Nm^{-2}. Heat released in this process is used to increase the temperature of 1 mole of Al. If molar heat capacity of Al is 24 J mol^{-1} K^{-1}, the temperature of Al increases by :

(1) $\frac{3}{2}$K (2) $\frac{2}{3}$K

(3) 1 K (4) 2 K

3. Which one of the following equations does not correctly represent the first law of thermodynamics for the given processes involving an ideal gas ? (Assume non-expansion work is zero)

(1) Cyclic process : $q = -w$

(2) Isothermal process : $q = -w$

(3) Adiabatic process : $\Delta U = -w$

(4) Isochoric process : $\Delta U = q$

4. For silver, $C_p(JK^{-1}mol^{-1}) = 23 + 0.01T$. If the temperature (T) of 3 moles of silver is raised from 300K to 1000 K at 1 atm pressure, the value of ΔH will be close to

(1) 21 kJ (2) 16 kJ

(3) 13 kJ (4) 62 kJ

5. 5 moles of an ideal gas at 100 K are allowed to undergo reversible compression till its temperature becomes 200 K.

If $C_V = 28\ JK^{-1}mol^{-1}$, calculate ΔU and ΔpV for this process. ($R = 8.0\ JK^{-1}\ mol^{-1}$)

(1) ΔU = 14 kJ; $\Delta(pV)$ = 4 kJ

(2) ΔU = 14 kJ; $\Delta(pV)$ = 18 kJ

(3) ΔU = 2.8 kJ; $\Delta(pV)$ = 0.8 kJ

(4) ΔU = 14 kJ; $\Delta(pV)$ = 0.8 kJ

6. Among the following, the set of parameters that represents path function, is :

(A) q + w (B) q

(C) w (D) H–TS

(1) (A) and (D) (2) (B), (C) and (D)

(3) (B) and (C) (4) (A), (B) and (C)

7. During compression of a spring the work done is 10kJ and 2kJ escaped to the surroundings as heat. The change in internal energy, ΔU(inkJ) is:

(1) 8 (2) 12

(3) – 12 (4) –8

8. An ideal gas is allowed to expand from 1 L to 10 L against a constant external pressure of 1bar. The work done in kJ is :

(1) –9.0 (2) +10.0

(3) –0.9 (4) –2.0

THERMODYNAMICS-02

1. Two blocks of the same metal having same mass and at temperature T_1 and T_2, respectively. are brought in contact with each other and allowed to attain thermal equilibrium at constant pressure. The change in entropy, ΔS, for this process is :

(1) $2C_P \ln\left(\frac{T_1+T_2}{4T_1T_2}\right)$ (2) $2C_P \ln\left[\frac{(T_1+T_2)^{\frac{1}{2}}}{T_1T_2}\right]$

(3) $C_P \ln\left[\frac{(T_1+T_2)^2}{4T_1T_2}\right]$ (4) $2C_P \ln\left[\frac{T_1+T_2}{2T_1T_2}\right]$

2. For the chemical reaction $X \rightleftharpoons Y$, the standard reaction Gibbs energy depends on temperature T (in K) as :

$$\Delta_r G^o \text{ (in kJ mol}^{-1}) = 120 - \frac{3}{8}T$$

The major component of the reaction mixture at T is :

(1) X if T = 315 K

(2) X if T = 350 K

(3) Y if T = 300 K

(4) Y if T = 280 K

3. The INCORRECT match in the following is
(1) $\Delta G^o < 0$, $K < 1$ (2) $\Delta G^o = 0$, $K = 1$
(3) $\Delta G^o > 0$, $K < 1$ (4) $\Delta G^o < 0$, $K > 1$

4. A process will be spontaneous at all temperatures if :-
(1) $\Delta H > 0$ and $\Delta S < 0$
(2) $\Delta H < 0$ and $\Delta S > 0$
(3) $\Delta H > 0$ and $\Delta S > 0$
(4) $\Delta H < 0$ and $\Delta S < 0$

5. For the equilibrium,
$2H_2O \rightleftharpoons H_3O^+ + OH^-$, the value of ΔG^o at 298 K is approximately :-
(1) -80 kJ mol^{-1}
(2) -100 kJ mol^{-1}
(3) 100 kJ mol^{-1}
(4) 80 kJ mol^{-1}

6. The standard reaction Gibbs energy for a chemical reaction at an absolute temperature T is given by

$$\Delta_r G^o = A - BT$$

Where A and B are non-zero constants. Which of the following is TRUE about this reaction ?
(1) Exothermic if $B < 0$
(2) Exothermic if $A > 0$ and $B < 0$
(3) Endothermic if $A < 0$ and $B > 0$
(4) Endothermic if $A > 0$

7. The reaction, $MgO(s) + C(s) \rightarrow Mg(S) + CO(g)$, for which $\Delta_r H^o = +491.1$ kJ mol^{-1} and $\Delta_r S^o = 198.0$ JK^{-1} mol^{-1}, is not feasible at 298 K. Temperature above which reaction will be feasible is :-
(1) 1890.0 K (2) 2480.3 K
(3) 2040.5 K (4) 2380.5 K

8. A process has $\Delta H = 200$ $Jmol^{-1}$ and $\Delta S = 40$ $JK^{-1}mol^{-1}$. Out of the values given below, choose the minimum temperature above which the process will be spontaneous :
(1) 5 K (2) 4 K (3) 20 K (4) 12 K

9. The entropy change associated with the conversion of 1 kg of ice at 273 K to water vapours at 383 K is :

(Specific heat of water liquid and water vapour are 4.2 kJ K^{-1} kg^{-1} and 2.0 kJ K^{-1} kg^{-1} ; heat of liquid fusion and vapourisation of water are 344 kJ kg^{-1} and 2491 kJ kg^{-1}, respectively).

(log 273 = 2.436, log 373 = 2.572, log 383 = 2.583)

(1) 7.90 kJ kg^{-1} K^{-1} (2) 2.64 kJ kg^{-1} K^{-1}
(3) 8.49 kJ kg^{-1} K^{-1} (4) 9.26 kJ kg^{-1} K^{-1}

IONIC EQUILIBRIUM

1. If K_{sp} of Ag_2CO_3 is 8×10^{-12}, the molar solubility of Ag_2CO_3 in 0.1M $AgNO_3$ is :
(1) 8×10^{-12} M (2) 8×10^{-10} M
(3) 8×10^{-11} M (4) 8×10^{-13} M

2. 25 ml of the given HCl solution requires 30 mL of 0.1 M sodium carbonate solution. What is the volume of this HCl solution required to titrate 30 mL of 0.2 M aqueous NaOH solution?
(1) 25 mL (2) 50 mL
(3) 12.5 mL (4) 75 mL

3. A mixture of 100 m mol of $Ca(OH)_2$ and 2g of sodium sulphate was dissolved in water and the volume was made up to 100 mL. The mass of calcium sulphate formed and the concentration of OH^- in resulting solution, respectively, are : (Molar mass of $Ca(OH)_2$, Na_2SO_4 and $CaSO_4$ are 74, 143 and 136 g mol^{-1}, respectively; K_{sp} of $Ca(OH)_2$ is 5.5×10^{-6})
(1) 1.9 g, 0.14 mol L^{-1}
(2) 13.6 g, 0.14 mol L^{-1}
(3) 1.9 g, 0.28 mol L^{-1}
(4) 13.6 g, 0.28 mol L^{-1}

4. The pH of rain water, is approximately :

(1) 6.5 (2) 7.5

(3) 5.6 (4) 7.0

5. 20 mL of 0.1 M H_2SO_4 solution is added to 30 mL of 0.2 M NH_4OH solution. The pH of the resulatant mixture is :

[pk_b of NH_4OH = 4.7].

(1) 9.4 (2) 5.0

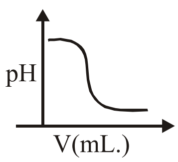
(3) 9.0 (4) 5.2

6. If solubility product of $Zr_3(PO_4)_4$ is denoted by K_{sp} and its molar solubility is denoted by S, then which of the following relation between S and K_{sp} is correct

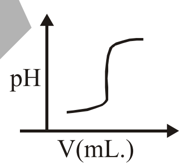
(1) $S=\left(\frac{K_{sp}}{929}\right)^{1/9}$ (2) $S=\left(\frac{K_{sp}}{216}\right)^{1/7}$

(3) $S=\left(\frac{K_{sp}}{144}\right)^{1/6}$ (4) $S=\left(\frac{K_{sp}}{6912}\right)^{1/7}$

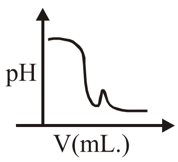
7. In an acid-base titration, 0.1 M HCl solution was added to the NaOH solution of unknown strength. Which of the following correctly shows the change of pH of the titraction mixture in this experiment?



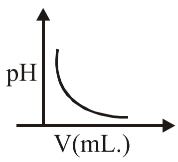
(A)



(B)



(C)



(D)

(1) (A) (2) (C) (3) (D) (4) (B)

8. Consider the following statements

(a) The pH of a mixture containing 400 mL of 0.1 M H_2SO_4 and 400 mL of 0.1 M NaOH will be approximately 1.3.

(b) Ionic product of water is temperature dependent.

(c) A monobasic acid with $K_a = 10^{-5}$ has a pH = 5. The degree of dissociation of this acid is 50%.

(d) The Le Chatelier's principle is not applicable to common-ion effect.

the correct statement are :

(1) (a), (b) and (d) (2) (a), (b) and (c)

(3) (a) and (b) (4) (b) and (c)

9. The pH of a 0.02M NH_4Cl solution will be [given $K_b(NH_4OH)=10^{-5}$ and log2=0.301]

(1) 4.65 (2) 5.35

(3) 4.35 (4) 2.65

10. What is the molar solubility of $Al(OH)_3$ in 0.2 M NaOH solution ? Given that, solubility product of $Al(OH)_3 = 2.4 \times 10^{-24}$:

(1) 12×10^{-23} (2) 12×10^{-21}

(3) 3×10^{-19} (4) 3×10^{-22}

11. The molar solubility of $Cd(OH)_2$ is 1.84×10^{-5} M in water. The expected solubility of $Cd(OH)_2$ in a buffer solution of pH = 12 is :

(1) 6.23×10^{-11} M (2) 1.84×10^{-9} M

(3) $\frac{2.49}{1.84}\times 10^{-9}$ M (4) 2.49×10^{-10} M

REAL GAS

1. The volume of gas A is twice than that of gas B. The compressibility factor of gas A is thrice than that of gas B at same temperature. The pressures of the gases for equal number of moles are :

(1) $2P_A = 3P_B$ (2) $P_A = 3P_B$

(3) $P_A = 2P_B$ (4) $3P_A = 2P_B$

2. Consider the van der Waals constants, a and b, for the following gases.

Gas	Ar	Ne	Kr	Xe
a/ (atm dm^6 mol^{-2})	1.3	0.2	5.1	4.1
b/ (10^{-2} dm^3 mol^{-1}	3.2	1.7	1.0	5.0

Which gas is expected to have the highest critical temperature?

(1) Kr (2) Ne

(3) Ar (4) Xe

3. At a given temperature T, gases Ne, Ar, Xe and Kr are found to deviate from ideal gas behaviour. Their equation of state is given as

$p = \frac{RT}{V-b}$ at T.

Here, b is the van der Waals constant. Which gas will exhibit steepest increase in the plot of Z (compression factor) vs p?

(1) Ne (2) Ar

(3) Xe (4) Kr

4. Consider the following table :

Gas	a/(k Pa dm^6 mol^{-1})	b/(dm^3 mol^{-1})
A	642.32	0.05196
B	155.21	0.04136
C	431.91	0.05196
D	155.21	0.4382

a and b are vander waals constant. The correct statement about the gases is :

(1) Gas C will occupy lesser volume than gas A; gas B will be lesser compressible than gas D

(2) Gas C will occupy more volume than gas A; gas B will be lesser compressible than gas D

(3) Gas C will occupy more volume than gas A; gas B will be more compressible than gas D

(4) Gas C will occupy lesser volume than gas A; gas B will be more compressible than gas D

LIQUID SOLUTION

1. Freezing point of a 4% aqueous solution of X is equal to freezing point of 12% aqueous solution of Y. If molecular weight of X is A, then molecular weight of Y is :-

(1) A (2) 3A

(3) 4A (4) 2A

2. Molecules of benzoic acid (C_6H_5COOH) dimerise in benzene. 'w' g of the acid dissolved in 30 g of benzene shows a depression in freezing point equal to 2K. If the percentage association of the acid to form dimer in the solution is 80, then w is :

(Given that $K_f = 5$ K kg mol^{-1}, Molar mass of benzoic acid = 122 g mol^{-1})

(1) 1.8 g (2) 2.4 g

(3) 1.0 g (4) 1.5 g

3. The freezing point of a diluted milk sample is found to be –0.2°C, while it should have been –0.5°C for pure milk. How much water has been added to pure milk to make the diluted sample ?

(1) 2 cups of water to 3 cups of pure milk

(2) 1 cup of water to 3 cups of pure milk

(3) 3 cups of water to 2 cups of pure milk

(4) 1 cup of water to 2 cups of pure milk

4. K_2HgI_4 is 40% ionised in aqueous solution. The value of its van't Hoff factor (i) is :-

(1) 1.8 (2) 2.2 (3) 2.0 (4) 1.6

5. Liquids A and B form an ideal solution in the entire composition range. At 350 K, the vapor pressures of pure A and pure B are 7×10^3 Pa and 12×10^3 Pa, respectively. The composition of the vapor in equilibrium with a solution containing 40 mole percent of A at this temperature is :

(1) $x_A = 0.37$; $x_B = 0.63$

(2) $x_A = 0.28$; $x_B = 0.72$

(3) $x_A = 0.76$; $x_B = 0.24$

(4) $x_A = 0.4$; $x_B = 0.6$

6. A solution containing 62 g ethylene glycol in 250 g water is cooled to –10°C. If K_f for water is 1.86 K kg mol^{-1}, the amount of water (in g) separated as ice is :

(1) 32 (2) 48 (3) 16 (4) 64

7. Which one of the following statements regarding Henry's law is not correct ?

(1) The value of K_H increases with increase of temperatrue and K_H is function of the nature of the gas

(2) Higher the value of K_H at a given pressure, higher is the solubility of the gas in the liquids.

(3) The partial pressure of the gas in vapour phase is proportional to the mole fraction of the gas in the solution.

(4) Different gases have different K_H (Henry's law constant) values at the same temperature.

8. Elevation in the boiling point for 1 molal solution of glucose is 2 K. The depression in the freezing point of 2 molal solutions of glucose in the same solvent is 2 K. The relation between K_b and K_f is:

(1) $K_b = 0.5\ K_f$ (2) $K_b = 2\ K_f$
(3) $K_b = 1.5\ K_f$ (4) $K_b = K_f$

9. The vapour pressures of pure liquids A and B are 400 and 600 mmHg, respectively at 298K. On mixing the two liquids, the sum of their initial volumes is equal to the volume of the final mixture. The mole fraction of liquid B is 0.5 in the mixture. The vapour pressure of the final solution, the mole fraction of components A and B in vapour phase, respectively are-

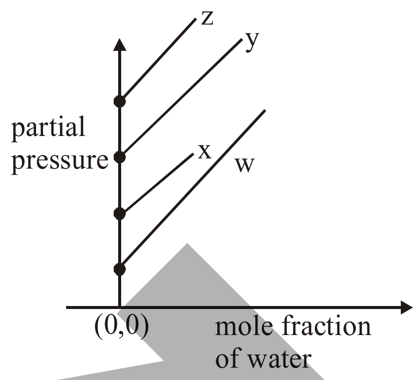
(1) 500 mmHg, 0.5, 0.5

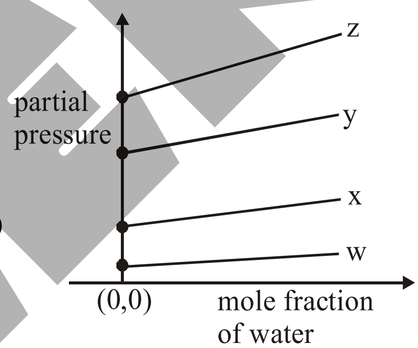
(2) 450 mmHg, 0.4, 0.6

(3) 450 mmHg, 0.5, 0.5

(4) 500 mmHg, 0.4, 0.6

10. For the solution of the gases w, x, y and z in water at 298K, the Henrys law constants (K_H) are 0.5, 2, 35 and 40 kbar, respectively. The correct plot for the given data is :-

(1)


(2)


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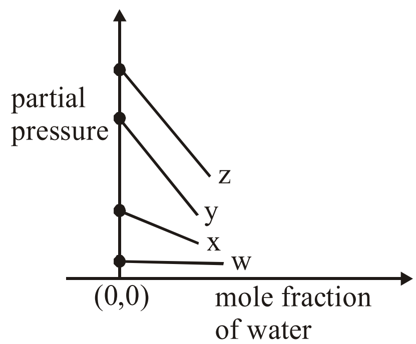

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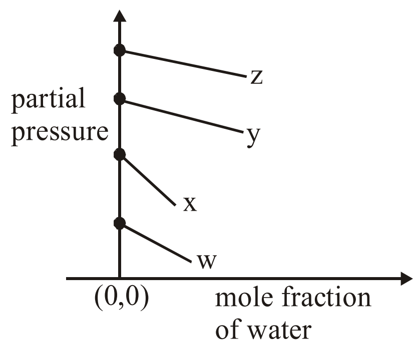


11. The osmotic pressure of a dilute solution of an ionic compound XY in water is four times that of a solution of 0.01 M $BaCl_2$ in water. Assuming complete dissociation of the given ionic compounds in water, the concentration of XY (in mol L^{-1}) in solution is :

(1) 6×10^{-2} (2) 4×10^{-4}

(3) 16×10^{-4} (4) 4×10^{-2}

12. Liquid 'M' and liquid 'N' form an ideal solution. The vapour pressures of pure liquids 'M' and 'N' are 450 and 700 mmHg, respectively, at the same temperature. Then correct statement is:

(x_M= Mole fraction of 'M' in solution ;
x_N = Mole fraction of 'N' in solution ;
y_M= Mole fraction of 'M' in vapour phase ;
y_N = Mole fraction of 'N' in vapour phase)

(1) $(x_M - y_M) < (x_N - y_N)$ (2) $\frac{x_M}{x_N} < \frac{y_M}{y_N}$

(3) $\frac{x_M}{x_N} > \frac{y_M}{y_N}$ (4) $\frac{x_M}{x_N} = \frac{y_M}{y_N}$

13. Molal depression constant for a solvent is 4.0 kg mol^{-1}. The depression in the freezing point of the solvent for 0.03 mol kg^{-1} solution of K_2SO_4 is :

(Assume complete dissociation of the electrolyte)

(1) 0.12 K (2) 0.36 K

(3) 0.18 K (4) 0.24 K

14. At room temperature, a dilute soluton of urea is prepared by dissolving 0.60 g of urea in 360 g of water. If the vapour pressure of pure water at this temperature is 35 mmHg, lowering of vapour pressure will be (molar mass of urea = 60 g mol^{-1}):-

(1) 0.027 mmHg (2) 0.028 mmHg

(3) 0.017 mmHg (4) 0.031 mmHg

15. A solution is prepared by dissolving 0.6 g of urea (molar mass = 60 g mol^{-1}) and 1.8 g of glucose (molar mass = 180 g mol^{-1}) in 100 mL of water at 27°C. The osmotic pressure of the solution is :

(R = 0.08206 L atm K^{-1} mol^{-1})

(1) 4.92 atm (2) 1.64 atm

(3) 2.46 atm (4) 8.2 atm

16. 1 g of non-volatile non-electrolyte solute is dissolved in 100g of two different solvents A and B whose ebullioscopic constants are in the ratio of 1 : 5. The ratio of the elevation in their boiling points, $\frac{\Delta T_b(A)}{\Delta T_b(B)}$, is :

(1) 5 : 1 (2) 10 : 1

(3) 1 : 5 (4) 1 : 0.2

CHEMICAL EQUILIBRIUM

1. In a chemical reaction, $A + 2B \underset{}{\overset{K}{\rightleftharpoons}} 2C + D$, the initial concentration of B was 1.5 times of the concentration of A, but the equilibrium concentrations of A and B were found to be equal. The equilibrium constant(K) for the aforesaid chemical reaction is :

(1) 16 (2) 4

(3) 1 (4) $\frac{1}{4}$

2. Two solids dissociate as follows

$A(s) \rightleftharpoons B(g) + C(g)$; $K_{p_1} = x\ atm^2$

$D(s) \rightleftharpoons C(g) + E(g)$; $K_{p_2} = y\ atm^2$

The total pressure when both the solids dissociate simultaneously is :-

(1) (x + y) atm (2) $x^2 + y^2$ atm

(3) $2\left(\sqrt{x+y}\right)$atm (4) $\sqrt{x+y}$ atm

3. Consider the reaction,

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

The equilibrium constant of the above reaction is K_P. If pure ammonia is left to dissociate, the partial pressure of ammonia at equilibrium is given by (Assume that $P_{NH_3} << P_{total}$ at equilibrium)

(1) $\frac{3^{\frac{3}{2}} K_P^{\frac{1}{2}} P^2}{4}$ (2) $\frac{3^{\frac{3}{2}} K_P^{\frac{1}{2}} P^2}{16}$

(3) $\frac{K_P^{\frac{1}{2}} P^2}{16}$ (4) $\frac{K_P^{\frac{1}{2}} P^2}{4}$

4. Consider the following reversible chemical reactions :

$A_2(g) + Br_2(g) \underset{}{\overset{K_1}{\rightleftharpoons}} 2AB(g)$ .....(1)

$6AB(g) \underset{}{\overset{K_2}{\rightleftharpoons}} 3A_2(g) + 3B_2(g)$ .....(2)

The relation between K_1 and K_2 is :

(1) $K_2 = K_1^3$ (2) $K_2 = K_1^{-3}$

(3) $K_1K_2 = 3$ (4) $K_1K_2 = \frac{1}{3}$

5. 5.1g NH_4SH is introduced in 3.0 L evacuated flask at 327°C. 30% of the solid NH_4SH decomposed to NH_3 and H_2S as gases. The K_p of the reaction at 327°C is

(R = 0.082 L atm $mol^{-1}K^{-1}$, Molar mass of S = 32 g $mol^{/01}$, molar mass of N = 14g mol^{-1})

(1) 1×10^{-4} atm^2

(2) 4.9×10^{-3} atm^2

(3) 0.242 atm^2

(4) 0.242×10^{-4} atm^2

6. The value of K_p/K_C for the following reactions at 300K are, respectively :

(At 300K, RT = 24.62 dm^{3}atm mol^{-1})

$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(1) 1, 24.62 dm^{3}atm mol^{-1}, 606.0 dm^{6}atm^{2}mol^{-2}

(2) 1, 4.1×10^{-2} dm^{-3}atm^{-1} mol^{-1}, 606.0 dm^6 atm^2 mol^{-2}

(3) 606.0 dm^{6}atm^{2}mol^{-2}, 1.65×10^{-3} dm^{3}atm^{-2} mol^{-1}

(4) 1, 24.62 dm^{3}atm mol^{-1}, 1.65×10^{-3} dm^{-6}atm^{-2} mol^2

7. For the following reactions, equilibrium constants are given :

$S(s) + O_2(g) \rightleftharpoons SO_2(g)$; $K_1 = 10^{52}$

$2S(s) + 3O_2(g) \rightleftharpoons 2SO_3(g)$; $K_2 = 10^{129}$

The equilibrium constant for the reaction,

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is :

(1) 10^{181} (2) 10^{154}

(3) 10^{25} (4) 10^{77}

8. For the reaction,

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$,

$\Delta H = -57.2$kJ mol^{-1} and

$K_c = 1.7 \times 10^{16}$.

Which of the following statement is INCORRECT?

(1) The equilibrium constant is large suggestive of reaction going to completion and so no catalyst is required.

(2) The equilibrium will shift in forward direction as the pressure increase.

(3) The equilibrium constant decreases as the temperature increases.

(4) The addition of inert gas at constant volume will not affect the equilibrium constant.

9. In which one of the following equilibria, $K_p \neq K_c$?

(1) $NO_2(g) + SO_2(g) \rightleftharpoons NO(g) + SO_3(g)$

(2) $2\,HI(g) \rightleftharpoons H_2(g) + I_2(g)$

(3) $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$

(4) $2C(s) + O_2(g) \rightleftharpoons 2CO(g)$

SURFACE CHEMISTRY

1. Among the following, the false statement is :

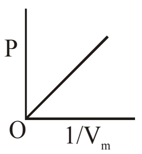
(1) Latex is a colloidal solution of rubber particles which are positively charged

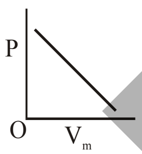
(2) Tyndall effect can be used to distinguish between a colloidal solution and a true solution.

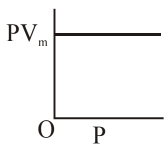
(3) It is possible to cause artificial rain by throwing electrified sand carrying charge opposite to the one on clouds from an aeroplane.

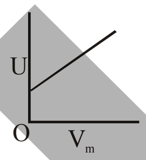
(4) Lyophilic sol can be coagulated by adding an electrolyte.

2. The combination of plots which does not represent isothermal expansion of an ideal gas is:

(A) 

(B) 

(C) 

(D) 

(1) (A) and (C) (2) (A) and (D)
(3) (B) and (D) (4) (B) and (C)

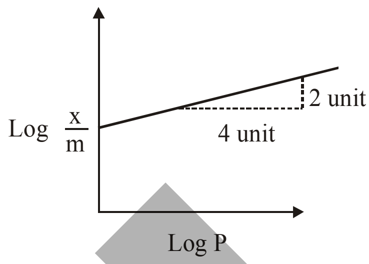
3. An example of solid sol is :

(1) Butter (2) Gem stones
(3) Paint (4) Hair cream

4. Among the colloids cheese (C), milk (M) and smoke (S), the correct combination of the dispersed phase and dispersion medium, respectively is :-

(1) C : solid in liquid; M : solid in liquid ; S : solid in gas
(2) C : solid in liquid; M : liquid in liquid ; S : gas in solid
(3) C : liquid in solid; M : liquid in solid ; S : solid in gas
(4) C : liquid in solid; M : liquid in liquid ; S : solid in gas

5. Adsorption of a gas follows Freundlich adsorption isotherm. In the given plot, x is the mass of the gas adsorbed on mass m of the adsorbent at pressure p. $\frac{x}{m}$ is proportional to

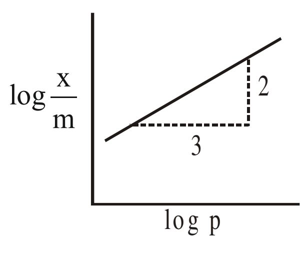


(1) $P^{1/4}$ (2) P^2 (3) P (4) $P^{1/2}$

6. Haemoglobin and gold sol are examples of :

(1) negatively charged sols
(2) positively charged sols]
(3) negatively and positively charged sols, respectively
(4) positively and negatively charged sols, respectively

7. Adsorption of a gas follows Freundlich adsorption isotherm x is the mass of the gas adsorbed on mass m of the adsorbent. The plot of log $\frac{x}{m}$ versus log p is shown in the given graph. $\frac{x}{m}$ is proportional to :



(1) $p^{3/2}$ (2) p^3 (3) $p^{2/3}$ (4) p^2

8. The aerosol is a kind of colloid in which :

(1) gas is dispersed in solid
(2) solid is dispersed in gas
(3) liquid is dispersed in water
(4) gas is dispersed in liquid

9. A gas undergoes physical adsorption on a surface and follows the given Freundlich adsorption isotherm equation

$$\frac{x}{m} = kp^{0.5}$$

Adsorption of the gas increases with :

(1) Decrease in p and decrease in T

(2) Increase in p and increase in T

(3) Increase in p and decrease in T

(4) Decrease in p and increase in T

10. The correct option among the following is :

(1) Colloidal particles in lyophobic sols can be precipiated by electrophoresis.

(2) Brownian motion in colloidal solution is faster the viscosity of the solution is very high.

(3) Colloidal medicines are more effective because they have small surface area.

(4) Addition of alum to water makes it unfit for drinking.

11. Peptization is a :

(1) process of converting a colloidal solution into precipitate

(2) process of converting precipitate into colloidal solution

(3) process of converting soluble particles to form colloidal solution

(4) process of bringing colloidal molecule into solution

12. Among the following, the INCORRECT statement about colloids is :

(1) They can scatter light

(2) They are larger than small molecules and have high molar mass

(3) The range of diameters of colloidal particles is between 1 and 1000 nm

(4) The osmotic pressure of a colloidal solution is of higher order than the true solution at the same concentration

13. 10 mL of 1mM surfactant solution forms a monolayer covering 0.24 cm^2 on a polar substrate. If the polar head is approximated as cube, what is its edge length?

(1) 2.0 pm (2) 2.0 nm

(3) 1.0 pm (4) 0.1 nm

14. For coagulation of arsenious sulphide sol, which one of the following salt solution will be most effective

(1) $AlCl_3$ (2) NaCl

(3) $BaCl_2$ (4) Na_3PO_4

MOLE CONCEPT

1. A 10 mg effervescent tablet containing sodium bicarbonate and oxalic acid releases 0.25 ml of CO_2 at T = 298.15 K and p = 1 bar. If molar volume of CO_2 is 25.0 L under such condition, what is the percentage of sodium bicarbonate in each tablet ? [Molar mass of $NaHCO_3$ = 84 g mol^{-1}]

(1) 16.8 (2) 8.4

(3) 0.84 (4) 33.6

2. For the following reaction, the mass of water produced from 445 g of $C_{57}H_{110}O_6$ is :

$$2C_{57}H_{110}O_6(s) + 163O_2(g) \rightarrow 114CO_2(g) + 110\ H_2O(l)$$

(1) 495 g (2) 490 g (3) 890 g (4) 445 g

3. An organic compound is estimated through Dumas method and was found to evolve 6 moles of CO_2. 4 moles of H_2O and 1 mole of nitrogen gas. The formula of the compound is

(1) $C_{12}H_8N$ (2) $C_{12}H_8N_2$

(3) C_6H_8N (4) $C_6H_8N_2$

4. The percentage composition of carbon by mole in methane is :

(1) 80% (2) 25%

(3) 75% (4) 20%

5. For a reaction,

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$;

identify dihydrogen (H_2) as a limiting reagent in the following reaction mixtures.

(1) 14g of N_2 + 4g of H_2

(2) 28g of N_2 + 6g of H_2

(3) 56g of N_2 + 10g of H_2

(4) 35g of N_2 + 8g of H_2

6. What would be the molality of 20% (mass/mass) aqueous solution of KI?

(molar mass of KI = 166 g mol^{-1})

(1) 1.08 (2) 1.48

(3) 1.51 (4) 1.35

7. At 300 K and 1 atmospheric pressure, 10 mL of a hydrocarbon required 55 mL of O_2 for complete combustion and 40 mL of CO_2 is formed. The formula of the hydrocarbon is :

(1) C_4H_8 (2) C_4H_7Cl
(3) C_4H_{10} (4) C_4H_6

8. The minimum amount of $O_2(g)$ consumed per gram of reactant is for the reaction :

(Given atomic mass : Fe = 56, O = 16, Mg = 24, P = 31, C = 12, H = 1)

(1) $C_3H_8(g) + 5\,O_2(g) \rightarrow 3\,CO_2(g) + 4\,H_2O(l)$

(2) $P_4(s) + 5\,O_2(g) \rightarrow P_4O_{10}(s)$

(3) $4\,Fe(s) + 3\,O_2(g) \rightarrow 2\,FeO_3(s)$

(4) $2\,Mg(s) + O_2(g) \rightarrow 2\,MgO(s)$

9. 5 moles of AB_2 weigh 125×10^{-3} kg and 10 moles of A_2B_2 weigh 300×10^{-3} kg. The molar mass of $A(M_A)$ and molar mass of $B(M_B)$ in kg mol^{-1} are :

(1) $M_A = 50 \times 10^{-3}$ and $M_B = 25 \times 10^{-3}$
(2) $M_A = 25 \times 10^{-3}$ and $M_B = 50 \times 10^{-3}$
(3) $M_A = 5 \times 10^{-3}$ and $M_B = 10 \times 10^{-3}$
(4) $M_A = 10 \times 10^{-3}$ and $M_B = 5 \times 10^{-3}$

10. 25 g of an unknown hydrocarbon upon burning produces 88 g of CO_2 and 9 g of H_2O. This unknown hydrocarbon contains.

(1) 20g of carbon and 5 g of hydrogen
(2) 24g of carbon and 1 g of hydrogen
(3) 18g of carbon and 7 g of hydrogen
(4) 22g of carbon and 3 g of hydrogen

IDEAL GAS

1. 0.5 moles of gas A and x moles of gas B exert a pressure of 200 Pa in a container of volume 10 m^3 at 1000 K. Given R is the gas constant in $JK^{-1}\,mol^{-1}$, x is :

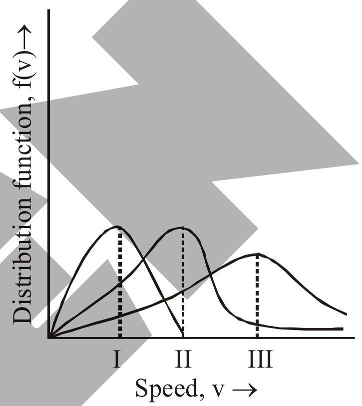
(1) $\frac{2R}{4+12}$ (2) $\frac{2R}{4-R}$

(3) $\frac{4-R}{2R}$ (4) $\frac{4+R}{2R}$

2. An open vessel at 27°C is heated until two fifth of the air (assumed as an ideal gas) in it has escaped from the vessel. Assuming that the volume of the vessel remains constant, the temperature at which the vessel has been heated is :

(1) 750°C (2) 500°C
(3) 750 K (4) 500 K

3. Points I, II and III in the following plot respectively correspond to
(V_{mp} : most probable velocity)



(1) V_{mp} of N_2 (300K); V_{mp} of H_2(300K); V_{mp} of O_2(400K)
(2) V_{mp} of H_2 (300K); V_{mp} of N_2(300K); V_{mp} of O_2(400K)
(3) V_{mp} of O_2 (400K); V_{mp} of N_2(300K); V_{mp} of H_2(300K)
(4) V_{mp} of N_2 (300K); V_{mp} of O_2(400K); V_{mp} of H_2(300K)

CONCENTRATION TERMS

1. The volume strength of 1M H_2O_2 is: (Molar mass of H_2O_2 = 34 g mol^{-1})

(1) 16.8 (2) 11.35 (3) 22.4 (4) 5.6

2. 8g of NaOH is dissolved in 18g of H_2O. Mole fraction of NaOH in solution and molality (in mol kg^{-1}) of the solutions respectively are:

(1) 0.167, 11.11 (2) 0.2, 22.20
(3) 0.2, 11.11 (4) 0.167,22.20

3. A solution of sodium sulfate contains 92 g of Na^+ ions per kilogram of water. The molality of Na^+ ions in that solution in mol kg^{-1} is:

(1) 16 (2) 8 (3) 4 (4) 12

4. The amount of sugar ($C_{12}H_{22}O_{11}$) required to prepare 2 L of its 0.1 M aqueous solution is :
(1) 68.4 g (2) 17.1 g
(3) 34.2 g (4)136.8 g

5. The strength of 11.2 volume solution of H_2O_2 is : [Given that molar mass of H = 1 g mol^{-1} and O = 16 g mol^{-1}]
(1) 13.6% (2) 3.4%
(3) 34% (4) 1.7%

6. The mole fraction of a solvent in aqueous solution of a solute is 0.8. The molality (in mol kg^{-1}) of the aqueous solution is
(1) 13.88×10^{-1}
(2) 13.88×10^{-2}
(3) 13.88
(4) 13.88×10^{-3}

ELECTROCHEMISTRY

1. The standard electrode potential $E^{\ominus}$ and its temeprature coefficient $\left(\frac{dE^{\ominus}}{dT}\right)$ for a cell are 2V and -5×10^{-4} VK^{-1} at 300 K respectively. The cell reaction is
$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
The standard reaction enthalpy $(\Delta_r H^{\ominus})$ at 300 K in kJ mol^{-1} is,
[Use R = 8JK^{-1} mol^{-1} and F = 96,000 Cmol^{-1}]
(1) –412.8 (2) –384.0
(3) 206.4 (4) 192.0

2. $\wedge_m^{\circ}$ for NaCl, HCl and NaA are 126.4, 425.9 and 100.5 S cm^{2}mol^{-1}, respectively. If the conductivity of 0.001 M HA is 5×10^{-5} S cm^{-1}, degree of dissociation of HA is :
(1) 0.75 (2) 0.125
(3) 0.25 (4) 0.50

3. Consider the following reduction processes :
$Zn^{2+} + 2e^- \rightarrow Zn(s);\ E^{\circ} = -0.76$ V
$Ca^{2+} + 2e^- \rightarrow Ca(s);\ E^{\circ} = -2.87$ V
$Mg^{2+} + 2e^- \rightarrow Mg(s);\ E^{\circ} = -2.36$ V
$Ni^{2+} + 2e^- \rightarrow Ni(s);\ E^{\circ} = -0.25$ V
The reducing power of the metals increases in the order :
(1) Ca < Zn < Mg < Ni
(2) Ni < Zn < Mg < Ca
(3) Zn < Mg < Ni < Ca
(4) Ca < Mg < Zn < Ni

4. In the cell :
Pt(s)|H_2(g, 1bar|HCl(aq)|AgCl(s)|Ag(s)|Pt(s)
the cell potential is 0.92V when a 10^{-6} molal HCl solution is used. The standard electrode potential of (AgCl/Ag,Cl^-) electrode is :
$\left\{\text{given}, \frac{2.303RT}{F} = 0.06\text{V at } 298\text{K}\right\}$
(1) 0.20 V (2) 0.76 V
(3) 0.40 V (4) 0.94 V

5. The anodic half-cell of lead-acid battery is recharged unsing electricity of 0.05 Faraday. The amount of $PbSO_4$ electrolyzed in g during the process in :
(Molar mass of $PbSO_4$ = 303 g mol^{-1})
(1) 22.8 (2) 15.2
(3) 7.6 (4) 11.4

6. For the cell Zn(s) | Zn^{2+}(aq) || M^{x+} (aq) | M(s), different half cells and their standard electrode potentials are given below :

$M^{x+}(aq/M(s)$	$Au^{3+}(aq)/Au(s)$	$Ag^{+}(aq)/Ag(s)$	$Fe^{3+}(aq)/Fe^{2+}(aq)$	$Fe^{2+}(aq)/Fe(s)$
$E^{o}_{M^{x+}/M^{(v)}}$	1.40	0.80	0.77	–0.44

If $E^{o}_{Zn^{2+}/Zn} = -0.76V$, which cathode will give a mximum value of E^{o}_{cell} per electron transferred ?
(1) Fe^{3+} / Fe^{2+} (2) Ag^{+} / Ag
(3) Au^{3+} / Au (4) Fe^{2+} / Fe

7. If the standard electrode potential for a cell is 2 V at 300 K, the equilibrium constant (K) for the reaction

$Zn(s) + Cu^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Cu(s)$

at 300 K is approximately.

($R = 8\ JK^{-1}\ mol^{-1}$, $F = 96000\ C\ mol^{-1}$)

(1) e^{160} (2) e^{320}

(3) e^{-160} (4) e^{-80}

8. Given the equilibrium constant :

K_C of the reaction :

$Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$ is 10×10^{15}, calculate the E^0_{cell} of this reaction at 298 K

$$\left[2.303\frac{RT}{F} \text{at } 298\,K = 0.059V\right]$$

(1) 0.04736 V

(2) 0.4736 V

(3) 0.4736 mV

(4) 0.04736 mV

9. Given that : $E^0_{O_2/H_2O} = +1.23V$,

$E^0_{S_2O_8^{2-}/SO_4^{2-}} = +2.05V$

$E^0_{Br_2/Br^-} = +1.09V$

$E^0_{Au^{3+}/Au} = +1.4V$

The strongest oxidizing agent is -

(1) O_2 (2) Br_2

(3) $S_2O_8^{2-}$ (4) Au^{3+}

10. Calculate the standard cell potential in(V) of the cell in which following reaction takes place :

$Fe^{2+}(aq) + Ag^{+}(aq) \rightarrow Fe^{3+}(aq) + Ag(s)$

Given that

$E^o_{Ag^+/Ag} = xV$

$E^o_{Fe^{2+}/Fe} = yV$

$E^o_{Fe^{3+}/Fe} = zV$

(1) x + 2y – 3z (2) x – z

(3) x – y (4) x + y – z

11. The standard Gibbs energy for the given cell reaction in kJ mol^{-1} at 298 K is :

$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$,

$E° = 2$ V at 298 K

(Faraday's constant, $F = 96000\ C\ mol^{-1}$)

(1) –384 (2) –192

(3) 192 (4) 384

12. A solution of $Ni(NO_3)_2$ is electrolysed between platinum electrodes using 0.1 Faraday electricity. How many mole of Ni will be deposited at the cathode?

(1) 0.20 (2) 0.05

(3) 0.10 (4) 0.15

13. Consider the statements S1 and S2 :

S1 : Conductivity always increases with decrease in the concentration of electrolyte.

S2 : Molar conductivity always incrteases with decrease in the concentration of electrolyte.

The correct option among the following is :

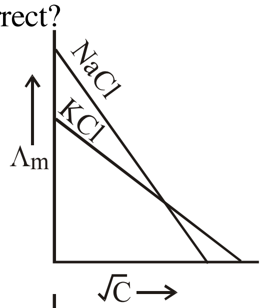
(1) Both S1 and S2 are correct

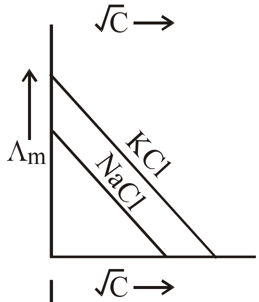
(2) S1 is wrong and S2 is correct

(3) S1 is correct and S2 is wrong

(4) Both S1 and S2 are wrong

14. Which one of the following graphs between molar conductivity (Λ_m) versus $\sqrt{C}$ is correct?

(1)


(2)


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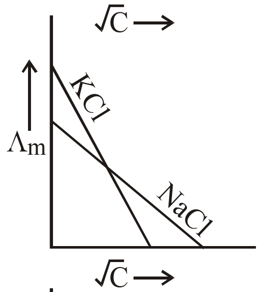

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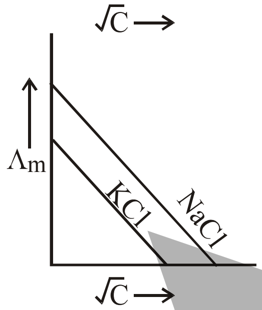


15. Given :

$Co^{3+} + e^- \rightarrow Co^{2+}$; $E^o = +1.81$ V

$Pb^{4+} + 2e^- \rightarrow Pb^{2+}$; $E^o = +1.67$ V

$Ce^{4+} + e^- \rightarrow Ce^{3+}$; $E^o = +1.61$ V

$Bi^{3+} + 3e^- \rightarrow Bi$; $E^o = +0.20$ V

Oxidizing power of the species will increase in the order :

(1) $Ce^{4+} < Pb^{4+} < Bi^{3+} < Co^{3+}$

(2) $Co^{3+} < Pb^{4+} < Ce^{4+} < Bi^{3+}$

(3) $Co^{3+} < Ce^{4+} < Bi^{3+} < Pb^{4+}$

(4) $Bi^{3+} < Ce^{4+} < Pb^{4+} < Co^{3+}$

16. The decreasing order of electrical conductivity of the following aqueous solutions is :

0.1 M Formic acid (A),

0.1 M Acetic acid (B)

0.1 M Benzoic acid (C)

(1) C > B > A (2) A > B > C

(3) A > C > B (4) C > A > B

REDOX

1. The hardness of a water sample (in terms of equivalents of $CaCO_3$) containing 10^{-3} M $CaSO_4$ is :

(molar mass of $CaSO_4$ = 136 g mol^{-1})

(1) 100 ppm

(2) 50 ppm

(3) 10 ppm

(4) 90 ppm

2. 50 mL of 0.5 M oxalic acid is needed to neutralize 25 mL of sodium hydroxide solution. The amount of NaOH in 50 mL of the given sodium hydroxide solution is :

(1) 4 g (2) 2 g (3) 8 g (4) 1 g

3. In the reaction of oxalate with permaganate in acidic medium, the number of electrons involved in producing one molecule of CO_2 is :

(1) 10 (2) 2

(3) 1 (4) 5

4. The chemical nature of hydrogen preoxide is :-

(1) Oxidising and reducing agent in acidic medium, but not in basic medium.

(2) Oxidising and reducing agent in both acidic and basic medium

(3) Reducing agent in basic medium, but not in acidic medium

(4) Oxidising agent in acidic medium, but not in basic medium.

5. In order to oxidise a mixture one mole of each of FeC_2O_4, $Fe_2(C_2O_4)_3$, $FeSO_4$ and $Fe_2(SO_4)_3$ in acidic medium, the number of moles of $KMnO_4$ required is -

(1) 3 (2) 2

(3) 1 (4) 1.5

6. 100 mL of a water sample contains 0.81 g of calcium bicarbonate and 0.73 of magnesium bicarbonate. The hardness of this water sample expressed in terms of equivalents of $CaCO_3$ is: (molar mass of calcium bicarbonate is 162 g mol^{-1} and magnesium bicarbonate is 146 $gmol^{-1}$)

(1) 1,000 ppm (2) 10,000 ppm

(3) 100 ppm (4) 5,000 ppm

7. An example of a disproportionation reaction is :

(1) $2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$

(2) $2MnO_4^- + 10I^- + 16H^+ \rightarrow 2Mn^{2+} + 5I_2 + 8H_2O$

(3) $2CuBr \rightarrow CuBr_2 + Cu$

(4) $2NaBr + Cl_2 \rightarrow 2NaCl + Br_2$

SOLID STATE

1. Which premitive unit cell has unequal edge lenghs ($a \neq b \neq c$) and all axial angles different from 90°

(1) Tetragonal (2) Hexagonal

(3) Monoclinic (4) Triclinic

2. A solid having density of 9×10^3 kg m^{-3} forms face centred cubic crystals of edge length $200\sqrt{2}$ pm. What is the molar mass of the solid ?

(Avogadro constant $\cong 6 \times 10^{23}$ mol^{-1}, $\pi \cong 3$)

(1) 0.0216 kg mol^{-1}

(2) 0.0305 kg mol^{-1}

(3) 0.4320 kg mol^{-1}

(4) 0.0432 kg mol^{-1}

3. The radius of the largest sphere which fits properly at the centre of the edge of body centred cubic unit cell is : (Edge length is represented by 'a') :-

(1) 0.134 a (2) 0.027 a

(3) 0.067 a (4) 0.047 a

4. At 100°C, copper (Cu) has FCC unit cell structure with cell edge length of x Å. What is the approximate density of Cu (in g cm^{-3}) at this temperature ?

[Atomic Mass of Cu = 63.55u]

(1) $\frac{105}{x^3}$ (2) $\frac{211}{x^3}$

(3) $\frac{205}{x^3}$ (4) $\frac{422}{x^3}$

5. The statement that is **INCORRECT** about the interstitial compounds is :

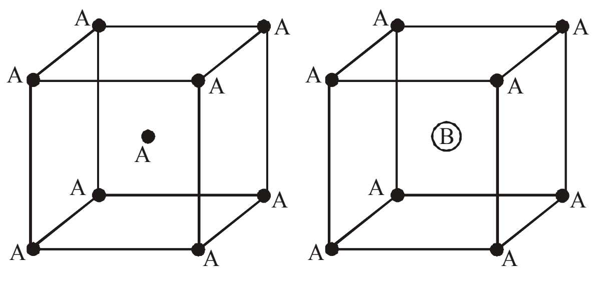
(1) They have high melting points

(2) They are chemically reactive

(3) They have metallic conductivity

(4) They are very hard

6. Consider the bcc unit cells of the solids 1 and 2 with the position of atoms as shown below. The radius of atom B is twice that of atom A. The unit cell edge length is 50% more in solid 2 than in 1. What is the approximate packing efficiency in solid 2?



Solid 1 Solid 2

(1) 45% (2) 65%

(3) 90% (4) 75%

7. An element has a face-centred cubic (fcc) structure with a cell edge of a. The distance between the centres of two nearest tetrahedral voids in the lattice is :

(1) $\frac{a}{2}$ (2) a

(3) $\frac{3}{2}a$ (4) $\sqrt{2}\,a$

8. The ratio of number of atoms present in a simple cubic, body centered cubic and face centered cubic structure are, respectively :

(1) 1 : 2 : 4 (2) 8 : 1 : 6

(3) 4 : 2 : 1 (4) 4 : 2 : 3

9. A compound of formula A_2B_3 has the hcp lattice. Which atom forms the hcp lattice and what fraction of tetrahedral voids is occupied by the other atoms :

(1) hcp lattice-A, $\frac{2}{3}$ Tetrachedral voids-B

(2) hcp lattice-B, $\frac{1}{3}$ Tetrachedral voids-A

(3) hcp lattice-B, $\frac{2}{3}$ Tetrachedral voids-A

(4) hcp lattice-A $\frac{1}{3}$ Tetrachedral voids-B

THERMOCHEMISTRY

1. Given :

(i) $C(graphite) + O_2(g) \rightarrow CO_2(g)$;

$\Delta rH° = x$ kJ mol^{-1}

(ii) $C(graphite) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$;

$\Delta rH° = y$ kJ mol^{-1}

(iii) $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$;

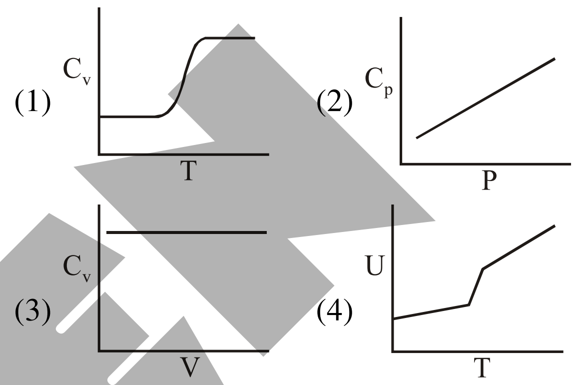
$\Delta rH° = z$ kJ mol^{-1}

Based on the above thermochemical equations, find out which one of the following algebraic relationships is correct ?

(1) z = x + y (2) x = y – z

(3) x = y + z (4) y = 2z – x

2. For diatomic ideal gas in a closed system, which of the following plots does not correctly describe the relation between various thermodynamic quantities ?



3. The process with negative entropy change is :

(1) Dissolution of iodine in water

(2) Synthesis of ammonia from N_2 and H_2

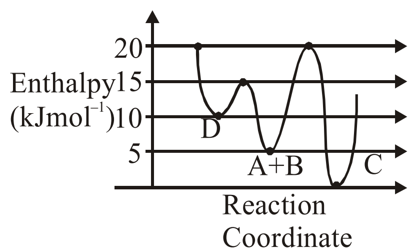
(3) Dissolution of $CaSO_4(s)$ to CaO(s) and $SO_3(g)$

(4) Subimation of dry ice

4. Consider the given plot of enthalpy of the following reaction between A and B.

$A + B \rightarrow C + D$

Identify the incorrect statement.



(1) C is the thermodynamically stable product.

(2) Formation of A and B from C has highest enthalpy of activation.

(3) D is kinetically stable product.

(4) Activation enthalpy to form C is 5kJ mol^{-1} less than that to form D.

5. Enthalpy of sublimation of iodine is 24 cal g^{-1} at 200°C. If specific heat of $I_2(s)$ and $I_2(vap)$ are 0.055 and 0.031 cal $g^{-1}K^{-1}$ respectively, then enthalpy of sublimation of iodine at 250°C in cal g^{-1} is :

(1) 2.85 (2) 11.4

(3) 5.7 (4) 22.8

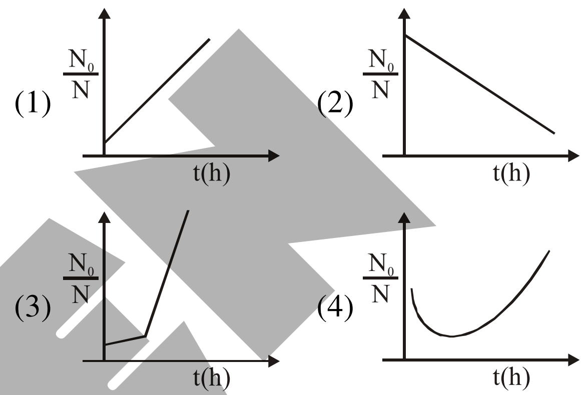
6. The difference between ΔH and ΔU (ΔH–ΔU), when the combustion of one mole of heptane (1) is carried out at a temperature T, is equal to:

(1) 3RT (2) –3RT

(3) –4RT (4) 4RT

RADIOACTIVITY

1. A bacterial infection in an internal wound grows as $N'(t) = N_0 \exp(t)$, where the time t is in hours. A dose of antibiotic, taken orally, needs 1 hour to reach the wound. Once it reaches there, the bacterial population goes down as $\frac{dN}{dt} = -5N^2$. What will be the plot of $\frac{N_0}{N}$ vs. t after 1 hour ?



ANSWER KEY

ATOMIC STRUCTURE

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	2	4	2	2	1	1	3	4	4
Que.	11	12	13	14	15	16				
Ans.	4	4	4	4	2	2				

CHEMICAL KINETICS

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	1	1	4	3	1	2	2	3	1
Que.	11	12	13	14						
Ans.	1	2	2	4						

THERMODYNAMICS-01

Que.	1	2	3	4	5	6	7	8		
Ans.	2	2	3	4	1	3	1	3		

THERMODYNAMIS-02

Que.	1	2	3	4	5	6	7	8	9	
Ans.	3	1	1	2	4	4	2	1	4	

IONIC EQUILIBRIUM

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	2	1	3	3	3	4	1	2	2	4
Que.	11									
Ans.	4									

REAL GAS

Que.	1	2	3	4
Ans.	1	1	3	3

LIQUID SOLUTION

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	2	2	3	1	2	4	2	2	4	3
Que.	11	12	13	14	15	16				
Ans.	1	3	2	3	1	3				

CHEMICAL EQUILIBRIUM

Que.	1	2	3	4	5	6	7	8	9	
Ans.	2	3	2	2	3	4	3	1	4	

SURFACE CHEMISTRY

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	3	2	4	4	4	3	2	3	1
Que.	11	12	13	14						
Ans.	2	4	1	1						

MOLE CONCEPT

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	2	1	4	4	3	3	4	3	3	2

IDEAL GAS

Que.	1	2	3
Ans.	3	4	4

CONCENTRATION TERMS

Que.	1	2	3	4	5	6
Ans.	2	1	3	1	2	3

ELECTROCHEMISTRY

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	2	2	1	3	2	1	2	3	1
Que.	11	12	13	14	15	16				
Ans.	1	2	2	2	4	3				

REDOX

Que.	1	2	3	4	5	6	7
Ans.	1	Bonus	3	2	2	2	3

SOLID STATE

Que.	1	2	3	4	5	6	7	8	9
Ans.	4	2	3	4	2	3	1	1	2

THERMOCHEMISTRY

Que.	1	2	3	4	5	6
Ans.	3	2	2	4	4	3

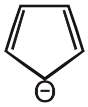
RADIOACTIVITY

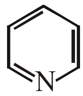
Que.	1
Ans.	1

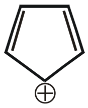
JANUARY & APRIL 2019 ATTEMPT (OC)

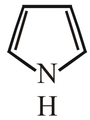
GOC

1. Which of the following compounds is not aromatic ?

(1) 

(2) 

(3) 

(4) 

2. The increasing basicity order of the following compounds is :

(A) $CH_3CH_2NH_2$

(B) CH_3CH_2NH with CH_2CH_3 on N

(C) $H_3C–N–CH_3$ with CH_3 on N

(D) $Ph–N–H$ with CH_3 on N

(1) (D)<(C)<(A)<(B) (2) (A)<(B)<(D)<(C)

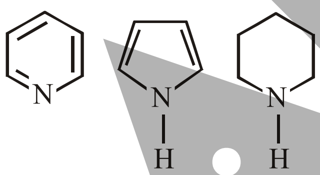
(3) (A)<(B)<(C)< (D) (4) (D)<(C)<(B)<(A)

3. Which amongst the following is the strongest acid ?

(1) CHI_3 (2) $CHCl_3$

(3) $CHBr_3$ (4) $CH(CN)_3$

4. Arrange the following amines in the decreasing order of basicity:



(I) (II) (III)

(1) I > II > III (2) III > II > I

(3) I > III > II (4) III > I > II

5. The correct decreasing order for acid strength is :-

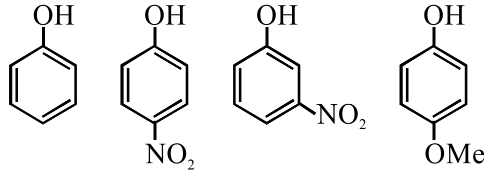
(1) NO_2CH_2COOH > $NCCH_2COOH$ > FCH_2COOH > $ClCH_2COOH$

(2) FCH_2COOH > $NCCH_2COOH$ > $NO_2CHCOOH$ > $ClCH_2COOH$

(3) NO_2CH_2COOH > FCH_2COOH > $CNCH_2COOH$ > $ClCH_2COOH$

(4) $CNCH_2COOH$ > O_2NCH_2COOH > FCH_2COOH > $ClCH_2COOH$

6. The increasing order of the pKa values of the following compounds is :



A B C D

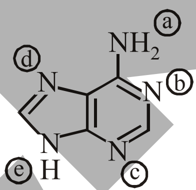
(1) D < A < C < B

(2) B < C < D < A

(3) C < B < A < D

(4) B < C < A < D

7. In the following compound,



the favourable site/s for protonation is/are :-

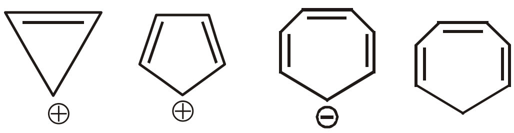
(1) (b), (c) and (d)

(2) (a)

(3) (a) and (e)

(4) (a) and (d)

8. Which compound(s) out of the following is/are not aromatic ?



(A) (B) (C) (D)

(1) C and D (2) B, C and D

(3) A and C (4) B

9. The correct order for acid strength of compounds

$CH≡CH$, $CH_3–C≡CH$ and $CH_2=CH_2$

is as follows :

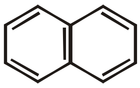
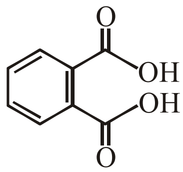
(1) $CH \equiv CH > CH_2 = CH_2 > CH_3–C \equiv CH$

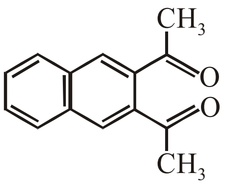
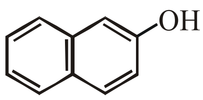
(2) $HC \equiv CH > CH_3 –C \equiv CH > CH_2 = CH_2$

(3) $CH_3–C \equiv CH > CH_2 = CH_2 > HC \equiv CH$

(4) $CH_3–C \equiv CH > CH \equiv CH > CH_2 = CH_2$

10. Among the following four aromatic compounds, which one will have the lowest melting point ?

(1)  (2) 

(3)  (4) 

11. In the following compounds, the decreasing order of basic strength will be -

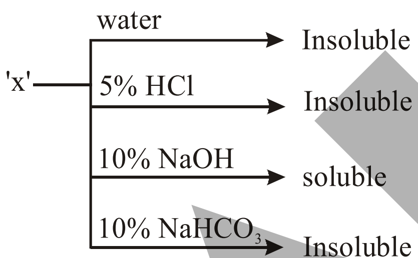
(1) $(C_2H_5)_2NH > C_2H_5NH_2 > NH_3$

(2) $(C_2H_5)_2NH > NH_3 > C_2H_5NH_2$

(3) $NH_3 > C_2H_5NH_2 > (C_2H_5)_2NH$

(4) $C_2H_5NH_2 > NH_3 > (C_2H_5)_2NH$

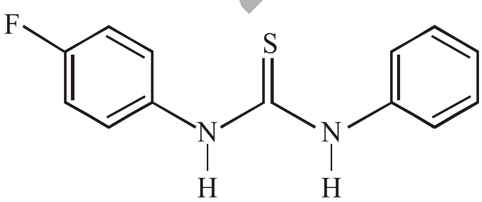
12. An organic compound 'X' showing the following solubility profile is -

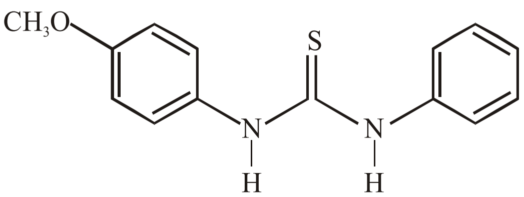


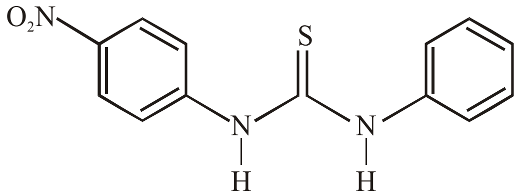
(1) m-Cresol (2) Oleic acid

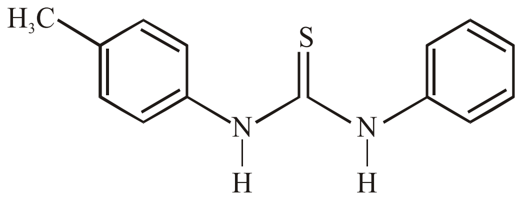
(3) o-Toluidine (4) Benzamide

13. The increasing order of the pK_b of the following compound is :

(A) 

(B) 

(C) 

(D) 

Options :

(1) (A) < (C) < (D) < (B)

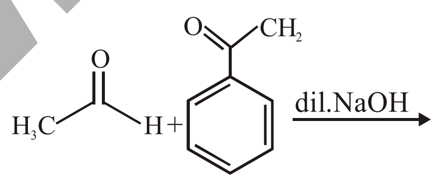
(2) (B) < (D) < (A) < (C)

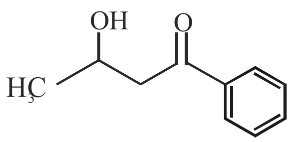
(3) (C) < (A) < (D) < (B)

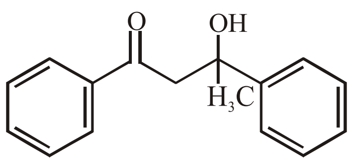
(4) (B) < (D) < (C) < (A)

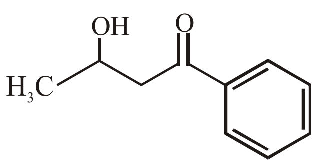
CARBONYL COMPOUND

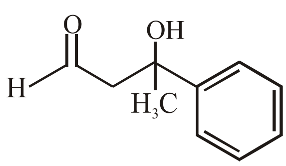
1. The major product formed in the following reaction is:



(1) 

(2) 

(3) 

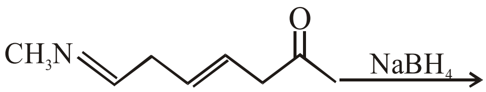
(4) 

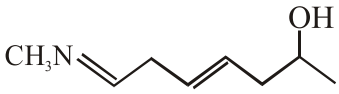
2. The major product of following reaction is :

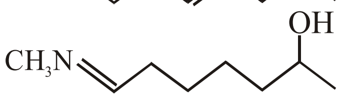
$$R-C\equiv N \xrightarrow[(2)H_2O]{(1)AlH(i-Bu_2)} ?$$

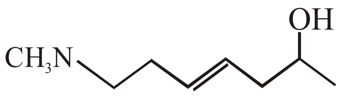
(1) RCHO (2) RCOOH
(3) RCH_2NH_2 (4) $RCONH_2$

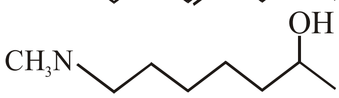
3. The major product of the following recation is:



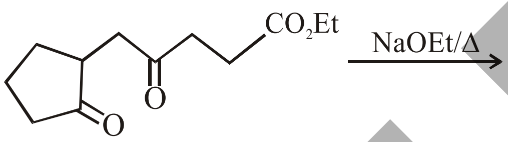
(1) 

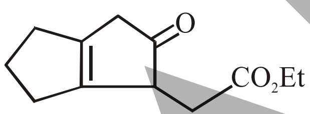
(2) 

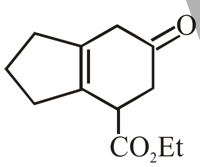
(3) 

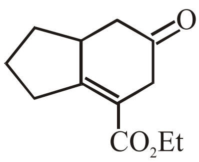
(4) 

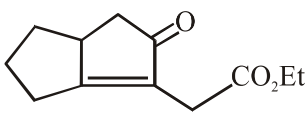
4. The major product obtained in the following reaction is :



(1) 

(2) 

(3) 

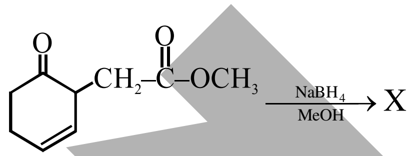
(4) 

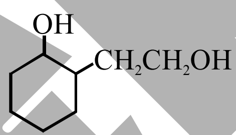
5. Which is the most suitable reagent for the following transformation ?

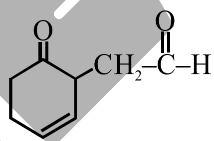
$$CH_3-CH=CH-CH_2-\underset{}{\overset{OH}{C}}H-CH_3 \longrightarrow CH_3-CH=CH-CH_2CO_2H$$

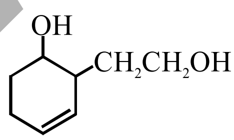
(1) alkaline $KMnO_4$ (2) $I_2/NaOH$
(3) Tollen's reagent (4) CrO_2/CS_2

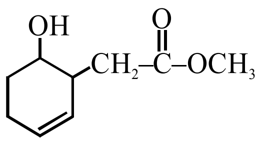
6. The major product 'X' formed in the following reaction is :



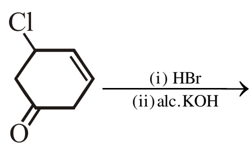
(1) 

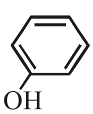
(2) 

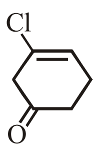
(3) 

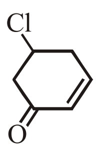
(4) 

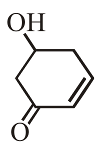
7. The major poduct of the following reaction is:



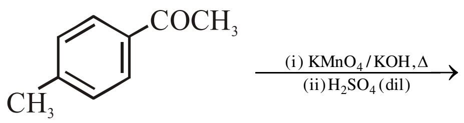
(1) 

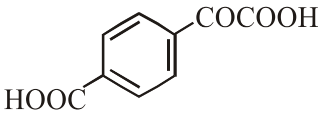
(2) 

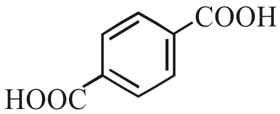
(3) 

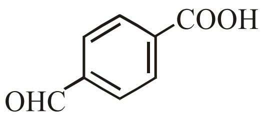
(4) 

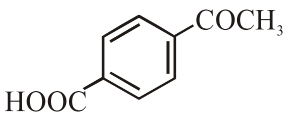
8. The major product of the following reaction is :



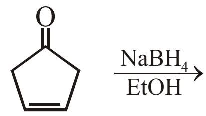
(1) 

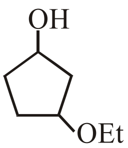
(2) 

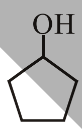
(3) 

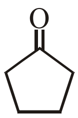
(4) 

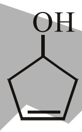
9. The major product of the following reaction is:



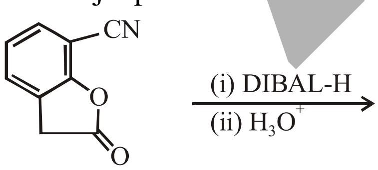
(1) 

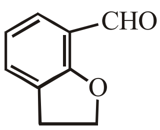
(2) 

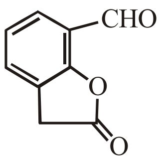
(3) 

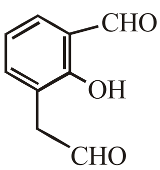
(4) 

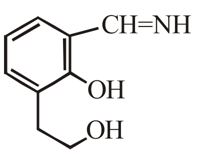
10. The major product of the following reaction is:



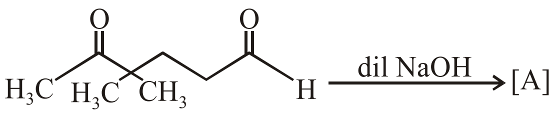
(1) 

(2) 

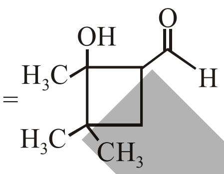
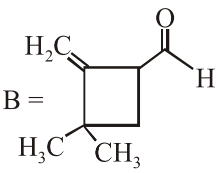
(3) 

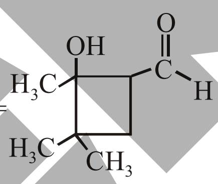
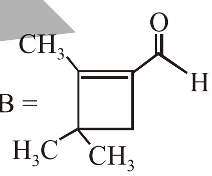
(4) 

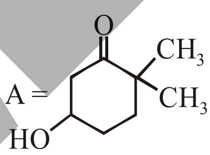
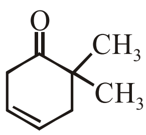
11. In the following reactions, products A and B are :

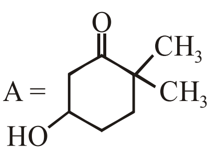
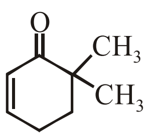


$$[A] \xrightarrow[\Delta]{H_3O^+} [B]$$

(1) A =  ; B = 

(2) A =  ; B = 

(3) A =  ; B = 

(4) A =  ; B = 

12. In the following reaction

$$\text{Aldehyde} + \text{Alcohol} \xrightarrow{HCl} \text{Acetal}$$

Aldehyde	Alcohol
HCHO	^{t}BuOH
CH_3CHO	MeOH

The best combinations is :

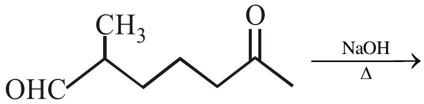
(1) HCHO and MeOH

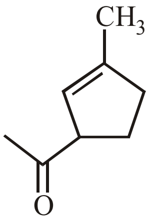
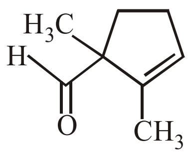
(2) HCHO and ^{t}BuOH

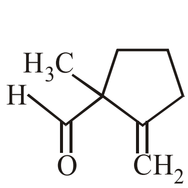
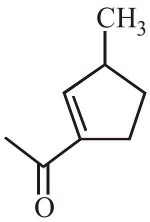
(3) CH_3CHO and MeOH

(4) CH_3CHO and ^{t}BuOH

13. The major product obtained in the following reaction is



(1)  (2) 

(3)  (4) 

14. In the following reaction

carbonyl compound + MeOH $\underset{}{\overset{HCl}{\rightleftharpoons}}$ acetal

Rate of the reaction is the highest for :

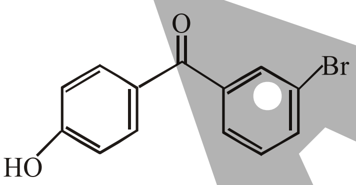
(1) Acetone as substrate and methanol in stoichiometric amount

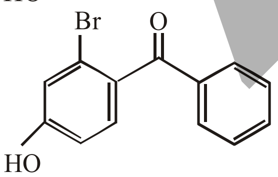
(2) Propanal as substrate and methanol in stoichiometric amount.

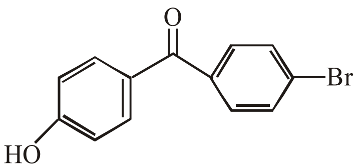
(3) Acetone as substrate and methanol in excess

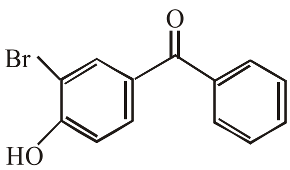
(4) Propanal as substrate and methanol in excess

15. p-Hydroxybenzophenone upon reaction with bromine in carbon tetrachloride gives:

(1) 

(2) 

(3) 

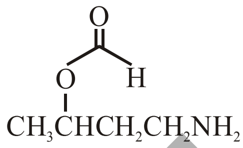
(4) 

16. The major product of the following reaction is :

$CH_3CH(OH)CH_2CH_2NH_2 \xrightarrow[\text{triethylamine}]{\text{ethyl formate (1equiv.)}}$

(1) $CH_3CH(OH)CH_2CH_2NHCHO$

(2) $CH_3CH{=}CH{-}CH_2NH_2$

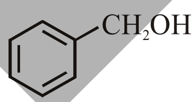
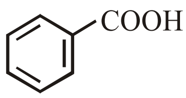
(3) 

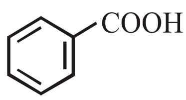
(4) $CH_3{-}CH(OH){-}CH{=}CH_2$

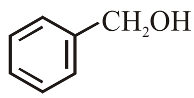
17. Major products of the following reaction are :

 + HCHO $\xrightarrow[\text{(ii) } H_3O^+]{\text{(i) 50\% NaOH}}$

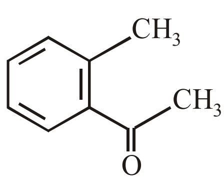
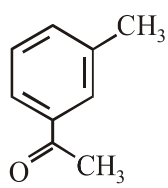
(1) CH_3OH and HCO_2H

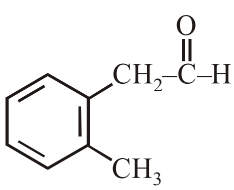
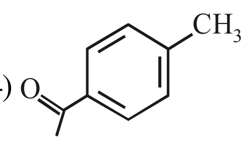
(2)  and 

(3) CH_3OH and 

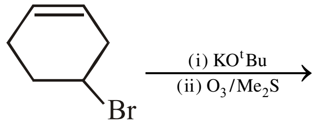
(4) HCOOH and 

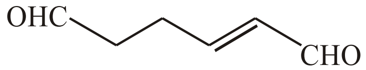
18. Compound A ($C_9H_{10}O$) shows positive iodoform test. Oxidation of A with $KMnO_4$/KOH gives acid B($C_8H_6O_4$). Anhydride of B is used for the preparation of phenolphthalein. Compound A is :-

(1)  (2) 

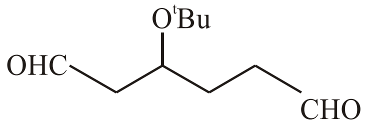
(3)  (4) 

19. The major product(s) obtained in the following reaction is/are :



(1) 

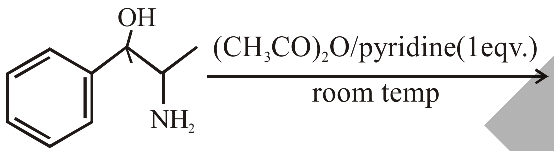
(2) 

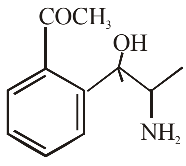
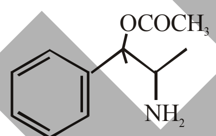
(3) 

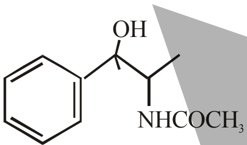
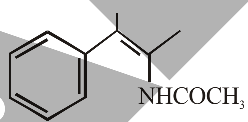
(4) 

CAD

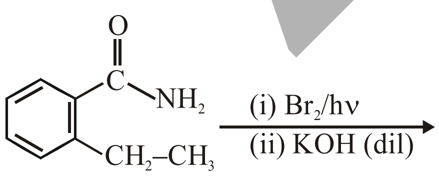
1. The major product obtained in the following reaction is :

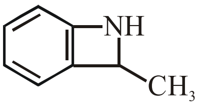
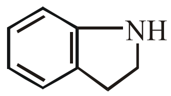


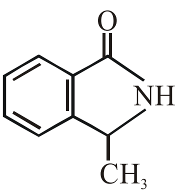
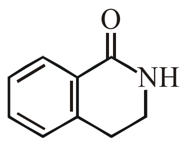
(1) 
(2) 

(3) 
(4) 

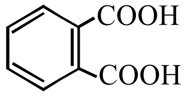
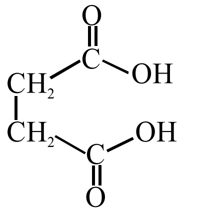
2. The major product of the following reaction is :

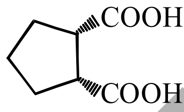
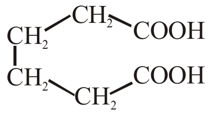


(1) 
(2) 

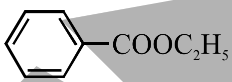
(3) 
(4) 

3. Which dicarboxylic acid in presence of a dehydrating agent is least reactive to give an anhydride :

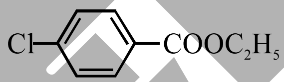
(1) 
(2) 

(3) 
(4) 

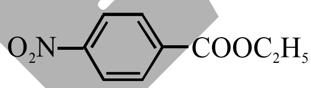
4. The decreasing order of ease of alkaline hydrolysis for the following esters is :



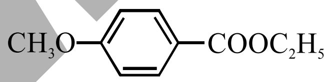
I



II



III

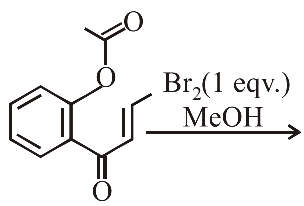


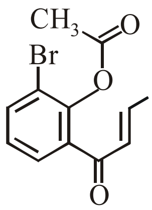
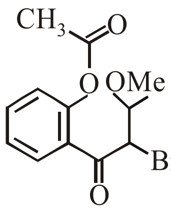
IV

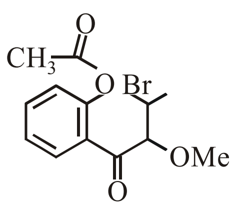
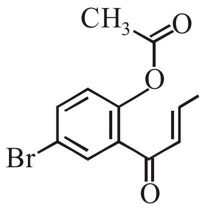
(1) IV > II > III > I (2) III > II > I > IV

(3) III > II > IV > I (4) II > III > I > IV

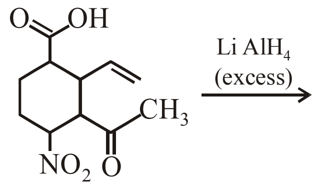
5. The major product obtained in the following conversion is :-

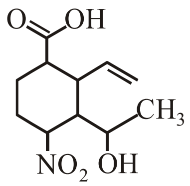


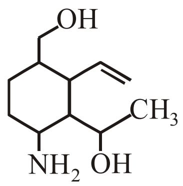
(1) 
(2) 

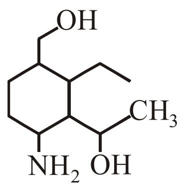
(3) 
(4) 

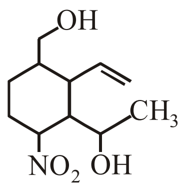
6. The major product obtained in the following reaction is :-



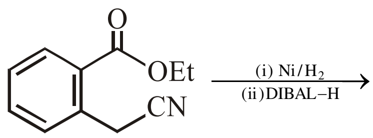
(1) 

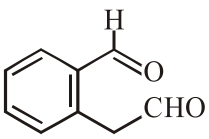
(2) 

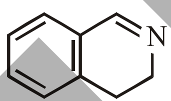
(3) 

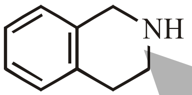
(4) 

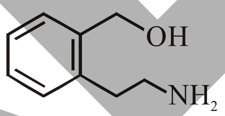
7. The major product of the following reaction is:



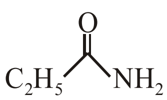
(1) 

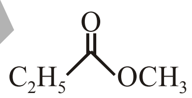
(2) 

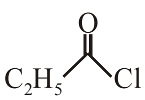
(3) 

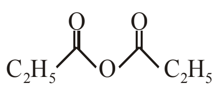
(4) 

8. The increasing order of the reactivity of the following with $LiAlH_4$ is :

(A) 

(B) 

(C) 

(D) 

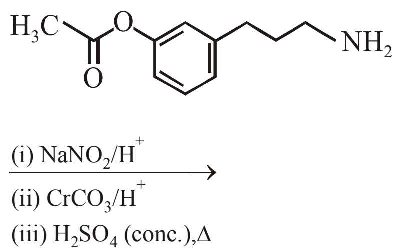
(1) (A) < (B) < (D) < (C)

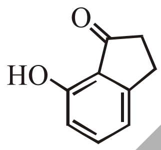
(2) (A) < (B) < (C) < (D)

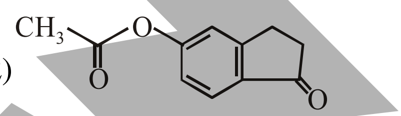
(3) (B) < (A) < (D) < (C)

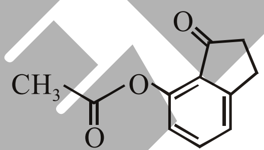
(4) (B) < (A) < (C) < (D)

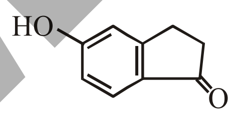
9. The major product of the following reaction is:



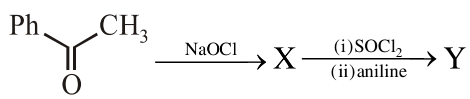
(1) 

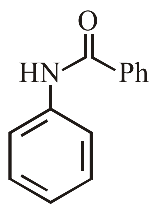
(2) 

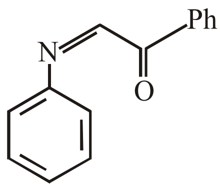
(3) 

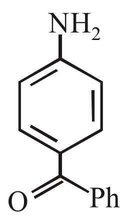
(4) 

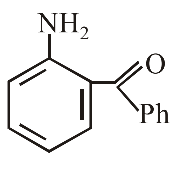
10. The major product 'Y' in the following reaction is:-



(1) 

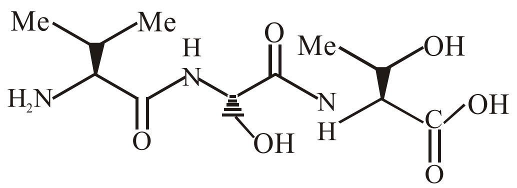
(2) 

(3) 

(4) 

BIOMOLECULE

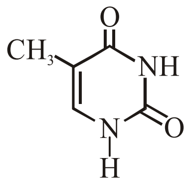
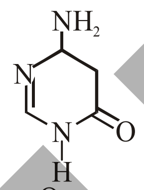
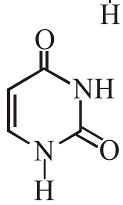
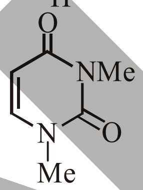
1. The correct sequence of amino acids present in the tripeptide given below is :



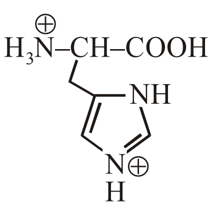
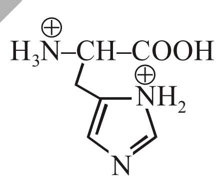
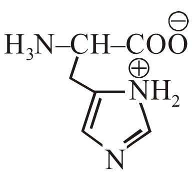
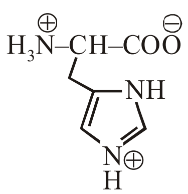
(1) Leu - Ser - Thr
(2) Thr - Ser- Leu
(3) Thr - Ser - Val
(4) Val - Ser - Thr

2. Which of the following tests cannot be used for identifying amino acids ?
(1) Biuret test (2) Xanthoproteic test
(3) Barfoed test (4) Ninhydrin test

3. Among the following compound which one is found in RNA ?

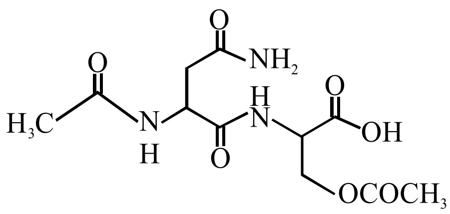
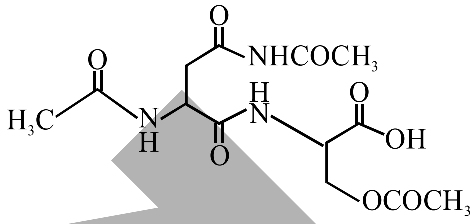
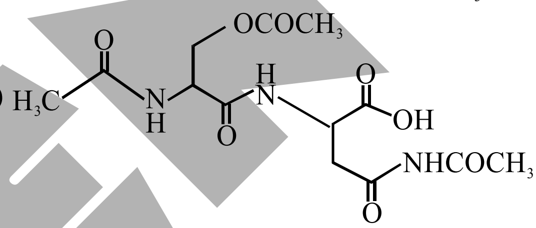
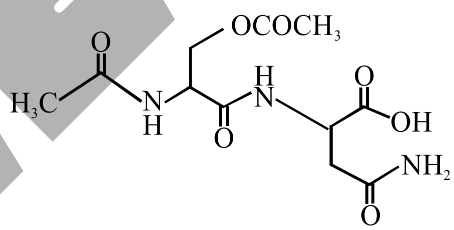
(1) 
(2) 
(3) 
(4) 

4. The correct structure of histidine in a strongly acidic solution (pH=2) is

(1) 
(2) 
(3) 
(4) 

5. The correct structure of product 'P' in the following reaction is :

$$\text{Asn-Ser} + \underset{\text{(excess)}}{(CH_3CO)_2O} \xrightarrow{NEt_3} P$$

(1) 
(2) 
(3) 
(4) 

6. Maltose on treatment with dilute HCl gives :
(1) D-Galactose
(2) D-Glucose
(3) D-Glucose and D-Fructose
(4) D-Fructose

7. Fructose and glucose can be distinguished by :
(1) Fehling's test (2) Barfoed's test
(3) Benedict's test (4) Seliwanoff's test

8. Which of the following statements is not true about sucrose?
(1) On hydrolysis, it produces glucose and fructose
(2) The glycosidic linkage is present between C_1 of α-glucose and C_1 of β-fructose
(3) It is also named as invert sugar
(4) It is a non reducing sugar

9. The peptide that gives positive ceric ammonium nitrate and carbylamine tests is :
(1) Lys-Asp (2) Ser-Lys
(3) Gln-Asp (4) Asp-Gln

10. Amylopectin is composed of :
(1) α-D-glucose, C_1–C_4 and C_1–C_6 linkages
(2) α-D-glucose, C_1–C_4 and C_2–C_6 linkages
(3) β-D-glucose, C_1–C_4 and C_2–C_6 linkages
(4) β-D-Glucose, C_1–C_4 and C_1–C_6 linkages

11. Number of stereo centers present in linear and cyclic structures of glucose are respectively :
(1) 4 & 5 (2) 5 & 5
(3) 4 & 4 (4) 5 & 4

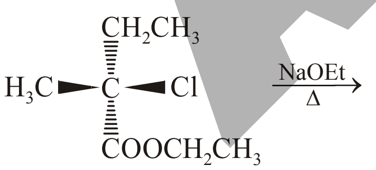
12. Which of the following statements is not true about RNA ?
(1) It has always double stranded α-helix structure
(2) It usually does not replicate
(3) It is present in the nucleus of the cell
(4) It controls the synthesis of protein

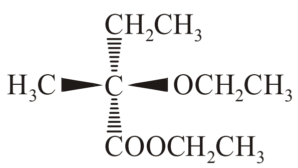
13. Glucose and Galactose are having identical configuration in all the positions except position.
(1) C–3 (2) C–2 (3) C–4 (4) C–5

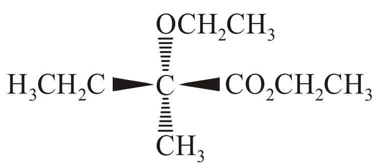
14. Which of the given statements is INCORRECT about glycogen ?
(1) It is a straight chain polymer similar to amylose
(2) Only α-linkages are present in the molecule
(3) It is present in animal cells
(4) It is present in some yeast and fungi

HALOGEN DERIVATIVE

1. The major product of the following reaction is:



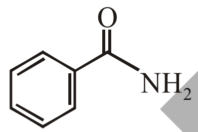
(1) 

(2) 

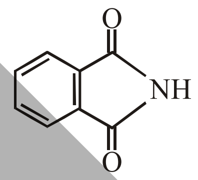
(3) $CH_3\underset{}{C}(CO_2CH_2CH_3)=CHCH_3$ ($CO_2CH_2CH_3$ on the C)

(4) $CH_3CH_2C(=CH_2)CO_2CH_2CH_3$

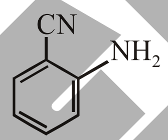
2. The increasing order of reactivity of the following compounds towards reaction with alkyl halides directly is :



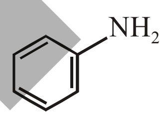
(A)



(B)



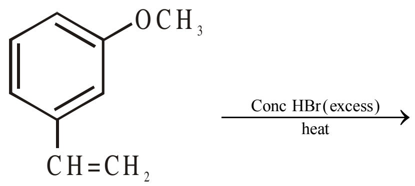
(C)

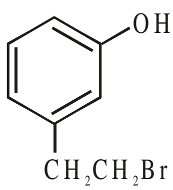


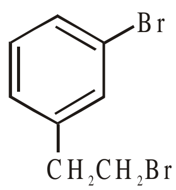
(D)

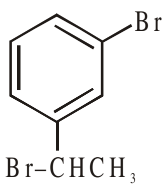
(1) (B) < (A) < (D) < (C)
(2) (B) < (A) < (C) < (D)
(3) (A) < (C) < (D) < (B)
(4) (A) < (B) < (C) < (D)

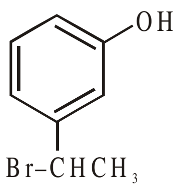
3. The major product of the following reactions:



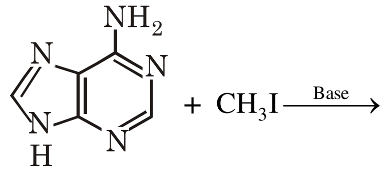
(1) 

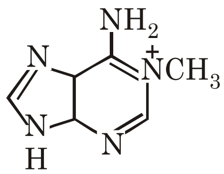
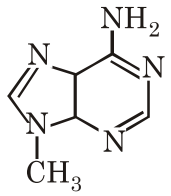
(2) 

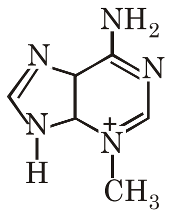
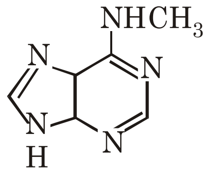
(3) 

(4) 

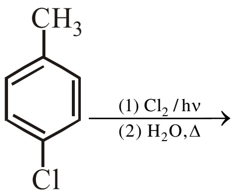
4. The major product in the following reaction is :

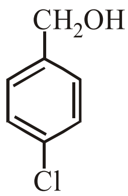
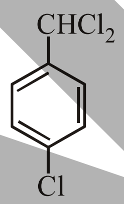


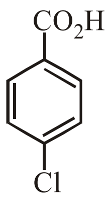
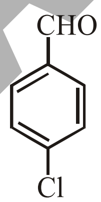
(1)  (2) 

(3)  (4) 

5. The major product of the following reaction is:



(1)  (2) 

(3)  (4) 

6. Which one of the following alkenes when treated with HCl yields majorly an anti Markovnikov product?

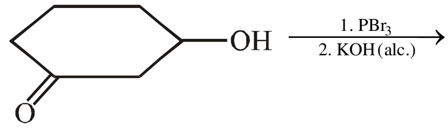
(1) $F_3C - CH = CH_2$

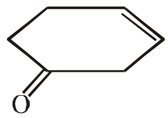
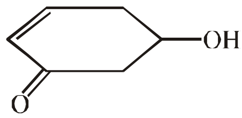
(2) $Cl - CH = CH_2$

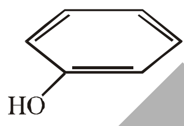
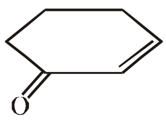
(3) $CH_3O - CH = CH_2$

(4) $H_2N - CH = CH_2$

7. The mojor product of the following reaction is :



(1)  (2) 

(3)  (4) 

8. The mojor product of the following reaction is :

$$CH_3C\equiv CH \xrightarrow[\text{(ii) DI}]{\text{(i) DCl (1 equiv.)}}$$

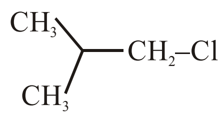
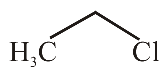
(1) $CH_3CD(Cl)CHD(I)$

(2) $CH_3CD_2CH(Cl)(I)$

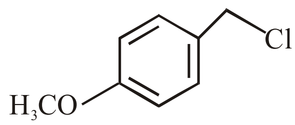
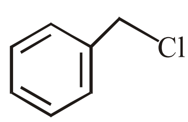
(3) $CH_3CD(I)CHD(Cl)$

(4) $CH_3C(I)(Cl)CHD_2$

9. Increasing order of reactivity of the following compounds for S_N1 substitution is:

(A) (B)

(C) (D)

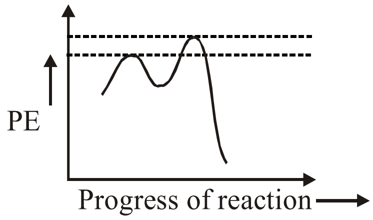
(1) (B) < (C) < (D) < (A)

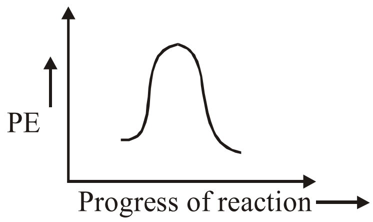
(2) (A) < (B) < (D) < (C)

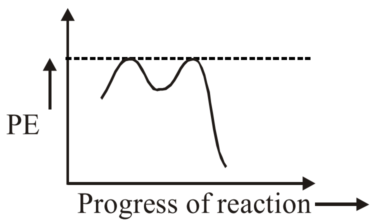
(3) (B) < (A) < (D) < (C)

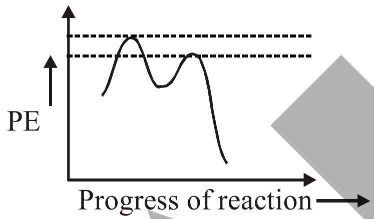
(4) (B) < (C) < (A) < (D)

10. Which of the following potential energy (PE) diagrams represents the S_N1 reaction?

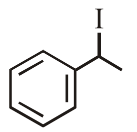
(1) 

(2) 

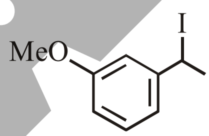
(3) 

(4) 

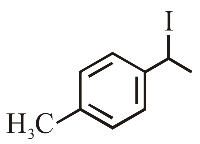
11. Increasing rate of S_N1 reaction in the following compounds is :



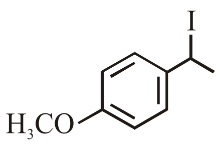
(A)



(B)



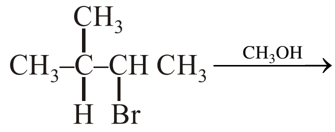
(C)

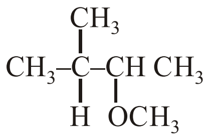


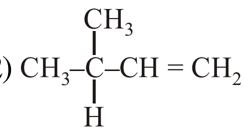
(D)

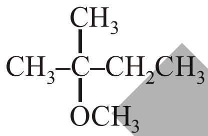
(1) (A) < (B) < (C) < (D)
(2) (B) < (A) < (D) < (C)
(3) (B) < (A) < (C) < (D)
(4) (A) < (B) < (D) < (C)

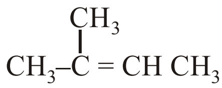
12. The major product of the following reaction is :-



(1) 

(2) 

(3) 

(4) 

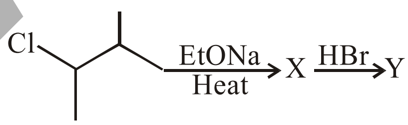
13. The increasing order of nucleophilicity of the following nucleophiles is :

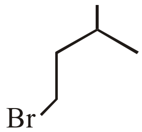
(a) $CH_3CO_2^{\ominus}$ (b) H_2O

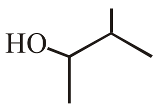
(c) $CH_3SO_3^{\ominus}$ (d) $\overset{\ominus}{O}H$

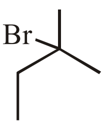
(1) (b) < (c) < (a) < (d) (2) (a) < (d) < (c) < (b)
(3) (d) < (a) < (c) < (b) (4) (b) < (c) < (d) < (a)

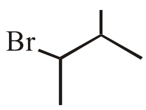
14. The major product 'Y' in the following reaction is:



(1) 

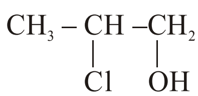
(2) 

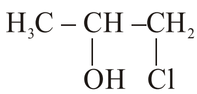
(3) 

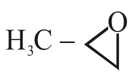
(4) 

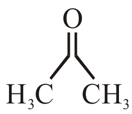
15. The major product of the following addition reaction is :

$$H_3C - CH = CH_2 \xrightarrow{Cl_2/H_2O}$$

(1) 

(2) 

(3) 

(4) 

16. An 'Assertion' and a 'Reason' are given below. Choose the correct answer from the following options.

Assertion (A) : Vinyl halides do not undergo nucleophilic substitution easily.

Reason (R) : Even though the intermediate carbocation is stabilized by loosely held π-electrons, the cleavage is difficult becuase of strong bonding.

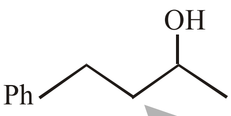
(1) Both (A) and (R) are wrong statements

(2) Both (A) and (R) are correct statements and (R) is the correct explanation of (A)

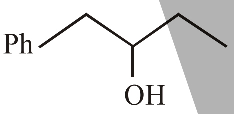
(3) Both (A) and (R) are correct statements but (R) is not the correct explanation of (A)

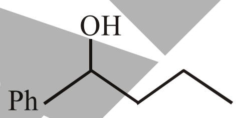
(4) (A) is a correct statement but (R) is a wrong statement.

17. Heating of 2-chloro-1-phenylbutane with EtOK/EtOH gives X as the major product. Reaction of X with $Hg(OAc)_2/H_2O$ followed by $NaBH_4$ gives Y as the major product. Y is :

(1) 

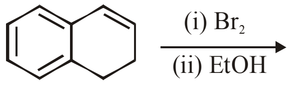
(2) 

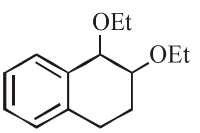
(3) 

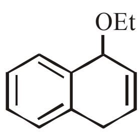
(4) 

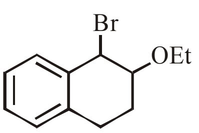
HYDROCARBON

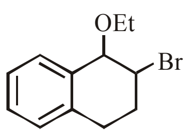
1. The major product the following reaction is :



(1) 

(2) 

(3) 

(4) 

2. Which hydrogen in compound (E) is easily replaceable during bromination reaction in presence of light :

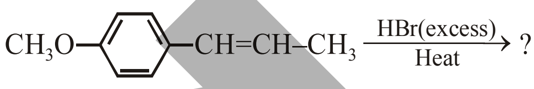
$$\underset{\delta}{CH_3}-\underset{\gamma}{CH_2}-\underset{\beta}{CH}=\underset{\alpha}{CH_2}$$

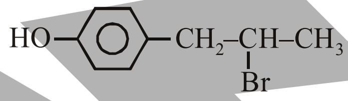
(E)

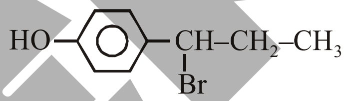
(1) β – hydrogen (2) γ – hydrogen

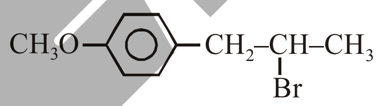
(3) δ – hydrogen (4) α – hydrogen

3. The major product in the following conversion is :



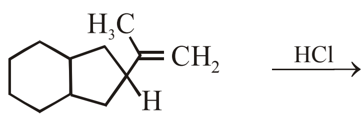
(1) 

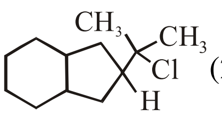
(2) 

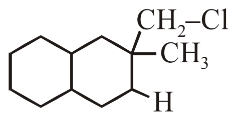
(3) 

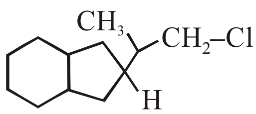
(4) 

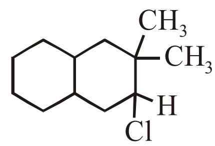
4. The major product of the following reaction is:



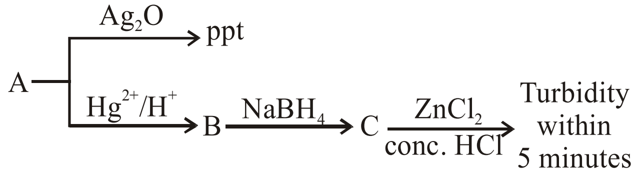
(1) 

(2) 

(3) 

(4) 

5. Consider the following reactions :



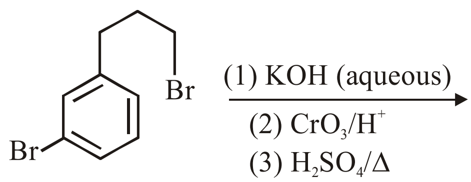
'A' is :

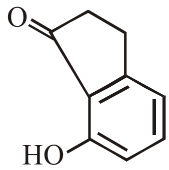
(1) $CH\equiv CH$ (2) $CH_3–C\equiv CH$

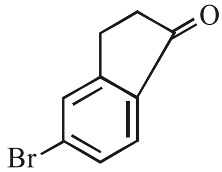
(3) $CH_2=CH_2$ (4) $CH_3–C\equiv C–CH_3$

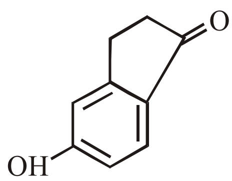
AROMATIC

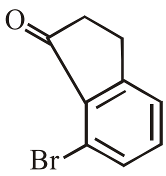
1. The major product of the following reaction is:



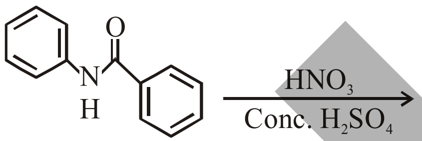
(1) 

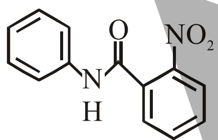
(2) 

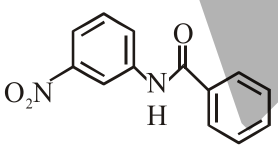
(3) 

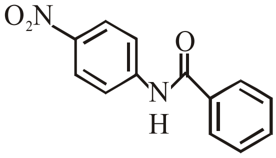
(4) 

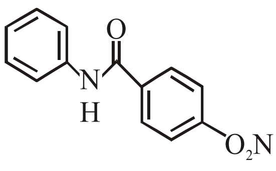
2. What will be the major product in the following mononitation reaction ?



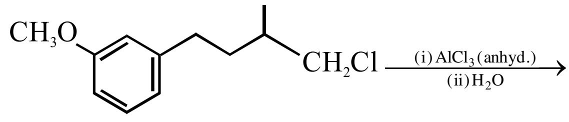
(1) 

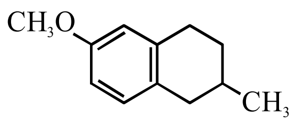
(2) 

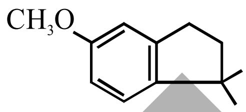
(3) 

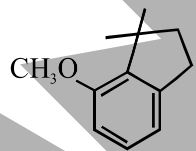
(4) 

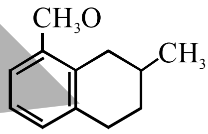
3. The major product of the following reaction is:



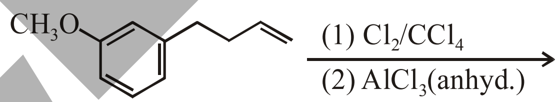
(1) 

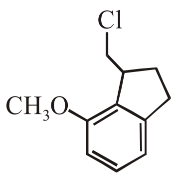
(2) 

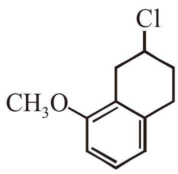
(3) 

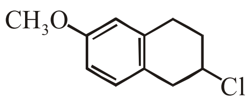
(4) 

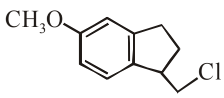
4. The major product of the following reaction is :



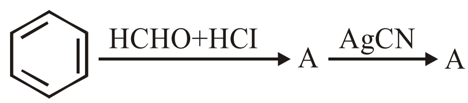
(1) 

(2) 

(3) 

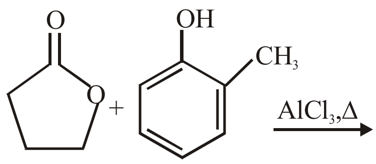
(4) 

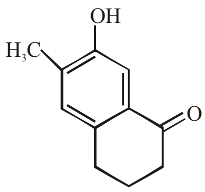
5. The compounds A and B in the following reaction are, respectively:

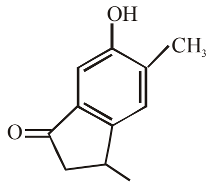


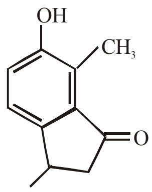
(1) A = Benzyl alcohol, B = Benzyl isocyanide
(2) A = Benzyl alcohol, B = Benzyl cyanide
(3) A = Benzyl chloride, B = Benzyl cyanide
(4) A = Benzyl chloride, B = Benzyl isocyanide

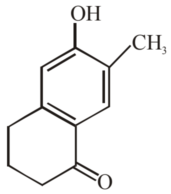
6. The major product of the following reaction is:



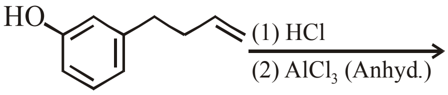
(1) 

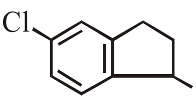
(2) 

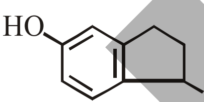
(3) 

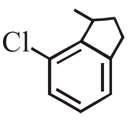
(4) 

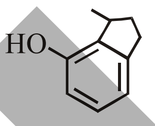
7. The major product of the following reaction is :-



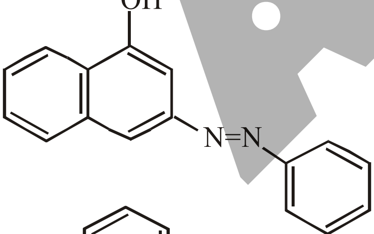
(1) 

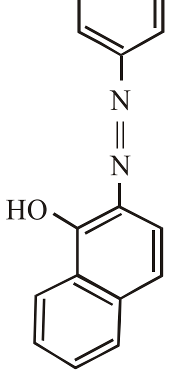
(2) 

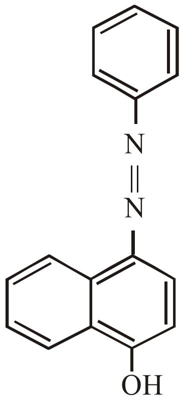
(3) 

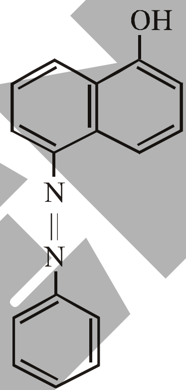
(4) 

8. Coupling of benzene diazonium chloride with 1-napthol in alkaline medium will give

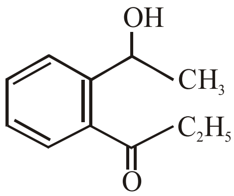
(1) 

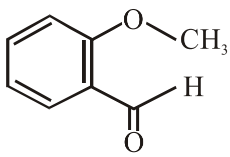
(2) 

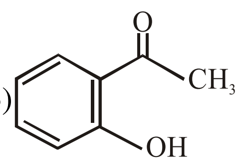
(3) 

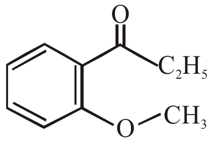
(4) 

9. An organic compound neither reacts with neutral ferric chloride solution nor with Fehling solution, It however, reacts with Grignard reagent and gives positive iodoform test. The compound is -

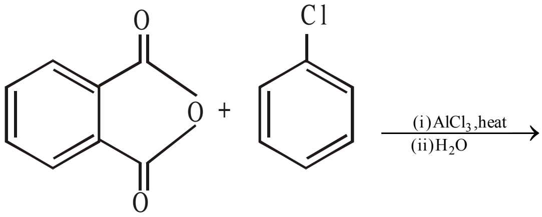
(1) 

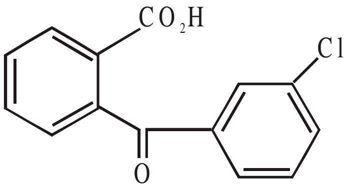
(2) 

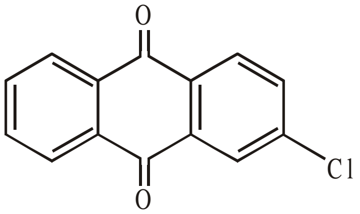
(3) 

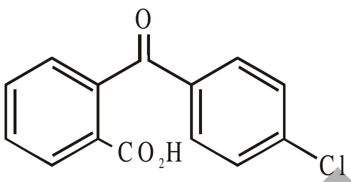
(4) 

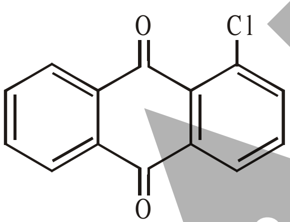
10. The major product of the following reaction is:



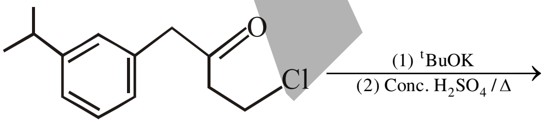
(1) 

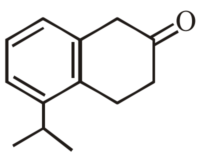
(2) 

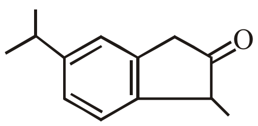
(3) 

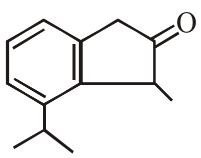
(4) 

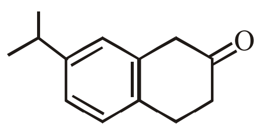
11. The major product of the following reaction is:



(1) 

(2) 

(3) 

(4) 

12. Polysubstitution is a major drawback in:

(1) Reimer Tiemann reaction

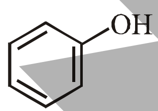
(2) Friedel Craft's acylation

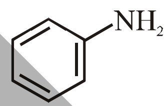
(3) Friedel Craft's alkylation

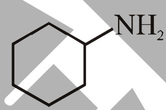
(4) Acetylation of aniline

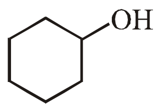
13. The organic compound that gives following qualitative analysis is :

Test	Inference
(a) Dil. HCl	Insoluble
(b) NaOH solution	soluble
(c) Br_2/water	Decolourization

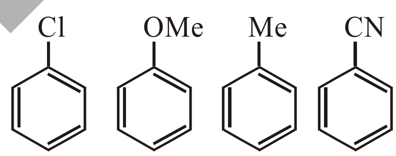
(1) 

(2) 

(3) 

(4) 

14. The increasing order of reactivity of the following compounds towards aromatic electrophilic substitution reaction is :

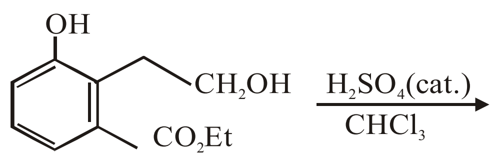


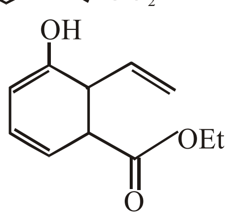
A B C D

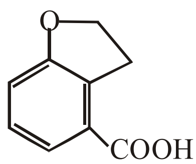
(1) D < B < A < C (2) A < B < C < D

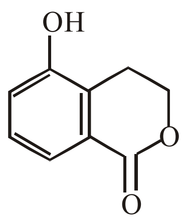
(3) D < A < C < B (4) B < C < A < D

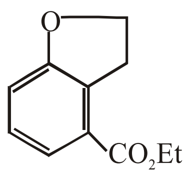
15. The major product of the following reaction is:



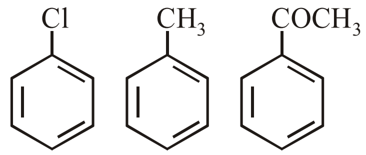
(1) 

(2) 

(3) 

(4) 

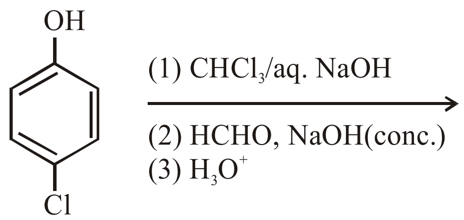
16. The increasing order of the reactivity of the following compounds towards electrophilic aromatic substitution reactions is :-

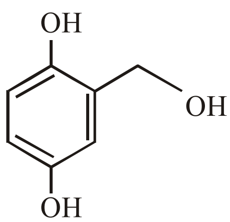


(I) (II) (III)

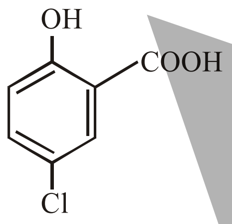
(1) I < III < II (2) II < I < III
(3) III < I < II (4) III < II < I

17. The major products of the following reaction are :

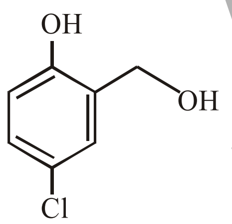


(1) 

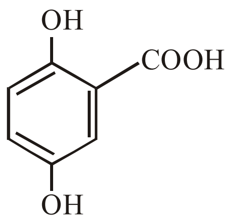
and Formic acid

(2) 

and Methanol

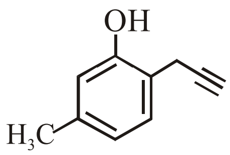
(3) 

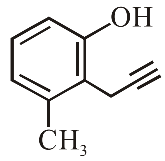
and Formic acid

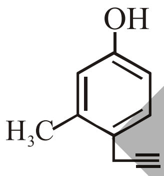
(4) 

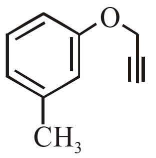
and Methanol

18. What will be the major product when m-cresol is reacted with propargyl bromide ($HC \equiv C{-}CH_2Br$) in present of K_2CO_3 in acetone

(1) 

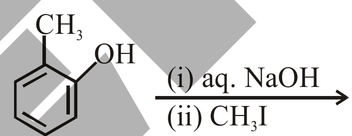
(2) 

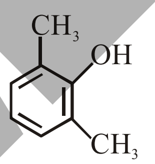
(3) 

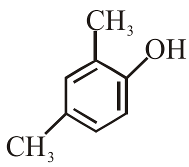
(4) 

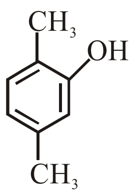
ALKAYLE HALIDE

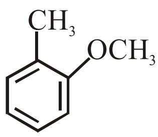
1. The major product of the following reaction is:



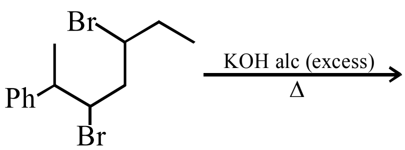
(1) 

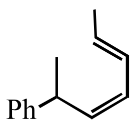
(2) 

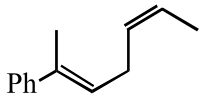
(3) 

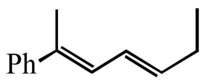
(4) 

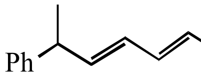
2. The major product of the following reaction is



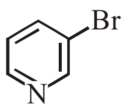
(1) 

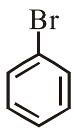
(2) 

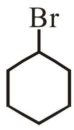
(3) 

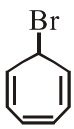
(4) 

3. Which of the following compounds will produce a precipitate with $AgNO_3$?

(1) 

(2) 

(3) 

(4) 

4. The major product of the following reaction is:

$$\underset{\quad\quad\quad\ \ Br\quad Br}{CH_3CH_2CH\!-\!CH_2} \xrightarrow[\text{(ii) } NaNH_2 \text{ in liq } NH_3]{\text{(i) KOH alc.}}$$

(1) $CH_3CH_2C{\equiv}CH$

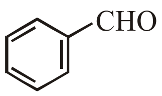
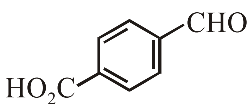
(2) $CH_3CH_2CH(NH_2)-CH_2NH_2$

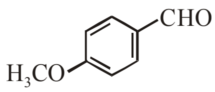
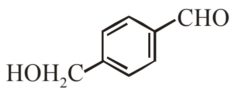
(3) $CH_3CH{=}C{=}CH_2$

(4) $CH_3CH{=}CHCH_2NH_2$

GRIGNARD REAGENT

1. The aldehydes which will not form Grignard product with one equivalent Grignard reagents are :

(A) 
(B) 

(C) 
(D) 

(1) (B), (C), (D) (2) (B), (D)

(3) (B), (C) (4) (C), (D)

2. $CH_3CH_2-C(OH)(Ph)-CH_3$ cannot be prepared by :

(1) $HCHO + PhCH(CH_3)CH_2MgX$

(2) $PhCOCH_2CH_3 + CH_3MgX$

(3) $PhCOCH_3 + CH_3CH_2MgX$

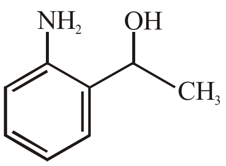
(4) $CH_3CH_2COCH_3 + PhMgX$

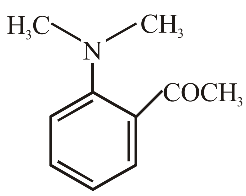
POC

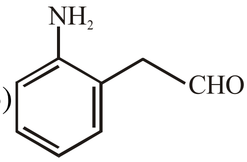
1. The tests performed on compound X and their inferences are:

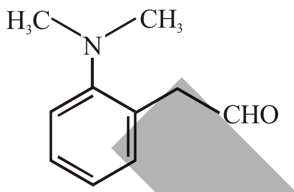
Test	Inference
(a) 2,4 - DNP test	Coloured precipitate
(b) Iodoform test	Yellow precipitate
(c) Azo-dye test	No dye formation

Compound 'X' is:

(1) 

(2) 

(3) 

(4) 

2. The correct match between item 'I' and item 'II' is :

Item 'I' (compound)	Item 'II' (reagent)
(A) Lysine	(P) 1-naphthol
(B) Furfural	(Q) ninhydrin
(C) Benzyl alcohol	(R) $KMnO_4$
(D) Styrene	(S) Ceric ammonium nitrate

(1) (A)→(Q), (B)→(P), (C)→(S), (D)→(R)

(2) (A)→(Q), (B)→(R), (C)→(S), (D)→(P)

(3) (A)→(Q), (B)→(P), (C)→(R), (D)→(S)

(4) (A)→(R), (B)→(P), (C)→(Q), (D)→(S)

3. The correct match between Item I and Item II is :-

	Item I		Item II
(A)	Ester test	(P)	Tyr
(B)	Carbylamine test	(Q)	Asp
(C)	Phthalein dye test	(R)	Ser
		(S)	Lys

(1) (A)→(Q); (B)→(S); (C)→(P)

(2) (A)→(R); (B)→(Q); (C)→(P)

(3) (A)→(Q); (B)→(S); (C)→(R)

(4) (A)→(R); (B)→(S); (C)→(Q)

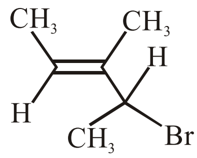
4. Hinsberg's reagent is :

(1) $C_6H_5SO_2Cl$ (2) C_6H_5COCl

(3) $SOCl_2$ (4) $(COCl)_2$

NOMENCLATURE

1. What is the IUPAC name of the following compound ?



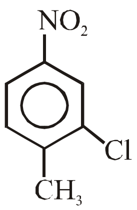
(1) 3-Bromo-1, 2-dimethylbut-1-ene]
(2) 4-Bromo-3-methylpent-2-ene
(3) 2-Bromo-3-methylpent-3-ene
(4) 3-Bromo-3-methyl-1, 2-dimethylprop-1-ene

2. The IUPAC name of the following compound is :

$$H_3C-\underset{|}{\overset{CH_3}{}}CH-\overset{OH}{\underset{|}{}}CH-CH_2-COOH$$

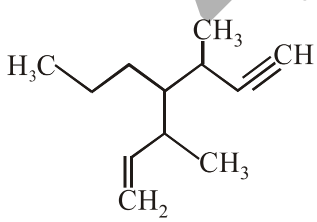
(1) 2-Methyl-3Hydroxypentan-5-oic acid
(2) 4,4-Dimethyl-3-hydroxy butanoic acid
(3) 3-Hydroxy-4 -methylpentanoic acid
(4) 4-Methyl-3-hydroxypentanoic acid

3. The correct IUPAC name of the following compound is :



(1) 5-chloro-4-methyl-1-nitrobenzene
(2) 2-methyl-5-nitro-1-chlorobenzene
(3) 3-chloro-4-methyl-1-nitrobenzene
(4) 2-chloro-1-methyl-4-nitrobenzene

4. The IUPAC name of the following compound is :



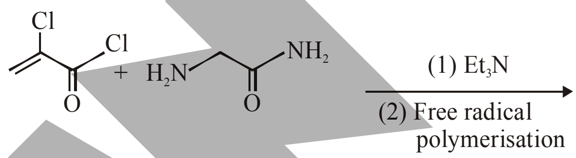
(1) 3,5-dimethyl-4-propylhept-6-en-1-yne
(2) 3-methyl-4-(3-methylprop-1-enyl)-1-heptyne
(3) 3-methyl-4-(1-methylprop-2-ynyl)-1-heptene
(4) 3,5-dimethyl-4-propylhept-1-en-6-yne

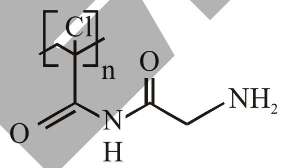
POLYMER

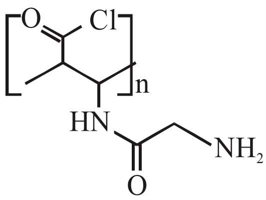
1. The two monomers for the synthesis of Nylone 6, 6 are :

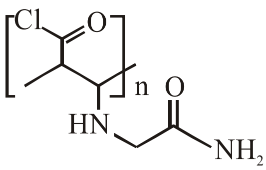
(1) $HOOC(CH_2)_6COOH$, $H_2N(CH_2)_6NH_2$
(2) $HOOC(CH_2)_4COOH$, $H_2N(CH_2)_4NH_2$
(3) $HOOC(CH_2)_6COOH$, $H_2N(CH_2)_4NH_2$
(4) $HOOC(CH_2)_4COOH$, $H_2N(CH_2)_6NH_2$

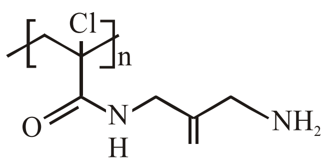
2. Major product of the following reaction is :



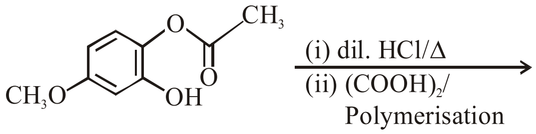
(1) 

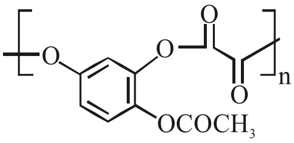
(2) 

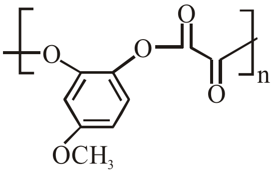
(3) 

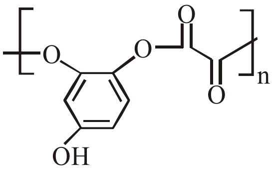
(4) 

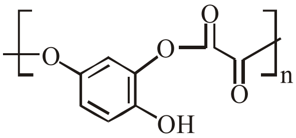
3. The major product of the following reaction is:



(1) 

(2) 

(3) 

(4) 

4. The homopolymer formed from 4-hydroxy-butanoic acid is :-

(1) $\left[\overset{O}{\overset{\|}{C}}(CH_2)_3{-}O \right]_n$ (2) $\left[O\overset{O}{\overset{\|}{C}}(CH_2)_3{-}O \right]_n$

(3) $\left[\overset{O}{\overset{\|}{C}}(CH_2)_2\overset{O}{\overset{\|}{C}}{-}O \right]_n$ (4) $\left[\overset{O}{\overset{\|}{C}}(CH_2)_2\overset{O}{\overset{\|}{C}} \right]_n$

5. The polymer obtained from the following reactions is :

(1) $\left[\overset{O}{\overset{\|}{C}}{-}(CH_2)_4{-}\overset{H}{N} \right]_n$ (2) $\left[O{-}(CH_2)_4{-}\overset{O}{\overset{\|}{C}} \right]_n$

(3) $\left[HN\overset{O}{\overset{\|}{C}}(CH_2)_4{-}\overset{O}{\overset{\|}{C}}{-}\overset{H}{N} \right]_n$ (4) $\left[O\overset{O}{\overset{\|}{C}}(CH_2)_4O \right]_n$

6. Poly-β-hydroxybutyrate-co-β-hydroxyvalerate(PHBV) is a copolymer of___.

(1) 3-hydroxybutanoic acid and 4-hydroxypentanoic acid

(2) 2-hydroxybutanoic acid and 3-hydroxypentanoic acid

(3) 3-hydroxybutanoic acid and 2-hydroxypentanoic acid

(4) 3-hydroxybutanoic acid and 3-hydroxypentanoic acid

7. The structure of Nylon-6 is :

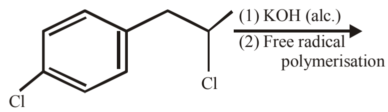
(1) $\left[(CH_2)_6 - \overset{O}{\overset{\|}{C}} - \overset{H}{\overset{|}{N}} \right]_n$

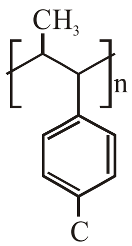
(2) $\left[(CH_2)_4 - \overset{O}{\overset{\|}{C}} - \overset{H}{\overset{|}{N}} \right]_n$

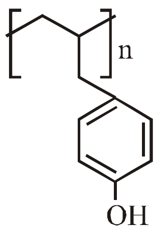
(3) $\left[\overset{O}{\overset{\|}{C}} - (CH_2)_5 - \overset{H}{\overset{|}{N}} \right]_n$

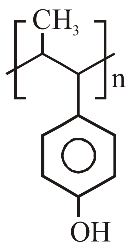
(4) $\left[\overset{O}{\overset{\|}{C}} - (CH_2)_6 - \overset{H}{\overset{|}{N}} \right]_n$

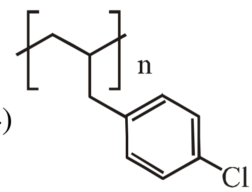
8. The major product of the following reaction is :



(1) 

(2) 

(3) 

(4) 

9. Which of the following compounds is a constituent of the polymer

$$\left[HN - \overset{O}{\overset{\|}{C}} - NH - CH_2 \right]_n ?$$

(1) Formaldehyde (2) Ammonia

(3) Methylamine (4) N-Methyl urea

10. Which of the following is a condensation polymer ?

(1) Buna - S (2) Nylon 6, 6

(3) Teflon (4) Neoprene

11. The correct match between Item-I and Item-II is:

	Item-I		Item-II
(a)	High density polythene	(I)	Peroxide catalyst
(b)	Polyacrylonitrile	(II)	Condensation at high temperature & pressure
(c)	Novolac	(III)	Ziegler-Natta Catalyst
(d)	Nylon 6	(IV)	Acid or base catalyst

(1) (a)$\rightarrow$(III), (b)$\rightarrow$(I), (c)$\rightarrow$(II), (d)$\rightarrow$(IV)

(2) (a)$\rightarrow$(IV), (b)$\rightarrow$(II), (c)$\rightarrow$(I), (d)$\rightarrow$(III)

(3) (a)$\rightarrow$(II), (b)$\rightarrow$(IV), (c)$\rightarrow$(I), (d)$\rightarrow$(III)

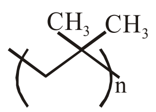
(4) (a)$\rightarrow$(III), (b)$\rightarrow$(I), (c)$\rightarrow$(IV), (d)$\rightarrow$(II)

12. Which of the following is a thermosetting polymer?

(1) Buna–N (2) PVC

(3) Bakelite (4) Nylon 6

13. The correct name of the following polymer is:



(1) Polyisoprene

(2) Polytert-butylene

(3) Polyisobutane

(4) Polyisobutylene

CHEMISTRY IN EVERYDAY LIFE

1. The correct match between Item(I) and Item(II) is :

Item-I	Item-II
(A) Nortehindrone	(P) Anti-biotic
(B) Ofloxacin	(Q) Anti-fertility
(C) Equanil	(R) Hypertension
	(S) Analgesics

(1) A-R, B-P, C-S

(2) A-Q, B-P, C-R

(3) A-R, B-P, C-R

(4) A-Q, B-R, C-S

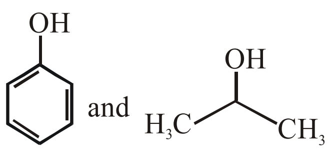
2. Noradrenaline is a /an

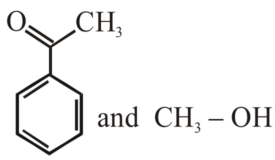
(1) Neurotransmitter (2) Antidepressant

(3) Antihistamine (4) Antacid

PHENOL

1. The product formed in the reaction of cumene with O_2 followed by treatment with dil. HCl are :

(1)


(2)


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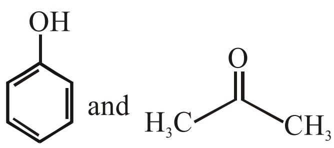
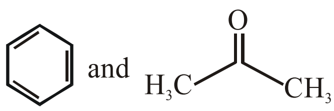
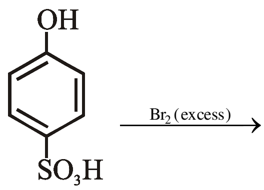
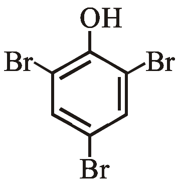
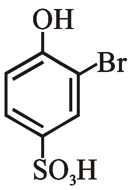


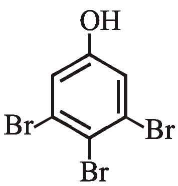
(4)


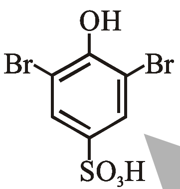
2. The major product of the following reaction is :



(1) 

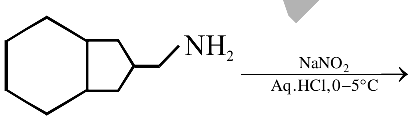
(2) 

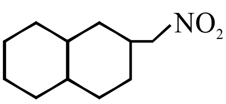
(3) 

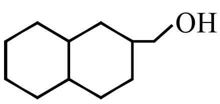
(4) 

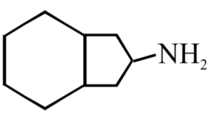
AMINE

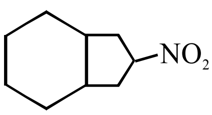
1. The major product formed in the reaction given below will be :



(1) 

(2) 

(3) 

(4) 

2. A compound 'X' on treatment with Br_2/NaOH, provided C_3H_9N, which gives positive carbylamine test. Compound 'X' is :-

(1) $CH_3COCH_2NHCH_3$

(2) $CH_3CH_2COCH_2NH_2$

(3) $CH_3CH_2CH_2CONH_2$

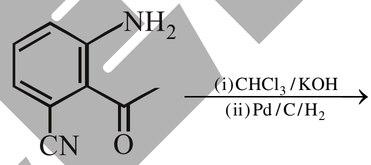
(4) $CH_3CON(CH_3)_2$

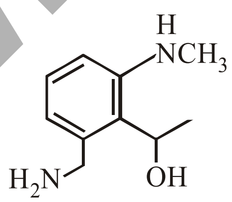
3. Which of the following amines can be prepared by Gabriel phthalimide reaction ?

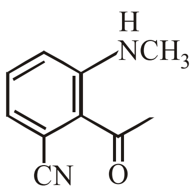
(1) Neo-pentylamine (2) n-butylamine

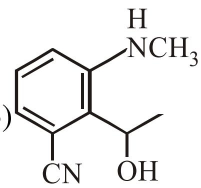
(3) triethylamine (4) t-butylamine

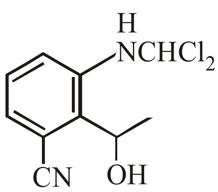
4. The major product obtained in the following reaction is :



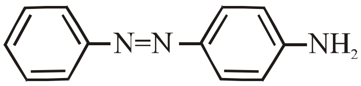
(1) 

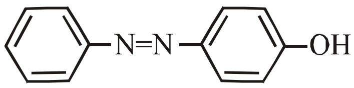
(2) 

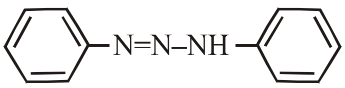
(3) 

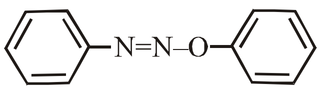
(4) 

5. Aniline dissolved in dilute HCl is reacted with sodium nitrite at 0°C. This solution was added dropwise to a solution containing equimolar mixture of aniline and phenol in dil. HCl. The structure of the major product is :

(1) 

(2) 

(3) 

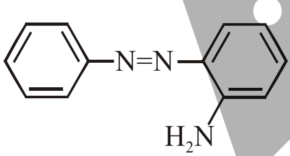
(4) 

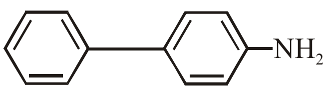
6. Ethylamine ($C_2H_5NH_2$) can be obtained from N-ethylphthalimide on treatment with :

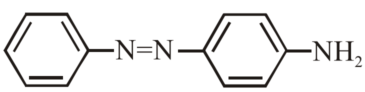
(1) $NaBH_4$ (2) CaH_2

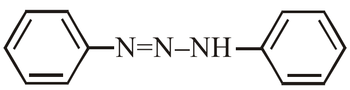
(3) H_2O (4) NH_2NH_2

7. Benzene diazonium chloride on reaction with aniline in the presence of dilute hydrochloric acid gives :

(1) 

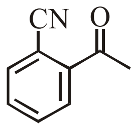
(2) 

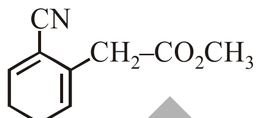
(3) 

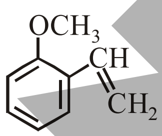
(4) 

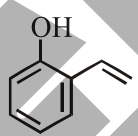
ORGANO METALIC

1. Which of the following compounds reacts with ethylmagnesium bromide and also decolourizes bromine water solution :-

(1) 

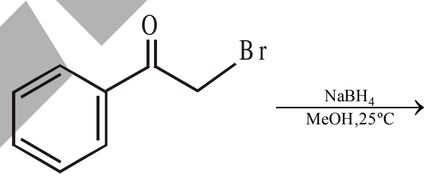
(2) 

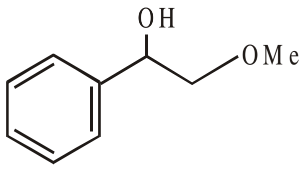
(3) 

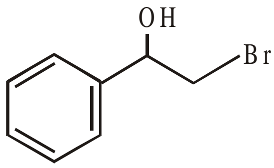
(4) 

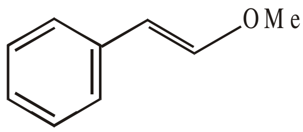
REDUCTION

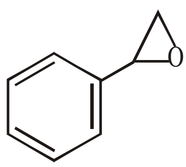
1. The major product of the following reaction is:



(1) 

(2) 

(3) 

(4) 

2. The major product of the following reaction is :

$CH_3CH = CHCO_2CH_3 \xrightarrow{LiAlH_4}$

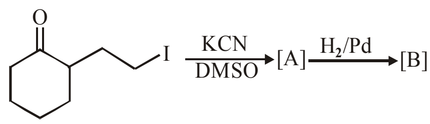
(1) $CH_3CH_2CH_2CHO$

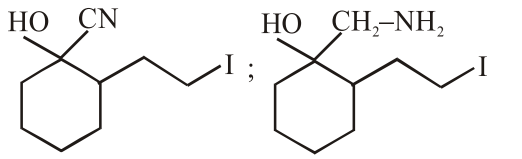
(2) $CH_3CH = CHCH_2OH$

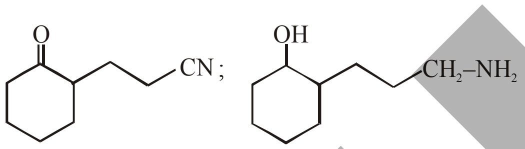
(3) $CH_3CH_2CH_2CO_2CH_3$

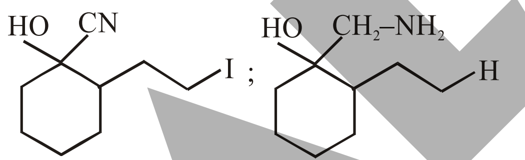
(4) $CH_3CH_2CH_2CH_2OH$

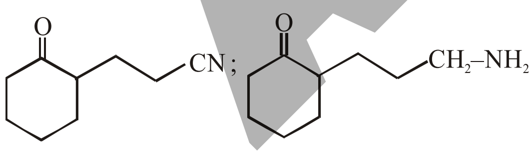
3. The major products A and B for the following reactions are, respectively:



(1) 

(2) 

(3) 

(4) 

4. Which of the following is NOT a correct method of the preparation of benzylamine from cyanobenzene ?

(1) (i) HCl/H_2O (ii) $NaBH_4$

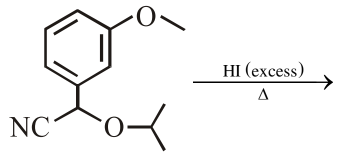
(2) (i) $LiAlH_4$ (ii) H_3O^+

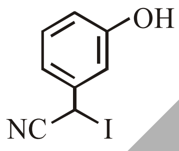
(3) (i) $SnCl_2$+HCl(gas) (ii) $NaBH_4$

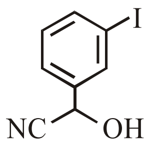
(4) H_2/Ni

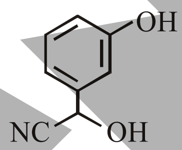
ALCOHOL & ETHER

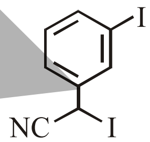
1. The major product of the following reaction is :



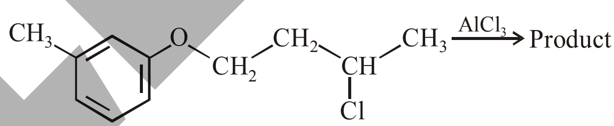
(1) 

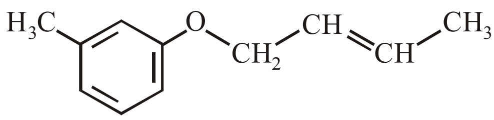
(2) 

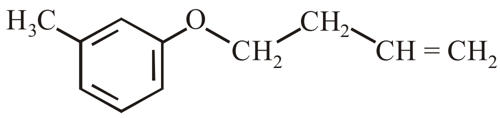
(3) 

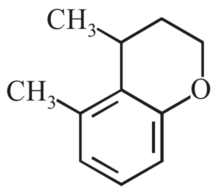
(4) 

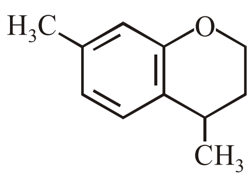
2. The major product obtained in the given reaction is :-



(1) 

(2) 

(3) 

(4) 

ANSWER KEY

GOC

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	1	4	4	1	4	1	2	2	1
Que.	11	12	13							
Ans.	1	1	2							

CARBONYL COMPOUND

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	1	3	4	2	4	1	2	4	3
Que.	11	12	13	14	15	16	17	18	19	
Ans.	4	1	4	4	4	1	4	1	2	

CAD

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	3	4	2	2	2	2	1	4	1

BIOMOLECULE

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	3	3	1	1	2	4	2	2	1
Que.	11	12	13	14						
Ans.	1	1	3	1						

HALOGEN DERIVATIVE

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	2	4	Bonus	4	1	4	4	3	4
Que.	11	12	13	14	15	16	17			
Ans.	3	3	1	3	2	4	4			

HYDROCARBON

Que.	1	2	3	4	5
Ans.	4	2	2	1	2

AROMATIC

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	2	3	2	4	4	1	2	3	1	3
Que.	11	12	13	14	15	16	17	18		
Ans.	4	3	1	3	3	3	3	4		

ALKAYLE HALIDE

Que.	1	2	3	4
Ans.	4	3	4	1

GRIGNARD REAGENT

Que.	1	2
Ans.	2	1

POC

Que.	1	2	3	4
Ans.	2	1	1	1

NOMENCLATURE				
Que.	**1**	**2**	**3**	**4**
Ans.	2	3	4	4

POLYMER										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	4	4	2	1	2	4	3	1	1	2
Que.	**11**	**12**	**13**							
Ans.	4	3	4							

CHEMISTRY IN EVERYDAY LIFE		
Que.	**1**	**2**
Ans.	2	1

PHENOL		
Que.	**1**	**2**
Ans.	3	1

AMINE							
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Ans.	Bonus	3	2	1	1	4	3

ORGANO METALIC	
Que.	**1**
Ans.	4

REDUCTION				
Que.	**1**	**2**	**3**	**4**
Ans.	4	2	2	1

ALCOHOL & ETHER		
Que.	**1**	**2**
Ans.	1	4

JANUARY & APRIL 2019 ATTEMPT (IOC)

COORDINATION COMPOUND

1. The metal d-orbitals that are directly facing the ligands in $K_3[Co(CN)_6]$ are :

(1) d_{xz}, d_{yz} and d_{z^2}

(2) d_{xy}, d_{xz} and d_{yz}

(3) d_{xy} and $d_{x^2-y^2}$

(4) $d_{x^2-y^2}$ and d_{z^2}

2. $Mn_2(CO)_{10}$ is an organometallic compound due to the presence of :

(1) Mn – Mn bond

(2) Mn – C bond

(3) Mn – O bond

(4) C – O bond

3. The pair of metal ions that can give a spin only magnetic moment of 3.9 BM for the complex $[M(H_2O)_6]Cl_2$, is :

(1) Cr^{2+} and Mn^{2+}

(2) V^{2+} and Co^{2+}

(3) V^{2+} and Fe^{2+}

(4) Co^{2+} and Fe^{2+}

4. The magnetic moment of an octahedral homoleptic Mn(II) complex is 5.9 BM. The suitable ligand for this complex is :

(1) CN^- (2) NCS^-

(3) CO (4) ethylenediamine

5. The coordination number of Th in $K_4[Th(C_2O_4)_4(OH_2)_2]$ is :-

$\left(C_2O_4^{2-} = \text{Oxalato}\right)$

(1) 6 (2) 10 (3) 14 (4) 8

6. The number of bridging CO ligand (s) and Co-Co bond (s) in $Co_2(CO)_8$, respectively are :-

(1) 0 and 2 (2) 2 and 0

(3) 4 and 0 (4) 2 and 1

7. The total number of isomers for a square planar complex $[M(F)(Cl)(SCN)(NO_2)]$ is :

(1) 12 (2) 8 (3) 16 (4) 4

8. Wilkinson catalyst is :

(1) $[(Ph_3P)_3RhCl]$ ($Et = C_2H_5$)

(2) $[Et_3P)_3IrCl]$

(3) $[Et_3P)_3RhCl]$

(4) $[Ph_3P)_3IrCl]$

9. Two complexes $[Cr(H_2O_6)Cl_3]$ (A) and $[Cr(NH_3)_6]Cl_3$ (B) are violet and yellow coloured, respectively. The incorrect statement regarding them is :

(1) Δ_0 value of (A) is less than that of (B).

(2) Δ_0 value of (A) and (B) are calculated from the energies of violet and yellow light, respectively

(3) Bothe absorb energies corresponding to their complementary colors.

(4) Bothe are paramagnetic with three unpaired electrons.

10. The highest value of the calculated spin only magnetic moment (in BM) among all the transition metal complexes is :

(1) 5.92 (2) 3.87

(3) 6.93 (4) 4.90

11. The complex thai has highest crystal field splitting energy (Δ), is :

(1) $K_3[Co(CN)_6]$

(2) $[Co(NH_3)_5(H_2O)]Cl_3$

(3) $K_2[CoCl_4]$

(4) $[Co(NH_3)_5Cl]Cl_2$

12. The difference in the number of unpaired electrons of a metal ion in its high-spin and low-spin octahedral complexes is two. The metal ion is :

(1) Fe^{2+} (2) Co^{2+}

(3) Mn^{2+} (4) Ni^{2+}

13. A reaction of cobalt(III) chloride and ethylenediamine in a 1 : 2 mole ratio generates two isomeric products A (violet coloured) B (green coloured). A can show optial actively, B is optically inactive. What type of isomers does A and B represent ?

(1) Geometrical isomers

(2) Ionisation isomers

(3) Coordination isomers

(4) Linkage isomers

14. The compound used in the treatment of lead poisoning is :

(1) EDTA (2) Cis-platin

(3) D-penicillamine (4) desferrioxime B

15. The coordination numbers of Co and Al in $[Co(Cl)(en)_2]Cl$ and $K_3[Al(C_2O_4)_3]$, respectively, are :

(en=ethane-1,2-diamine)

(1) 3 and 3 (2) 6 and 6

(3) 5 and 6 (4) 5 and 3

16. The crystal fied stabilization energy (CFSE) of $[Fe(H_2O)_6]Cl_2$ and $K_2[NiCl_4]$, respectively, are :-

(1) $-0.4\Delta_O$ and $-0.8\Delta_t$

(2) $-0.4\Delta_O$ and $-1.2\Delta_t$

(3) $-2.4\Delta_O$ and $-1.2\Delta_t$

(4) $-0.6\Delta_O$ and $-0.8\Delta_t$

17. The INCORRECT statement is :

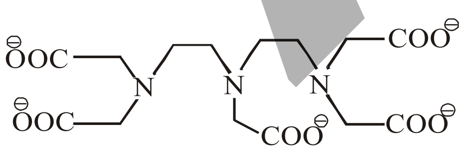
(1) the spin-only magnetic moments of $[Fe(H_2O)_6]^{2+}$ and and $[Cr(H_2O)_6]^{2+}$ are nearly similar.

(2) the spin-only magnetic moment of $[Ni(NH_3)_4(H_2O)_2]^{2+}$ is 2.83BM.

(3) the gemstone, ruby, has Cr^{3+} ions occupying the octahedral sites of beryl.

(4) the color of $[CoCl(NH_3)_5]^{2+}$ is violet as it absorbs the yellow light.

18. The maximum possible denticities of a ligand given below towards a common transition and inner-transition metal ion, respectively, are :



(1) 6 and 8 (2) 8 and 6

(3) 8 and 8 (4) 6 and 6

19. The compound that inhibits the growth of tumors is :

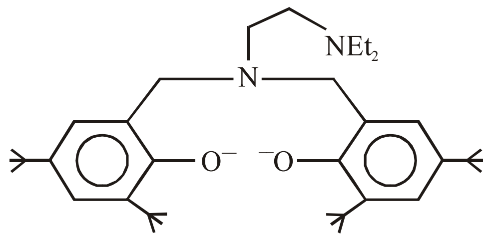
(1) cis-$[Pd(Cl)_2(NH_3)_2]$

(2) cis-$[Pt(Cl)_2(NH_3)_2]$

(3) trans-$[Pt(Cl)_2(NH_3)_2]$

(4) trans-$[Pd(Cl)_2(NH_3)_2]$

20. The following ligand is



(1) Bidentate (2) Hexadentate

(3) Tetradentate (4) Tridentate

21. The correct order of the spin-only magnetic moment of metal ions in the following low spin complexes, $[V(CN)_6]^{4-}$, $[Fe(CN)_6]^{4-}$, $[Ru(NH_3)_6]^{3+}$, and $[Cr(NH_3)_6]^{2+}$, is :

(1) $V^{2+} > Cr^{2+} > Ru^{3+} > Fe^{2+}$

(2) $V^{2+} > Ru^{3+} > Cr^{2+} > Fe^{2+}$

(3) $Cr^{2+} > V^{2+} > Ru^{3+} > Fe^{2+}$

(4) $Cr^{2+} > Ru^{3+} > Fe^{2+} > V^{2+}$

22. The calculated spin-only magnetic moments (BM) of the anionic and cationic species of $[Fe(H_2O)_6]_2$ and $[Fe(CN)_6]$, respectively, are :

(1) 4.9 and 0 (2) 2.84 and 5.92

(3) 0 and 4.9 (4) 0 and 5.92

23. The degenerate orbitals of $[Cr(H_2O)_6]^{3+}$ are :

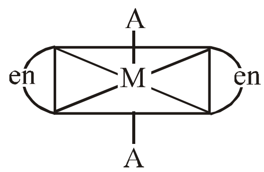
(1) d_{yz} and d_{z^2} (2) d_{z^2} and d_{xz}

(3) d_{xz} and d_{yz} (4) $d_{x^2-y^2}$ and d_{xy}

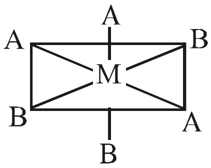
24. The one that will show optical activity is :

(en = ethane-1,2-diamine)

(1)



(2)



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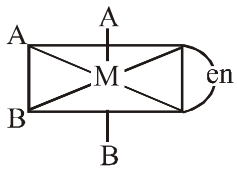

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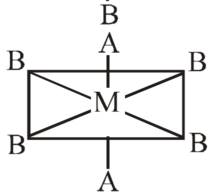
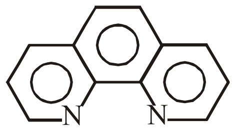


25. The species that can have a trans-isomer is :
(en = ethane-1, 2-diamine, ox = oxalate)
(1) $[Pt(en)Cl_2]$ (2) $[Cr(en)_2(ox)]^+$
(3) $[Zn(en)Cl_2]$ (4) $[Pt(en)_2Cl_2]^{2+}$

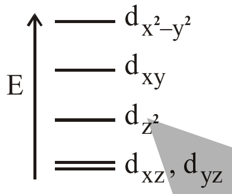
26. Three complexes,
$[CoCl(NH_3)_5]^{2+}$ (I),
$[Co(NH_3)_5H_2O]^{3+}$ (II) and
$[Co(NH_3)_6]^{3+}$ (III)
absorb light in the visible region. The correct order of the wavelength of light absorbed by them is :
(1) (III) > (I) > (II) (2) (I) > (II) > (III)
(3) (II) > (I) > (III) (4) (III) > (II) > (I)

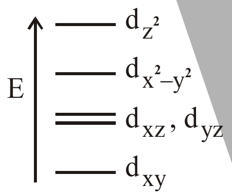
27. The complex ion that will lose its crystal field stabilization energy upon oxidation of its metal to +3 state is

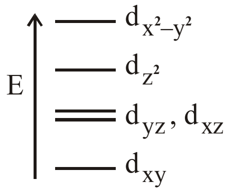
(Phen = 

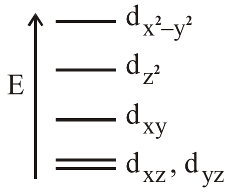
and ignore pairing energy)
(1) $[Fe(phen)_3]^{2+}$ (2) $[Zn(phen)_3]^{2+}$
(3) $[Ni(phen)_3]^{2+}$ (4) $[Co(phen)_3]^{2+}$

28. Complete removal of both the axial ligands (along the z-axis) from an octahedral complex leads to which of the following splitting patterns? (relative orbital energies not on scale).

(1) 

(2) 

(3) 

(4) 

CHEMICAL BONDING

1. The element that shows greater ability to form pπ-pπ multiple bonds, is :
(1) Si (2) Ge (3) Sn (4) C

2. The element that does NOT show catenation is:
(1) Sn (2) Ge (3) Si (4) Pb

3. The chloride that CANNOT get hydrolysed is :
(1) $SiCl_4$ (2) $SnCl_4$ (3) $PbCl_4$ (4) CCl_4

4. The relative stability of +1 oxidation state of group 13 elements follows the order :-
(1) Al < Ga < Tl < In
(2) Tl < In < Ga < Al
(3) Al < Ga < In < Tl
(4) Ga < Al < In < Tl

5. The hydride that is NOT electron deficient is :-
(1) B_2H_6 (2) AlH_3 (3) SiH_4 (4) GaH_3

6. The type of hybridisation and number of lone pair(s) of electrons of Xe in $XeOF_4$, respectively, are :
(1) sp^3d and 1 (2) sp^3d and 2
(3) sp^3d^2 and 1 (4) sp^3d^2 and 2

7. Two pi and half sigma bonds are present in:
(1) N_2^+ (2) N_2 (3) O_2^+ (4) O_2

8. The pair that contains two P–H bonds in each of the oxoacids is :
(1) H_3PO_2 nad $H_4P_2O_5$
(2) $H_4P_2O_5$ and $H_4P_2O_6$
(3) H_3PO_3 and H_3PO_2
(4) $H_4P_2O_5$ nad H_3PO_3

9. According to molecular orbital theory, which of the following is true with respect to Li_2^+ and Li_2^-?
(1) Both are unstable
(2) Li_2^+ is unstable and Li_2^- is stable
(3) Li_2^+ is stable and Li_2^- is unstable
(4) Both are stable

10. C_{60}, an allotrope of carbon contains :
(1) 20 hexagons and 12 pentagons.
(2) 12 hexagons and 20 pentagons.
(3) 18 hexagons and 14 pentagons.
(4) 16 hexagons and 16 pentagons.

11. Aluminium is usually found in +3 oxidation stagte. In contarast, thallium exists in +1 and +3 oxidation states. This is due to :
(1) lanthanoid contraction
(2) lattice effect
(3) diagonal relationship
(4) inert pair effect

12. Good reducing nature of H_3PO_2 attributed to the presence of:
(1) One P-OH bond (2) One P-H bond
(3) Two P-H bonds (4) Two P-OH bonds

13. In which of the following processes, the bond order has increased and paramagnetic character has changed to diamagnetic ?
(1) $N_2 \rightarrow N_2^+$ (2) $NO \rightarrow NO^+$
(3) $O_2 \rightarrow O_2^{2-}$ (4) $O_2 \rightarrow O_2^+$

14. The number of 2-centre-2-electron and 3-centre-2-electron bonds in B_2H_6, respectively, are :
(1) 2 and 4 (2) 2 and 1
(3) 2 and 2 (4) 4 and 2

15. The C–C bond length is maximum in
(1) graphite (2) C_{70}
(3) diamond (4) C_{60}

16. The correct sequence of thermal stability of the following carbonates is
(1) $BaCO_3 < CaCO_3 < SrCO_3 < MgCO_3$
(2) $MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$
(3) $BaCO_3 < SrCO_3 < CaCO_3 < MgCO_3$
(4) $MgCO_3 < SrCO_3 < CaCO_3 < BaCO_3$

17. The correct statement among the following is
(1) $(SiH_3)_3N$ is pyramidal and more basic than $(CH_3)_3N$
(2) $(SiH_3)_3N$ is planar and more basic than $(CH_3)_3N$
(3) $(SiH_3)_3N$ is pyramidal and less basic than $(CH_3)_3N$
(4) $(SiH_3)_3N$ is planar and less basic than $(CH_3)_3N$

18. The basic structural unit of feldspar, zeolites, mica, and asbestos is :
(1) $(SiO_3)^{2-}$ (2) SiO_2
(3) $(SiO_4)^{4-}$ (4) $\left(\begin{matrix}R\\|\\Si-O\\|\\R\end{matrix}\right)_n$ (R=Me)

19. The number of pentagons in C_{60} and trigons (triangles) in white phosphorus, respectively, are:
(1) 12 and 3 (2) 20 and 4
(3) 12 and 4 (4) 20 and 3

20. The ion that has sp^3d^2 hybridization for the central atom, is :
(1) $[ICl_2]^-$ (2) $[IF_6]^-$
(3) $[ICl_4]^-$ (4) $[BrF_2]^-$

21. The covalent alkaline earth metal halide (X = Cl, Br, I) is :
(1) CaX_2 (2) SrX_2
(3) BeX_2 (4) MgX_2

22. Among the following molecules / ions,
$C_2^{2-}, N_2^{2-}, O_2^{2-}, O_2$
which one is diamagnetic and has the shortest bond length?
(1) C_2^{2-} (2) N_2^{2-} (3) O_2 (4) O_2^{2-}

23. The correct statement about ICl_5 and ICl_4^- is
(1) ICl_5 is trigonal bipyramidal and ICl_4^- is tetrahedral.
(2) ICl_5 is square pyramidal and ICl_4^- is tetrahedral.
(3) ICl_5 is square pyramidal and ICl_4^- is square planar.
(4) Both are isostructural.

24. The correct order of the oxidation states of nitrogen in NO, N_2O, NO_2 and N_2O_3 is :
(1) $NO_2 < N_2O_3 < NO < N_2O$
(2) $NO_2 < NO < N_2O_3 < N_2O$
(3) $N_2O < N_2O_3 < NO < NO_2$
(4) $N_2O < NO < N_2O_3 < NO_2$

25. Among the following, the molecule expected to be stabilized by anion formation is :
C_2, O_2, NO, F_2
(1) NO (2) C_2 (3) F_2 (4) O_2

26. The number of water molecule(s) not coordinated to copper ion directly in $CuSO_4.5H_2O$, is :
(1) 4 (2) 3 (3) 1 (4) 2

27. Among the following species, the diamagnetic molecule is

(1) O_2 (2) NO

(3) B_2 (4) CO

28. The structures of beryllium chloride in the solid state and vapour, phase, respectively,are :

(1) chain and dimeric (2) chain and chain

(3) dimeric and dimeric (4) dimeric and chain

29. HF has highest boiling point among hydrogen halides, because it has :

(1) lowest dissociation enthalpy

(2) strongest van der Waals' interactions

(3) strongest hydrogen bonding

(4) lowest ionic character

30. The correct statements among I to III are :

(I) Valence bond theory cannot explain the color exhibited by transition metal complexes.

(II) Valence bond theory can predict quantitatively the magnetic properties of transtition metal complexes.

(III) Valence bond theory cannot distinguish ligands as weak and strong field ones.

(1) (I) and (II) only

(2) (I), (II) and (III)

(3) (I) and (III) only

(4) (II) and (III) only

31. The oxoacid of sulphur that does not contain bond between sulphur atoms is :

(1) $H_2S_4O_6$ (2) $H_2S_2O_7$

(3) $H_2S_2O_3$ (4) $H_2S_2O_4$

32. During the change of O_2 to O_2^-, the incoming electron goes to the orbital :

(1) $\sigma^*\ ^2P_z$ (2) $\pi\ ^2P_y$

(3) $\pi^*\ ^2P_x$ (4) $\pi\ ^2P_x$

S-BLOCK

1. A metal on combustion in excess air forms X, X upon hydrolysis with water yields H_2O_2 and O_2 along with another product. The metal is :

(1) Rb (2) Na (3) Mg (4) Li

2. Match the following items in column I with the corresponding items in column II.

Column I		Column II	
(i)	$Na_2CO_3\cdot 10\ H_2O$	(P)	Portland cement ingredient
(ii)	$Mg(HCO_3)_2$	(Q)	Castner-Keller process
(iii)	NaOH	(R)	Solvay process
(iv)	$Ca_3Al_2O_6$	(S)	Temporary hardness

(1) (i)→(C); (ii)→(B); (iii)→(D); (iv)→(A)

(2) (i)→(C); (ii)→(D); (iii)→(B); (iv)→(A)

(3) (i)→(D); (ii)→(A); (iii)→(B); (iv)→(C)

(4) (i)→(B); (ii)→(C); (iii)→(A); (iv)→(D)

3. The metal used for making X-ray tube window is :

(1) Mg (2) Na (3) Ca (4) Be

4. The alkaline earth metal nitrate that does not crystallise with water molecules, is :

(1) $Sr(NO_3)_2$ (2) $Mg(NO_3)_2$

(3) $Ca(NO_3)_2$ (4) $Ba(NO_3)_2$

5. The metal that forms nitride by reacting directly with N_2 of air, is :

(1) K (2) Cs (3) Li (4) Rb

6. Sodium metal on dissolution in liquid ammonia gives a deep blue solution due to the formation of:

(1) sodium ion-ammonia complex

(2) sodamide

(3) sodium-ammonia complex

(4) ammoniated electrons

7. Magnisium powder burns in air to give:

(1) MgO only

(2) MgO and $Mg(NO_3)_2$

(3) MgO and Mg_3N_2

(4) $Mg(NO_3)_2$ and Mg_3N_2

8. A hydrated solid X on heating initially gives a monohydrated compound Y. Y upon heating above 373K leads to an anhydrous white powder Z. X and Z, respectively, are:

(1) Washing soda and soda ash.

(2) Washing soda and dead burnt plaster.

(3) Baking soda and dead burnt plaster.

(4) Baking soda and soda ash.

9. The temporary hardness of a water sample is due to compound X. Boiling this sample converts X to compound Y. X and Y, respectively, are :

(1) $Ca(HCO_3)_2$ and CaO

(2) $Mg(HCO_3)_2$ and $MgCO_3$

(3) $Mg(HCO_3)_2$ and $Mg(OH)_2$

(4) $Ca(HCO_3)_2$ and $Ca(OH)_2$

10. The INCORRECT statement is :

(1) Lithium is least reactive with water among the alkali metals.

(2) LiCl crystallises from aqueous solution as $LiCl.2H_2O$.

(3) Lithium is the strongest reducing agent among the alkali metals.

(4) $LiNO_3$ decomposes on heating to give $LiNO_2$ and O_2.

PERIODIC TABLE

1. The element with Z = 120 (not yet discovered) will be an/a :

(1) transition metal

(2) inner-transition metal

(3) alkaline earth metal

(4) alkali metal

2. The correct order of atomic radii is :

(1) Ce > Eu > Ho > N

(2) N > Ce > Eu > Ho

(3) Eu > Ce > Ho > N

(4) Ho > N > Eu > Ce

3. The amphoteric hydroxide is :

(1) $Ca(OH)_2$ (2) $Be(OH)_2$

(3) $Sr(OH)_2$ (4) $Mg(OH)_2$

4. The correct order of the atomic radii of C, Cs, Al and S is :

(1) S < C < Al < Cs

(2) S < C < Cs < Al

(3) C < S < Cs < Al

(4) C < S < Al < Cs

5. The correct option with respect to the Pauling electronegativity values of the elements is :-

(1) Ga < Ge   (2) Si < Al

(3) P > S   (4) Te > Se

6. The effect of lanthanoid contraction in the lanthanoid series of elements by and large means :

(1) decrease in both atomic and ionic radii

(2) increase in atomic radii and decrease in ionic radii

(3) increase in both atomic and ionic radii

(4) decrease in atomic radii and increase in ionic radii

7. The electronegativity of aluminium is similar to :

(1) Boron   (2) Carbon

(3) Lithium   (4) Beryllium

8. In general, the properties that decrease and increase down a group in the periodic table, respectively, are :

(1) electronegativity and electron gain enthalpy.

(2) electronegativity and atomic radius.

(3) atomic radius and electronegativity.

(4) electron gain enthalpy and electronegativity.

9. When the first electron gain enthalpy ($\Delta_{eg}H$) of oxygen is –141 kJ/mol, its second electron gain enthalpy is :

(1) almost the same as that of the first

(2) negative , but less negative than the first

(3) a positive value

(4) a more negative value than the first

10. The pair that has similar atomic radii is :

(1) Sc and Ni   (2) Ti and HF

(3) Mo and W   (4) Mn and Re

11. In comparison to boron, berylium has :

(1) lesser nuclear charge and greater first ionisation enthalpy

(2) lesser nuclear charge and lesser first ionisation enthalpy

(3) greater nuclear charge and greater first ionisation enthalpy

(4) greater nuclear charge and lesser first ionisation enthalpy

12. The group number, number of valence electrons, and valency of an element with atomic number 15, respectively, are
(1) 16, 5 and 2 (2) 16, 6 and 3
(3) 15, 5 and 3 (4) 15, 6 and 2

13. The highest possible oxidation states of uranium and plutonium, respectively, are :-
(1) 6 and 4 (2) 7 and 6
(3) 4 and 6 (4) 6 and 7

14. The noble gas that does NOT occur in the atmosphere is:
(1) He (2) Ra (3) Ne (4) Kr

15. The correct order of the first ionization enthalpies is:
(1) Mn < Ti < Zn < Ni
(2) Ti < Mn < Ni < Zn
(3) Zn < Ni < Mn < Ti
(4) Ti < Mn < Zn < Ni

16. The correct order of hydration enthalpies of alkali metal ions is -
(1) $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$
(2) $Li^+ > Na^+ > K^+ > Cs^+ > Rb^+$
(3) $Na^+ > Li^+ > K^+ > Rb^+ > Cs^+$
(4) $Na^+ > Li^+ > K^+ > Cs^+ > Rb^+$

17. The IUPAC symbol for the element with atomic number 119 would be :
(1) unh (2) uun (3) une (4) uue

18. The size of the iso-electronic species Cl^-, Ar and Ca^{2+} is affected by -
(1) Principal quantum number of valence shell
(2) Nuclear charge
(3) Azimuthal qunatum number of valence shell
(4) Electron-electron interaction in the outer orbitals

19. The element having greatest difference between its first and second ionization energies, is :
(1) Ca (2) K (3) Ba (4) Sc

METALLURGY

1. In the Hall-Heroult process, aluminium is formed at the cathode. The cathode is made out of :
(1) Platinum (2) Carbon
(3) Pure aluminium (4) Copper

2. The pair that does NOT require calcination is:
(1) ZnO and MgO
(2) Fe_2O_3 and $CaCO_3.MgCO_3$
(3) ZnO and $Fe_2O_3.xH_2O$
(4) $ZnCO_3$ and CaO

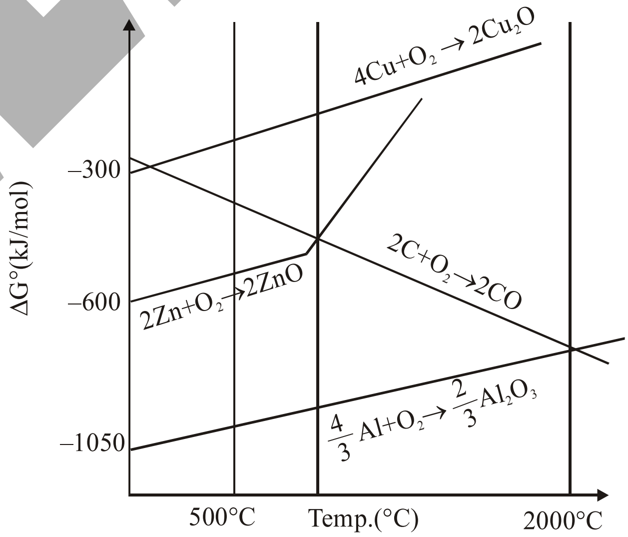
3. Match the ores(Column A) with the metals (column B) :

Column-A Ores	***Column-B Metals***
(I) Siderite	(a) Zinc
(II) Kaolinite	(b) Copper
(III) Malachite	(c) Iron
(IV) Calamine	(d) Aluminium

(1) I-b ; II-c ; III-d ; IV-a
(2) I-c ; II-d ; III-a ; IV-b
(3) I-c ; II-d ; III-b ; IV-a
(4) I-a ; II-b ; III-c ; IV-d

4. The ore that contains both iron and copper is:
(1) malachite (2) dolomite
(3) azurite (4) copper pyrites

5. The correct statement regarding the given Ellingham diagram is:



(1) At 800°C, Cu can be used for the extraction of Zn from ZnO
(2) At 500 C, coke can be used for the extraction of Zn from ZnO
(3) Coke cannot be used for the extraction of Cu from Ca_2O.
(4) At 1400°C, Al can be used for the extraction of Zn from ZnO

6. The reaction that does NOT define calcination is :-

(1) $ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$

(2) $Fe_2O_3 \cdot XH_2O \xrightarrow{\Delta} Fe_2O_3 + XH_2O$

(3) $CaCO_3 \cdot MgCO_3 \xrightarrow{\Delta} CaO + MgO + 2\,CO_2$

(4) $2\,Cu_2S + 3\,O_2 \xrightarrow{\Delta} 2\,Cu_2O + 2\,SO_2$

7. Hall-Heroult's process is given by "

(1) $Cr_2O_3 + 2Al \rightarrow Al_2O_3 + 2Cr$

(2) Cu^{2+} (aq.) + $H_2(g) \rightarrow Cu(s) + 2H^+$ (aq)

(3) $ZnO + C \xrightarrow{\text{Coke, 1673K}} Zn + CO$

(4) $2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2$

8. The idea of froth floatation method came from a person X and this method is related to the process Y of ores. X and Y, respectively, are:

(1) fisher woman and concentration

(2) washer man and reduction

(3) washer woman and concentration

(4) fisher man and reduction

9. The correct statement is :

(1) leaching of bauxite using concentrated NaOH solution gives sodium aluminate and sodium silicate

(2) the blistered appearance of copper during the metallurgical process is due to the evolution of CO_2

(3) pig iron is obtained from cast iron

(4) the Hall-Heroult process is used for the production of aluminium and iron

10. The correct statement is :

(1) zincite is a carbonate ore

(2) aniline is a froth stabilizer

(3) zone refining process is used for the refining of titanium

(4) sodium cyanide cannot be used in the metallurgy of silver

11. With respect to an ore, Ellingham diagram helps to predict the feasibility of its -

(1) Vapour phase refining

(2) Zone refining

(3) Electrolysis

(4) Thermal reduction

12. The Mond process is used for the

(1) extraction of Mo

(2) Purification of Ni

(3) Purification of Zr and Ti

(4) Extraction of Zn

13. The ore that contains the metal in the form of fluoride is :

(1) magnetite (2) sphalerite

(3) malachite (4) cryolite

14. The one that is not a carbonate is :

(1) bauxite (2) siderite

(3) calamine (4) malachite

15. **Assertion:** For the extraction of iron, haematite ore is used.

Reason: Haematite is a carbonate ore of iron.

(1) Only the reason is correct.

(2) Both the assertion and reason are correct and the reason is the correct explanation for the assertion.

(3) Only the assertion is correct.

(4) Both the assertion and reason are correct, but the reason is not the correct explanation for the assertion.

16. Match the refining methods (Column I) with metals (Column II).

Column I (Refining methods)	Column II (Metals)
(I) Liquation	(a) Zr
(II) Zone Refining	(b) Ni
(III) Mond Process	(c) Sn
(IV) Van Arkel Method	(d) Ga

(1) (I) – (b); (II) – (c); (III) – (d); (IV) – (a)

(2) (I) – (b); (II) – (d); (III) – (a); (IV) – (c)

(3) (I) – (c); (II) – (a); (III) – (b); (IV) – (d)

(4) (I) – (c); (II) – (d); (III) – (b); (IV) – (a)

17. The alloy used in the construction of aircrafts is :-

(1) Mg – Sn (2) Mg – Mn

(3) Mg – Al (4) Mg – Zn

QUANTUM NUMBER

1. The total number of isotopes of hydrogen and number of radioactive isotopes among them, respectively, are :
(1) 2 and 0 (2) 3 and 2
(3) 3 and 1 (4) 2 and 1

2. The isotopes of hydrogen are :
(1) Tritium and protium only
(2) Deuterium and tritium only
(3) Protium and deuterum only
(4) Protium, deuterium and tritium

3. The 71st electron of an element X with an atomic number of 71 enters into the orbital :
(1) 4f (2) 6p (3) 6s (4) 5d

4. The quantum number of four electrons are given below -
I. $n = 4, l = 2, m_l = -2, m_s = -½$
II. $n = 3, l = 2, m_l = 1, m_s = +½$
III. $n = 4, l = 1, m_l = 0, m_s = +½$
IV. $n = 3, l = 1, m_l = 1, m_s = -½$
The correct order of their increasing energies will be -
(1) IV < III < II < I (2) IV < II < III < I
(3) I < II < III < IV (4) I < III < II < IV

5. The isoelectronic set of ions is :
(1) N^{3-}, Li^+, Mg^{2+} and O^{2-}
(2) Li^+, Na^+, O^{2-} and F^-
(3) F^-, Li^+, Na^+ and Mg^{2+}
(4) N^{3-}, O^{2-}, F^- and Na^+

P-BLOCK

1. Among the following reactions of hydrogen with halogens, the one that requires a catalyst is :
(1) $H_2 + I_2 \rightarrow 2HI$ (2) $H_2 + F_2 \rightarrow 2HF$
(3) $H_2 + Cl_2 \rightarrow 2HCl$ (4) $H_2 + Br_2 \rightarrow 2HBr$

2. Which of the following is not and example of heterogeneous catalytic reaction ?
(1) Ostwald's process
(2) Haber's process
(3) Combustion of coal
(4) Hydrogenation of vegetable oils

3. Diborane (B_2H_6) reacts independently with O_2 and H_2O to produce, respectively
(1) HBO_2 and H_3BO_3 (2) H_3BO_3 and B_2O_3
(3) B_2O_3 and H_3BO_3 (4) B_2O_3 and $[BH_4]^-$

4. The one that is extensively used as a piezoelectric material is :
(1) Quartz (2) Amorphous silica
(3) Mica (4) Tridymite

5. The amorphous form of silica is :
(1) quartz (2) kieselguhr
(3) cristobalite (4) tridymite

6. The correct statements among I to III regarding group 13 element oxides are,
(I) Boron trioxide is acidic.
(II) Oxides of aluminium and gallium are amphoteric.
(III) Oxides of indium and thalliumare basic.
(1) (I), (II) and (III) (2) (II) and (III) only
(3) (I) and (III) only (4) (I) and (II) only

7. The correct order of catenation is :
(1) $C > Si > Ge \approx Sn$ (2) $C > Sn > Si \approx Ge$
(3) $Ge > Sn > Si > C$ (4) $Si > Sn > C > Ge$

8. The synonym for water gas when used in the production of methanol is :-
(1) natural gas (2) laughing gas
(3) syn gas (4) fuel gas

D-BLOCK

1. The element that usually does not show variable oxidation states is :
(1) V (2) Ti (3) Sc (4) Cu

2. $\underline{A} \xrightarrow{4\,KOH,\,O_2} 2\underline{B} + 2\,H_2O$ (Green)
$3\,\underline{B} \xrightarrow{4\,HCl} 2\,\underline{C} + MnO_2 + 2\,H_2O$ (Purple)
$2\,\underline{B} \xrightarrow{H_2O,\,KI} 2\,\underline{A} + 2KOH + \underline{D}$
In the above sequence of reactions, A and D respectively, are :-
(1) KIO_3 and MnO_2 (2) KI and K_2MnO_4
(3) MnO_2 and KIO_3 (4) KI and $KMnO_4$

3. The transition element that has lowest enthalpy of atomisation, is :

(1) Zn (2) Cu (3) V (4) Fc

4. Match the catalysts **(Column I)** with products **(Column II)**.

Column I	Column II
(A) V_2O_5	(i) Polyethylene
(B) $TiCl_4/Al(Me)_3$	(ii) ethanal
(C) $PdCl_2$	(iii) H_2SO_4
(D) Iron Oxide	(iv) NH_3

(1) (A)-(ii); (B)-(iii); (C)-(i); (D)-(iv)

(2) (A)-(iii); (B)-(i); (C)-(ii); (D)-(iv)

(3) (A)-(iii); (B)-(iv); (C)-(i); (D)-(ii)

(4) (A)-(iv); (B)-(iii); (C)-(ii); (D)-(i)

5. Consider the hydrates ions of Ti^{2+}, V^{2+}, Ti^{3+} and Sc^{3+}. The correct order of their spin-only magnetic moments is :

(1) $Sc^{3+} < Ti^{3+} < Ti^{2+} < V^{2+}$

(2) $Ti^{3+} < Ti^{2+} < Sc^{3+} < V^{2+}$

(3) $Sc^{3+} < Ti^{3+} < V^{2+} < Ti^{2+}$

(4) $V^{2+} < Ti^{2+} < Ti^{3+} < Sc^{3+}$

HYDROGEN & IT'S COMPOUND

1. NaH is an example of :

(1) Electron-rich hydride

(2) Molecular hydride

(3) Saline hydride

(4) Metallic hydride

2. The correct statements among (a) to (d) regarding H_2 as a fuel are :

(a) It produces less pollutant than petrol

(b) A cylinder of compressed dihydrogen weighs ~ 30 times more than a petrol tank producing the same amount of energy

(c) Dihydrogen is stored in tanks of metal alloys like $NaNi_5$

(d) On combustion, values of energy released per gram of liquid dihydrogen and LPG are 50 and 142 kJ, respectively

(1) b and d only (2) a, b and c only

(3) b, c and d only (4) a and c only

3. The temporary hardness of water is due to :-

(1) $Ca(HCO_3)_2$ (2) NaCl

(3) Na_2SO_4 (4) $CaCl_2$

4. The chemical nature of hydrogen preoxide is :-

(1) Oxidising and reducing agent in acidic medium, but not in basic medium.

(2) Oxidising and reducing agent in both acidic and basic medium

(3) Reducing agent in basic medium, but not in acidic medium

(4) Oxidising agent in acidic medium, but not in basic medium.

5. The metal that gives hydrogen gas upon treatment with both acid as well as base is :

(1) zinc (2) iron

(3) magnesium (4) mercury

ENVIRONMENTAL CHEMISTRY

1. Water samples with BOD values of 4 ppm and 18 ppm, respectively, are :

(1) Highly polluted and Clean

(2) Highly polluted and Highly polluted

(3) Clean and Highly polluted

(4) Clean and Clean

2. The upper stratosphere consisting of the ozone layer protects us from the sun's radiation that falls in the wavelength region of :

(1) 600-750 nm (2) 0.8-1.5 nm

(3) 400-550 nm (4) 200-315 nm

3. The compound that is NOT a common component of photochemical smog is :

(1) O_3 (2) $CH_2=CHCHO$

(3) CF_2Cl_2 (4) $H_3C-\underset{\underset{O}{\|}}{C}-OONO_2$

4. Taj Mahal is being slowly disfigured and discoloured. This is primarily due to :-

(1) Water pollution (2) Global warming

(3) Soil pollution (4) Acid rain

5. The higher concentration of which gas in air can cause stiffness of flower buds ?

(1) SO_2 (2) NO_2

(3) CO_2 (4) CO

6. Peoxyacetyl nitrate (PAN), an eye irritant is produced by :
(1) Acid rain
(2) Photochemical smog
(3) Classical smog
(4) Organic waste

7. The correct set of species responsible for the photochemical smog is :
(1) NO, NO_2, O_3 and hydrocarbons
(2) N_2,O_2, O_3 and hydrocarbons
(3) N_2, NO_2 and hydrocarbons
(4) CO_2, NO_2, SO_2 and hydrocarbons

8. Air pollution that occurs in sunlight is :
(1) oxidising smog (2) acid rain
(3) reducing smog (4) fog

9. **Assertion :** Ozone is destroyed by CFCs in the upper stratosphere
Reason : Ozone holes increase the amount of UV radiation reaching the earth.
(1) Assertion and reason are correct, but the reason is not the explanation for the assertion
(2) Assertion is false, but the reason is correct
(3) Assertion and reason are incorrect, Assertion and reason are both correct
(4) And the reason is the correct explanation for the assertion

10. Which is wrong with respect to our responsibility as a human being to protect our environment ?
(1) Avoiding the use of floodlighted facilities
(2) Restricting the use of vehicles
(3) Using plastic bags
(4) Setting up compost tin in gardens

11. Excessive release of CO_2 into the atomosphere results in :
(1) polar vortex
(2) depletion of ozone
(3) formation of smog
(4) global warming

12. The layer of atmosphere between 10 km to 50 km above the sea level is called as :
(1) troposphere (2) mesosphere
(3) stratosphere (4) thermosphere

13. The regions of the atmosphere, where clouds form and where we live respectively, are :-
(1) Stratosphere and Troposphere
(2) Troposphere and Stratosphere
(3) Troposphere and Troposphere
(4) Stratosphere and Stratosphere

14. The primary pollutant that leads to photochemical smog is :
(1) sulphur dioxide (2) acrolein
(3) ozone (4) nitrogen oxides

SALT ANALYSIS

1. Chlorine on reaction with hot and concentrated sodium hydroxide gives :
(1) Cl^- and ClO_2^-
(2) Cl^- and ClO_3^-
(3) Cl^- and ClO^-
(4) ClO_3^- and ClO_2^-

2. Iodine reacts with concentrated HNO_3 to yield Y along with other products. The oxidation state of iodine in Y, is :-
(1) 5 (2) 3 (3) 1 (4) 7

3. An organic compound 'A' is oxidized with Na_2O_2 followed by boiling with HNO_3.The resultant solution is then treated with ammonium molybdate to yield a yellow precipitate.
Based on above observation, the element present in the given compound is :
(1) Sulphur (2) Nitrogen
(3) Fluorine (4) Phosphorus

4. Which one of the following is likely to give a precipitate with $AgNO_3$ solution ?
(1) $(CH_3)_3CCl$ (2) $CHCl_3$
(3) CH_2=CH–Cl (4) CCl_4

F-BLOCK

1. The lanthanide ion that would show colour is-
(1) Sm^{3+} (2) La^{3+}
(3) Lu^{3+} (4) Gd^{3+}

2. The maximum number of possible oxidation states of actinoides are shown by
(1) berkelium (Bk) and californium (Cf)
(2) nobelium (No) and lawrencium (Lr)
(3) actinium (Ac) and thorium (Th)
(4) neptunium (Np) and plutonium (Pu)

ANSWER KEY

COORDINATION COMPOUND

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	4	2	2	2	2	4	1	1	2	1
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	1	2	1	1	3	1	3	1	2	3
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**		
Ans.	1	Bonus	3	3	4	2	1	1		

CHEMICAL BONDING

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	4	4	4	3	3	3	1	1	4	1
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	3	2	4	3	2	4	3	3	3
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	3	1	3	4	2	3	4	1	3	3
Que.	**31**	**32**								
Ans.	2	3								

S-BLOCK

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	1	2	4	4	3	4	3	1	3	4

PERIODIC TABLE

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	3	3	2	4	1	1	4	2	3	3
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	
Ans.	1	3	4	Bonus	2	1	4	2	2	

METALLURGY

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	1	3	4	4	4	4	3	1	2
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**			
Ans.	4	2	4	1	3	4	3			

QUANTUM NUMBER

Que.	**1**	**2**	**3**	**4**	**5**
Ans.	3	4	1	2	4

P-BLOCK

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Ans.	1	3	3	1	2	1	1	3

D-BLOCK					
Que.	1	2	3	4	5
Ans.	3	3	2	2	1

HYDROGEN & ITS COMPOUND					
Que.	1	2	3	4	5
Ans.	3	2	1	2	1

ENVIRONMENTAL CHEMISTRY										
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	4	3	4	1	2	1	1	1	3
Que.	11	12	13	14						
Ans.	4	3	3	4						

SALT ANALYSIS				
Que.	1	2	3	4
Ans.	2	1	4	1

F-BLOCK		
Que.	1	2
Ans.	1	4

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

Chapter Contents 03

JEE (MAIN) TOPICWISE TEST PAPERS JANUARY & APRIL 2019

MATHEMATICS

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

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JEE (MAIN) TOPICWISE TEST PAPERS JANUARY & APRIL 2019

MATHEMATICS

JANUARY & APRIL 2019 ATTEMPT (MATHEMATICS)

COMPOUND ANGLE

1. For any $\theta \in \left(\frac{\pi}{4},\frac{\pi}{2}\right)$, the expression $3(\sin\theta - \cos\theta)^4 + 6(\sin\theta + \cos\theta)^2 + 4\sin^6\theta$ equals :

(1) $13 - 4\cos^6\theta$

(2) $13 - 4\cos^4\theta + 2\sin^2\theta\cos^2\theta$

(3) $13 - 4\cos^2\theta + 6\cos^4\theta$

(4) $13 - 4\cos^2\theta + 6\sin^2\theta\cos^2\theta$

2. The value of $\cos\frac{\pi}{2^2}\cdot\cos\frac{\pi}{2^3}\cdot.....\cdot\cos\frac{\pi}{2^{10}}\cdot\sin\frac{\pi}{2^{10}}$ is :

(1) $\frac{1}{256}$ (2) $\frac{1}{2}$

(3) $\frac{1}{512}$ (4) $\frac{1}{1024}$

3. Let $f_k(x) = \frac{1}{k}(\sin^k x + \cos^k x)$ for k = 1, 2, 3, ... Then for all $x \in R$, the value of $f_4(x) - f_6(x)$ is equal to :-

(1) $\frac{5}{12}$ (2) $\frac{-1}{12}$ (3) $\frac{1}{4}$ (4) $\frac{1}{12}$

4. The maximum value of $3\cos\theta + 5\sin\left(\theta - \frac{\pi}{6}\right)$ for any real value of θ is :

(1) $\sqrt{19}$ (2) $\frac{\sqrt{79}}{2}$ (3) $\sqrt{31}$ (4) $\sqrt{34}$

5. If $\cos(\alpha+\beta) = \frac{3}{5}, \sin(\alpha-\beta) = \frac{5}{13}$ and $0 < \alpha, \beta < \frac{\pi}{4}$, then $\tan(2\alpha)$ is equal to :

(1) $\frac{21}{16}$ (2) $\frac{63}{52}$

(3) $\frac{33}{52}$ (4) $\frac{63}{16}$

6. The value of $\cos^2 10° - \cos 10°\cos 50° + \cos^2 50°$ is

(1) $\frac{3}{2}(1+\cos 20°)$

(2) $\frac{3}{4}$

(3) $\frac{3}{4} + \cos 20°$

(4) $\frac{3}{2}$

7. The value of sin 10º sin30º sin50º sin70º is :-

(1) $\frac{1}{36}$ (2) $\frac{1}{32}$

(3) $\frac{1}{18}$ (4) $\frac{1}{16}$

QUADRATIC EQUATION

1. Let α and β be two roots of the equation $x^2 + 2x + 2 = 0$, then $\alpha^{15} + \beta^{15}$ is equal to :

(1) 512 (2) –512 (3) –256 (4) 256

2. If both the roots of the quadratic equation $x^2 - mx + 4 = 0$ are real and distinct and they lie in the interval [1,5], then m lies in the interval:

(1) (4,5) (2) (3,4)

(3) (5,6) (4) (–5,–4)

3. The number of all possible positive integral values of α for which the roots of the quadratic equation, $6x^2-11x+\alpha = 0$ are rational numbers is :

(1) 2 (2) 5 (3) 3 (4) 4

4. Consider the quadratic equation $(c-5)x^2-2cx + (c-4) = 0$, $c\neq5$. Let S be the set of all integral values of c for which one root of the equation lies in the interval (0,2) and its other root lies in the interval (2,3). Then the number of elements in S is :

(1) 11 (2) 18 (3) 10 (4) 12

5. The values of λ such that sum of the squares of the roots of the quadratic equation,

$x^2 + (3 - \lambda) x + 2 = \lambda$ has the least value is :

(1) 2 (2) $\frac{4}{9}$

(3) $\frac{15}{8}$ (4) 1

6. If one real root of the quadratic equation $81x^2 + kx + 256 = 0$ is cube of the other root, then a value of k is

(1) –81 (2) 100 (3) –300 (4) 144

7. Let α and β be the roots of the quadratic equation

$x^2 \sin\theta - x(\sin\theta\cos\theta + 1) + \cos\theta = 0$

$(0 < \theta < 45^\circ)$, and $\alpha < \beta$. Then $\sum_{n=0}^{\infty}\left(\alpha^n + \frac{(-1)^n}{\beta^n}\right)$ is equal to :-

(1) $\frac{1}{1-\cos\theta} + \frac{1}{1+\sin\theta}$

(2) $\frac{1}{1+\cos\theta} + \frac{1}{1-\sin\theta}$

(3) $\frac{1}{1-\cos\theta} - \frac{1}{1+\sin\theta}$

(4) $\frac{1}{1+\cos\theta} - \frac{1}{1-\sin\theta}$

8. If λ be the ratio of the roots of the quadratic equation in x, $3m^2x^2+m(m-4)x+2 = 0$, then the least value of m for which $\lambda + \frac{1}{\lambda} = 1$, is :

(1) $2-\sqrt{3}$ (2) $4-3\sqrt{2}$

(3) $-2+\sqrt{2}$ (4) $4-2\sqrt{3}$

9. The number of integral values of m for which the quadratic expression. $(1 + 2m)x^2 - 2(1 + 3m)x + 4(1 + m)$, $x \in R$, is always positive, is :

(1) 8 (2) 7 (3) 6 (4) 3

10. If α and β be the roots of the equation $x^2 - 2x + 2 = 0$, then the least value of n for which $\left(\frac{\alpha}{\beta}\right)^n = 1$ is :

(1) 2 (2) 3

(3) 4 (4) 5

11. The sum of the solutions of the equation $\left|\sqrt{x}-2\right| + \sqrt{x}\left(\sqrt{x}-4\right) + 2 = 0, (x > 0)$ is equal to :

(1) 4 (2) 9

(3) 10 (4) 12

12. The number of integral values of m for which the equation

$(1 + m^2)x^2 - 2(1 + 3m)x + (1 + 8m) = 0$

has no real root is :

(1) infinitely many (2) 2

(3) 3 (4) 1

13. Let p, q $\in$ R. If $2-\sqrt{3}$ is a root of the quadratic equation, $x^2 + px + q = 0$, then :

(1) $q^2 + 4p + 14 = 0$ (2) $p^2 - 4q - 12 = 0$

(3) $q^2 - 4p - 16 = 0$ (4) $p^2 - 4q + 12 = 0$

14. If m is chosen in the quadratic equation $(m^2 + 1) x^2 - 3x + (m^2 + 1)^2 = 0$ such that the sum of its roots is greatest, then the absolute difference of the cubes of its roots is :-

(1) $8\sqrt{3}$ (2) $4\sqrt{3}$

(3) $10\sqrt{5}$ (4) $8\sqrt{5}$

15. If α and β are the roots of the quadratic equation, $x^2 + x\sin\theta - 2\sin\theta = 0$, $\theta \in \left(0, \frac{\pi}{2}\right)$, then $\frac{\alpha^{12}+\beta^{12}}{\left(\alpha^{-12}+\beta^{-12}\right)\left(\alpha-\beta\right)^{24}}$ is equal to :

(1) $\frac{2^6}{(\sin\theta+8)^{12}}$ (2) $\frac{2^{12}}{(\sin\theta-8)^{6}}$

(3) $\frac{2^{12}}{(\sin\theta-4)^{12}}$ (4) $\frac{2^{12}}{(\sin\theta+8)^{12}}$

SEQUENCE & PROGRESSION

1. If a, b and c be three distinct real numbers in G. P. and a + b + c = xb, then x cannot be :
(1) 4 (2) –3 (3) –2 (4) 2

2. Let $a_1, a_2, \dots\dots\dots, a_{30}$ be an A. P., $S = \sum_{i=1}^{30} a_i$ and $T = \sum_{i=1}^{15} a_{(2i-1)}$. If $a_5 = 27$ and S – 2T = 75, then a_{10} is equal to :
(1) 57 (2) 47 (3) 42 (4) 52

3. The sum of the follwing series
$$1+6+\frac{9\left(1^2+2^2+3^2\right)}{7}+\frac{12\left(1^2+2^2+3^2+4^2\right)}{9}+\frac{15\left(1^2+2^2+....+5^2\right)}{11}+.... \text{ up to}$$
15 terms, is:
(1) 7820 (2) 7830 (3) 7520 (4) 7510

4. Let a, b and c be the 7th, 11th and 13th terms respectively of a non-constant A.P. If these are also the three consecutive terms of a G.P., then $\frac{a}{c}$ is equal to:
(1) $\frac{1}{2}$ (2) 4 (3) 2 (4) $\frac{7}{13}$

5. The sum of an infinite geometric series with positive terms is 3 and the sum of the cubes of its terms is $\frac{27}{19}$. Then the common ratio of this series is :
(1) $\frac{4}{9}$ (2) $\frac{2}{9}$ (3) $\frac{2}{3}$ (4) $\frac{1}{3}$

6. Let $a_1, a_2, \dots, a_{10}$ be a G.P. If $\frac{a_3}{a_1} = 25$, then $\frac{a_9}{a_5}$ equals :
(1) $2(5^2)$ (2) $4(5^2)$ (3) 5^4 (4) 5^3

7. If 19th term of a non-zero A.P. is zero, then its (49th term) : (29th term) is :-
(1) 3 : 1 (2) 4 : 1
(3) 2 : 1 (4) 1 : 3

8. Let x, y be positive real numbers and m, n positive integers. The maximum value of the expression $\frac{x^m y^n}{(1+x^{2m})(1+y^{2n})}$ is :-
(1) $\frac{1}{2}$ (2) $\frac{1}{4}$ (3) $\frac{m+n}{6mn}$ (4) 1

9. The product of three consecutive terms of a G.P. is 512. If 4 is added to each of the first and the second of these terms, the three terms now from an A.P. Then the sum of the original three terms of the given G.P. is
(1) 36 (2) 24 (3) 32 (4) 28

10. Let $S_k = \frac{1+2+3+....+k}{k}$.
If $S_1^2 + S_2^2 + ... + S_{10}^2 = \frac{5}{12}A$, then A is equal to :
(1) 303 (2) 283 (3) 156 (4) 301

11. If $\sin^4\alpha + 4\cos^4\beta + 2 = 4\sqrt{2}\sin\alpha\cos\beta$;
$\alpha, \beta \in [0, \pi]$, then cos(α + β) – cos(α – β) is equal to :
(1) 0 (2) $-\sqrt{2}$ (3) –1 (4) $\sqrt{2}$

12. If the sum of the first 15 tems of the series $\left(\frac{3}{4}\right)^3+\left(1\frac{1}{2}\right)^3+\left(2\frac{1}{4}\right)^3+3^3+\left(3\frac{3}{4}\right)^3+....$ is equal to 225 k, then k is equal to :
(1) 9 (2) 27 (3) 108 (4) 54

13. The sum of all natural numbers 'n' such that 100 < n < 200 and H.C.F. (91, n) > 1 is :
(1) 3221 (2) 3121
(3) 3203 (4) 3303

14. The sum $\sum_{k=1}^{20} k\frac{1}{2^k}$ is equal to-
(1) $2-\frac{3}{2^{17}}$ (2) $2-\frac{11}{2^{19}}$
(3) $1-\frac{11}{2^{20}}$ (4) $2-\frac{21}{2^{20}}$

15. If three distinct numbers a,b,c are in G.P. and the equations $ax^2 + 2bx + c = 0$ and $dx^2 + 2ex + f = 0$ have a common root, then which one of the following statements is correct?

(1) d,e,f are in A.P.

(2) $\frac{d}{a}, \frac{e}{b}, \frac{f}{c}$ are in G.P.

(3) $\frac{d}{a}, \frac{e}{b}, \frac{f}{c}$ are in A.P.

(4) d,e,f are in G.P.

16. Let the sum of the first n terms of a non-constant A.P., a_1, a_2, a_3, ... be $50n + \frac{n(n-7)}{2}A$, wherre A is a constant. If d is the common difference of this A.P., then the ordered pair (d, a_{50}) is equal to

(1) (A, 50+46A) (2) (A, 50+45A)
(3) (50, 50+46A) (4) (50, 50+45A)

17. If the sum and product of the first three term in an A.P. are 33 and 1155, respectively, then a value of its 11^{th} term is :-

(1) –25 (2) 25
(3) –36 (4) –35

18. The sum of the series $1 + 2 \times 3 + 3 \times 5 + 4 \times 7 + ...$ upto 11^{th} term is :-

(1) 915 (2) 946
(3) 945 (4) 916

19. The sum

$$\frac{3\times1^3}{1^2}+\frac{5\times(1^3+2^3)}{1^2+2^2}+\frac{7\times(1^3+2^3+3^3)}{1^2+2^2+3^2}+.......$$

upto 10^{th} term, is :

(1) 660 (2) 620
(3) 680 (4) 600

20. If $a_1, a_2, a_3, ..., a_n$ are in A.P. and $a_1 + a_4 + a_7 + ... + a_{16} = 114$, then $a_1 + a_6 + a_{11} + a_{16}$ is equal to :

(1) 38 (2) 98
(3) 76 (4) 64

21. The sum $1 + \frac{1^3+2^3}{1+2}+\frac{1^3+2^3+3^3}{1+2+3}+....$

$$+\frac{1^3+2^3+3^3+....+15^3}{1+2+3+....+15}-\frac{1}{2}(1+2+3+....+15)]$$

(1) 1240 (2)1860
(3) 660 (4) 620

22. Let a, b and c be in G. P. with common ratio r, where $a \neq 0$ and $0 < r \leq \frac{1}{2}$. If 3a, 7b and 15c are the first three terms of an A. P., then the 4^{th} term of this A. P. is :

(1) $\frac{7}{3}a$ (2) a

(3) $\frac{2}{3}a$ (4) 5a

23. If α and β are the roots of the equation $375x^2 - 25x - 2 = 0$, then $\lim_{n\to\infty}\sum_{r=1}^{n}\alpha^r + \lim_{n\to\infty}\sum_{r=1}^{n}\beta^r$ is equal to :

(1) $\frac{21}{346}$ (2) $\frac{29}{358}$ (3) $\frac{1}{12}$ (4) $\frac{7}{116}$

24. Let S_n denote the sum of the first n terms of an A.P. If $S_4 = 16$ and $S_6 = -48$, then S_{10} is equal to :

(1) –320 (2) –260 (3) –380 (4) –410

25. If $a_1, a_2, a_3, ...$ are in A.P. such that $a_1 + a_7 + a_{16} = 40$, then the sum of the first 15 terms of this A.P. is :

(1) 200 (2) 280
(3) 120 (4) 150

26. If α,β and γ are three consecutive terms of a non-constant G.P. such that the equations $\alpha x^2 + 2\beta x + \gamma = 0$ and $x^2 + x - 1 = 0$ have a common root, then $\alpha(\beta + \gamma)$ is equal to :

(1) βγ (2) 0 (3) αγ (4) αβ

TRIGONOMETRY EQUATION

1. If $0 \le x < \frac{\pi}{2}$, then the number of values of x for which sin x-sin2x+sin3x = 0, is

(1) 2 (2) 1 (3) 3 (4) 4

2. The sum of all values of $\theta \in \left(0, \frac{\pi}{2}\right)$ satisfying $\sin^2 2\theta + \cos^4 2\theta = \frac{3}{4}$ is :

(1) $\frac{\pi}{2}$ (2) π

(3) $\frac{3\pi}{8}$ (4) $\frac{5\pi}{4}$

3. Let $S = \{\theta \in [-2\pi, 2\pi] : 2\cos^2\theta + 3\sin\theta = 0\}$. Then the sum of the elements of S is

(1) $\frac{13\pi}{6}$ (2) π (3) 2π (4) $\frac{5\pi}{3}$

4. All the pairs (x, y) that satisfy the inequality $2\sqrt{\sin^2 x - 2\sin x + 5} \cdot \frac{1}{4^{\sin^2 y}} \le 1$ also satisfy the eauation.

(1) sin x = |siny| (2) sin x = 2 sin y

(3) 2|sinx| = 3siny (4) 2sin x = siny

5. The number of solutions of the equation $1 + \sin^4 x = \cos^2 3x,\ x \in \left[-\frac{5\pi}{2}, \frac{5\pi}{2}\right]$ is :

(1) 5 (2) 4 (3) 7 (4) 3

6. Let S be the set of all $\alpha \in R$ such that the equation, $\cos 2x + \alpha \sin x = 2\alpha - 7$ has a solution. Then S is equal to :

(1) [2, 6] (2) [3,7] (3) R (4) [1,4]

SOLUTION OF TRIANGLE

1. If 5, 5r, $5r^2$ are the lengths of the sides of a triangle, then r cannot be equal to :

(1) $\frac{3}{2}$ (2) $\frac{3}{4}$

(3) $\frac{5}{4}$ (4) $\frac{7}{4}$

2. With the usual notation, in ΔABC, if $\angle A + \angle B = 120°$, $a = \sqrt{3} + 1$ and $b = \sqrt{3} - 1$, then the ratio $\angle A : \angle B$, is :

(1) 7 : 1 (2) 5 : 3 (3) 9 : 7 (4) 3 : 1

3. In a triangle, the sum of lengths of two sides is x and the product of the lengths of the same two sides is y. If $x^2 - c^2 = y$, where c is the length of the third side of the triangle, then the circumradius of the triangle is :

(1) $\frac{y}{\sqrt{3}}$ (2) $\frac{c}{\sqrt{3}}$

(3) $\frac{c}{3}$ (4) $\frac{3}{2}y$

4. Given $\frac{b+c}{11} = \frac{c+a}{12} = \frac{a+b}{13}$ for a ΔABC with usual notation. If $\frac{\cos A}{\alpha} = \frac{\cos B}{\beta} = \frac{\cos C}{\gamma}$, then the ordered triad (α, β, γ) has a value :-

(1) (3, 4, 5) (2) (19, 7, 25)

(3) (7, 19, 25) (4) (5, 12, 13)

5. If the lengths of the sides of a triangle are in A.P. and the greatest angle is double the smallest, then a ratio of lengths of the sides of this triangle is :

(1) 5 : 9 : 13 (2) 5 : 6 : 7

(3) 4 : 5 : 6 (4) 3 : 4 : 5

6. The angles A, B and C of a triangle ABC are in A.P. and a : b = 1 : $\sqrt{3}$. If c = 4 cm, then the area (in sq. cm) of this triangle is :

(1) $4\sqrt{3}$ (2) $\frac{2}{\sqrt{3}}$

(3) $2\sqrt{3}$ (4) $\frac{4}{\sqrt{3}}$

HEIGHT & DISTANCE

1. Consider a triangular plot ABC with sides AB=7m, BC=5m and CA=6m. A vertical lamp-post at the mid point D of AC subtends an angle 30° at B. The height (in m) of the lamp-post is:

(1) $7\sqrt{3}$ (2) $\frac{2}{3}\sqrt{21}$

(3) $\frac{3}{2}\sqrt{21}$ (4) $2\sqrt{21}$

2. If the angle of elevation of a cloud from a point P which is 25 m above a lake be 30º and the angle of depression of reflection of the cloud in the lake from P be 60º, then the height of the cloud (in meters) from the surface of the lake is :

(1) 42 (2) 50 (3) 45 (4) 60

3. Two vertical poles of heights, 20m and 80m stand a part on a horizontal plane. The height (in meters) of the point of intersection of the lines joining the top of each pole to the foot of the other, from this horizontal plane is :

(1) 12 (2) 15
(3) 16 (4) 18

4. Two poles standing on a horizontal ground are of heights 5m and 10 m respectively. The line joining their tops makes an angle of 15º with ground. Then the distance (in m) between the poles, is :-

(1) $\frac{5}{2}(2+\sqrt{3})$ (2) $5(\sqrt{3}+1)$

(3) $5(2+\sqrt{3})$ (4) $10(\sqrt{3}-1)$

5. ABC is a triangular park with AB = AC = 100 metres. A vertical tower is situated at the mid-point of BC. If the angles of elevation of the top of the tower at A and B are $\cot^{-1}\left(3\sqrt{2}\right)$ and $\text{cosec}^{-1}\left(2\sqrt{2}\right)$ respectively, then the height of the tower (in metres) is :

(1) $10\sqrt{5}$ (2) $\frac{100}{3\sqrt{3}}$ (3) 20 (4) 25

6. A 2 m ladder leans against a vertical wall. If the top of the ladder begins to slide down the wall at the rate 25 cm/ sec., then the rate (in cm/sec.) at which the bottom of the ladder slides away from the wall on the horizontal ground when the top of the ladder is 1 m above the ground is :

(1) $25\sqrt{3}$ (2) 25 (3) $\frac{25}{\sqrt{3}}$ (4) $\frac{25}{3}$

7. The angle of elevation of the top of vertical tower standing on a horizontal plane is observed to be 45° from a point A on the plane. Let B be the point 30 m vertically above the point A. If the angle of elevation of the top of the tower from B be 30°, then the distance (in m) of the foot of the tower from the point A is:

(1) $15\left(3-\sqrt{3}\right)$ (2) $15\left(3+\sqrt{3}\right)$

(3) $15\left(1+\sqrt{3}\right)$ (4) $15\left(5-\sqrt{3}\right)$

DETERMINANT

1. The system of linear equations.

$x + y + z = 2$

$2x + 3y + 2z = 5$

$2x + 3y + (a^2 - 1)z = a + 1$

(1) has infinitely many solutions for a = 4

(2) is inconsistent when $|a| = \sqrt{3}$

(3) is inconsistent when a = 4

(4) has a unique solution for $|a| = \sqrt{3}$

2. If the system of linear equations

$x-4y+7z = g$

$3y - 5z = h$

$-2x + 5y - 9z = k$

is consistent, then :

(1) g + h + k = 0

(2) 2g + h + k = 0

(3) g + h + 2k = 0

(4) g + 2h + k = 0

3. If the system of equations

$x+y+z = 5$

$x+2y+3z = 9$

$x+3y+\alpha z = \beta$

has infinitely many solutions, then $\beta-\alpha$ equals:

(1) 5 (2) 18 (3) 21 (4) 8

4. Let $d \in R$, and

$$A = \begin{bmatrix} -2 & 4+d & (\sin\theta)-2 \\ 1 & (\sin\theta)+2 & d \\ 5 & (2\sin\theta)-d & (-\sin\theta)+2+2d \end{bmatrix},$$

$\theta \in [0,2\pi]$. If the minimum value of det(A) is 8, then a value of d is :

(1) –7 (2) $2\left(\sqrt{2}+2\right)$

(3) –5 (4) $2\left(\sqrt{2}+1\right)$

5. Let $a_1, a_2, a_3, ..., a_{10}$ be in G.P. with $a_i > 0$ for $i = 1,2,...., 10$ and S be the set of pairs (r,k), r, $k \in N$ (the set of natural numbers) for which $\begin{vmatrix} \log_e a_1^r a_2^k & \log_e a_2^r a_3^k & \log_e a_3^r a_4^k \\ \log_e a_4^r a_5^k & \log_e a_5^r a_6^k & \log_e a_6^r a_7^k \\ \log_e a_7^r a_8^k & \log_e a_8^r a_9^k & \log_e a_9^r a_{10}^k \end{vmatrix} = 0$

Then the number of elements in S, is :

(1) Infinitely many (2) 4

(3) 10 (4) 2

6. The number of values of $\theta \in (0,\pi)$ for which the system of linear equations

$x + 3y + 7z = 0$

$-x + 4y + 7z = 0$

$(\sin 3\theta)x + (\cos 2\theta)y + 2z = 0$

has a non-trivial solution, is :

(1) One (2) Three (3) Four (4) Two

7. If the system of linear equations

$2x + 2y + 3z = a$

$3x - y + 5z = b$

$x - 3y + 2z = c$

where a, b, c are non-zero real numbers, has more then one solution, then :

(1) $b - c - a = 0$ (2) $a + b + c = 0$

(3) $b + c - a = 0$ (4) $b - c + a = 0$

8. If $\begin{vmatrix} a-b-c & 2a & 2a \\ 2b & b-c-a & 2b \\ 2c & 2c & c-a-b \end{vmatrix} = (a+b+c)$

$(x + a + b + c)^2$, $x \neq 0$ and $a + b + c \neq 0$, then x is equal to :-

(1) $-(a + b + c)$ (2) $2(a + b + c)$

(3) abc (4) $-2(a + b + c)$

9. An ordered pair(α,β) for which the system of linear equations

$(1+\alpha)x + \beta y+z = 2$

$\alpha x+(1+\beta)y+z = 3$

$\alpha x+\beta y+2z = 2$ has a unique solution is

(1) (1,–3) (2) (–3,1)

(3) (2, 4) (4) (–4, 2)

10. The set of all values of λ for which the system of linear equations.

$x - 2y - 2z = \lambda x$

$x + 2y + z = \lambda y$

$-x - y = \lambda z$

has a non-trivial solution.

(1) contains more than two elements

(2) is a singleton

(3) is an empty set

(4) contains exactly two elements

11. The greatest value of $c \in R$ for which the system of linear equations

$x - cy - cz = 0$

$cx - y + cz = 0$

$cx + cy - z = 0$

has a non-trivial solution, is :

(1) $\frac{1}{2}$ (2) –1

(3) 0 (4) 2

12. If the system of linear equations

$x - 2y + kz = 1$

$2x + y + z = 2$

$3x - y - kz = 3$

has a solution (x,y,z), $z \neq 0$, then (x,y) lies on the straight line whose equation is :

(1) $3x - 4y - 1 = 0$ (2) $3x - 4y - 4 = 0$

(3) $4x - 3y - 4 = 0$ (4) $4x - 3y - 1 = 0$

13. If the system of equations 2x + 3y – z = 0, x + ky – 2z = 0 and 2x – y + z = 0 has a non-trival solution (x, y, z), then $\frac{x}{y}+\frac{y}{z}+\frac{z}{x}+k$ is equal to:-

(1) $\frac{3}{4}$ (2) –4 (3) $\frac{1}{2}$ (4) $-\frac{1}{4}$

14. If $\Delta_1 = \begin{vmatrix} x & \sin\theta & \cos\theta \\ -\sin\theta & -x & 1 \\ \cos\theta & 1 & x \end{vmatrix}$ and

$\Delta_2 = \begin{vmatrix} x & \sin 2\theta & \cos 2\theta \\ -\sin 2\theta & -x & 1 \\ \cos 2\theta & 1 & x \end{vmatrix}$, $x \neq 0$; then for all $\theta \in \left(0, \frac{\pi}{2}\right)$:

(1) $\Delta_1 - \Delta_2 = x(\cos 2\theta - \cos 4\theta)$

(2) $\Delta_1 + \Delta_2 = -2x^3$

(3) $\Delta_1 - \Delta_2 = -2x^3$

(4) $\Delta_1 + \Delta_2 = -2(x^3 + x - 1)$

15. Let λ be a real number for which the system of linear equations

x + y + z = 6

4x + λy – λz = λ – 2

3x + 2y – 4z = –5

has infinitely many solutions. Then λ is a root of the quadratic equation.

(1) $\lambda^2 - 3\lambda - 4 = 0$ (2) $\lambda^2 - \lambda - 6 = 0$

(3) $\lambda^2 + 3\lambda - 4 = 0$ (4) $\lambda^2 + \lambda - 6 = 0$

16. The sum of the real roots of the equatuion

$\begin{vmatrix} x & -6 & -1 \\ 2 & -3x & x-3 \\ -3 & 2x & x+2 \end{vmatrix} = 0$, is equal to :

(1) 6 (2) 1 (3) 0 (4) – 4

17. A value of θ ∈ (0, π/3), for which

$\begin{vmatrix} 1+\cos^2\theta & \sin^2\theta & 4\cos 6\theta \\ \cos^2\theta & 1+\sin^2\theta & 4\cos 6\theta \\ \cos^2\theta & \sin^2\theta & 1+4\cos 6\theta \end{vmatrix} = 0$, is :

(1) $\frac{7\pi}{24}$ (2) $\frac{\pi}{18}$ (3) $\frac{\pi}{9}$ (4) $\frac{7\pi}{36}$

18. If [x] denotes the greatest integer ≤ x, then the system of linear equations $[\sin\theta]x + [-\cos\theta]y = 0$

$[\cot\theta]x + y = 0$

(1) have infinitely many solutions if $\theta \in \left(\frac{\pi}{2}, \frac{2\pi}{3}\right) \cup \left(\pi, \frac{7\pi}{6}\right)$

(2) have infinitely many solutions if $\theta \in \left(\frac{\pi}{2}, \frac{2\pi}{3}\right)$ and has a unique solution if $\theta \in \left(\pi, \frac{7\pi}{6}\right)$

(3) has a unique solution if $\theta \in \left(\frac{\pi}{2}, \frac{2\pi}{3}\right)$ and have infinitely many solutions if $\theta \in \left(\pi, \frac{7\pi}{6}\right)$

(4) has a unique solution if $\theta \in \left(\frac{\pi}{2}, \frac{2\pi}{3}\right) \cup \left(\pi, \frac{7\pi}{6}\right)$

STRAIGHT LINE

1. Consider the set of all lines px + qy + r = 0 such that 3p + 2q + 4r = 0. Which one of the following statements is true ?

(1) The lines are all parallel.

(2) Each line passes through the origin.

(3) The lines are not concurrent

(4) The lines are concurrent at the point $\left(\frac{3}{4}, \frac{1}{2}\right)$

2. Let the equations of two sides of a triangle be 3x – 2y + 6 = 0 and 4x + 5y – 20 = 0. If the orthocentre of this triangle is at (1,1), then the equation of its third side is :

(1) 122y – 26x – 1675 = 0

(2) 26x + 61y + 1675 = 0

(3) 122y + 26x + 1675 = 0

(4) 26x – 122y – 1675 = 0

3. Let S be the set of all triangles in the xy-plane, each having one vertex at the origin and the other two vertices lie on coordinate axes with integral coordinates. If each triangle in S has area 50sq. units, then the number of elements in the set S is:

(1) 9 (2) 18 (3) 32 (4) 36

4. If the line $3x + 4y - 24 = 0$ intersects the x-axis at the point A and the y-axis at the point B, then the incentre of the triangle OAB, where O is the origin, is

(1) (3, 4) (2) (2, 2) (3) (4, 4) (4) (4, 3)

5. A point P moves on the line $2x - 3y + 4 = 0$. If Q(1,4) and R(3,–2) are fixed points, then the locus of the centroid of ΔPQR is a line :

(1) parallel to x-axis (2) with slope $\frac{2}{3}$

(3) with slope $\frac{3}{2}$ (4) parallel to y-axis

6. Two vertices of a triangle are (0,2) and (4,3). If its orthocentre is at the origin, then its third vertex lies in which quadrant ?

(1) Fourth (2) Second (3) Third (4) First

7. Two sides of a parallelogram are along the lines, $x + y = 3$ and $x - y + 3 = 0$. If its diagonals intersect at (2,4), then one of its vertex is :

(1) (2,6) (2) (2,1) (3) (3,5) (4) (3,6)

8. If in a parallelogram ABDC, the coordinates of A, B and C are respectively (1, 2), (3, 4) and (2, 5), then the equation of the diagonal AD is:-

(1) $5x + 3y - 11 = 0$ (2) $3x - 5y + 7 = 0$
(3) $3x + 5y - 13 = 0$ (4) $5x - 3y + 1 = 0$

9. If the straight line, $2x-3y+17 = 0$ is perpendicular to the line passing through the points (7, 17) and (15, β), then β equals :-

(1) –5 (2) $-\frac{35}{3}$ (3) $\frac{35}{3}$ (4) 5

10. If a straight line passing thourgh the point P(–3, 4) is such that its intercepted portion between the coordinate axes is bisected at P, then its equation is :

(1) $x - y + 7 = 0$ (2) $3x - 4y + 25 = 0$
(3) $4x + 3y = 0$ (4) $4x - 3y + 24 = 0$

11. If a circle of radius R passes through the origin O and intersects the coordinate axes at A and B, then the locus of the foot of perpendicular from O on AB is :

(1) $(x^2 + y^2)^2 = 4Rx^2y^2$
(2) $(x^2 + y^2)(x + y) = R^2xy$
(3) $(x^2 + y^2)^3 = 4R^2x^2y^2$
(4) $(x^2 + y^2)^2 = 4R^2x^2y^2$

12. A point on the straight line, $3x + 5y = 15$ which is equidistant from the coordinate axes will lie only in :

(1) 1st and 2nd quadrants
(2) 4th quadrant
(3) 1st, 2nd and 4th quadrant
(4) 1st quadrant

13. Suppose that the points (h,k), (1,2) and (–3,4) lie on the line L_1. If a line L_2 passing through the points (h,k) and (4,3) is perpendicular to L_1, then $\frac{k}{h}$ equals :

(1) 3 (2) $-\frac{1}{7}$ (3) $\frac{1}{3}$ (4) 0

14. Slope of a line passing through P(2, 3) and intersecting the line, $x + y = 7$ at a distance of 4 units from P, is

(1) $\frac{\sqrt{5}-1}{\sqrt{5}+1}$ (2) $\frac{1-\sqrt{5}}{1+\sqrt{5}}$

(3) $\frac{1-\sqrt{7}}{1+\sqrt{7}}$ (4) $\frac{\sqrt{7}-1}{\sqrt{7}+1}$

15. If the two lines $x + (a - 1) y = 1$ and $2x + a^2y = 1 (a \in R - \{0, 1\})$ are perpendicular, then the distance of their point of intersection from the origin is :-

(1) $\frac{2}{5}$ (2) $\frac{2}{\sqrt{5}}$ (3) $\frac{\sqrt{2}}{5}$ (4) $\sqrt{\frac{2}{5}}$

16. A rectangle is inscribed in a circle with a diameter lying along the line $3y = x + 7$. If the two adjacent vertices of the rectangle are (–8, 5) and (6, 5), then the area of the rectangle (in sq. units) is :-

(1) 72 (2) 84 (3) 98 (4) 56

17. The region represented by $|x-y| \leq 2$ and $|x+y| \leq 2$ is bounded by a :

(1) square of side length $2\sqrt{2}$ units

(2) rhombus of side length 2 units

(3) square of area 16 sq, units

(4) rhombus of area $8\sqrt{2}$ sq. units

18. Lines are drawn parallel to the line $4x-3y+2=0$, at a distance $\frac{3}{5}$ from the origin.

Then which one of the following points lies on any of these lines ?

(1) $\left(-\frac{1}{4},\frac{2}{3}\right)$ (2) $\left(\frac{1}{4},\frac{1}{3}\right)$

(3) $\left(-\frac{1}{4},-\frac{2}{3}\right)$ (4) $\left(\frac{1}{4},-\frac{1}{3}\right)$

19. The equation $y = \sin x \sin(x+2) - \sin^2(x+1)$ represents a straight line lying in :

(1) second and third quadrants only

(2) third and fourth quadrants only

(3) first, third and fourth quadrants

(4) first, second and fourth quadrants

20. A straight line L at a distance of 4 units from the origin makes positive intercepts on the coordinate axes and the perpendicular from the origin to this line makes an angle of 60° with the line $x+y=0$. Then an equation of the line L is :

(1) $\left(\sqrt{3}+1\right)x+\left(\sqrt{3}-1\right)y=8\sqrt{2}$

(2) $\left(\sqrt{3}-1\right)x+\left(\sqrt{3}+1\right)y=8\sqrt{2}$

(3) $\sqrt{3}x+y=8$

(4) $x+\sqrt{3}y=8$

21. A triangle has a vertex at (1, 2) and the mid points of the two sides through it are (–1, 1) and (2,3). Then the centroid of this triangle is :

(1) $\left(\frac{1}{3},1\right)$ (2) $\left(\frac{1}{3},2\right)$

(3) $\left(1,\frac{7}{3}\right)$ (4) $\left(\frac{1}{3},\frac{5}{3}\right)$

CIRCLE

1. Three circles of radii a, b, c(a < b < c) touch each other externally. If they have x-axis as a common tangent, then :

(1) $\frac{1}{\sqrt{a}}=\frac{1}{\sqrt{b}}+\frac{1}{\sqrt{c}}$

(2) a, b, c are in A. P.

(3) $\sqrt{a},\sqrt{b},\sqrt{c}$ are in A. P.

(4) $\frac{1}{\sqrt{b}}=\frac{1}{\sqrt{a}}+\frac{1}{\sqrt{c}}$

2. If the circles $x^2 + y^2 - 16x - 20y + 164 = r^2$ and $(x-4)^2 + (y-7)^2 = 36$ intersect at two distinct points, then:

(1) $0 < r < 1$ (2) $1 < r < 11$

(3) $r > 11$ (4) $r = 11$

3. If a circle C passing through the point (4,0) touches the circle $x^2 + y^2 + 4x - 6y = 12$ externally at the point (1, –1), then the radius of C is :

(1) $\sqrt{57}$ (2) 4 (3) $2\sqrt{5}$ (4) 5

4. If the area of an equilateral triangle inscribed in the circle, $x^2 + y^2 + 10x + 12y + c = 0$ is $27\sqrt{3}$ sq. units then c is equal to :

(1) 20 (2) 25 (3) 13 (4) –25

5. A square is inscribed in the circle $x^2 + y^2 - 6x + 8y - 103 = 0$ with its sides parallel to the corrdinate axes. Then the distance of the vertex of this square which is nearest to the origin is :-

(1) 13 (2) $\sqrt{137}$ (3) 6 (4) $\sqrt{41}$

6. The straight line $x + 2y = 1$ meets the coordinate axes at A and B. A circle is drawn through A, B and the origin. Then the sum of perpendicular distances from A and B on the tangent to the circle at the origin is :

(1) $\frac{\sqrt{5}}{4}$ (2) $\frac{\sqrt{5}}{2}$ (3) $2\sqrt{5}$ (4) $4\sqrt{5}$

7. Two circles with equal radii are intersecting at the points (0, 1) and (0, –1). The tangent at the point (0, 1) to one of the circles passes through the centre of the other circle. Then the distance between the centres of these circles is :

(1) 1 (2) $\sqrt{2}$ (3) $2\sqrt{2}$ (4) 2

8. A circle cuts a chord of length 4a on the x-axis and passes through a point on the y-axis, distant 2b from the origin. Then the locus of the centre of this circle, is :-

(1) A hyperbola (2) A parabola
(3) A straight line (4) An ellipse

9. If a variable line, $3x+4y-\lambda=0$ is such that the two circles $x^2 + y^2 - 2x - 2y + 1 = 0$ and $x^2+y^2-18x-2y+78 = 0$ are on its opposite sides, then the set of all values of λ is the interval :-

(1) [12, 21] (2) (2, 17)
(3) (23, 31) (4) [13, 23]

10. Let C_1 and C_2 be the centres of the circles $x^2+y^2-2x-2y-2 = 0$ and $x^2+y^2-6x-6y+14 = 0$ respectively. If P and Q are the points of intersection of these circles, then the area (in sq. units) of the quadrilateral PC_1QC_2 is :

(1) 8 (2) 6 (3) 9 (4) 4

11. Let O(0, 0) and A(0, 1) be two fixed points. Then the locus of a point P such that the perimeter of ΔAOP is 4, is :

(1) $8x^2 - 9y^2 + 9y = 18$
(2) $9x^2 + 8y^2 - 8y = 16$
(3) $8x^2 + 9y^2 - 9y = 18$
(4) $9x^2 - 8y^2 + 8y = 16$

12. The sum of the squares of the lengths of the chords intercepted on the circle, $x^2 + y^2 = 16$, by the lines, $x + y = n$, $n \in N$, where N is the set of all natural numbers, is :

(1) 320 (2) 160
(3) 105 (4) 210

13. The tangent and the normal lines at the point $(\sqrt{3},1)$ to the circle $x^2 + y^2 = 4$ and the x-axis form a triangle. The area of this triangle (in square units) is :

(1) $\frac{1}{3}$ (2) $\frac{4}{\sqrt{3}}$ (3) $\frac{1}{\sqrt{3}}$ (4) $\frac{2}{\sqrt{3}}$

14. If a tangent to the circle $x^2 + y^2 = 1$ intersects the coordinate axes at distinct points P and Q, then the locus of the mid-point of PQ is

(1) $x^2 + y^2 - 2xy = 0$
(2) $x^2 + y^2 - 16x^2y^2 = 0$
(3) $x^2 + y^2 - 4x^2y^2 = 0$
(4) $x^2 + y^2 - 2x^2y^2 = 0$

15. The common tangent to the circles $x^2 + y^2 = 4$ and $x^2 + y^2 + 6x + 8y - 24 = 0$ also passes through the point :-

(1) (–4, 6) (2) (6, –2)
(3) (–6, 4) (4) (4, –2)

16. If the circles $x^2 + y^2 + 5Kx + 2y + K = 0$ and $2(x^2+y^2)+2Kx+3y-1=0$, $(K \in R)$, intersect at the points P and Q, then the line $4x + 5y - K = 0$ passes through P and Q for :

(1) exactly two values of K
(2) exactly one value of K
(3) no value of K.
(4) infinitely many values of K

17. The line x = y touches a circle at the point (1, 1). If the circle also passes through the point (1, –3), then its radius is :

(1) $3\sqrt{2}$ (2) 3 (3) $2\sqrt{2}$ (4) 2

18. The locus of the centres of the circles, which touch the circle, $x^2 + y^2 = 1$ externally, also touch the y-axis and lie in the first quadrant, is :

(1) $y = \sqrt{1+4x}$, $x \geq 0$

(2) $x = \sqrt{1+4y}$, $y \geq 0$

(3) $x = \sqrt{1+2y}$, $y \geq 0$

(4) $y = \sqrt{1+2x}$, $x \geq 0$

19. If the angle of intersection at a point where the two circles with radii 5 cm and 12 cm intersect is 90°, then the length (in cm) of their common chord is :

(1) $\frac{60}{13}$ (2) $\frac{120}{13}$ (3) $\frac{13}{2}$ (4) $\frac{13}{5}$

20. A circle touching the x-axis at (3, 0) and making an intercept of length 8 on the y-axis passes through the point :

(1) (3, 10) (2) (2,3) (3) (1,5) (4) (3,5)

PERMUTATION & COMBINATION

1. Consider a class of 5 girls and 7 boys. The number of different teams consisting of 2 girls and 3 boys that can be formed from this class, if there are two specific boys A and B, who refuse to be the members of the same team, is:

(1) 200 (2) 300 (3) 500 (4) 350

2. The number of natural numbers less than 7,000 which can be formed by using the digits 0,1,3,7,9 (repitition of digits allowed) is equal to :

(1) 250 (2) 374 (3) 372 (4) 375

3. The sum of all two digit positive numbers which when divided by 7 yield 2 or 5 as remainder is :

(1) 1365 (2) 1256 (3) 1465 (4) 1356

4. Let S = {1,2,3, ..., 100}. The number of non-empty subsets A of S such that the product of elements in A is even is :-

(1) $2^{50}(2^{50}-1)$ (2) $2^{100}-1$

(3) $2^{50}-1$ (4) $2^{50}+1$

5. There are m men and two women participating in a chess tournament. Each participant plays two games with every other participant. If the number of games played by the men between themselves exceeds the number of games played between the men and the women by 84, then the value of m is :

(1) 9 (2) 11 (3) 12 (4) 7

6. If ${}^nC_4$, ${}^nC_5$ and ${}^nC_6$ are in A.P., then n can be:

(1) 14 (2) 11 (3) 9 (4) 12

7. All possible numbers are formed using the digits 1, 1, 2, 2, 2, 2, 3, 4, 4 taken all at a time. The number of such numbers in which the odd digits occupy even places is :

(1) 175 (2) 162

(3) 160 (4) 180

8. The number of four-digit numbers strictly greater than 4321 that can be formed using the digits 0,1,2,3,4,5 (repetition of digits is allowed) is :

(1) 288 (2) 306 (3) 360 (4) 310

9. A committee of 11 members is to be formed from 8 males and 5 females. If m is the number of ways the committee is formed with at least 6 males and n is the number of ways the committee is formed with at least 3 females, then :

(1) m = n = 78 (2) n = m – 8

(3) m + n = 68 (4) m = n = 68

10. Some identical balls are arranged in rows to form an equilateral triangle. The first row consists of one ball, the second row consists of two balls and so on. If 99 more identical balls are addded to the total number of balls used in forming the equilaterial triangle, then all these balls can be arranged in a square whose each side contains exactly 2 balls less than the number of balls each side of the triangle contains. Then the number of balls used to form the equilateral triangle is :-

(1) 190 (2) 262 (3) 225 (4) 157

11. The number of 6 digit numbers that can be formed using the digits 0, 1, 2, 5, 7 and 9 which are divisible by 11 and no digit is repeated, is :

(1) 36 (2) 60 (3) 48 (4) 72

12. Suppose that 20 pillars of the same height have been erected along the boundary of a circular stadium. If the top of each pillar has been connected by beams with the top of all its non-adjacent pillars, then the total number beams is :

(1) 210 (2) 190

(3) 170 (4) 180

13. A group of students comprises of 5 boys and n girls. If the number of ways, in which a team of 3 students can randomly be selected from this group such that there is at least one boy and at least one girl in each team, is 1750, then n is equal to :

(1) 25 (2) 28 (3) 27 (4) 24

14. The number of ways of choosing 10 objects out of 31 objects of which 10 are identical and the remaining 21 are distinct, is :

(1) 2^{20} (2) $2^{20} - 1$

(3) $2^{20} + 1$ (4) 2^{21}

BINOMIAL THEOREM

1. If the fractional part of the number $\frac{2^{403}}{15}$ is $\frac{k}{15}$, then k is equal to :

(1) 14 (2) 6 (3) 4 (4) 8

2. The coefficient of t^4 in the expansion of $\left(\frac{1-t^6}{1-t}\right)^3$ is

(1) 12 (2) 15 (3) 10 (4) 14

3. $\sum_{i=1}^{20}\left(\frac{{}^{20}C_{i-1}}{{}^{20}C_i + {}^{20}C_{i-1}}\right)^3 = \frac{k}{21}$, then k equals :

(1) 200 (2) 50 (3) 100 (4) 400

4. If the third term in the binomial expansion of $\left(1+x^{\log_2 x}\right)^5$ equals 2560, then a possible value of x is:

(1) $2\sqrt{2}$ (2) $\frac{1}{8}$ (3) $4\sqrt{2}$ (4) $\frac{1}{4}$

5. The positive value of λ for which the co-efficient of x^2 in the expression $x^2\left(\sqrt{x}+\frac{\lambda}{x^2}\right)^{10}$ is 720, is :

(1) $\sqrt{5}$ (2) 4 (3) $2\sqrt{2}$ (4) 3

6. If $\sum_{r=0}^{25}\left\{{}^{50}C_r \cdot {}^{50-r}C_{25-r}\right\} = K\left({}^{50}C_{25}\right)$, then K is equal to :

(1) $2^{25} - 1$ (2) $(25)^2$ (3) 2^{25} (4) 2^{24}

7. The sum of the real values of x for which the middle term in the binomial expansion of $\left(\frac{x^3}{3}+\frac{3}{x}\right)^8$ equals 5670 is :

(1) 6 (2) 8 (3) 0 (4) 4

8. The value of r for which

${}^{20}C_r\,{}^{20}C_0 + {}^{20}C_{r-1}\,{}^{20}C_1 + {}^{20}C_{r-2}\,{}^{20}C_2 + \ldots\ {}^{20}C_0\,{}^{20}C_r$

is maximum, is

(1) 20 (2) 15 (3) 11 (4) 10

9. Let $(x + 10)^{50} + (x - 10)^{50} = a_0 + a_1x + a_2x^2 + \ldots + a_{50}x^{50}$, for all $x \in R$, then $\frac{a_2}{a_0}$ is equal to:-

(1) 12.50 (2) 12.00 (3) 12.75 (4) 12.25

10. Let $S_n = 1 + q + q^2 + \ldots + q^n$ and $T_n = 1+\left(\frac{q+1}{2}\right)+\left(\frac{q+1}{2}\right)^2+\ldots\ldots+\left(\frac{q+1}{2}\right)^n$, where q is a real number and $q \neq 1$. If ${}^{101}C_1 + {}^{101}C_2.S_1 + \ldots + {}^{101}C_{101}.S_{100} = \alpha T_{100}$, then α is equal to :-

(1) 2^{100} (2) 200 (3) 2^{99} (4) 202

11. A ratio of the 5^{th} term from the beginning to the 5^{th} term from the end in the binomial expansion of $\left(2^{1/3}+\frac{1}{2(3)^{1/3}}\right)^{10}$ is :

(1) $1 : 4(16)^{\frac{1}{3}}$ (2) $1 : 2(6)^{\frac{1}{3}}$

(3) $2(36)^{\frac{1}{3}} : 1$ (4) $4(36)^{\frac{1}{3}} : 1$

12. The total number of irrational terms in the binomial expansion of $\left(7^{1/5}-3^{1/10}\right)^{60}$ is :

(1) 55 (2) 49 (3) 48 (4) 54

13. The sum of the series

$2.{}^{20}C_0 + 5.{}^{20}C_1 + 8.{}^{20}C_2 + 11.{}^{20}C_3 + \ldots + 62.{}^{20}C_{20}$ is equal to :

(1) 2^{24} (2) 2^{25}

(3) 2^{26} (4) 2^{23}

14. The sum of the co-efficients of all even degree terms in x in the expansion of $\left(x+\sqrt{x^3-1}\right)^6+\left(x-\sqrt{x^3-1}\right)^6, (x>1)$ is equal to :

(1) 32 (2) 26 (3) 29 (4) 24

15. If the fourth term in the binomial expansion of $\left(\sqrt{\frac{1}{x^{1+\log_{10}x}}}+x^{\frac{1}{12}}\right)^6$ is equal to 200, and x > 1, then the value of x is :

(1) 10^3 (2) 100 (3) 10^4 (4) 10

16. If the fourth term in the binomial expansion of $\left(\frac{2}{x}+x^{\log_8 x}\right)^6$ (x > 0) is 20×8^7, then a value of x is :

(1) 8 (2) 8^2 (3) 8^{-2} (4) 8^3

17. If some three consecutive in the binomial expansion of $(x + 1)^n$ is powers of x are in the ratio 2 : 15 : 70, then the average of these three coefficient is :-

(1) 964 (2) 625 (3) 227 (4) 232

18. If the coefficients of x^2 and x^3 are both zero, in the expansion of the expression $(1 + ax + bx^2)(1 – 3x)^{15}$ in powers of x, then the ordered pair (a, b) is equal to :

(1) (28, 315) (2) (–54, 315)
(3) (–21, 714) (4) (24, 861)

19. The smallest natural number n, such that the coefficient of x in the expansion of $\left(x^2+\frac{1}{x^3}\right)^n$ is ${}^nC_{23}$, is :

(1) 35 (2) 38 (3) 23 (4) 58

20. The coefficient of x^{18} in the product $(1+x)(1–x)^{10}(1 + x + x^2)^9$ is :

(1) –84 (2) 84 (3) 126 (4) –126

21. If ${}^{20}C_1 + (2^2)\,{}^{20}C_2 + (3^2)\,{}^{20}C_3 + ... + (20^2)\,{}^{20}C_{20} = A(2^\beta)$, then the ordered pair (A, β) is equal to:

(1) (420, 18) (2) (380, 19)
(3) (380, 18) (4) (420, 19)

22. The term independent of x in the expansion of $\left(\frac{1}{60}-\frac{x^8}{81}\right)\cdot\left(2x^2-\frac{3}{x^2}\right)^6$ is equal to :

(1) 36 (2) – 108 (3) – 72 (4) – 36

SET

1. In a class of 140 students numbered 1 to 140, all even numbered students opted mathematics course, those whose number is divisible by 3 opted Physics course and theose whose number is divisible by 5 opted Chemistry course. Then the number of students who did not opt for any of the three courses is :

(1) 102 (2) 42 (3) 1 (4) 38

2. Two newspapers A and B are published in a city. It is known that 25% of the city populations reads A and 20% reads B while 8% reads both A and B. Further, 30% of those who read A but not B look into advertisements and 40% of those who read B but not A also look into advertisements, while 50% of those who read both A and B look into advertisements. Then the percentage of the population who look into advertisement is :-

(1) 12.8 (2) 13.5 (3) 13.9 (4) 13

3. Let A, B and C be sets such that $\phi \neq A \cap B \subseteq C$. Then which of the following statements is not true?

(1) If $(A – C) \subseteq B$, then $A \subseteq B$

(2) $(C \cup A) \cap (C \cup B) = C$

(3) If $(A – B) \subseteq C$, then $A \subseteq C$

(4) $B \cap C \neq \phi$

RELATION

1. Let Z be the set of integers. If $A = \left\{x \in Z : 2^{(x+2)(x^2-5x+6)} = 1\right\}$ and $B = \{x \in Z : -3 < 2x - 1 < 9\}$, then the number of subsets of the set A × B, is:

(1) 2^{18} (2) 2^{10} (3) 2^{15} (4) 2^{12}

FUNCTION

1. For $x \in R - \{0, 1\}$, let $f_1(x) = \frac{1}{x}$, $f_2(x) = 1 - x$ and $f_3(x) = \frac{1}{1-x}$ be three given functions. If a function, J(x) satisfies $(f_2 o J o f_1)(x) = f_3(x)$ then J(x) is equal to :-

(1) $f_3(x)$

(2) $f_1(x)$

(3) $f_2(x)$

(4) $\frac{1}{x}f_3(x)$

2. Let A={xεR:x is not a positive integer}. Define a function f :A→R as $f(x) = \frac{2x}{x-1}$ then f is

(1) injective but not surjective

(2) not injective

(3) surjective but not injective

(4) neither injective nor surjective

3. Let N be the set of natural numbers and two functions f and g be defined as f,g : N→N such that : $f(n) = \begin{cases} \frac{n+1}{2} & \text{if n is odd} \\ \frac{n}{2} & \text{if n is even} \end{cases}$ and $g(n) = n-(-1)^n$. The fog is :

(1) Both one-one and onto

(2) One-one but not onto

(3) Neither one-one nor onto

(4) onto but not one-one

4. Let f : R → R be defined by $f(x) = \frac{x}{1+x^2}$, $x \in R$. Then the range of f is :

(1) $(-1, 1) - \{0\}$ (2) $\left[-\frac{1}{2}, \frac{1}{2}\right]$

(3) $R - \left[-\frac{1}{2}, \frac{1}{2}\right]$ (4) $R - [-1, 1]$

5. Let a function $f : (0, \infty) \to (0, \infty)$ be defined by $f(x) = \left|1 - \frac{1}{x}\right|$. Then f is :-

(1) Injective only

(2) Not injective but it is surjective

(3) Both injective as well as surjective

(4) Neither injective nor surjective

6. The number of functions f from {1, 2, 3, ..., 20} onto {1, 2, 3, ..., 20} such that f(k) is a multiple of 3, whenever k is a multiple of 4, is :-

(1) (15)! × 6! (2) $5^6 \times 15$

(3) 5! × 6! (4) $6^5 \times (15)!$

7. If $f(x) = \log_e\left(\frac{1-x}{1+x}\right), |x| < 1$, then $f\left(\frac{2x}{1+x^2}\right)$ is equal to :

(1) $2f(x)$ (2) $2f(x^2)$

(3) $(f(x))^2$ (4) $-2f(x)$

8. Let $f(x) = a^x$ $(a > 0)$ be written as $f(x) = f_1(x) + f_2(x)$, where $f_1(x)$ is an even function of $f_2(x)$ is an odd function. Then $f_1(x + y) + f_1(x - y)$ equals

(1) $2f_1(x)f_1(y)$

(2) $2f_1(x)f_2(y)$

(3) $2f_1(x + y)f_2(x - y)$

(4) $2f_1(x + y)f_1(x - y)$

9. Let $\sum_{k=1}^{10} f(a+k) = 16(2^{10}-1)$, where the function f satisfies $f(x + y) = f(x)f(y)$ for all natural numbers x, y and $f(1) = 2$. then the natural number 'a' is

(1) 4 (2) 3 (3) 16 (4) 2

10. If the function $f : R - \{1, -1\} \to A$ defined by $f(x) = \frac{x^2}{1-x^2}$, is surjective, then A is equal to

(1) $R - [-1, 0)$

(2) $R - (-1, 0)$

(3) $R - \{-1\}$

(4) $[0, \infty)$

11. The domain of the definition of the function $f(x)=\frac{1}{4-x^2}+\log_{10}(x^3-x)$ is :-

(1) $(1, 2) \cup (2, \infty)$

(2) $(-1, 0) \cup (1, 2) \cup (3, \infty)$

(3) $(-1, 0) \cup (1, 2) \cup (2, \infty)$

(4) $(-2, -1) \cup (-1, 0) \cup (2, \infty)$

12. Le $f(x) = x^2$, $x \in R$. For any $A \subseteq R$, define $g(A) = \{x \in R, f(x) \in A\}$. If $S = [0, 4]$, then which one of the following statements is not true ?

(1) $f(g(S)) \neq f(S)$ (2) $f(g(S)) = S$

(3) $g(f(S)) = g(S)$ (4) $g(f(S)) \neq S$

13. The number of real roots of the equation $5 + |2^x - 1| = 2^x (2^x - 2)$ is :

(1) 2 (2) 3 (3) 4 (4) 1

14. For $x \in \left(0, \frac{3}{2}\right)$, let $f(x) = \sqrt{x}$, $g(x) = \tan x$ and $h(x)=\frac{1-x^2}{1+x^2}$. If $\phi(x) = ((hof)og)(x)$, then $\phi\left(\frac{\pi}{3}\right)$ is equal to :

(1) $\tan\frac{\pi}{12}$ (2) $\tan\frac{7\pi}{12}$

(3) $\tan\frac{11\pi}{12}$ (4) $\tan\frac{5\pi}{12}$

15. For $x \in R$, let $[x]$ denote the greatest integer $\le x$, then the sum of the series

$$\left[-\frac{1}{3}\right]+\left[-\frac{1}{3}-\frac{1}{100}\right]+\left[-\frac{1}{3}-\frac{2}{100}\right]+.....+\left[-\frac{1}{3}-\frac{99}{100}\right]$$

is

(1) –153 (2) –133

(3) –131 (4) –135

INVERSE TRIGONOMETRY FUNCTION

1. If $\cos^{-1}\left(\frac{2}{3x}\right)+\cos^{-1}\left(\frac{3}{4x}\right)=\frac{\pi}{2}\left(x>\frac{3}{4}\right)$ then x is equal to :

(1) $\frac{\sqrt{145}}{12}$ (2) $\frac{\sqrt{145}}{10}$

(3) $\frac{\sqrt{146}}{12}$ (4) $\frac{\sqrt{145}}{11}$

2. If $x = \sin^{-1}(\sin 10)$ and $y=\cos^{-1}(\cos 10)$, then $y-x$ is equal to:

(1) π (2) 7π (3) 0 (4) 10

3. The value of $\cot\left(\sum_{n=1}^{19}\cot^{-1}\left(1+\sum_{p=1}^{n}2p\right)\right)$ is :

(1) $\frac{22}{23}$ (2) $\frac{23}{22}$

(3) $\frac{21}{19}$ (4) $\frac{19}{21}$

4. All x satisfying the inequality $(\cot^{-1} x)^2 - 7 (\cot^{-1} x) + 10 > 0$, lie in the interval:-

(1) $(-\infty, \cot 5) \cup (\cot 4, \cot 2)$

(2) $(\cot 5, \cot 4)$

(3) $(\cot 2, \infty)$

(4) $(-\infty, \cot 5) \cup (\cot 2, \infty)$

5. Considering only the principal values of inverse functions, the set $A=\left\{x\ge 0:\tan^{-1}(2x)+\tan^{-1}(3x)=\frac{\pi}{4}\right\}$

(1) is an empty set

(2) Contains more than two elements

(3) Contains two elements

(4) is a singleton

6. If $\alpha = \cos^{-1}\left(\frac{3}{5}\right), \beta = \tan^{-1}\left(\frac{1}{3}\right)$,

where $0 < \alpha, \beta < \frac{\pi}{2}$, then $\alpha - \beta$ is equal to :

(1) $\sin^{-1}\left(\frac{9}{5\sqrt{10}}\right)$ (2) $\tan^{-1}\left(\frac{9}{14}\right)$

(3) $\cos^{-1}\left(\frac{9}{5\sqrt{10}}\right)$ (4) $\tan^{-1}\left(\frac{9}{5\sqrt{10}}\right)$

7. If $\cos^{-1}x - \cos^{-1}\frac{y}{2} = \alpha$,

where $-1 \le x \le 1, -2 \le y \le 2, x \le \frac{y}{2}$, then for all x, y, $4x^2 - 4xy\cos\alpha + y^2$ is equal to

(1) $4\sin^2\alpha - 2x^2y^2$ (2) $4\cos^2\alpha + 2x^2y^2$
(3) $4\sin^2\alpha$ (4) $2\sin^2\alpha$

8. The value of $\sin^{-1}\left(\frac{12}{13}\right) - \sin^{-1}\left(\frac{3}{5}\right)$ is equal to:

(1) $\pi - \sin^{-1}\left(\frac{63}{65}\right)$ (2) $\pi - \cos^{-1}\left(\frac{33}{65}\right)$

(3) $\frac{\pi}{2} - \sin^{-1}\left(\frac{56}{65}\right)$ (4) $\frac{\pi}{2} - \cos^{-1}\left(\frac{9}{65}\right)$

LIMIT

1. $\lim_{y\to 0}\frac{\sqrt{1+\sqrt{1+y^4}} - \sqrt{2}}{y^4}$

(1) exists and equals $\frac{1}{4\sqrt{2}}$

(2) does not exist

(3) exists and equals $\frac{1}{2\sqrt{2}}$

(4) exists and equals $\frac{1}{2\sqrt{2}\left(\sqrt{2}+1\right)}$

2. For each $x \varepsilon R$, let [x] be the greatest integer less than or equal to x. Then $\lim_{x\to 0^-}\frac{x([x]+|x|)\sin[x]}{|x|}$ is equal to

(1) – sin1 (2) 0
(3) 1 (4) sin1

3. For each $t \in R$, let [t] be the greatest integer less than or equal to t. Then,

$$\lim_{x\to 1+}\frac{(1-|x|+\sin|1-x|)\sin\left(\frac{\pi}{2}[1-x]\right)}{|1-x|[1-x]}$$

(1) equals –1

(2) equals 1

(3) does not exist

(4) equals 0

4. Let [x] denote the greatest integer less than or equal to x. Then :-

$$\lim_{x\to 0}\frac{\tan(\pi\sin^2 x) + (|x| - \sin(x[x]))^2}{x^2}$$

(1) equals π (2) equals 0
(3) equals $\pi + 1$ (4) does not exist

5. $\lim_{x\to 0}\frac{x\cot(4x)}{\sin^2 x\cot^2(2x)}$ is equal to :-

(1) 2 (2) 0
(3) 4 (4) 1

6. $\lim_{x\to \pi/4}\frac{\cot^3 x - \tan x}{\cos\left(x + \pi/4\right)}$ is :

(1) 4 (2) $8\sqrt{2}$
(3) 8 (4) $4\sqrt{2}$

7. $\lim_{x\to 1-}\frac{\sqrt{\pi} - \sqrt{2\sin^{-1}x}}{\sqrt{1-x}}$ equal to :

(1) $\frac{1}{\sqrt{2\pi}}$ (2) $\sqrt{\frac{\pi}{2}}$

(3) $\sqrt{\frac{2}{\pi}}$ (4) $\sqrt{\pi}$

8. $\lim_{x\to 0}\frac{\sin^2 x}{\sqrt{2} - \sqrt{1+\cos x}}$ equals :

(1) $2\sqrt{2}$ (2) $4\sqrt{2}$
(3) $\sqrt{2}$ (4) 4

9. Let $f : R \to R$ be a differentiable function satisfying $f'(3) + f'(2) = 0$.

Then $\lim\limits_{x\to 0}\left(\frac{1+f(3+x)-f(3)}{1+f(2-x)-f(2)}\right)^{\frac{1}{x}}$ is equal to

(1) e^2 (2) e (3) e^{-1} (4) 1

10. If $f(x)=[x]-\left[\frac{x}{4}\right], x\in R$, where [x] denotes the greatest integer function, then :

(1) Both $\lim\limits_{x\to 4-} f(x)$ and $\lim\limits_{x\to 4+} f(x)$ exist but are not equal

(2) $\lim\limits_{x\to 4-} f(x)$ exists but $\lim\limits_{x\to 4+} f(x)$ does not exist

(3) $\lim\limits_{x\to 4+} f(x)$ exists but $\lim\limits_{x\to 4-} f(x)$ does not exist

(4) f is continuous at x = 4

11. If $\lim\limits_{x\to 1}\frac{x^4-1}{x-1}=\lim\limits_{x\to k}\frac{x^3-k^3}{x^2-k^2}$, then k is :

(1) $\frac{3}{8}$ (2) $\frac{3}{2}$ (3) $\frac{4}{3}$ (4) $\frac{8}{3}$

12. If $\lim\limits_{x\to 1}\frac{x^2-ax+b}{x-1}=5$, then a + b is equal to :-

(1) –7 (2) – 4 (3) 5 (4) 1

13. $\lim\limits_{x\to 0}\frac{x+2\sin x}{\sqrt{x^2+2\sin x+1}-\sqrt{\sin^2 x-x+1}}$ is :

(1) 3 (2) 2 (3) 6 (4) 1

14. Let f(x) = 5– |x–2| and g(x) = |x + 1|, $x \in R$. If f(x) attains maximum value at α and g(x) attains minimum value at β, then

$\lim\limits_{x\to -\alpha\beta}\frac{(x-1)(x^2-5x+6)}{x^2-6x+8}$ is equal to :

(1) 1/2 (2) –3/2 (3) 3/2 (4) –1/2

CONTINUITY

1. Let f : R → R be a function defined as :

$$f(x)=\begin{cases}5, & \text{if } x\le 1\\ a+bx, & \text{if } 1<x<3\\ b+5x, & \text{if } 3\le x<5\\ 30, & \text{if } x\ge 5\end{cases}$$

Then, f is :

(1) continuous if a = 5 and b = 5

(2) continuous if a = –5 and b = 10

(3) continuous if a = 0 and b = 5

(4) not continuous for any values of a and b

2. Let $f : [-1,3] \to R$ be defined as

$$f(x)=\begin{cases}|x|+[x], & -1\le x<1\\ x+|x|, & 1\le x<2\\ x+[x], & 2\le x\le 3\end{cases},$$

where [t] denotes the greatest integer less than or equal to t. Then, f is discontinuous at:

(1) four or more points

(2) only one point

(3) only two points

(4) only three points

3. If the function f defined on $\left(\frac{\pi}{6},\frac{\pi}{3}\right)$ by

$$f(x)=\begin{cases}\frac{\sqrt{2}\cos x-1}{\cot x-1}, & x\ne\frac{\pi}{4}\\ k, & x=\frac{\pi}{4}\end{cases}$$ is continuous,

then k is equal to

(1) $\frac{1}{2}$ (2) 1 (3) $\frac{1}{\sqrt{2}}$ (4) 2

4. If the function $f(x)=\begin{cases}a|\pi-x|+1, & x\le 5\\ b|x-\pi|+3, & x>5\end{cases}$ is continuous at x = 5, then the value of a – b is:-

(1) $\frac{2}{5-\pi}$ (2) $\frac{2}{\pi-5}$

(3) $\frac{2}{\pi+5}$ (4) $\frac{-2}{\pi+5}$

5. If $f(x) = \begin{cases} \dfrac{\sin(p+1)+\sin x}{x}, & x<0 \\ q, & x=0 \\ \dfrac{\sqrt{x+x^2}-\sqrt{x}}{x^{3/2}}, & x>0 \end{cases}$

is continuous at x = 0, then the ordered pair (p,q) is equal to :

(1) $\left(\frac{5}{2},\frac{1}{2}\right)$ (2) $\left(-\frac{3}{2},-\frac{1}{2}\right)$

(3) $\left(-\frac{1}{2},\frac{3}{2}\right)$ (4) $\left(-\frac{3}{2},\frac{1}{2}\right)$

DIFFERENTIABILITY

1. Let f be a differentiable function from R to R such that $|f(x)-f(y)| \le 2|x-y|^{\frac{3}{2}}$, for all x, y ε R. If $f(0) = 1$ then $\int_0^1 f^2(x)dx$ is equal to

(1) 0 (2) $\frac{1}{2}$ (3) 2 (4) 1

2. Let $f(x)=\begin{cases}\max\{|x|,x^2\}, & |x|\le 2\\ 8-2|x|, & 2<|x|\le 4\end{cases}$

Let S be the set of points in the interval (–4,4) at which f is not differentiable. Then S:

(1) is an empty set

(2) equals {–2, –1, 1, 2}

(3) equals {–2, –1, 0, 1, 2}

(4) equals {–2, 2}

3. Let f : (–1,1)→R be a function defined by $f(x) = \max\left\{-|x|,-\sqrt{1-x^2}\right\}$. If K be the set of all points at which f is not differentiable, then K has exactly :

(1) Three elements (2) One element

(3) Five elements (4) Two elements

4. Let K be the set of all real values of x where the function $f(x) = \sin|x| - |x| + 2(x-\pi)\cos|x|$ is not differentiable. Then the set K is equal to :-

(1) {π} (2) {0}

(3) φ (an empty set) (4) {0, π}

5. Let S be the set of all points in (–π,π) at which the function, f(x) = min {sinx, cosx} is not differentiable. Then S is a subset of which of the following?

(1) $\left\{-\frac{3\pi}{4},-\frac{\pi}{4},\frac{3\pi}{4},\frac{\pi}{4}\right\}$

(2) $\left\{-\frac{3\pi}{4},-\frac{\pi}{2},\frac{\pi}{2},\frac{3\pi}{4}\right\}$

(3) $\left\{-\frac{\pi}{2},-\frac{\pi}{4},\frac{\pi}{4},\frac{\pi}{2}\right\}$

(4) $\left\{-\frac{\pi}{4},0,\frac{\pi}{4}\right\}$

6. Let $f(x) = \begin{cases}-1, & -2\le x<0\\ x^2-1, & 0\le x\le 2\end{cases}$ and $g(x) = |f(x)| + f(|x|)$. Then, in the interval 1(–2, 2), g is :-

(1) differentiable at all points

(2) not differentiable at two points

(3) not continuous

(4) not differentiable at one point

7. Let $f(x) = 15 - |x-10|$; x ∈ R. Then the set of all values of x, at which the function, $g(x) = f(f(x))$ is not differentiable, is :

(1) {5,10,15,20} (2) {10,15}

(3) {5,10,15} (4) {10}

8. Let $f : R \to R$ be differentiable at c ∈ R and $f(c) = 0$. If $g(x) = |f(x)|$, then at x = c, g is :

(1) differentiable if $f'(c) = 0$

(2) not differentiable

(3) differentiable if $f'(c) \ne 0$

(4) not differentiable if $f'(c) = 0$

METHOD OF DIFFERENTIATION

1. If x = 3 tan t and y = 3 sec t, then the value of $\frac{d^2y}{dx^2}$ at $t=\frac{\pi}{4}$, is:

(1) $\frac{3}{2\sqrt{2}}$ (2) $\frac{1}{3\sqrt{2}}$ (3) $\frac{1}{6}$ (4) $\frac{1}{6\sqrt{2}}$

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2. Let f : R→R be a function such that $f(x) = x^3+x^2f'(1) + xf''(2)+f'''(3)$, x∈R. Then f(2) equal :

(1) 8 (2) –2 (3) –4 (4) 30

3. If $x\log_e(\log_e x) - x^2 + y^2 = 4 (y > 0)$, then dy/dx at x = e is equal to :

(1) $\frac{e}{\sqrt{4+e^2}}$ (2) $\frac{(1+2e)}{2\sqrt{4+e^2}}$

(3) $\frac{(2e-1)}{2\sqrt{4+e^2}}$ (4) $\frac{(1+2e)}{\sqrt{4+e^2}}$

4. For x >1, if $(2x)^{2y} = 4e^{2x-2y}$, then $(1+\log_e 2x)^2\frac{dy}{dx}$ is equal to :

(1) $\log_e 2x$ (2) $\frac{x\log_e 2x+\log_e 2}{x}$

(3) $x\log_e 2x$ (4) $\frac{x\log_e 2x-\log_e 2}{x}$

5. Let *f* be a differentiable function such that $f(1) = 2$ and $f'(x) = f(x)$ for all x∈R. If $h(x) = f(f(x))$, then h'(1) is equal to :

(1) 4e (2) $4e^2$ (3) 2e (4) $2e^2$

6. If $2y=\left(\cot^{-1}\left(\frac{\sqrt{3}\cos x+\sin x}{\cos x-\sqrt{3}\sin x}\right)\right)^2, x\in\left(0,\frac{\pi}{2}\right)$, then $\frac{dy}{dx}$ is equal to :

(1) $2x-\frac{\pi}{3}$ (2) $\frac{\pi}{3}-x$

(3) $\frac{\pi}{6}-x$ (4) $x-\frac{\pi}{6}$

7. If $f(1) = 1$, $f'(1) = 3$, then the derivative of $f(f(f(x))) + (f(x))^2$ at x = 1 is :

(1) 12 (2) 33 (3) 9 (4) 15

8. Let $f(x) = \log_e(\sin x)$, $(0 < x < \pi)$ and $g(x) = \sin^{-1}(e^{-x})$, $(x \geq 0)$. If α is a positive real number such that a = (fog)'(α) and b = (fog)(α), then :

(1) $a\alpha^2 - b\alpha - a = 0$

(2) $a\alpha^2 + b\alpha - a = -2\alpha^2$

(3) $a\alpha^2 + b\alpha + a = 0$

(4) $a\alpha^2 - b\alpha - a = 1$

9. If $e^y + xy = e$, the ordered pair $\left(\frac{dy}{dx},\frac{d^2y}{dx^2}\right)$ at x = 0 is equal to :

(1) $\left(-\frac{1}{e},\frac{1}{e^2}\right)$ (2) $\left(\frac{1}{e},\frac{1}{e^2}\right)$

(3) $\left(\frac{1}{e},-\frac{1}{e^2}\right)$ (4) $\left(-\frac{1}{e},-\frac{1}{e^2}\right)$

10. The derivative of $\tan^{-1}\left(\frac{\sin x-\cos x}{\sin x+\cos x}\right)$, with respect to $\frac{x}{2}$, where $\left(x\in\left(0,\frac{\pi}{2}\right)\right)$ is :

(1) $\frac{1}{2}$ (2) $\frac{2}{3}$ (3) 1 (4) 2

INDEFINITE INTEGRATION

1. For $x^2 \neq n\pi + 1$, n ∈ N (the set of natural numbers), the integral

$$\int x\sqrt{\frac{2\sin(x^2-1)-\sin 2(x^2-1)}{2\sin(x^2-1)+\sin 2(x^2-1)}}dx$$

is equal to :

(where c is a constant of integration)

(1) $\log_e\left|\sec\left(\frac{x^2-1}{2}\right)\right|+c$

(2) $\log_e\left|\frac{1}{2}\sec^2(x^2-1)\right|+c$

(3) $\frac{1}{2}\log_e\left|\sec^2\left(\frac{x^2-1}{2}\right)\right|+c$

(4) $\frac{1}{2}\log_e\left|\sec(x^2-1)\right|+c$

2. If $f(x)=\int\frac{5x^8+7x^6}{(x^2+1+2x^7)^2}dx, (x\geq 0)$ and $f(0) = 0$, then the value of $f(1)$ is :

(1) $-\frac{1}{2}$ (2) $\frac{1}{2}$ (3) $-\frac{1}{4}$ (4) $\frac{1}{4}$

3. Let $n \geq 2$ be a natural number and $0<\theta<\pi/2$.

Then $\int \frac{(\sin^n\theta - \sin\theta)^{\frac{1}{n}}\cos\theta}{\sin^{n+1}\theta}d\theta$ is equal to :

(Where C is a constant of integration)

(1) $\frac{n}{n^2-1}\left(1-\frac{1}{\sin^{n+1}\theta}\right)^{\frac{n+1}{n}}+C$

(2) $\frac{n}{n^2+1}\left(1-\frac{1}{\sin^{n-1}\theta}\right)^{\frac{n+1}{n}}+C$

(3) $\frac{n}{n^2-1}\left(1-\frac{1}{\sin^{n-1}\theta}\right)^{\frac{n+1}{n}}+C$

(4) $\frac{n}{n^2-1}\left(1+\frac{1}{\sin^{n-1}\theta}\right)^{\frac{n+1}{n}}+C$

4. If $\int x^5 e^{-4x^3}dx = \frac{1}{48}e^{-4x^3}f(x)+C$, where C is a constant of integration, then f(x) is equal to :

(1) $-4x^3 - 1$ (2) $4x^3 + 1$

(3) $-2x^3 - 1$ (4) $-2x^3 + 1$

5. If $\int \frac{\sqrt{1-x^2}}{x^4}dx = A(x)\left(\sqrt{1-x^2}\right)^m + C$, for a suitable chosen integer m and a function A(x), where C is a constant of integration then $(A(x))^m$ equals :

(1) $\frac{-1}{3x^3}$ (2) $\frac{-1}{27x^9}$ (3) $\frac{1}{9x^4}$ (4) $\frac{1}{27x^6}$

6. If $\int \frac{x+1}{\sqrt{2x-1}}dx = f(x)\sqrt{2x-1}+C$, where C is a constant of integration, then f(x) is equal to :-

(1) $\frac{1}{3}(x+4)$ (2) $\frac{1}{3}(x+1)$

(3) $\frac{2}{3}(x+2)$ (4) $\frac{2}{3}(x-4)$

7. The integral $\int \cos(\log_e x)dx$ is equal to :

(where C is a constant of integration)

(1) $\frac{x}{2}[\sin(\log_e x)-\cos(\log_e x)]+C$

(2) $\frac{x}{2}[\cos(\log_e x)+\sin(\log_e x)]+C$

(3) $x[\cos(\log_e x)+\sin(\log_e x)]+C$

(4) $x[\cos(\log_e x)-\sin(\log_e x)]+C$

8. The integral $\int \frac{3x^{13}+2x^{11}}{\left(2x^4+3x^2+1\right)^4}dx$ is equal to :

(where C is a constant of integration)

(1) $\frac{x^4}{\left(2x^4+3x^2+1\right)^3}+C$

(2) $\frac{x^{12}}{6\left(2x^4+3x^2+1\right)^3}+C$

(3) $\frac{x^4}{6\left(2x^4+3x^2+1\right)^3}+C$

(4) $\frac{x^{12}}{\left(2x^4+3x^2+1\right)^3}+C$

9. $\int \frac{\sin\frac{5x}{2}}{\sin\frac{x}{2}}dx$ is equal to :

(where c is a constant of integration)

(1) $2x + \sin x + 2\sin 2x + c$

(2) $x + 2\sin x + 2\sin 2x + c$

(3) $x + 2\sin x + \sin 2x + c$

(4) $2x + \sin x + \sin 2x + c$

10. If $\int \frac{dx}{x^3(1+x^6)^{2/3}} = xf(x)(1+x^6)^{\frac{1}{3}} + C$

where C is a constant of integration, then the function $f(x)$ is equal to-

(1) $-\frac{1}{6x^3}$ (2) $\frac{3}{x^2}$

(3) $-\frac{1}{2x^2}$ (4) $-\frac{1}{2x^3}$

11. The integral $\int \sec^{2/3} x \operatorname{cosec}^{4/3} x\, dx$ is equal to

(Hence C is a constant of integration)

(1) $3\tan^{-1/3}x + C$ (2) $-\frac{3}{4}\tan^{-4/3} x + C$

(3) $-3\cot^{-1/3}x + C$ (4) $-3\tan^{-1/3}x + C$

12. If $\int \frac{dx}{(x^2-2x+10)^2}$

$= A\left(\tan^{-1}\left(\frac{x-1}{3}\right) + \frac{f(x)}{x^2-2x+10}\right) + C$

where C is a constant of integration, then :

(1) $A = \frac{1}{27}$ and $f(x) = 9(x-1)$

(2) $A = \frac{1}{81}$ and $f(x) = 3(x-1)$

(3) $A = \frac{1}{54}$ and $f(x) = 9(x-1)^2$

(4) $A = \frac{1}{54}$ and $f(x) = 3(x-1)$

13. If $\int x^5 e^{-x^2} dx = g(x)e^{-x^2} + c$, where c is a constant of integration, then g(–1) is equal to :

(1) $-\frac{5}{2}$ (2) 1

(3) $-\frac{1}{2}$ (4) –1

14. The integral $\int \frac{2x^3-1}{x^4+x} dx$ is equal to :

(Here C is a constant of integration)

(1) $\log_e\left|\frac{x^3+1}{x}\right| + C$

(2) $\frac{1}{2}\log_e \frac{(x^3+1)^2}{|x^3|} + C$

(3) $\frac{1}{2}\log_e \frac{|x^3+1|}{x^2} + C$

(4) $\log_e \frac{|x^3+1|}{x^2} + C$

15. Let $\alpha \in (0, \pi/2)$ be fixed. If the integral $\int \frac{\tan x + \tan\alpha}{\tan x - \tan\alpha} dx =$

A(x) cos2α + B(x) sin2α + C, where C is a constant of integration, then the functions A(x) and B(x) are respectively :

(1) $x - \alpha$ and $\log_e|\cos(x-\alpha)|$

(2) $x + \alpha$ and $\log_e|\sin(x-\alpha)|$

(3) $x - \alpha$ and $\log_e|\sin(x-\alpha)|$

(4) $x + \alpha$ and $\log_e|\sin(x+\alpha)|$

16. If $\int e^{\sec x}(\sec x \tan x f(x) + (\sec x \tan x + \sec^2 x)dx =$ $e^{\sec x}f(x) + C$, then a possible choice of f(x) is :-

(1) $\sec x - \tan x - \frac{1}{2}$

(2) $x\sec x + \tan x + \frac{1}{2}$

(3) $\sec x + x\tan x - \frac{1}{2}$

(4) $\sec x + \tan x + \frac{1}{2}$

DEFINITE INTEGRATION

1. The value of $\int_{0}^{\pi}|\cos x|^3\,dx$

(1) 2/3 (2) 0 (3) –4/3 (4) 4/3

2. If $\int_{0}^{\frac{\pi}{3}}\frac{\tan\theta}{\sqrt{2k\sec\theta}}d\theta=1-\frac{1}{\sqrt{2}},(k>0)$, then the value of k is :

(1) 2 (2) $\frac{1}{2}$ (3) 4 (4) 1

3. Let $I=\int_a^b(x^4-2x^2)dx$. If I is minimum then the ordered pair (a, b) is :

(1) $\left(-\sqrt{2},0\right)$ (2) $\left(-\sqrt{2},\sqrt{2}\right)$

(3) $\left(0,\sqrt{2}\right)$ (4) $\left(\sqrt{2},-\sqrt{2}\right)$

4. The value of $\int_{-\pi/2}^{\pi/2}\frac{dx}{[x]+[\sin x]+4}$,

where [t] denotes the greatest integer less than or equal to t, is :

(1) $\frac{1}{12}(7\pi+5)$

(2) $\frac{3}{10}(4\pi-3)$

(3) $\frac{1}{12}(7\pi-5)$

(4) $\frac{3}{20}(4\pi-3)$

5. If $\int_0^x f(t)dt=x^2+\int_x^1 t^2f(t)dt$, then f'(1/2) is :

(1) $\frac{6}{25}$ (2) $\frac{24}{25}$ (3) $\frac{18}{25}$ (4) $\frac{4}{5}$

6. The value of the integral $\int_{-2}^{2}\frac{\sin^2 x}{\left[\frac{x}{\pi}\right]+\frac{1}{2}}dx$

(where [x] denotes the greatest integer less than or equal to x) is :

(1) 4 (2) 4 – sin4 (3) sin 4 (4) 0

7. The integral $\int_{\pi/6}^{\pi/4}\frac{dx}{\sin 2x(\tan^5 x+\cot^5 x)}$ equals :

(1) $\frac{1}{10}\left(\frac{\pi}{4}-\tan^{-1}\left(\frac{1}{9\sqrt{3}}\right)\right)$

(2) $\frac{1}{5}\left(\frac{\pi}{4}-\tan^{-1}\left(\frac{1}{3\sqrt{3}}\right)\right)$

(3) $\frac{\pi}{10}$

(4) $\frac{1}{20}\tan^{-1}\left(\frac{1}{9\sqrt{3}}\right)$

8. Let f and g be continuous functions on [0, a] such that f(x) = f(a–x) and g(x)+g(a–x)=4, then $\int_0^a f(x)g(x)dx$ is equal to :-

(1) $4\int_0^a f(x)dx$ (2) $2\int_0^a f(x)dx$

(3) $-3\int_0^a f(x)dx$ (4) $\int_0^a f(x)dx$

9. The integral $\int_1^e\left\{\left(\frac{x}{e}\right)^{2x}-\left(\frac{e}{x}\right)^x\right\}\log_e x\,dx$ is equal to :

(1) $\frac{1}{2}-e-\frac{1}{e^2}$ (2) $\frac{3}{2}-\frac{1}{e}-\frac{1}{2e^2}$

(3) $-\frac{1}{2}+\frac{1}{e}-\frac{1}{2e^2}$ (4) $\frac{3}{2}-e-\frac{1}{2e^2}$

10. $\lim_{n\to\infty}\left(\frac{n}{n^2+1^2}+\frac{n}{n^2+2^2}+\frac{n}{n^2+3^2}+....+\frac{1}{5n}\right)$ is equal to :

(1) $\frac{\pi}{4}$ (2) $\tan^{-1}(2)$ (3) $\tan^{-1}(3)$ (4) $\frac{\pi}{2}$

11. If $f(x)=\frac{2-x\cos x}{2+x\cos x}$ and $g(x)=\log_e x$, $(x>0)$

then the value of integral $\int_{-\frac{\pi}{4}}^{\frac{\pi}{4}}g(f(x))dx$ is :

(1) $\log_e 3$ (2) $\log_e 2$

(3) $\log_e e$ (4) $\log_e 1$

12. Let $f(x)=\int_0^x g(t)dt$, where g is a non-zero even function. If $f(x+5)=g(x)$, then $\int_0^x f(t)dt$ equals-

(1) $\int_{x+5}^{5} g(t)dt$ (2) $5\int_{x+5}^{5} g(t)dt$

(3) $\int_{5}^{x+5} g(t)dt$ (4) $2\int_{5}^{x+5} g(t)dt$

13. The value of $\int_0^{\pi/2} \frac{\sin^3 x}{\sin x+\cos x}dx$ is

(1) $\frac{\pi-2}{4}$ (2) $\frac{\pi-2}{8}$ (3) $\frac{\pi-1}{4}$ (4) $\frac{\pi-1}{2}$

14. If $f : R \to R$ is a differentiable function and f(2) = 6, then $\lim_{x\to 2}\int_6^{f(x)} \frac{2t dt}{(x-2)}$ is :-

(1) 0 (2) 2f'(2)
(3) 12f '(2) (4) 24f '(2)

15. The value of $\int_0^{2\pi}[\sin 2x(1+\cos 3x)]dx$, where [t] denotes the greatest integer function, is :

(1) -2π (2) π (3) $-\pi$ (4) 2π

16. $\lim_{n\to\infty}\left(\frac{(n+1)^{1/3}}{n^{4/3}}+\frac{(n+2)^{1/3}}{n^{4/3}}+......+\frac{(2n)^{1/3}}{n^{4/3}}\right)$ is equal to :

(1) $\frac{4}{3}(2)^{4/3}$ (2) $\frac{3}{4}(2)^{4/3}-\frac{4}{3}$

(3) $\frac{3}{4}(2)^{4/3}-\frac{3}{4}$ (4) $\frac{4}{3}(2)^{3/4}$

17. The integral $\int_{\pi/6}^{\pi/3}\sec^{2/3}x\,\mathrm{cosec}^{4/3}x\,dx$ equal to:

(1) $3^{7/6}-3^{5/6}$ (2) $3^{5/3}-3^{1/3}$
(3) $3^{4/3}-3^{1/3}$ (4) $3^{5/6}-3^{2/3}$

18. If $\int_0^{\frac{\pi}{2}}\frac{\cot x}{\cot x+\mathrm{cosec}\,x}dx = m(\pi+n)$, then m . n is equal to :

(1) –1 (2) 1 (3) $\frac{1}{2}$ (4) $-\frac{1}{2}$

19. The value of the integral $\int_0^1 x\cot^{-1}(1-x^2+x^4)dx$ is :-

(1) $\frac{\pi}{4}-\frac{1}{2}\log_e 2$ (2) $\frac{\pi}{2}-\log_e 2$

(3) $\frac{\pi}{2}-\frac{1}{2}\log_e 2$ (4) $\frac{\pi}{4}-\log_e 2$

20. Let $f : R \to R$ be a continuously differentiable function wuch that f(2) = 6 and f(2) = $\frac{1}{48}$.

If $\int_6^{f(x)} 4t^3 dt=(x-2)g(x)$, then $\lim_{x\to 2} g(x)$ is equal to :

(1) 24 (2) 36 (3) 12 (4) 18

21. A value of α such that

$$\int_{\alpha}^{\alpha+1}\frac{dx}{(x+\alpha)(x+\alpha+1)}=\log_e\left(\frac{9}{8}\right) \text{ is :}$$

(1) $\frac{1}{2}$ (2) 2 (3) $-\frac{1}{2}$ (4) – 2

TANGENT & NORMAL

1. If θ denotes the acute angle between the curves, $y = 10 - x^2$ and $y = 2 + x^2$ at a point of their intersection, then $|\tan\theta|$ is equal to :

(1) 4/9 (2) 7/17 (3) 8/17 (4) 8/15

2. The tangent to the curve $y = x^2 - 5x + 5$, parallel to the line $2y = 4x + 1$, also passes through the point.

(1) $\left(\frac{1}{4},\frac{7}{2}\right)$ (2) $\left(\frac{7}{2},\frac{1}{4}\right)$

(3) $\left(-\frac{1}{8},7\right)$ (4) $\left(\frac{1}{8},-7\right)$

3. A helicopter is flying along the curve given by $y - x^{3/2} = 7, (x \geq 0)$. A soldier positioned at the point $\left(\frac{1}{2}, 7\right)$ wants to shoot down the helicopter when it is nearest to him. Then this nearest distance is:

(1) $\frac{1}{2}$ (2) $\frac{1}{3}\sqrt{\frac{7}{3}}$ (3) $\frac{1}{6}\sqrt{\frac{7}{3}}$ (4) $\frac{\sqrt{5}}{6}$

4. Let S be the set of all values of x for which the tangent to the curve $y = f(x) = x^3 - x^2 - 2x$ at (x, y) is parallel to the line segment joining the points $(1, f(1))$ and $(-1, f(-1))$, then S is equal to :

(1) $\left\{-\frac{1}{3}, -1\right\}$ (2) $\left\{\frac{1}{3}, -1\right\}$

(3) $\left\{-\frac{1}{3}, 1\right\}$ (4) $\left\{\frac{1}{3}, 1\right\}$

5. If the tangent to the curve, $y = x^3 + ax - b$ at the point (1, –5) is perpendicular to the line, $-x + y + 4 = 0$, then which one of the following points lies on the curve ?

(1) (–2, 2) (2) (2, –2)

(3) (2, –1) (4) (–2, 1)

6. A water tank has the shape of an inverted right circular cone, whose semi-vertical angle is $\tan^{-1}\left(\frac{1}{2}\right)$. Water is poured into it at a constant rage of 5 cubic meter per minute. The the rate (in m/min.), at which the level of water is rising at the instant when the depth of water in the tank is 10m; is :-

(1) $2/\pi$ (2) $1/5\pi$ (3) $1/10\pi$ (4) $1/15\pi$

7. A spherical iron ball of radius 10 cm is coated with a layer of ice of uniform thickness that melts at a rate of 50 cm³/min. When the thickness of the ice is 5cm, then the rate at which the thickness (in cm/min) of the ice decreases, is :

(1) $\frac{1}{9\pi}$ (2) $\frac{5}{6\pi}$ (3) $\frac{1}{18\pi}$ (4) $\frac{1}{36\pi}$

8. If the tangent to the curve $y = \frac{x}{x^2 - 3}, x \in R$, $\left(x \neq \pm\sqrt{3}\right)$, at a point $(\alpha, \beta) \neq (0, 0)$ on it is parallel to the line $2x + 6y - 11 = 0$, then :

(1) $|6\alpha + 2\beta| = 19$ (2) $|2\alpha + 6\beta| = 11$

(3) $|6\alpha + 2\beta| = 9$ (4) $|2\alpha + 6\beta| = 19$

MONOTONICITY

1. Let $f(x) = \frac{x}{\sqrt{a^2 + x^2}} - \frac{d - x}{\sqrt{b^2 + (d - x)^2}}$, $x \in R$, where a, b and d are non-zero real constants. Then :-

(1) f is a decreasing function of x

(2) f is neither increasing nor decreasing function of x

(3) f' is not a continuous function of x

(4) f is an increasing function of x

2. If the function f given by $f(x) = x^3 - 3(a - 2)x^2 + 3ax + 7$, for some $a \in R$ is increasing in (0, 1] and decreasing in [1, 5), then a root of the equation, $\frac{f(x) - 14}{(x - 1)^2} = 0 (x \neq 1)$ is :

(1) 6 (2) 5 (3) 7 (4) –7

3. Let $f : [0, 2] \to R$ be a twice differentiable function such that $f''(x) > 0$, for all $x \in (0, 2)$. If $\phi(x) = f(x) + f(2 - x)$, then ϕ is :

(1) decreasing on (0, 2)

(2) decreasing on (0, 1) and increasing on (1, 2)

(3) increasing on (0, 2)

(4) increasing on (0, 1) and decreasing on (1, 2)

4. Let $f(x) = e^x - x$ and $g(x) = x^2 - x$, $\forall x \in R$. Then the set of all $x \in R$, where the function $h(x) = (f o g)(x)$ is increasing, is :

(1) $\left[-1, \frac{-1}{2}\right] \cup \left[\frac{1}{2}, \infty\right)$ (2) $\left[0, \frac{1}{2}\right] \cup [1, \infty)$

(3) $\left[\frac{-1}{2}, 0\right] \cup [1, \infty)$ (4) $[0, \infty)$

5. If m is the minimum value of k for which the function $f(x) = x\sqrt{kx - x^2}$ is increasing in the interval [0, 3] and M is the maximum value of f in [0, 3] when k = m, then the ordered pair (m, M) is equal to :

(1) $(4,\ 3\sqrt{2})$ (2) $(4,\ 3\sqrt{3})$

(3) $(3,\ 3\sqrt{3})$ (4) $(5,\ 3\sqrt{6})$

MAXIMA & MINIMA

1. The maximum volume (in cu. m) of the right circular cone having slant height 3m is :

(1) $3\sqrt{3}\ \pi$ (2) $6\ \pi$ (3) $2\sqrt{3}\ \pi$ (4) $\frac{4}{3}\ \pi$

2. The shortest distance between the point $\left(\frac{3}{2}, 0\right)$ and the curve $y = \sqrt{x}, (x > 0)$ is :

(1) $\frac{\sqrt{5}}{2}$ (2) $\frac{5}{4}$

(3) $\frac{3}{2}$ (4) $\frac{\sqrt{3}}{2}$

3. The maximum value of the function $f(x) = 3x^3 - 18x^2 + 27x - 40$ on the set $S = \{x \in R : x^2 + 30 \le 11x\}$ is :

(1) 122 (2) –222

(3) –122 (4) 222

4. The maximum area (in sq. units) of a rectangle having its base on the x-axis and its other two vertices on the parabola, $y = 12 - x^2$ such that the rectangle lies inside the parabola, is :-

(1) $20\sqrt{2}$ (2) $18\sqrt{3}$

(3) 32 (4) 36

5. The shortest distance between the line y = x and the curve $y^2 = x - 2$ is :

(1) $\frac{7}{4\sqrt{2}}$ (2) $\frac{7}{8}$

(3) $\frac{11}{4\sqrt{2}}$ (4) 2

6. If S_1 and S_2 are respectively the sets of local minimum and local maximum points of the function, $f(x) = 9x^4 + 12x^3 - 36x^2 + 25$, $x \in R$, then :

(1) $S_1 = \{-2, 1\}$; $S_2 = \{0\}$

(2) $S_1 = \{-2, 0\}$; $S_2 = \{1\}$

(3) $S_1 = \{-2\}$; $S_2 = \{0, 1\}$

(4) $S_1 = \{-1\}$; $S_2 = \{0, 2\}$

7. The height of a right circular cylinder of maximum volume inscribed in a sphere of radius 3 is

(1) $2\sqrt{3}$ (2) $\sqrt{3}$

(3) $\sqrt{6}$ (4) $\frac{2}{3}\sqrt{3}$

8. If $f(x)$ is a non-zero polynomial of degree four, having local extreme points at x = –1, 0, 1; then the set $S = \{x \in R : f(x) = f(0)\}$ Contains exactly :

(1) four irrational numbers.

(2) two irrational and one rational number.

(3) four rational numbers.

(4) two irrational and two rational numbes.

9. Let $a_1, a_2, a_3,......$ be an A. P. with $a_6 = 2$. Then the common difference of this A. P., which maximises the produce $a_1a_4a_5$, is :

(1) $\frac{6}{5}$ (2) $\frac{8}{5}$

(3) $\frac{2}{3}$ (4) $\frac{3}{2}$

DIFFERENTIAL EQUATION

1. If y = y(x) is the solution of the differential equation, $x\frac{dy}{dx} + 2y = x^2$ satisfying y(1) = 1, then $y\left(\frac{1}{2}\right)$ is equal to :

(1) $\frac{7}{64}$ (2) $\frac{13}{16}$

(3) $\frac{49}{16}$ (4) $\frac{1}{4}$

2. Let f:[0,1]→R be such that $f(xy) = f(x).f(y)$ for all x,y,ε[0,1], and $f(0)\neq 0$. If y = y(x) satisfies the differential equation, $\frac{dy}{dx} = f(x)$ with y(0) = 1, then $y\left(\frac{1}{4}\right)+y\left(\frac{3}{4}\right)$ is equal to

(1) 4 (2) 3

(3) 5 (4) 2

3. If $\frac{dy}{dx}+\frac{3}{\cos^2 x}y=\frac{1}{\cos^2 x}, x\in\left(\frac{-\pi}{3},\frac{\pi}{3}\right)$, and $y\left(\frac{\pi}{4}\right)=\frac{4}{3}$, then $y\left(-\frac{\pi}{4}\right)$ equals :

(1) $\frac{1}{3}+e^6$ (2) $\frac{1}{3}$

(3) $-\frac{4}{3}$ (4) $\frac{1}{3}+e^3$

4. Let f be a differentiable function such that $f'(x)=7-\frac{3}{4}\frac{f(x)}{x},(x>0)$ and $f(1) \neq 4$. Then $\lim_{x\to 0^+} xf\left(\frac{1}{x}\right)$:

(1) Exists and equals 4

(2) Does not exist

(3) Exist and equals 0

(4) Exists and equals $\frac{4}{7}$

5. The curve amongst the family of curves, represented by the differential equation, $(x^2 - y^2)dx + 2xy\,dy = 0$ which passes through (1,1) is :

(1) A circle with centre on the y-axis

(2) A circle with centre on the x-axis

(3) An ellipse with major axis along the y-axis

(4) A hyperbola with transverse axis along the x-axis

6. If y(x) is the solution of the differential equation $\frac{dy}{dx}+\left(\frac{2x+1}{x}\right)y = e^{-2x}$, x > 0, where $y(1) = \frac{1}{2}e^{-2}$, then :

(1) y(x) is decreasing in (0, 1)

(2) y(x) is decreasing in $\left(\frac{1}{2},1\right)$

(3) $y(\log_e 2) = \frac{\log_e 2}{4}$

(4) $y(\log_e 2) = \log_e 4$

7. The solution of the differential equation, $\frac{dy}{dx}=(x-y)^2$, when y(1) = 1, is :-

(1) $\log_e\left|\frac{2-y}{2-x}\right| = 2(y-1)$

(2) $\log_e\left|\frac{2-x}{2-y}\right| = x-y$

(3) $-\log_e\left|\frac{1+x-y}{1-x+y}\right| = x+y-2$

(4) $-\log_e\left|\frac{1-x+y}{1+x-y}\right| = 2(x-1)$

8. Lety = y(x) be the solution of the differential equation, $x\frac{dy}{dx}+y = x\log_e x,(x > 1)$. If $2y(2) = \log_e 4-1$, then y(e) is equal to :-

(1) $\frac{e^2}{4}$ (2) $\frac{e}{4}$

(3) $-\frac{e}{2}$ (4) $-\frac{e^2}{2}$

9. If a cuver passes through the point (1, –2) and has slope of the tangent at any point (x, y) on it as $\frac{x^2-2y}{x}$, then the curve also passes through the point :

(1) $(-\sqrt{2},1)$ (2) $(\sqrt{3},0)$

(3) (–1, 2) (4) (3, 0)

10. Let y = y(x) be the solution of the differential equation, $\left(x^2+1\right)^2 \frac{dy}{dx} + 2x\left(x^2+1\right)y = 1$ such that y(0) = 0. If $\sqrt{a}\,y(1) = \frac{\pi}{32}$, then the value of 'a' is :

(1) $\frac{1}{2}$ (2) $\frac{1}{16}$

(3) $\frac{1}{4}$ (4) 1

11. Given that the slope of the tangent to a curve y = y(x) at any point (x,y) is $\frac{2y}{x^2}$. If the curve passes through the centre of the circle $x^2 + y^2 - 2x - 2y = 0$, then its equation is :

(1) $x \log_e|y| = 2(x-1)$

(2) $x \log_e|y| = x - 1$

(3) $x^2 \log_e|y| = -2(x-1)$

(4) $x \log_e|y| = -2(x-1)$

12. The solution of the differential equation $x\frac{dy}{dx} + 2y = x^2$ $(x \neq 0)$ with y(1) = 1, is

(1) $y = \frac{x^3}{5} + \frac{1}{5x^2}$

(2) $y = \frac{4}{5}x^3 + \frac{1}{5x^2}$

(3) $y = \frac{3}{4}x^2 + \frac{1}{4x^2}$

(4) $y = \frac{x^2}{4} + \frac{3}{4x^2}$

13. If $\cos x \frac{dy}{dx} - y\sin x = 6x, (0 < x < \frac{\pi}{2})$ and $y\left(\frac{\pi}{3}\right) = 0$, then $y\left(\frac{\pi}{6}\right)$ is equal to :-

(1) $-\frac{\pi^2}{4\sqrt{3}}$ (2) $-\frac{\pi^2}{2}$

(3) $-\frac{\pi^2}{2\sqrt{3}}$ (4) $\frac{\pi^2}{2\sqrt{3}}$

14. If y = y (x) is the solution of the differential equation $\frac{dy}{dx} = (\tan x - y)\sec^2 x$, $x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$, such that y(0) = 0, then $y\left(-\frac{\pi}{4}\right)$ is equal to :

(1) $2 + \frac{1}{e}$ (2) $\frac{1}{2} - e$ (3) e – 2 (4) $\frac{1}{2} - e$

15. Let y = y(x) be the solution of the differential equation, $\frac{dy}{dx} + y\tan x = 2x + x^2\tan x$, $x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$, such that y(0) = 1. Then :

(1) $y'\left(\frac{\pi}{4}\right) + y'\left(\frac{-\pi}{4}\right) = -\sqrt{2}$

(2) $y'\left(\frac{\pi}{4}\right) - y'\left(\frac{-\pi}{4}\right) = \pi - \sqrt{2}$

(3) $y\left(\frac{\pi}{4}\right) - y\left(-\frac{\pi}{4}\right) = \sqrt{2}$

(4) $y\left(\frac{\pi}{4}\right) + y\left(-\frac{\pi}{4}\right) = \frac{\pi^2}{2} + 2$

16. Consider the differential equation, $y^2dx + \left(x - \frac{1}{y}\right)dy = 0$. If value of y is 1 when x = 1, the the value of x for which y = 2, is :

(1) $\frac{1}{2} + \frac{1}{\sqrt{e}}$ (2) $\frac{3}{2} - \sqrt{e}$

(3) $\frac{5}{2} + \frac{1}{\sqrt{e}}$ (4) $\frac{3}{2} - \frac{1}{\sqrt{e}}$

17. The general solution of the differential equation $(y^2 - x^3)\,dx - xydy = 0$ $(x \neq 0)$ is : (where c is a constant of integration)

(1) $y^2 + 2x^3 + cx^2 = 0$

(2) $y^2 + 2x^2 + cx^3 = 0$

(3) $y^2 - 2x^3 + cx^2 = 0$

(4) $y^2 - 2x^2 + cx^3 = 0$

AREA UNDER THE CURVE

1. The area (in sq. units) bounded by the parabola $y = x^2 - 1$, the tangent at the point (2, 3) to it and the y-axis is :

(1) $\frac{14}{3}$ (2) $\frac{56}{3}$ (3) $\frac{8}{3}$ (4) $\frac{32}{3}$

2. The area of the region $A = [(x,y) : 0 \le y \le x|x| + 1 \text{ and } -1 \le x \le 1]$ in sq. units, is :

(1) $\frac{2}{3}$ (2) $\frac{1}{3}$ (3) 2 (4) $\frac{4}{3}$

3. If the area enclosed between the curves $y=kx^2$ and $x=ky^2$, $(k>0)$, is 1 square unit. Then k is:

(1) $\frac{1}{\sqrt{3}}$ (2) $\frac{2}{\sqrt{3}}$ (3) $\frac{\sqrt{3}}{2}$ (4) $\sqrt{3}$

4. The tangent to the curve, $y = xe^{x^2}$ passing through the point (1,e) also passes through the point :

(1) $\left(\frac{4}{3}, 2e\right)$ (2) (2,3e) (3) $\left(\frac{5}{3}, 2e\right)$ (4) (3,6e)

5. The area (in sq. units) of the region bounded by the curve $x^2 = 4y$ and the straight line $x = 4y - 2$:-

(1) $\frac{5}{4}$ (2) $\frac{9}{8}$ (3) $\frac{3}{4}$ (4) $\frac{7}{8}$

6. The area (in sq. units) of the region bounded by the parabola, $y = x^2 + 2$ and the lines, $y = x + 1$, $x = 0$ and $x = 3$, is :

(1) $\frac{15}{4}$ (2) $\frac{15}{2}$ (3) $\frac{21}{2}$ (4) $\frac{17}{4}$

7. The area (in sq. units) of the region $A = \{(x, y) \in R \times R | 0 \le x \le 3, 0 \le y \le 4, y \le x^2 + 3x\}$ is :

(1) $\frac{53}{6}$ (2) $\frac{59}{6}$

(3) 8 (4) $\frac{26}{3}$

8. Let $S(\alpha) = \{(x,y) : y^2 \le x, 0 \le x \le \alpha\}$ and $A(\alpha)$ is area of the region $S(\alpha)$. If for a λ, $0 < \lambda < 4$, $A(\lambda) : A(4) = 2 : 5$, then λ equals

(1) $2\left(\frac{4}{25}\right)^{\frac{1}{3}}$ (2) $4\left(\frac{4}{25}\right)^{\frac{1}{3}}$

(3) $2\left(\frac{2}{5}\right)^{\frac{1}{3}}$ (4) $4\left(\frac{2}{5}\right)^{\frac{1}{3}}$

9. The area (in sq. units) of the region $A = \{(x, y) : x^2 \le y \le x + 2\}$ is

(1) $\frac{10}{3}$ (2) $\frac{9}{2}$

(3) $\frac{31}{6}$ (4) $\frac{13}{6}$

10. The area (in sq. units) of the region

$A = \{(x,y) : \frac{y^2}{2} \le x \le y + 4\}$ is :-

(1) $\frac{53}{3}$ (2) 18 (3) 30 (4) 16

11. The area (in sq. units) of the region bounded by the curves $y = 2^x$ and $y = |x + 1|$, in the first quadrant is :

(1) $\frac{3}{2} - \frac{1}{\log_e 2}$ (2) $\frac{1}{2}$

(3) $\log_e 2 + \frac{3}{2}$ (4) $\frac{3}{2}$

12. If the area (in sq. units) of the region $\{(x, y) : y^2 \le 4x, x + y \le 1, x \ge 0, y \ge 0\}$ is $a\sqrt{2} + b$, then a – b is equal to :

(1) $\frac{8}{3}$ (2) $\frac{10}{3}$ (3) 6 (4) $-\frac{2}{3}$

13. If the area (in sq. units) bounded by the parabola $y^2 = 4\lambda x$ and the line $y = \lambda x$, $\lambda > 0$, is $\frac{1}{9}$, then λ is equal to :

(1) 24 (2) 48

(3) $4\sqrt{3}$ (4) $2\sqrt{6}$

MATRIX

1. If $A = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$, then the matrix A^{-50} when $\theta = \frac{\pi}{12}$, is equal to :

(1) $\begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}$ (2) $\begin{bmatrix} \frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$

(3) $\begin{bmatrix} \frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & \frac{1}{2} \end{bmatrix}$ (4) $\begin{bmatrix} \frac{\sqrt{3}}{2} & -\frac{1}{2} \\ \frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}$

2. If $A = \begin{bmatrix} e^t & e^{-t}\cos t & e^{-t}\sin t \\ e^t & -e^{-t}\cos t - e^{-t}\sin t & -e^{-t}\sin t + e^{-t}\cos t \\ e^t & 2e^{-t}\sin t & -2e^{-t}\cos t \end{bmatrix}$

Then A is-

(1) Invertible only if $t = \frac{\pi}{2}$

(2) not invertible for any tεR

(3) invertible for all tεR

(4) invertible only if t=π

3. Let $A = \begin{bmatrix} 2 & b & 1 \\ b & b^2+1 & b \\ 1 & b & 2 \end{bmatrix}$ where $b > 0$. Then the minimum value of $\frac{\det(A)}{b}$ is :

(1) $\sqrt{3}$ (2) $-\sqrt{3}$ (3) $-2\sqrt{3}$ (4) $2\sqrt{3}$

4. Let $A = \begin{pmatrix} 0 & 2q & r \\ p & q & -r \\ p & -q & r \end{pmatrix}$. It $AA^T = I_3$, then |p| is :

(1) $\frac{1}{\sqrt{2}}$ (2) $\frac{1}{\sqrt{5}}$ (3) $\frac{1}{\sqrt{6}}$ (4) $\frac{1}{\sqrt{3}}$

5. Let A and B be two invertible matrices of order 3×3. If $\det(ABA^T) = 8$ and $\det(AB^{-1}) = 8$, then $\det(BA^{-1}B^T)$ is equal to :-

(1) 16 (2) $\frac{1}{16}$ (3) $\frac{1}{4}$ (4) 1

6. Let $P = \begin{bmatrix} 1 & 0 & 0 \\ 3 & 1 & 0 \\ 9 & 3 & 1 \end{bmatrix}$ and $Q = [q_{ij}]$ be two 3×3 matrices such that $Q - P^5 = I_3$. Then $\frac{q_{21}+q_{31}}{q_{32}}$ is equal to:

(1) 15 (2) 9 (3) 135 (4) 10

7. If $A = \begin{bmatrix} 1 & \sin\theta & 1 \\ -\sin\theta & 1 & \sin\theta \\ -1 & -\sin\theta & 1 \end{bmatrix}$; then for all $\theta \in \left(\frac{3\pi}{4}, \frac{5\pi}{4}\right)$, det(A) lies in the interval :

(1) $\left[\frac{5}{2}, 4\right)$ (2) $\left(\frac{3}{2}, 3\right]$

(3) $\left(0, \frac{3}{2}\right]$ (4) $\left(1, \frac{5}{2}\right]$

8. Let the number 2,b,c be in an A.P. and $A = \begin{bmatrix} 1 & 1 & 1 \\ 2 & b & c \\ 4 & b^2 & c^2 \end{bmatrix}$. If $\det(A) \in [2,16]$, then c lies in the interval :

(1) [2,3) (2) $(2 + 2^{3/4}, 4)$

(3) $[3, 2 + 2^{3/4}]$ (4) [4,6]

9. Let $A = \begin{pmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{pmatrix}, (\alpha \in R)$ such that $A^{32} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$. Then a value of α is

(1) $\frac{\pi}{16}$ (2) 0 (3) $\frac{\pi}{32}$ (4) $\frac{\pi}{64}$

10. If $\begin{bmatrix}1&1\\0&1\end{bmatrix}\cdot\begin{bmatrix}1&2\\0&1\end{bmatrix}\cdot\begin{bmatrix}1&3\\0&1\end{bmatrix}\cdots\cdots\begin{bmatrix}1&n-1\\0&1\end{bmatrix}=\begin{bmatrix}1&78\\0&1\end{bmatrix}$, then the inverse of $\begin{bmatrix}1&n\\0&1\end{bmatrix}$ is

(1) $\begin{bmatrix}1&-13\\0&1\end{bmatrix}$ (2) $\begin{bmatrix}1&0\\12&1\end{bmatrix}$

(3) $\begin{bmatrix}1&-12\\0&1\end{bmatrix}$ (4) $\begin{bmatrix}1&0\\13&1\end{bmatrix}$

11. The total number of matrices

$A=\begin{pmatrix}0&2y&1\\2x&y&-1\\2x&-y&1\end{pmatrix}$, $(x, y \in R, x \neq y)$ for which

$A^TA = 3I_3$ is :-

(1) 6 (2) 2 (3) 3 (4) 4

12. If $B=\begin{bmatrix}5&2\alpha&1\\0&2&1\\\alpha&3&-1\end{bmatrix}$ is the inverse of a 3 × 3 matrix A, then the sum of all values of α for which det (A) + 1 = 0, is :

(1) 0 (2) 2 (3) 1 (4) –1

13. If a is A symmetric matrix and B is a skew-symmetrix matrix such that $A+B=\begin{bmatrix}2&3\\5&-1\end{bmatrix}$, then AB is equal to :

(1) $\begin{bmatrix}-4&2\\1&4\end{bmatrix}$ (2) $\begin{bmatrix}-4&-2\\-1&4\end{bmatrix}$

(3) $\begin{bmatrix}4&-2\\-1&-4\end{bmatrix}$ (4) $\begin{bmatrix}4&-2\\1&-4\end{bmatrix}$

VECTORS

1. Let $\vec{a}=\hat{i}-\hat{j}, \vec{b}=\hat{i}+\hat{j}+\hat{k}$ and $\vec{c}$ be a vector such that $\vec{a}\times\vec{c}+\vec{b}=\vec{0}$ and $\vec{a}.\vec{c}=4$, then $|\vec{c}|^2$ is equal to:-

(1) $\frac{19}{2}$ (2) 8

(3) $\frac{17}{2}$ (4) 9

2. Let $\vec{a}=\hat{i}+\hat{j}+\sqrt{2}\hat{k}$, $\vec{b}=b_1\hat{i}+b_2\hat{j}+\sqrt{2}\hat{k}$ and $\vec{c}=5\hat{i}+\hat{j}+\sqrt{2}\hat{k}$ be three vectors such that the projection vector of $\vec{b}$ on $\vec{a}$ is $\vec{a}$. If $\vec{a}+\vec{b}$ is perpendicular to $\vec{c}$, then $|\vec{b}|$ is equal to:

(1) $\sqrt{22}$ (2) 4 (3) $\sqrt{32}$ (4) 6

3. Let $\vec{a}=2\hat{i}+\lambda_1\hat{j}+3\hat{k}$, $\vec{b}=4\hat{i}+(3-\lambda_2)\hat{j}+6\hat{k}$ and $\vec{c}=3\hat{i}+6\hat{j}+(\lambda_3-1)\hat{k}$ be three vectors such that $\vec{b}=2\vec{a}$ and $\vec{a}$ is perpendicular to $\vec{c}$. Then a possible value of $(\lambda_1,\lambda_2,\lambda_3)$ is :-

(1) $\left(\frac{1}{2},4,-2\right)$ (2) $\left(-\frac{1}{2},4,0\right)$

(3) (1,3,1) (4) (1,5,1)

4. Let $\vec{\alpha}=(\lambda-2)\vec{a}+\vec{b}$ and $\vec{\beta}=(4\lambda-2)\vec{a}+3\vec{b}$ be two given vectors where vectors $\vec{a}$ and $\vec{b}$ are non-collinear. The value of λ for which vectors $\vec{\alpha}$ and $\vec{\beta}$ are collinear, is :

(1) –3 (2) 4 (3) 3 (4) –4

5. Let $\vec{a}=\hat{i}+2\hat{j}+4\hat{k}$, $\vec{b}=\hat{i}+\lambda\hat{j}+4\hat{k}$ and $\vec{c}=2\hat{i}+4\hat{j}+(\lambda^2-1)\hat{k}$ be coplanar vectors. Then the non-zero vector $\vec{a}\times\vec{c}$ is :

(1) $-14\hat{i}-5\hat{j}$ (2) $-10\hat{i}-5\hat{j}$

(3) $-10\hat{i}+5\hat{j}$ (4) $-14\hat{i}+5\hat{j}$

6. Let $\sqrt{3}\hat{i}+\hat{j}$, $\hat{i}+\sqrt{3}\hat{j}$ and $\beta\hat{i}+(1-\beta)\hat{j}$ respectively be the position vectors of the points A, B and C with respect to the origin O. If the distance of C from the bisector of the acute angle between OA and OB is $\frac{3}{\sqrt{2}}$, then the sum of all possible values of β is :-

(1) 2 (2) 1

(3) 3 (4) 4

7. The sum of the distinct real values of μ, for which the vectors, $\mu\hat{i}+\hat{j}+\hat{k}$, $\hat{i}+\mu\hat{j}+\hat{k}$, $\hat{i}+\hat{j}+\mu\hat{k}$ are co-planer, is :

(1) 2 (2) 0 (3) –1 (4) 1

8. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three unit vectors, out of which vectors $\vec{b}$ and $\vec{c}$ are non-parallel. If α and β are the angles which vector $\vec{a}$ makes with vectors $\vec{b}$ and $\vec{c}$ respectively and $\vec{a}\times(\vec{b}\times\vec{c})=\frac{1}{2}\vec{b}$, then $|\alpha-\beta|$ is equal to :

(1) 60º (2) 30º (3) 90º (4) 45º

9. The magnitude of the projection of the vector $2\hat{i}+3\hat{j}+\hat{k}$ on the vector perpendicular to the plane containing the vectors $\hat{i}+\hat{j}+\hat{k}$ and $\hat{i}+2\hat{j}+3\hat{k}$, is :

(1) $\frac{\sqrt{3}}{2}$ (2) $\sqrt{\frac{3}{2}}$

(3) $\sqrt{6}$ (4) $3\sqrt{6}$

10. Let $\vec{a}=3\hat{i}+2\hat{j}+x\hat{k}$ and $\vec{b}=\hat{i}-\hat{j}+\hat{k}$, for some real x. Then $|\vec{a}\times\vec{b}|=r$ is possible if :

(1) $3\sqrt{\frac{3}{2}}<r<5\sqrt{\frac{3}{2}}$ (2) $0<r\le\sqrt{\frac{3}{2}}$

(3) $\sqrt{\frac{3}{2}}<r\le 3\sqrt{\frac{3}{2}}$ (4) $r\ge 5\sqrt{\frac{3}{2}}$

11. Let $\vec{\alpha}=3\hat{i}+\hat{j}$ and $\vec{\beta}=2\hat{i}-\hat{j}+3\hat{k}$. If $\vec{\beta}=\vec{\beta}_1-\vec{\beta}_2$, where $\vec{\beta}_1$ is parallel to $\vec{\alpha}$ and $\vec{\beta}_2$ is perpendicular to $\vec{\alpha}$, then $\vec{\beta}_1\times\vec{\beta}_2$ is equal to

(1) $-3\hat{i}+9\hat{j}+5\hat{k}$ (2) $3\hat{i}-9\hat{j}-5\hat{k}$

(3) $\frac{1}{2}(-3\hat{i}+9\hat{j}+5\hat{k})$ (4) $\frac{1}{2}(3\hat{i}-9\hat{j}+5\hat{k})$

12. If a unit vector $\vec{a}$ makes angles $\pi/3$ with $\hat{i}$, $\pi/4$ with $\hat{j}$ and $\theta\in(0,\pi)$ with $\hat{k}$, then a value of θ is :-

(1) $\frac{5\pi}{12}$ (2) $\frac{5\pi}{6}$

(3) $\frac{2\pi}{3}$ (4) $\frac{\pi}{4}$

13. The distance of the point having position vector $-\hat{i}+2\hat{j}+6\hat{k}$ from the straight line passing through the point (2, 3, –4) and parallel to the vector, $6\hat{i}+3\hat{j}-4\hat{k}$ is :

(1) 7 (2) $4\sqrt{3}$

(3) $2\sqrt{13}$ (4) 6

14. If the volume of parallelopiped formed by the vectors $\hat{i}+\lambda\hat{j}+\hat{k}$, $\hat{j}+\lambda\hat{k}$ and $\lambda\hat{i}+\hat{k}$ is minimum, then λ is equal to :

(1) $\sqrt{3}$ (2) $-\frac{1}{\sqrt{3}}$

(3) $\frac{1}{\sqrt{3}}$ (4) $-\sqrt{3}$

15. Let $\vec{a}=3\hat{i}+2\hat{j}+2\hat{k}$ and $\vec{b}=\hat{i}+2\hat{j}-2\hat{k}$ be two vectors. If a vector perpendicular to both the vectors $\vec{a}+\vec{b}$ and $\vec{a}-\vec{b}$ has the magnitude 12 then one such vector is

(1) $4(2\hat{i}+2\hat{j}-\hat{k})$

(2) $4(-2\hat{i}-2\hat{j}+\hat{k})$

(3) $4(2\hat{i}-2\hat{j}-\hat{k})$

(4) $4(2\hat{i}+2\hat{j}+\hat{k})$

16. Let $\alpha\in R$ and the three vectors $\vec{a}=\alpha\hat{i}+\hat{j}+3\hat{k}$, $\vec{b}=2\hat{i}+\hat{j}-\alpha\hat{k}$ and $\vec{c}=\alpha\hat{i}-2\hat{j}+3\hat{k}$. Then the set S = {$\alpha$: $\vec{a}$, $\vec{b}$ and $\vec{c}$ are coplanar}

(1) is singleton

(2) Contains exactly two numbers only one of which is positive

(3) Contains exactly two positive numbers

(4) is empty

3D

1. The plane through the intersection of the planes x + y + z = 1 and 2x + 3y – z + 4 = 0 and parallel to y-axis also passes through the point :

(1) (–3, 0, –1) (2) (3, 3, –1)
(3) (3, 2, 1) (4) (–3, 1, 1)

2. The equation of the line passing through (–4, 3, 1), parallel to the plane $x + 2y - z - 5 = 0$ and intersecting the line $\frac{x+1}{-3} = \frac{y-3}{2} = \frac{z-2}{-1}$ is:

(1) $\frac{x+4}{-1} = \frac{y-3}{1} = \frac{z-1}{1}$

(2) $\frac{x+4}{3} = \frac{y-3}{-1} = \frac{z-1}{1}$

(3) $\frac{x+4}{1} = \frac{y-3}{1} = \frac{z-1}{3}$

(4) $\frac{x-4}{2} = \frac{y+3}{1} = \frac{z+1}{4}$

3. The equation of the plane containing the straight line $\frac{x}{2} = \frac{y}{3} = \frac{z}{4}$ and perpendicular to the plane containing the straight lines $\frac{x}{3} = \frac{y}{4} = \frac{z}{2}$ and $\frac{x}{4} = \frac{y}{2} = \frac{z}{3}$ is:

(1) x + 2y – 2z = 0 (2) x – 2y + z = 0
(3) 5x + 2y – 4z = 0 (4) 3x + 2y – 3z = 0

4. If the lines x = ay+b, z = cy + d and x=a'z + b', y = c'z + d' are perpendicular, then:

(1) cc' + a + a' = 0 (2) aa' + c + c' = 0
(3) ab' + bc' + 1 = 0 (4) bb' + cc' + 1 = 0

5. The plane passing through the point (4, –1, 2) and parallel to the lines $\frac{x+2}{3} = \frac{y-2}{-1} = \frac{z+1}{2}$ and $\frac{x-2}{1} = \frac{y-3}{2} = \frac{z-4}{3}$ also passes through the point :

(1) (–1, –1, –1) (2) (–1, –1, 1)
(3) (1, 1, –1) (4) (1, 1, 1)

6. Let A be a point on the line $\vec{r} = (1-3\mu)\hat{i} + (\mu-1)\hat{j} + (2+5\mu)\hat{k}$ and B(3, 2, 6) be a point in the space. Then the value of μ for which the vector $\overline{AB}$ is parallel to the plane $x - 4y + 3z = 1$ is :

(1) $\frac{1}{2}$ (2) $-\frac{1}{4}$ (3) $\frac{1}{4}$ (4) $\frac{1}{8}$

7. The plane which bisects the line segment joining the points (–3,–3,4) and (3,7,6) at right angles, passes through which one of the following points ?

(1) (4, –1,7) (2) (4,1,–2)
(3) (–2,3,5) (4) (2,1,3)

8. On which of the following lines lies the point of intersection of the line, $\frac{x-4}{2} = \frac{y-5}{2} = \frac{z-3}{1}$ and the plane, x + y + z = 2 ?

(1) $\frac{x-2}{2} = \frac{y-3}{2} = \frac{z+3}{3}$

(2) $\frac{x-4}{1} = \frac{y-5}{1} = \frac{z-5}{-1}$

(3) $\frac{x-1}{1} = \frac{y-3}{2} = \frac{z+4}{-5}$

(4) $\frac{x+3}{3} = \frac{4-y}{3} = \frac{z+1}{-2}$

9. The direction ratios of normal to the plane through the points (0, –1, 0) and (0, 0, 1) and making an anlge $\frac{\pi}{4}$ with the plane y–z+5=0 are:

(1) $2\sqrt{3}$, 1, –1 (2) 2, $\sqrt{2}$, $-\sqrt{2}$
(3) 2, –1, 1 (4) $\sqrt{2}$, 1, –1

10. The plane containing the line $\frac{x-3}{2} = \frac{y+2}{-1} = \frac{z-1}{3}$ and also containing its projection on the plane 2x + 3y – z = 5, contains which one of the following points ?

(1) (2, 0, –2) (2) (–2, 2, 2)
(3) (0, –2, 2) (4) (2, 2, 0)

11. If the point $(2, \alpha, \beta)$ lies on the plane which passes through the points (3, 4, 2) and (7, 0, 6) and is perpendicular to the plane $2x - 5y = 15$, then $2\alpha - 3\beta$ is equal to :-

(1) 5 (2) 17 (3) 12 (4) 7

12. Two lines $\frac{x-3}{1}=\frac{y+1}{3}=\frac{z-6}{-1}$ and $\frac{x+5}{7}=\frac{y-2}{-6}=\frac{z-3}{4}$ intersect at the point R. The reflection of R in the xy-plane has coordinates :-

(1) (2, 4, 7) (2) (–2, 4, 7)

(3) (2, –4, –7) (4) (2, –4, 7)

13. The perpendicular distance from the origin to the plane containing the two lines, $\frac{x+2}{3}=\frac{y-2}{5}=\frac{z+5}{7}$ and $\frac{x-1}{1}=\frac{y-4}{4}=\frac{z+4}{7}$, is:

(1) $11/\sqrt{6}$ (2) $6\sqrt{11}$ (3) 11 (4) $11\sqrt{6}$

14. A tetrahedron has vertices P(1, 2, 1), Q(2, 1, 3), R(–1,1,2) and O(0, 0, 0). The angle between the faces OPQ and PQR is :

(1) $\cos^{-1}\left(\frac{9}{35}\right)$ (2) $\cos^{-1}\left(\frac{19}{35}\right)$

(3) $\cos^{-1}\left(\frac{17}{31}\right)$ (4) $\cos^{-1}\left(\frac{7}{31}\right)$

15. If an angle between the line, $\frac{x+1}{2}=\frac{y-2}{1}=\frac{z-3}{-2}$ and the plane, $x-2y-kz=3$ is $\cos^{-1}\left(\frac{2\sqrt{2}}{3}\right)$, then a value of k is:

(1) $-\frac{5}{3}$ (2) $\sqrt{\frac{3}{5}}$ (3) $\sqrt{\frac{5}{3}}$ (4) $-\frac{3}{5}$

16. Let S be the set of all real values of λ such that a plane passing through the points $(-\lambda^2, 1, 1)$, $(1, -\lambda^2, 1)$ and $(1, 1, -\lambda^2)$ also passes through the point (–1, –1, 1). Then S is equal to :

(1) $\{\sqrt{3}\}$ (2) $\{\sqrt{3}-\sqrt{3}\}$

(3) {1 , –1} (4) {3, –3}

17. The length of the perpendicular from the point (2, –1, 4) on the straight line, $\frac{x+3}{10}=\frac{y-2}{-7}=\frac{z}{1}$ is :

(1) less than 2

(2) greater than 3 but less than 4

(3) greater than 4

(4) greater than 2 but less than 3

18. The equation of a plane containing the line of intersection of the planes $2x - y - 4 = 0$ and $y + 2z - 4 = 0$ and passing through the point (1, 1, 0) is :

(1) $x + 3y + z = 4$ (2) $x - y - z = 0$

(3) $x - 3y - 2z = -2$ (4) $2x - z = 2$

19. The vector equation of the plane through the line of intersection of the planes $x + y + z = 1$ and $2x + 3y + 4z = 5$ which is perpendicular to the plane $x - y + z = 0$ is :

(1) $\vec{r}\times(\hat{i}+\hat{k})+2=0$

(2) $\vec{r}.(\hat{i}-\hat{k})-2=0$

(3) $\vec{r}.(\hat{i}-\hat{k})+2=0$

(4) $\vec{r}\times(\hat{i}-\hat{k})+2=0$

20. If a point R(4,y,z) lies on the line segment joining the points P(2,–3,4) and Q(8,0,10), then the distance of R from the origin is :

(1) $2\sqrt{14}$ (2) 6

(3) $\sqrt{53}$ (4) $2\sqrt{21}$

21. A plane passing through the points (0, –1, 0) and (0, 0, 1) and making an angle $\frac{\pi}{4}$ with the plane $y - z + 5 = 0$, also passes through the point

(1) $(-\sqrt{2},1,-4)$ (2) $(\sqrt{2},1,4)$

(3) $(\sqrt{2},-1,4)$ (4) $(-\sqrt{2},-1,-4)$

22. If the line, $\frac{x-1}{2}=\frac{y+1}{3}=\frac{z-2}{4}$ meets the plane, $x+2y+3z=15$ at a point P, then the distance of P from the origin is

(1) $\frac{9}{2}$ (2) $2\sqrt{5}$ (3) $\frac{\sqrt{5}}{2}$ (4) $\frac{7}{2}$

23. The vertices B and C of a ΔABC lie on the line, $\frac{x+2}{3}=\frac{y-1}{0}=\frac{z}{4}$ such that BC = 5 units. Then the area (in sq. units) of this triangle, given that the point A(1, –1, 2), is :-

(1) $2\sqrt{34}$ (2) $\sqrt{34}$ (3) 6 (4) $5\sqrt{17}$

24. Let P be the plane, which contains the line of intersection of the planes, $x+y+z-6=0$ and $2x+3y+z+5=0$ and it is perpendicular to the xy-plane. Then the distance of the point (0, 0, 256) from P is equal to :-

(1) $63\sqrt{5}$ (2) $205\sqrt{5}$

(3) $17/\sqrt{5}$ (4) $11/\sqrt{5}$

25. If the system of linear equations

$x+y+z=5$

$x+2y+2z=6$

$x+3y+\lambda z=\mu$, $(\lambda,\mu\in R)$, has infinitely many solutions, then the value of $\lambda+\mu$ is :

(1) 12 (2) 10 (3) 9 (4) 7

26. Let A(3, 0, –1), B (2, 10, 6) and C(1, 2, 1) be the vertices of a triangle and M be the midpoint of AC. If G divides BM in the ratio, 2 : 1, then $\cos(\angle GOA)$ (O being the origin) is equal to :

(1) $\frac{1}{\sqrt{30}}$ (2) $\frac{1}{6\sqrt{10}}$

(3) $\frac{1}{\sqrt{15}}$ (4) $\frac{1}{2\sqrt{15}}$

27. If the length of the perpendicular from the point $(\beta, 0, \beta)$ $(\beta\neq 0)$ to the line, $\frac{x}{1}=\frac{y-1}{0}=\frac{z+1}{-1}$ is $\sqrt{\frac{3}{2}}$, then β is equal to :

(1) –1 (2) 2 (3) –2 (4) 1

28. If Q(0, –1, –3) is the image of the point P in the plane $3x-y+4z=2$ and R is the point (3, –1, –2), then the area (in sq. units) of ΔPQR is :

(1) $\frac{\sqrt{65}}{2}$ (2) $\frac{\sqrt{91}}{4}$ (3) $2\sqrt{13}$ (4) $\frac{\sqrt{91}}{2}$

29. A perpendicular is drawn from a point on the line $\frac{x-1}{2}=\frac{y+1}{-1}=\frac{z}{1}$ to the plane $x+y+z=3$ such that the foot of the perpendicular Q also lies on the plane $x-y+z=3$. Then the co-ordinates of Q are :

(1) (2, 0, 1) (2) (4, 0, –1)

(3) (–1, 0, 4) (4) (1, 0, 2)

30. If the plane $2x-y+2z+3=0$ has the distances $\frac{1}{3}$ and $\frac{2}{3}$ units from the planes $4x-2y+4z+\lambda=0$ and $2x-y+2z+\mu=0$, respectively, then the maximum value of $\lambda+\mu$ is equal to :

(1) 15 (2) 5

(3) 13 (4) 9

31. If the line $\frac{x-2}{3}=\frac{y+1}{2}=\frac{z-1}{-1}$ intersects the palne $2x+3y-z+13=0$ at a point P and the plane $3x+y+4z=16$ at a point Q, then PQ is equal to :

(1) $2\sqrt{14}$ (2) $\sqrt{14}$ (3) $2\sqrt{7}$ (4) 14

32. The length of the perpendicular drawn from the point (2, 1, 4) to the plane containing the lines

$\vec{r}=(\hat{i}+\hat{j})+\lambda(\hat{i}+2\hat{j}-\hat{k})$ and

$\vec{r}=(\hat{i}+\hat{j})+\mu(-\hat{i}+\hat{j}-2\hat{k})$ is :

(1) $\sqrt{3}$ (2) $\frac{1}{\sqrt{3}}$

(3) $\frac{1}{3}$ (4) 3

33. A plane which bisects the angle between the two given planes $2x - y + 2z - 4 = 0$ and $x + 2y + 2z - 2 = 0$, passes through the point:

(1) (2,4,1) (2) (2, – 4, 1)

(3) (1, 4, – 1) (4) (1, – 4, 1)

PARABOLA

1. Equation of a common tangent to the circle, $x^2 + y^2 - 6x = 0$ and the parabola, $y^2 = 4x$, is:

(1) $2\sqrt{3}\,y = 12x + 1$ (2) $2\sqrt{3}\,y = -x - 12$

(3) $\sqrt{3}\,y = x + 3$ (4) $\sqrt{3}\,y = 3x + 1$

2. Axis of a parabola lies along x-axis. If its vertex and focus are at distances 2 and 4 respectively from the origin, on the positive x-axis then which of the following points does not lie on it ?

(1) (4, –4) (2) $(5, 2\sqrt{6})$

(3) (8, 6) (4) $6, 4\sqrt{2}$

3. Let A(4,–4) and B(9,6) be points on the parabola, $y^2 = 4x$. Let C be chosen on the arc AOB of the parabola, where O is the origin, such that the area of ΔACB is maximum. Then, the area (in sq. units) of ΔACB, is:

(1) $31\frac{3}{4}$ (2) 32 (3) $30\frac{1}{2}$ (4) $31\frac{1}{4}$

4. If the parabolas $y^2=4b(x-c)$ and $y^2=8ax$ have a common normal, then which one of the following is a valid choice for the ordered triad (a,b,c)

(1) (1, 1, 0) (2) $\left(\frac{1}{2},2,3\right)$

(3) $\left(\frac{1}{2},2,0\right)$ (4) (1, 1, 3)

5. The length of the chord of the parabola $x^2 = 4y$ having equation $x - \sqrt{2}y + 4\sqrt{2} = 0$ is :

(1) $2\sqrt{11}$ (2) $3\sqrt{2}$

(3) $6\sqrt{3}$ (4) $8\sqrt{2}$

6. If the area of the triangle whose one vertex is at the vertex of the parabola, $y^2 + 4(x - a^2) = 0$ and the other two vertices are the points of intersection of the parabola and y-axis, is 250 sq. units, then a value of 'a' is :-

(1) $5\sqrt{5}$ (2) $(10)^{2/3}$ (3) $5(2^{1/3})$ (4) 5

7. The area (in sq. units) in the first quadrant bounded by the parabola, $y = x^2 + 1$, the tangent to it at the point (2, 5) and the coordinate axes is :-

(1) $\frac{14}{3}$ (2) $\frac{187}{24}$

(3) $\frac{37}{24}$ (4) $\frac{8}{3}$

8. Let P(4, –4) and Q(9, 6) be two points on the parabola, $y^2= 4x$ and let X be any point on the arc POQ of this parabola, where O is the vertex of this parabola, such that the area of ΔPXQ is maximum. Then this maximum area (in sq. units) is :

(1) $\frac{125}{4}$ (2) $\frac{125}{2}$

(3) $\frac{625}{4}$ (4) $\frac{75}{2}$

9. The equation of a tangent to the parabola, $x^2 = 8y$, which makes an angle θ with the positive direction of x-axis, is :

(1) $x = y\cot\theta + 2\tan\theta$

(2) $x = y\cot\theta - 2\tan\theta$

(3) $y = x\tan\theta - 2\cot\theta$

(4) $y = x\tan\theta + 2\cot\theta$

10. The tangent to the parabola $y^2 = 4x$ at the point where it intersects the circle $x^2 + y^2 = 5$ in the first quadrant, passes through the point :

(1) $\left(-\frac{1}{3},\frac{4}{3}\right)$ (2) $\left(-\frac{1}{4},\frac{1}{2}\right)$

(3) $\left(\frac{3}{4},\frac{7}{4}\right)$ (4) $\left(\frac{1}{4},\frac{3}{4}\right)$

11. If one end of a focal chord of the parabola, $y^2 = 16x$ is at (1, 4), then the length of this focal chord is

(1) 25 (2) 24 (3) 20 (4) 22

12. If the tangent to the parabola $y^2 = x$ at a point (α, β), $(\beta > 0)$ is also a tangent to the ellipse, $x^2 + 2y^2 = 1$, then α is equal to :

(1) $2\sqrt{2}+1$ (2) $\sqrt{2}-1$

(3) $\sqrt{2}+1$ (4) $2\sqrt{2}-1$

13. The area (in sq. units) of the smaller of the two circles that touch the parabola, $y^2 = 4x$ at the point (1, 2) and the x-axis is :-

(1) $4\pi(2-\sqrt{2})$ (2) $8\pi(3-2\sqrt{2})$

(3) $4\pi(3+\sqrt{2})$ (4) $8\pi(2-\sqrt{2})$

14. If the line $ax + y = c$, touches both the curves $x^2 + y^2 = 1$ and $y^2 = 4\sqrt{2}x$, then $|c|$ is equal to:

(1) 1/2 (2) 2

(3) $\sqrt{2}$ (4) $\frac{1}{\sqrt{2}}$

15. The tangents to the curve $y = (x - 2)^2 - 1$ at its points of intersection with the line $x - y = 3$, intersect at the point :

(1) $\left(-\frac{5}{2},-1\right)$ (2) $\left(-\frac{5}{2},1\right)$

(3) $\left(\frac{5}{2},-1\right)$ (4) $\left(\frac{5}{2},1\right)$

16. The equation of a common tangent to the curves, $y^2 = 16x$ and $xy = -4$ is :

(1) $x + y + 4 = 0$ (2) $x - 2y + 16 = 0$

(3) $2x - y + 2 = 0$ (4) $x - y + 4 = 0$

ELLIPSE

1. If tangents are drawn to the ellipse $x^2 + 2y^2 = 2$ at all points on the ellipse other than its four vertices then the mid points of the tangents intercepted betwen the coordinate axes lie on the curve :

(1) $\frac{x^2}{2}+\frac{y^2}{4}=1$ (2) $\frac{x^2}{4}+\frac{y^2}{2}=1$

(3) $\frac{1}{2x^2}+\frac{1}{4y^2}=1$ (4) $\frac{1}{4x^2}+\frac{1}{2y^2}=1$

2. Let the length of the latus rectum of an ellipse with its major axis along x-axis and centre at the origin, be 8. If the distance between the foci of this ellipse is equal to the length of its minor axis, then which one of the following points lies on it ?

(1) $\left(4\sqrt{3}, 2\sqrt{3}\right)$

(2) $\left(4\sqrt{3}, 2\sqrt{2}\right)$

(3) $\left(4\sqrt{2}, 2\sqrt{2}\right)$

(4) $\left(4\sqrt{2}, 2\sqrt{3}\right)$

3. Let S and S' be the foci of the ellipse and B be any one of the extremities of its minor axis. If $\Delta S'BS$ is a right angled triangle with right angle at B and area $(\Delta S'BS) = 8$ sq. units, then the length of a latus rectum of the ellipse is :

(1) $2\sqrt{2}$ (2) 2

(3) 4 (4) $4\sqrt{2}$

4. If the tangents on the ellipse $4x^2 + y^2 = 8$ at the points (1, 2) and (a, b) are perpendicular to each other, then a^2 is equal to :

(1) $\frac{64}{17}$ (2) $\frac{2}{17}$

(3) $\frac{128}{17}$ (4) $\frac{4}{17}$

5. In an ellipse, with centre at the origin, if the difference of the lengths of major axis and minor axis is 10 and one of the foci is at $\left(0, 5\sqrt{3}\right)$, then the length of its latus rectum is:

(1) 10 (2) 8 (3) 5 (4) 6

6. If the line x – 2y = 12 is tangent to the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ at the point $\left(3,\frac{-9}{2}\right)$, then the length of the latus recturm of the ellipse is :

(1) 9 (2) $8\sqrt{3}$ (3) $12\sqrt{2}$ (4) 5

7. The tangent and normal to the ellipse $3x^2 + 5y^2 = 32$ at the point P(2, 2) meet the x-axis at Q and R, respectively. Then the area (in sq. units) of the triangle PQR is :

(1) $\frac{14}{3}$ (2) $\frac{16}{3}$ (3) $\frac{68}{15}$ (4) $\frac{34}{15}$

8. If the normal to the ellipse $3x^2 + 4y^2 = 12$ at a point P on it is parallel to the line, 2x + y = 4 and the tangent to the ellipse at P passes through Q(4, 4) then PQ is equal to :

(1) $\frac{\sqrt{221}}{2}$ (2) $\frac{\sqrt{157}}{2}$ (3) $\frac{\sqrt{61}}{2}$ (4) $\frac{5\sqrt{5}}{2}$

9. An ellipse, with foci at (0, 2) and (0, –2) and minor axis of length 4, passes through which of the following points ?

(1) $(1,\ 2\sqrt{2})$

(2) $(2,\ \sqrt{2})$

(3) $(2,\ 2\sqrt{2})$

(4) $(\sqrt{2},\ 2)$

HYPERBOLA

1. Let $0 < \theta < \frac{\pi}{2}$. If the eccentricity of the hyperbola $\frac{x^2}{\cos^2\theta}-\frac{y^2}{\sin^2\theta}=1$ is greater than 2, then the length of its latus rectum lies in the interval :

(1) (2, 3] (2) (3, ∞)

(3) (3/2, 2] (4) (1, 3/2]

2. A hyperbola has its centre at the origin, passes through the point (4,2) and has transverse axis of length 4 along the x-axis. Then the eccentricity of the hyperbola is :

(1) $\frac{2}{\sqrt{3}}$ (2) $\frac{3}{2}$

(3) $\sqrt{3}$ (4) 2

3. The equation of a tangent to the hyperbola $4x^2–5y^2 = 20$ parallel to the line x–y = 2 is :

(1) x–y+9 = 0

(2) x–y+7 = 0

(3) x–y+1 = 0

(4) x–y–3 = 0

4. Let $S=\left\{(x,y)\in R^2:\frac{y^2}{1+r}-\frac{x^2}{1-r}=1\right\}$, where $r \neq \pm 1$. Then S represents :

(1) A hyperbola whose eccentricity is $\frac{2}{\sqrt{r+1}}$, where $0 < r < 1$.

(2) An ellipse whose eccentricity is $\frac{1}{\sqrt{r+1}}$, where r > 1

(3) A hyperbola whose eccentricity is $\frac{2}{\sqrt{1-r}}$, when $0 < r < 1$.

(4) An ellipse whose eccentricity is $\sqrt{\frac{2}{r+1}}$, when r > 1

5. Equation of a common tangent to the parabola $y^2 = 4x$ and the hyperbole xy = 2 is :

(1) x + 2y + 4 = 0

(2) x – 2y + 4 = 0

(3) x + y + 1 = 0

(4) 4x + 2y + 1 = 0

6. If a hyperbola has length of its conjugate axis equal to 5 and the distance between its foci is 13, then the eccentricity of the hyperbola is :-

(1) 2 (2) $\frac{13}{6}$ (3) $\frac{13}{8}$ (4) $\frac{13}{12}$

7. If the vertices of a hyperbola be at (–2, 0) and (2, 0) and one of its foci be at (–3, 0), then which one of the following points does not lie on this hyperbola?

(1) $\left(4,\sqrt{15}\right)$ (2) $\left(-6,2\sqrt{10}\right)$

(3) $\left(6,5\sqrt{2}\right)$ (4) $\left(2\sqrt{6},5\right)$

8. If the eccentricity of the standard hyperbola passing through the point (4,6) is 2, then the equation of the tangent to the hyperbola at (4,6) is-

(1) $2x - y - 2 = 0$

(2) $3x - 2y = 0$

(3) $2x - 3y + 10 = 0$

(4) $x - 2y + 8 = 0$

9. If the line $y = mx + 7\sqrt{3}$ is normal to the hyperbola $\frac{x^2}{24} - \frac{y^2}{18} = 1$, then a value of m is

(1) $\frac{\sqrt{5}}{2}$ (2) $\frac{3}{\sqrt{5}}$

(3) $\frac{2}{\sqrt{5}}$ (4) $\frac{\sqrt{15}}{2}$

10. If a directrix of a hyperbola centred at the origin and passing through the point $\left(4,-2\sqrt{3}\right)$ is $5x = 4\sqrt{5}$ and its eccentricity is e, then :

(1) $4e^4 - 24e^2 + 35 = 0$

(2) $4e^4 + 8e^2 - 35 = 0$

(3) $4e^4 - 12e^2 - 27 = 0$

(4) $4e^4 - 24e^2 + 27 = 0$

11. If $5x + 9 = 0$ is the directrix of the hyperbola $16x^2 - 9y^2 = 144$, then its corresponding focus is :

(1) $\left(-\frac{5}{3},0\right)$ (2) (5, 0)

(3) (–5, 0) (4) $\left(\frac{5}{3},0\right)$

12. Let P be the point of intersection of the common tangents to the parabola $y^2 = 12x$ and the hyperbola $8x^2 - y^2 = 8$. If S and S' denote the foci of the hyperbola where S lies on the positive x-axis then P divides SS' in a ratio:

(1) 5:4 (2) 14:13 (3) 2:1 (4) 13:11

COMPLEX NUMBER

1. Let A $=\left\{\theta \in \left(-\frac{\pi}{2},\pi\right) : \frac{3+2i\sin\theta}{1-2i\sin\theta} \text{ is purely imaginary}\right\}$.

Then the sum of the elements in A is :

(1) $\frac{5\pi}{6}$ (2) $\frac{2\pi}{3}$

(3) $\frac{3\pi}{4}$ (4) π

2. Let z_0 be a root of the quadratic equation, $x^2 + x + 1 = 0$. If $z = 3 + 6iz_0^{81} - 3iz_0^{93}$, then arg z is equal to:

(1) $\frac{\pi}{4}$ (2) $\frac{\pi}{3}$

(3) 0 (4) $\frac{\pi}{6}$

3. Let z_1 and z_2 be any two non-zero complex numbers such that $3|z_1| = 4|z_2|$. If $z = \frac{3z_1}{2z_2} + \frac{2z_2}{3z_1}$ then:

(1) $|z| = \frac{1}{2}\sqrt{\frac{17}{2}}$ (2) Re(z) = 0

(3) $|z| = \sqrt{\frac{5}{2}}$ (4) Im(z) = 0

4. Let $z = \left(\frac{\sqrt{3}}{2} + \frac{i}{2}\right)^5 + \left(\frac{\sqrt{3}}{2} - \frac{i}{2}\right)^5$. If R(z) and I[z] respectively denote the real and imaginary parts of z, then :

(1) R(z) > 0 and I(z) > 0

(2) R(z) < 0 and I(z) > 0

(3) R(z) = –3

(4) I(z) = 0

5. Let $\left(-2 - \frac{1}{3}i\right)^3 = \frac{x + iy}{27} (i = \sqrt{-1})$, where x and y are real numbers, then y – x equals :

(1) –85 (2) 85

(3) –91 (4) 91

6. Let z be a complex number such that $|z| + z = 3 + i$ (where $i = \sqrt{-1}$). Then |z| is equal to :-

(1) $\frac{5}{4}$ (2) $\frac{\sqrt{41}}{4}$ (3) $\frac{\sqrt{34}}{3}$ (4) $\frac{5}{3}$

7. If $\frac{z-\alpha}{z+\alpha} (\alpha \in R)$ is a purely imaginary number and |z| = 2, then a value of α is :

(1) 1 (2) 2

(3) $\sqrt{2}$ (4) $\frac{1}{2}$

8. Let Z_1 and Z_2 be two complex numbers satisfying $|Z_1| = 9$ and $|Z_2 - 3 - 4i| = 4$. Then the minimum value of $|Z_1 - Z_2|$ is :

(1) 0 (2) 1

(3) $\sqrt{2}$ (4) 2

9. If $z = \frac{\sqrt{3}}{2} + \frac{i}{2} \left(i = \sqrt{-1}\right)$, then $\left(1 + iz + z^5 + iz^8\right)^9$ is equal to

(1) –1 (2) 1

(3) 0 (4) $(-1 + 2i)^9$

10. All the points in the set $S = \left\{\frac{\alpha + i}{\alpha - i} : \alpha \in R\right\} \left(i = \sqrt{-1}\right)$ lie on a

(1) circle whose radius is 1.

(2) straight line whose slope is 1.

(3) straight line whose slope is –1

(4) circle whose radius is $\sqrt{2}$.

11. Let α and β be the roots of the equation $x^2 + x + 1 = 0$. Then for $y \neq 0$ in R,

$$\begin{vmatrix} y+1 & \alpha & \beta \\ \alpha & y+\beta & 1 \\ \beta & 1 & y+\alpha \end{vmatrix}$$ is equal to

(1) y^3 (2) $y^3 - 1$

(3) $y(y^2 - 1)$ (4) $y(y^2 - 3)$

12. Let $z \in C$ be such that $|z| < 1$. If $\omega = \frac{5+3z}{5(1-z)}$,

then:-

(1) $5Im(\omega) < 1$ (2) $4Im(\omega) > 5$

(3) $5Re(\omega) > 1$ (4) $5Re(\omega) > 4$

13. If $a > 0$ and $z = \frac{(1+i)^2}{a-i}$, has magnitude $\sqrt{\frac{2}{5}}$,

then $\bar{z}$ is equal to :

(1) $-\frac{3}{5}-\frac{1}{5}i$ (2) $-\frac{1}{5}+\frac{3}{5}i$

(3) $-\frac{1}{5}-\frac{3}{5}i$ (4) $\frac{1}{5}-\frac{3}{5}i$

14. If z and w are two complex numbers such that

$|zw| = 1$ and $\arg(z) - \arg(w) = \frac{\pi}{2}$, then :

(1) $\bar{z}w = i$ (2) $\bar{z}w = -i$

(3) $z\bar{w} = \frac{1-i}{\sqrt{2}}$ (4) $z\bar{w} = \frac{-1+i}{\sqrt{2}}$

15. The equation $|z-i| = |z-1|$, $i = \sqrt{-1}$, represents:

(1) the line through the origin with slope –1.

(2) a circle of radius 1.

(3) a circle of radius $\frac{1}{2}$.

(4) the line through the origin with slope 1.

16. Let $z \in C$ with $Im(z) = 10$ and it satisfies $\frac{2z-n}{2z+n} = 2i-1$ for some natural number n. Then :

(1) n = 20 and Re(z) = – 10

(2) n = 20 and Re(z) = 10

(3) n = 40 and Re(z) = – 10

(4) n = 40 and Re(z) = 10

PROBABILITY

1. Two cards are drawn successively with replacement from a well-shuffled deck of 52 cards. Let X denote the random variable of number of aces obtained in the two drawn cards. Then P(X = 1) + P(X = 2) equals :

(1) 52/169 (2) 25/169

(3) 49/169 (4) 24/169

2. An urn contains 5 red and 2 green balls. A ball is drawn at random from the urn. If the drawn ball is green, then a red ball is added to the urn and if the drawn ball is red, then a green ball is added to the urn; the original ball is not returned to the urn. Now, a second ball is drawn at random from it. The probability that the second ball is red, is :

(1) $\frac{26}{49}$ (2) $\frac{32}{49}$ (3) $\frac{27}{49}$ (4) $\frac{21}{49}$

3. An unbiased coin is tossed. If the outcome is a head then a pair of unbiased dice is rolled and the sum of the numbers obtained on them is noted. If the toss of the coin results in tail then a card from a well-shuffled pack of nine cards numbered 1,2,3,...,9 is randomly picked and the number on the card is noted. The probability that the noted number is either 7 or 8 is :

(1) $\frac{13}{36}$ (2) $\frac{19}{36}$ (3) $\frac{19}{72}$ (4) $\frac{15}{72}$

4. If the probability of hitting a target by a shooter, in any shot, is 1/3, then the minimum number of independent shots at the target required by him so that the probability of hitting the target at least once is greater than $\frac{5}{6}$, is :

(1) 6 (2) 5 (3) 4 (4) 3

5. Two integers are selected at random from the set {1, 2,...., 11}. Given that the sum of selected numbers is even, the conditional probability that both the numbers are even is :

(1) $\frac{2}{5}$ (2) $\frac{1}{2}$ (3) $\frac{3}{5}$ (4) $\frac{7}{10}$

6. Let S = {1, 2, ... , 20}. A subset B of S is said to be "nice", if the sum of the elements of B is 203. Then the probability that a randomly chosen subset of S is "nice" is :-

(1) $\frac{6}{2^{20}}$ (2) $\frac{5}{2^{20}}$

(3) $\frac{4}{2^{20}}$ (4) $\frac{7}{2^{20}}$

7. A bag contains 30 white balls and 10 red balls. 16 balls are drawn one by one randomly from the bag with replacement. If X be the number of white balls drawn, the $\left(\frac{\text{mean of X}}{\text{standard deviation of X}}\right)$ is equal to :-

(1) 4 (2) $\frac{4\sqrt{3}}{3}$ (3) $4\sqrt{3}$ (4) $3\sqrt{2}$

8. In a random experiment, a fair die is rolled until two fours are obtained in succession. The probability that the experiment will end in the fifth throw of the die is equal to :

(1) $\frac{150}{6^5}$ (2) $\frac{175}{6^5}$ (3) $\frac{200}{6^5}$ (4) $\frac{225}{6^5}$

9. Consider three boxes, each containing 10 balls labelled 1,2,....,10. Suppose one ball is randomly drawn from each of the boxes. Denote by n_i, the label of the ball drawn from the i^{th} box, (i = 1, 2, 3). Then, the number of ways in which the balls can be chosen such that $n_1 < n_2 < n_3$ is :

(1) 82 (2) 240 (3) 164 (4) 120

10. In a game, a man wins Rs. 100 if he gets 5 of 6 on a throw of a fair die and loses Rs. 50 for getting any other number on the die. If he decides to throw the die either till he gets a five or a six or to a maximum of three throws, then his expected gain/loss (in rupees) is :

(1) $\frac{400}{3}$ gain (2) $\frac{400}{3}$ loss

(3) 0 (4) $\frac{400}{9}$ loss

11. In a class of 60 students, 40 opted for NCC, 30 opted for NSS and 20 opted for both NCC and NSS. If one of these students is selected at random, then the probability that the student selected has opted neither for NCC nor for NSS is :

(1) $\frac{2}{3}$ (2) $\frac{1}{6}$

(3) $\frac{1}{3}$ (4) $\frac{5}{6}$

12. Let A and B be two non-null events such that $A \subset B$. Then, which of the following statements is always correct ?

(1) $P(A|B) = 1$

(2) $P(A|B) = P(B) - P(A)$

(3) $P(A|B) \leq P(A)$

(4) $P(A|B) \geq P(A)$

13. The minimum number of times one has to toss a fair coin so that the probability of observing at least one head is at least 90% is :

(1) 5 (2) 3 (3) 2 (4) 4

14. Four persons can hit a target correctly with probabilities $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}$ and $\frac{1}{8}$ respectively. if all hit at the target independently, then the probability that the target would be hit, is

(1) $\frac{25}{192}$ (2) $\frac{1}{192}$

(3) $\frac{25}{32}$ (4) $\frac{7}{32}$

15. Assume that each born child is equally likely to be a boy or a girl. If two families have two children each, then the conditional probability that all children are girls given that at least two are girls is :

(1) $\frac{1}{11}$ (2) $\frac{1}{17}$

(3) $\frac{1}{10}$ (4) $\frac{1}{12}$

16. Minimum number of times a fair coin must be tossed so that the probability of getting at least one head is more than 99% is :

(1) 5 (2) 6

(3) 7 (4) 8

17. If three of the six vertices of a regular hexagon are chosen at random, then the probability that the triangle formed with these chosen vertices is equilateral is :

(1) $\frac{3}{10}$ (2) $\frac{1}{10}$

(3) $\frac{3}{20}$ (4) $\frac{1}{5}$

18. Let a random variable X have a binomial distribution with mean 8 and variance 4. If $P(x \leq 2) = \frac{k}{2^{16}}$, then k is equal to :

(1) 17 (2) 1

(3) 121 (4) 137

19. For and initial screening of an admission test, a candidate is given fifty problems to solve. If the probability that the candidate can solve any problem is $\frac{4}{5}$, then the probability that he is unable to solve less than two problems is :

(1) $\frac{316}{25}\left(\frac{4}{5}\right)^{48}$ (2) $\frac{54}{5}\left(\frac{4}{5}\right)^{49}$

(3) $\frac{164}{25}\left(\frac{1}{5}\right)^{48}$ (4) $\frac{201}{5}\left(\frac{1}{5}\right)^{49}$

20. A person throws two fair dice. He wins Rs. 15 for throwing a doublet (same numbers on the two dice), wins Rs.12 when the throw results in the sum of 9, and loses Rs. 6 for any other outcome on the throw. Then the expected gain/loss (in Rs.) of the person is :

(1) 2 gain (2) $\frac{1}{2}$ loss (3) $\frac{1}{4}$ loss (4) $\frac{1}{2}$ gain

STATISTICS

1. 5 students of a class have an average height 150 cm and variance 18 cm^2. A new student, whose height is 156 cm, joined them. The variance (in cm^2) of the height of these six students is:

(1) 22 (2) 20

(3) 16 (4) 18

2. A data consists of n observations:

x_1, x_2, ..., x_n. If $\sum_{i=1}^{n}(x_i+1)^2 = 9n$ and $\sum_{i=1}^{n}(x_i-1)^2 = 5n$, then the standard deviation of this data is :

(1) 5 (2) $\sqrt{5}$ (3) $\sqrt{7}$ (4) 2

3. The mean of five observations is 5 and their variance is 9.20. If three of the given five observations are 1, 3 and 8, then a ratio of other two observations is :

(1) 4 : 9 (2) 6 : 7

(3) 5 : 8 (4) 10 : 3

4. If mean and standard deviation of 5 observations x_1, x_2, x_3,x_4,x_5 are 10 and 3, respectively, then the variance of 6 observations x_1,x_2,...,x_5 and –50 is equal to:

(1) 582.5 (2) 507.5 (3) 586.5 (4) 509.5

5. The outcome of each of 30 items was observed; 10 items gave an outcome $\frac{1}{2}-d$ each, 10 items gave outcome $\frac{1}{2}$ each and the remaining 10 items gave outcome $\frac{1}{2}+d$ each. If the variance of this outcome data is $\frac{4}{3}$ then |d| equals :-

(1) 2 (2) $\frac{\sqrt{5}}{2}$

(3) $\frac{2}{3}$ (4) $\sqrt{2}$

6. If the sum of the deviations of 50 observations from 30 is 50, then the mean of these observation is :

(1) 50 (2) 51 (3) 30 (4) 31

7. The mean and the variance of five observation are 4 and 5.20, respectively. If three of the observations are 3, 4 and 4; then then absolute value of the difference of the other two observations, is :

(1) 1 (2) 3

(3) 7 (4) 5

8. The mean and variance of seven observations are 8 and 16, respectively. If 5 of the observations are 2, 4, 10, 12, 14, then the product of the remaining two observations is :

(1) 40 (2) 49

(3) 48 (4) 45

9. A student scores the following marks in five tests : 45,54,41,57,43. His score is not known for the sixth test. If the mean score is 48 in the six tests, then the standard deviation of the marks in six tests is

(1) $\frac{10}{\sqrt{3}}$ (2) $\frac{100}{\sqrt{3}}$

(3) $\frac{100}{3}$ (4) $\frac{10}{3}$

10. If the standard deviation of the numbers –1, 0, 1, k is $\sqrt{5}$ where k > 0, then k is equal to

(1) $2\sqrt{\frac{10}{3}}$ (2) $2\sqrt{6}$

(3) $4\sqrt{\frac{5}{3}}$ (4) $\sqrt{6}$

11. The mean and the median of the following ten numbers in increasing order 10, 22, 26, 29, 34, x 42, 67, 70, y are 42 and 35 respectively, then $\frac{y}{x}$ is equal to :-

(1) 7/3 (2) 9/4

(3) 7/2 (4) 8/3

12. If for some $x \in R$, the frequency distribution of the marks obtained by 20 students in a test is :

Marks	2	3	5	7
Frequencey	$(x+1)^2$	$2x-5$	x^2-3x	x

then the mean of the marks is :

(1) 2.8 (2) 3.2

(3) 3.0 (4) 2.5

13. If both the mean and the standard deviation of 50 observations $x_1, x_2, ..., x_{50}$ are equal to 16, then the mean of $(x_1 - 4)^2, (x_2 - 4)^2, ... (x_{50} - 4)^2$ is :

(1) 525 (2) 380

(3) 480 (4) 400

14. If the data $x_1, x_2, ..., x_{10}$ is such that the mean of first four of these is 11, the mean of the remaining six is 16 and the sum of squares of all of these is 2,000; then the standard deviation of this data is :

(1) 4 (2) 2

(3) $\sqrt{2}$ (4) $2\sqrt{2}$

REASONING

1. If the Boolean expression $(p \oplus q) \wedge (\sim p \odot q)$ is equivalent to $p \wedge q$, where $\oplus, \odot \in \{\wedge, \vee\}$, then the ordered pair $(\oplus, \odot)$ is:

(1) $(\wedge, \vee)$ (2) $(\vee, \vee)$

(3) $(\wedge, \wedge)$ (4) $(\vee, \wedge)$

2. The logical statement

$[\sim(\sim p \vee q) \vee (p \wedge r) \wedge (\sim q \wedge r)]$ is equivalent to:

(1) $(p \wedge r) \wedge \sim q$

(2) $(\sim p \wedge \sim q) \wedge r$

(3) $\sim p \vee r$

(4) $(p \wedge \sim q) \vee r$

3. Consider the following three statements :

P : 5 is a prime number.

Q : 7 is a factor of 192.

R : L.C.M. of 5 and 7 is 35.

Then the truth value of which one of the following statements is true ?

(1) $(P \wedge Q) \vee (\sim R)$ (2) $(\sim P) \wedge (\sim Q \wedge R)$

(3) $(\sim P) \vee (Q \wedge R)$ (4) $P \vee (\sim Q \wedge R)$

4. If q is false and $p \wedge q \leftrightarrow r$ is true, then which one of the following statements is a tautology?

(1) $(p \vee r) \rightarrow (p \wedge r)$

(2) $p \vee r$

(3) $p \wedge r$

(4) $(p \wedge r) \rightarrow (p \vee r)$

5. Contrapositive of the statement

"If two numbers are not equal, then their squares are not equal." is :-

(1) If the squares of two numbers are equal, then the numbers are equal.

(2) If the squares of two numbers are equal, then the numbers are not equal.

(3) If the squares of two numbers are not equal, then the numbers are equal.

(4) If the squares of two numbers are not equal, then the numbers are not equal.

6. The Boolean expression

$((p \wedge q) \vee (p \vee \sim q)) \wedge (\sim p \wedge \sim q)$ is equivalent to:

(1) $p \wedge (\sim q)$ (2) $p \vee (\sim q)$

(3) $(\sim p) \wedge (\sim q)$ (4) $p \wedge q$

7. The expression $\sim(\sim p \rightarrow q)$ is logically equvalent to :

(1) $\sim p \wedge \sim q$ (2) $p \wedge q$

(3) $\sim p \wedge q$ (4) $p \wedge \sim q$

8. The contrapositive of the statement "If you are born in India, then you are a citizen of India", is :

(1) If you are born in India, then you are not a citizen of India.

(2) If you are not a citizen of India, then you are not born in India.

(3) If you are a citizen of India, then you are born in India.

(4) If you are not born in India, then you are not a citizen of India.

9. Which one of the following statements is not a tautology ?

(1) $(p \wedge q) \to p$

(2) $(p \wedge q) \to (\sim p) \vee q$

(3) $p \to (p \vee q)$

(4) $(p \vee q) \to (p \vee (\sim q))$

10. For any two statements p and q, the negation of the expression $p \vee (\sim p \wedge q)$ is

(1) $p \wedge q$ (2) $p \leftrightarrow q$

(3) $\sim p \vee \sim q$ (4) $\sim p \wedge \sim q$

11. If $P \Rightarrow (q \vee r)$ is false, then the truth values of p, q, r are respectively :-

(1) F, T, T (2) T, F, F

(3) T, T, F (4) F, F, F

12. Which one of the following Boolean expressions is a tautology ?

(1) $(P \vee q) \wedge (\sim p \vee \sim q)$

(2) $(P \wedge q) \vee (p \wedge \sim q)$

(3) $(P \vee q) \wedge (p \vee \sim q)$

(4) $(P \vee q) \vee (p \vee \sim q)$

13. The negation of the boolean expression $\sim s \vee (\sim r \wedge s)$ is equivalent to :

(1) r (2) $s \wedge r$

(3) $s \vee r$ (4) $\sim s \wedge \sim r$

14. If the truth value of the statement $P \to (\sim p \vee r)$ is false(F), then the truth values of the statements p, q, r are respectively :

(1) F, T, T

(2) T, F, F

(3) T, T, F

(4) T, F, T

15. The Boolean expression $\sim(p \Rightarrow (\sim q))$ is equivalent to :

(1) $(\sim p) \Rightarrow q$ (2) $p \vee q$

(3) $q \Rightarrow \sim p$ (4) $p \wedge q$

MATHEMATICAL INDUCTION

1. Consider the statement : "P(n): $n^2 - n + 41$ is prime." Then which one of the following is true?

(1) P(5) is false but P(3) is true

(2) Both P(3) and P(5) are false

(3) P(3) is false but P(5) is true

(4) Both P(3) and P(5) are true

ANSWER KEY

COMPOUND ANGLE

Que.	1	2	3	4	5	6	7
Ans.	1	3	4	1	4	2	4

QUADRATIC EQUATION

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	1	3	1	1	3	1	2	2	3
Que.	11	12	13	14	15					
Ans.	3	1	2	4	4					

SEQUENCE & PROGRESSION

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	4	1	2	3	3	1	2	4	1
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	2	2	2	2	3	1	1	2	1	3
Que.	21	22	23	24	25	26				
Ans.	4	2	3	1	1	1				

TRIGONOMETRIC EQUATION

Que.	1	2	3	4	5	6
Ans.	1	1	3	1	1	1

SOLUTION OF TRIANGLE

Que.	1	2	3	4	5	6
Ans.	4	1	2	3	3	3

HEIGHT & DISTANCE

Que.	1	2	3	4	5	6	7
Ans.	2	2	3	3	3	3	2

DETERMINANT

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	2	2	4	3	1	4	1	4	3	2
Que.	11	12	13	14	15	16	17	18		
Ans.	1	3	3	2	2	3	3	2		

STRAIGHT LINE

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	4	4	2	2	2	4	4	4	4
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	3	3	4	2	1	1	2	2
Que.	21									
Ans.	2									

CIRCLE										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	1	2	4	2	4	2	4	2	1	4
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	2	4	4	3	2	3	1	4	2	1

PERMUTATION & COMBINATION										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	2	4	1	3	1	4	4	1	1
Que.	**11**	**12**	**13**	**14**						
Ans.	2	3	1	1						

BIONOMIAL THEOREM										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	4	2	3	4	2	3	3	1	4	1
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	4	2	4	4	2	4	1	2	2
Que.	**21**	**22**								
Ans.	1	4								

SET			
Que.	**1**	**2**	**3**
Ans.	4	3	1

RELATION	
Que.	**1**
Ans.	3

FUNCTION										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	1	1	4	2	Bonus	1	1	1	2	1
Que.	**11**	**12**	**13**	**14**	**15**					
Ans.	3	3	4	3	2					

INVERSE TRIGONOMETRIC FUNCTION								
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Ans.	1	1	3	3	4	1	3	3

LIMIT										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	1	1	4	4	4	3	3	2	4	4
Que.	**11**	**12**	**13**	**14**						
Ans.	4	1	2	1						

CONTINUITY

Que.	1	2	3	4	5
Ans.	4	4	1	1	4

DIFFERENTIABILITY

Que.	1	2	3	4	5	6	7	8
Ans.	4	3	1	3	1	4	3	1

METHOD OF DIFFERENTIATION

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	2	3	4	1	4	2	4	1	4

INDEFINITE INTEGRATION

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1 or 3	4	3	1	2	1	2	2	3	4
Que.	11	12	13	14	15	16				
Ans.	4	4	1	1	3	4				

DEFINITE INTEGRATION

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	1	2	4	2	4	1	2	4	2
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	3	3	3	3	1	1	1	4
Que.	21									
Ans.	4									

TANGENT & NORMAL

Que.	1	2	3	4	5	6	7	8
Ans.	4	4	3	3	2	2	3	1

MONOTONICITY

Que.	1	2	3	4	5
Ans.	4	3	2	2	2

MAXIMA & MINIMA

Que.	1	2	3	4	5	6	7	8	9
Ans.	3	1	1	3	1	1	1	2	2

DIFFERENTIAL EQUATION

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	2	1	1	2	2	4	2	2	2
Que.	11	12	13	14	15	16	17			
Ans.	1	4	3	3	2	4	1			

AREA UNDER THE CURVE

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	3	1	1	2	2	2	2	2	2
Que.	11	12	13							
Ans.	1	3	1							

MATRIX

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	3	4	1	2	4	2	4	4	1
Que.	11	12	13							
Ans.	4	3	3							

VECTOR

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	4	2	4	3	2	3	2	2	4
Que.	11	12	13	14	15	16				
Ans.	3	3	1	3	3	4				

3D

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	2	2	2	4	3	2	3	2,4	1
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	4	3	1	2	3	2	2	2	3	1
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	2	1	2	4	2	3	1	4	1	3
Que.	31	32	33							
Ans.	1	1	2							

PARABOLA

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	3	4	1,2,3,4	3	4	3	1	1	3
Que.	11	12	13	14	15	16				
Ans.	1	3	2	3	3	4				

ELLIPSE

Que.	1	2	3	4	5	6	7	8	9	
Ans.	3	2	3	2	3	1	3	4	4	

HYPERBOLA

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	2	1	3	4	1	4	3	1	3	1
Que.	11	12								
Ans.	3	1								

COMPLEX NUMBER										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	1	Bonus	4	4	4	2	1	1	1
Que.	**11**	**12**	**13**	**14**	**15**	**16**				
Ans.	1	3	3	2	4	3				

PROBABILITY										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	2	3	2	1	2	3	2	4	3
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	2	4	4	3	1	3	2	4	2	2

STATISTICS										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	2	1	2	4	4	3	3	1	2
Que.	**11**	**12**	**13**	**14**						
Ans.	1	1	4	2						

REASONING										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	1	1	4	4	1	3	1	2	4	4
Que.	**11**	**12**	**13**	**14**	**15**					
Ans.	2	4	2	3	4					

MATHEMATICAL INDUCTION	
Que.	**1**
Ans.	4