ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

Chapter Contents

JEE (MAIN) JANUARY 2020 TEST PAPERS

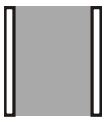
JEE (MAIN) SEPTEMBER 2020 TEST PAPERS

IMPORTANT NOTES

SET # 01

PHYSICS

1. A parallel plate capacitor has plates of area A separated by distance 'd' between them. It is filled with a dielectric which has a dielectric constant that varies as $k(x) = K(1 + \alpha x)$ where 'x' is the distance measured from one of the plates. If $(\alpha d) << 1$, the total capacitance of the system is best given by the expression :



(1) $\frac{AK\varepsilon_0}{d}\left(1+\frac{\alpha d}{2}\right)$ (2) $\frac{A\varepsilon_0 K}{d}\left(1+\left(\frac{\alpha d}{2}\right)^2\right)$

(3) $\frac{A\varepsilon_0 K}{d}\left(1+\frac{\alpha^2 d^2}{2}\right)$ (4) $\frac{AK\varepsilon_0}{d}(1+\alpha d)$

2. The time period of revolution of electron in its ground state orbit in a hydrogen atom is 1.6×10^{-16} s. The frequency of revolution of the electron in its first excited state (in s^{-1}) is:

(1) 6.2×10^{15} (2) 5.6×10^{12}

(3) 7.8×10^{14} (4) 1.6×10^{14}

3. A long solenoid of radius R carries a time (t)-dependent current $I(t) = I_0 t(1 - t)$. A ring of radius 2R is placed coaxially near its middle. During the time interval $0 \le t \le 1$, the induced current (I_R) and the induced EMF(V_R) in the ring change as :

(1) At t = 0.5 direction of I_R reverses and V_R is zero

(2) Direction of I_R remains unchanged and V_R is zero at t = 0.25

(3) Direction of I_R remains unchanged and V_R is maximum at t = 0.5

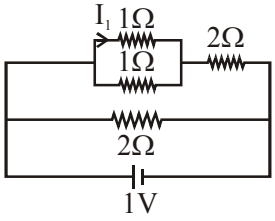
(4) At t = 0.25 direction of I_R reverses and V_R is maximum

4. A 60 HP electric motor lifts an elevator having a maximum total load capacity of 2000 kg. If the frictional force on the elevator is 4000 N, the speed of the elevator at full load is close to: (1 HP = 746 W, g = 10 ms^{-2})

(1) 1.7 ms^{-1} (2) 2.0 ms^{-1}

(3) 1.9 ms^{-1} (4) 1.5 ms^{-1}

5. The current I_1 (in A) flowing through 1 Ω resistor in the following circuit is :



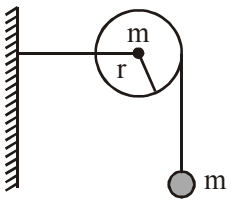
(1) 0.5 (2) 0.2 (3) 0.25 (4) 0.4

6. A litre of dry air at STP expands adiabatically to a volume of 3 litres. If $\gamma = 1.40$, the work done by air is : ($3^{1.4} = 4.6555$) [Take air to be an ideal gas]

(1) 90.5 J (2) 48 J

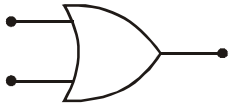
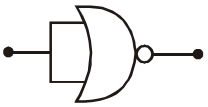
(3) 60.7 J (4) 100.8 J

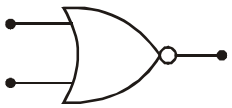
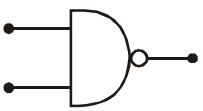
7. As shown in the figure, a bob of mass m is tied by a massless string whose other end portion is wound on a fly wheel (disc) of radius r and mass m. When released from rest the bob starts falling vertically. When it has covered a distance of h, the angular speed of the wheel will be :



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

8. Which of the following gives a reversible operation?

(1)  (2) 

(3)  (4) 

9. If we need a magnification of 375 from a compound microscope of tube length 150 mm and an objective of focal length 5 mm, the focal length of the eye-piece, should be close to :

(1) 22 mm (2) 12 mm

(3) 33 mm (4) 2 mm

10. The radius of gyration of a uniform rod of length l, about an axis passing through a point $\frac{l}{4}$ away from the centre of the rod, and perpendicular to it, is :

(1) $\frac{1}{8}l$ (2) $\sqrt{\frac{7}{48}}l$ (3) $\sqrt{\frac{3}{8}}l$ (4) $\frac{1}{4}l$

11. If the magnetic field in a plane electromagnetic wave is given by $\vec{B} = 3\times10^{-8}\sin\left(1.6\times10^{3}x + 48\times10^{10}t\right)\hat{j}T$, then what will be expression for electric field?

(1) $\vec{E} = \left(9\sin\left(1.6\times10^{3}x + 48\times10^{10}t\right)\hat{k}\ V/m\right)$

(2) $\vec{E} = \left(3\times10^{-8}\sin\left(1.6\times10^{3}x + 48\times10^{10}t\right)\hat{i}\ V/m\right)$

(3) $\vec{E} = \left(60\sin\left(1.6\times10^{3}x + 48\times10^{10}t\right)\hat{k}\ V/m\right)$

(4) $\vec{E} = \left(3\times10^{-8}\sin\left(1.6\times10^{3}x + 48\times10^{10}t\right)\hat{j}\ V/m\right)$

12. Consider a circular coil of wire carrying constant current I, forming a magnetic dipole. The magnetic flux through an infinite plane that contains the circular coil and excluding the circular coil area is given by ϕ_i. The magnetic flux through the area of the circular coil area is given by ϕ_0. Which of the following option is correct ?

(1) $\phi_i = -\phi_0$ (2) $\phi_i = \phi_0$
(3) $\phi_i < \phi_0$ (4) $\phi_i > \phi_0$

13. Speed of a transverse wave on a straight wire (mass 6.0 g, length 60 cm and area of cross-section 1.0 mm^2) is 90 ms^{-1}. If the Young's modulus of wire is 16×10^{11} Nm^{-2}, the extension of wire over its natural length is :

(1) 0.02 mm (2) 0.04 mm
(3) 0.03 mm (4) 0.01 mm

14. Visible light of wavelength 6000×10^{-8} cm falls normally on a single slit and produces a diffraction pattern. It is found that the second diffraction minimum is at 60° from the central maximum. If the first minimum is produced at θ_1, then θ_1 is close to :

(1) 20° (2) 45° (3) 30° (4) 25°

15. A polarizer - analyser set is adjusted such that the intensity of light coming out of the analyser is just 10% of the original intensity. Assuming that the polarizer - analyser set does not absorb any light, the angle by which the analyser need to be rotated further to reduce the output intensity to be zero, is :

(1) 18.4° (2) 71.6° (3) 90° (4) 45°

16. A satellite of mass m is launched vertically upwards with an initial speed u from the surface of the earth. After it reaches height R (R = radius of the earth), it ejects a rocket of mass $\frac{m}{10}$ so that subsequently the satellite moves in a circular orbit. The kinetic energy of the rocket is (G is the gravitational constant; M is the mass of the earth):

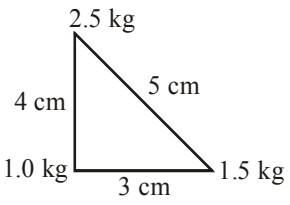
(1) $\frac{m}{20}\left(u-\sqrt{\frac{2GM}{3R}}\right)^2$

(2) $5m\left(u^2-\frac{119}{200}\frac{GM}{R}\right)$

(3) $\frac{3m}{8}\left(u+\sqrt{\frac{5GM}{6R}}\right)^2$

(4) $\frac{m}{20}\left(u^2+\frac{113}{200}\frac{GM}{R}\right)$

17. Three point particles of masses 1.0 kg, 1.5 kg and 2.5 kg are placed at three corners of a right angle triangle of sides 4.0 cm, 3.0 cm and 5.0 cm as shown in the figure. The center of mass of the system is at a point:



(1) 1.5 cm right and 1.2 cm above 1 kg mass
(2) 0.9 cm right and 2.0 cm above 1 kg mass
(3) 0.6 cm right and 2.0 cm above 1 kg mass
(4) 2.0 cm right and 0.9 cm above 1 kg mass

18. Two moles of an ideal gas with $\frac{C_P}{C_V}=\frac{5}{3}$ are mixed with 3 moles of another ideal gas with $\frac{C_P}{C_V}=\frac{4}{3}$. The value of $\frac{C_P}{C_V}$ for the mixture is:

(1) 1.50 (2) 1.42

(3) 1.45 (4) 1.47

19. A LCR circuit behaves like a damped harmonic oscillator. Comparing it with a physical spring-mass damped oscillator having damping constant 'b', the correct equivalence would be:

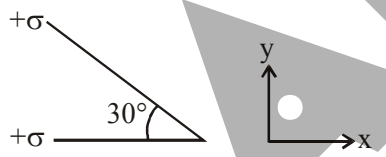
(1) $L \leftrightarrow m, C \leftrightarrow \frac{1}{k}, R \leftrightarrow b$

(2) $L \leftrightarrow \frac{1}{b}, C \leftrightarrow \frac{1}{m}, R \leftrightarrow \frac{1}{k}$

(3) $L \leftrightarrow m, C \leftrightarrow k, R \leftrightarrow b$

(4) $L \leftrightarrow k, C \leftrightarrow b, R \leftrightarrow m$

20. Two infinite planes each with uniform surface charge density + σ are kept in such a way that the angle between them is 30°. The electric field in the region shown between them is given by:



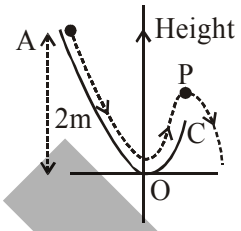
(1) $\frac{\sigma}{\varepsilon_0}\left[\left(1+\frac{\sqrt{3}}{2}\right)\hat{y}+\frac{\hat{x}}{2}\right]$

(2) $\frac{\sigma}{2\varepsilon_0}\left[\left(1-\frac{\sqrt{3}}{2}\right)\hat{y}-\frac{\hat{x}}{2}\right]$

(3) $\frac{\sigma}{2\varepsilon_0}\left[\left(1+\sqrt{3}\right)\hat{y}+\frac{\hat{x}}{2}\right]$

(4) $\frac{\sigma}{2\varepsilon_0}\left[\left(1+\sqrt{3}\right)\hat{y}-\frac{\hat{x}}{2}\right]$

21. A particle (m = 1 kg) slides down a frictionless track (AOC) starting from rest at a point A (height 2 m). After reaching C, the particle continues to move freely in air as a projectile. When it reaching its highest point P (height 1 m), the kinetic energy of the particle (in J) is : (Figure drawn is schematic and not to scale; take g=10 ms^{-2})_____.



22. A Carnot engine operates between two reservoirs of temperatures 900 K and 300 K. The engine performs 1200 J of work per cycle. The heat energy (in J) delivered by the engine to the low temperature reservoir, in a cycle, is____.

23. A beam of electromagnetic radiation of intensity 6.4 × 10^{-5} W/cm^2 is comprised of wavelength, λ = 310 nm. It falls normally on a metal (work function φ = 2eV) of surface area of 1 cm^2. If one in 10^3 photons ejects an electron, total number of electrons ejected in 1 s is 10^x. (hc=1240 eVnm, 1eV=1.6×10^{-19} J), then x is____.

24. A non-isotropic solid metal cube has coefficients of linear expansion as :

5 × 10^{-5}/°C along the x-axis and 5 × 10^{-6}/°C along the y and the z-axis. If the coefficient of volume expansion of the solid is C × 10^{-16}/°C then the value of C is _____.

25. A loop ABCDEFA of straight edges has six corner points A(0,0,0), B(5,0,0), C(5,5,0), D(0, 5, 0), E(0, 5, 5) and F(0, 0, 5). The magnetic field in this region is $\vec{B}=\left(3\hat{i}+4\hat{k}\right)T$.

The quantity of flux through the loop ABCDEFA (in Wb) is _____ .

CHEMISTRY

1. A solution of m-chloroaniline, m-chlorophenol and m-chlorobenzoic acid in ethyl acetate was extracted initially with a saturated solution of $NaHCO_3$ to give fraction A. The left over organic phase was extracted with dilute NaOH solution to give fraction B. The final organic layer was labelled as fraction C. Fractions A, B and C, contain respectively :

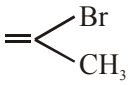
(1) m-chlorobenzoic acid, m-chloroaniline and m-chlorophenol

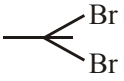
(2) m-chloroaniline, m-chlorobenzoic acid and m-chlorophenol

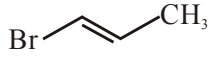
(3) m-chlorobenzoic acid, m-chlorophenol and m-chloroaniline

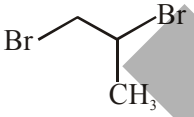
(4) m-chlorophenol, m-chlorobenzoic acid and m-chloroaniline

2. 1-methyl ethylene oxide when treated with an excess of HBr produces :

(1) 

(2) 

(3) 

(4) 

3. Amongst the following statements, that which was not proposed by Dalton was :

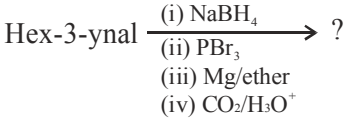
(1) all the atoms of a given element have identical properties including identical mass. Atoms of different elements differ in mass.

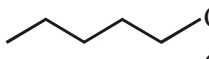
(2) chemical reactions involve reorganisation of atoms. These are neither created nor destroyed in a chemical reaction.

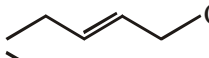
(3) when gases combine or reproduced in a chemical reaction they do so in a simple ratio by volume provided all gases are at the same T & P.

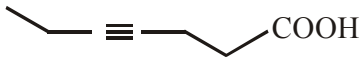
(4) matter consists of indivisible atoms.

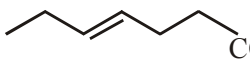
4. What is the product of following reaction ?



(1) 

(2) 

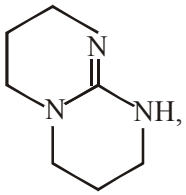
(3) 

(4) 

5. The increasing order of pK_b for the following compounds will be :

$NH_2 - CH = NH$,

(A)



(B)

CH_3NHCH_3

(C)

(1) (A) < (B) < (C) (2) (C) < (A) < (B)

(3) (B) < (A) < (C) (4) (B) < (C) < (A)

6. The atomic radius of Ag is closest to :

(1) Cu (2) Hg (3) Au (4) Ni

7. The dipole moments of CCl_4, $CHCl_3$ and CH_4 are in the order :

(1) $CH_4 = CCl_4 < CHCl_3$

(2) $CH_4 < CCl_4 < CHCl_3$

(3) $CCl_4 < CH_4 < CHCl_3$

(4) $CHCl_3 < CH_4 = CCl_4$

8. Given that the standard potentials (E°) of Cu^{2+}/Cu and Cu^{+}/Cu are 0.34 V and 0.522 V respectively, the E° of Cu^{2+}/Cu^{+} is :

(1) +0.158 V (2) 0.182 V

(3) –0.182 V (4) –0.158 V

9. In comparison to the zeolite process for the removal of permanent hardness, the synthetic resins method is :

(1) less efficient as it exchanges only anions

(2) more efficient as it can exchange only cations

(3) less efficient as the resins cannot be regenerated

(4) more efficient as it can exchange both cations as well as anions

10. The relative strength of interionic/ intermolecular forces in decreasing order is :

(1) ion-dipole > ion-ion > dipole-dipole

(2) dipole-dipole > ion-dipole > ion-ion

(3) ion-dipole > dipole-dipole > ion-ion

(4) ion-ion > ion-dipole > dipole-dipole

11. Consider the following reactions :

(a) $(CH_3)_3CCH(OH)CH_3 \xrightarrow{conc.H_2SO_4}$

(b) $(CH_3)_2CHCH(Br)CH_3 \xrightarrow{alc.KOH}$

(c) $(CH_3)_2CHCH(Br)CH_3 \xrightarrow[\text{It should be } (CH_3)_3CO^{\ominus}K^{\oplus}]{\text{given by NTA } (CH_3)_3O^{\ominus}K^{\oplus}}$

(d) $(CH_3)_2\underset{\underset{OH}{|}}{C}-CH_2-CHO \xrightarrow{\Delta}$

Which of these reaction(s) will not produce Saytzeff product ?

(1) (c) only (2) (a), (c) and (d)

(3) (d) only (4) (b) and (d)

12. The purest form of commercial iron is

(1) scrap iron and pig iron

(2) wrought iron

(3) cast iron

(4) pig iron

13. At 35°C, the vapour pressure of CS_2 is 512 mm Hg and that of acetone is 344 mm Hg. A solution of CS_2 in acetone has a total vapour pressure of 600 mm Hg. The false statement amongst the following is :

(1) heat must be absorbed in order to produce the solution at 35°C

(2) Raoult's law is not obeyed by this system

(3) a mixture of 100 mL CS_2 and 100 mL acetone has a volume < 200 mL

(4) CS_2 and acetone are less attracted to each other than to themselves

14. The electron gain enthalpy (in kJ/mol) of fluorine, chlorine, bromine and iodine, respectively are :

(1) – 333, – 349, – 325 and – 296

(2) –296, – 325, – 333 and – 349

(3) – 333, – 325, – 349 and – 296

(4) –349, – 333, – 325 and – 296

15. The number of orbitals associated with quantum numbers n = 5, $m_s = +\frac{1}{2}$ is :

(1) 11 (2) 25

(3) 15 (4) 50

16. Match the following :

(i) Riboflavin	(a) Beriberi
(ii) Thiamine	(b) Scurvy
(iii)Pyridoxine	(c) Cheilosis
(iv)Ascorbic acid	(d) Convulsions

(1) (i)-(c), (ii)-(a), (iii)-(d), (iv)-(b)

(2) (i)-(c), (ii)-(d), (iii)-(a), (iv)-(b)

(3) (i)-(d), (ii)-(b), (iii)-(a), (iv)-(c)

(4) (i)-(a), (ii)-(d), (iii)-(c), (iv)-(b)

17. The theory that can completely/properly explain the nature of bonding in $[Ni(CO)_4]$ is :

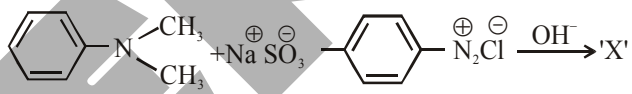
(1) Werner's theory

(2) Crystal field theory

(3) Valence bond theory

(4) Molecular orbital theory

18. Consider the following reaction :



The product 'X' is used :

(1) in acid base titration as an indicator

(2) in protein estimation as an alternative to ninhydrin

(3) in laboratory test for phenols

(4) as food grade colourant

19. The IUPAC name of the complex $[Pt(NH_3)_2Cl(NH_2CH_3)]Cl$ is :

(1) Diammine (methanamine) chlorido platinum (II) chloride

(2) Bisammine (methanamine) chlorido platinum (II) chloride

(3) Diamminechlorido (aminomethane) platinum(II) chloride

(4) Diamminechlorido (methanamine) platinum (II) chloride

20. Oxidation number of potassium in K_2O, K_2O_2 and KO_2 , respectively, is :

(1) +1, +4 and +2 (2) +1, +2 and +4

(3) +1, +1 and +1 (4) +2 , +1 and $+\frac{1}{2}$

21. For the reaction ;

$A(l) \rightarrow 2B(g)$

ΔU = 2.1 kcal , ΔS = 20 cal K^{-1} at 300 K

Hence ΔG in kcal is_____ .

22. During the nuclear explosion, one of the products is ^{90}Sr with half life of 6.93 years. if 1 μg of ^{90}Sr was absorbed in the bones of a newly born baby in place of Ca, how much time, in years , is required to reduce it by 90% if it is not lost metabolically_____ .

23. The number of chiral carbons in chloramphenicol is _____ .

24. Two solutions A and B, each of 100 L was made by dissolving 4g of NaOH and 9.8 g of H_2SO_4 in water, respectively. The pH of the resultant solution obtained from mixing 40 L of solution A and 10 L of solution B is_____.

25. Chlorine reacts with hot and concentrated NaOH and produces compounds (X) and (Y). Compound (X) gives white precipitate with silver nitrate solution. The average bond order between Cl and O atoms in (Y) is _____.

MATHEMATICS

1. If $g(x) = x^2 + x - 1$ and

$(gof)(x) = 4x^2 - 10x + 5$, then $f\left(\frac{5}{4}\right)$ is equal to

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

2. If $\text{Re}\left(\frac{z-1}{2z+i}\right) = 1$, where $z = x + iy$, then the point (x,y) lies on a :

(1) circle whose centre is at $\left(-\frac{1}{2}, -\frac{3}{2}\right)$

(2) circle whose diameter is $\frac{\sqrt{5}}{2}$

(3) straight line whose slope is $\frac{3}{2}$

(4) straight line whose slope is $-\frac{2}{3}$

3. Five numbers are in A.P., whose sum is 25 and product is 2520. If one of these five numbers is $-\frac{1}{2}$, then the greatest number amongst them is :

(1) $\frac{21}{2}$ (2) 27 (3) 16 (4) 7

4. If

$$y(\alpha) = \sqrt{2\left(\frac{\tan\alpha + \cot\alpha}{1+\tan^2\alpha}\right) + \frac{1}{\sin^2\alpha}}, \alpha \in \left(\frac{3\pi}{4}, \pi\right),$$

then $\frac{dy}{d\alpha}$ at $\alpha = \frac{5\pi}{6}$ is :

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

5. Let α be a root of the equation $x^2 + x + 1 = 0$

and the matrix $A = \frac{1}{\sqrt{3}}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha^4 \end{bmatrix}$, then the matrix A^{31} is equal to:

(1) A^3 (2) A (3) A^2 (4) I_3

6. If $y = mx + 4$ is a tangent to both the parabolas, $y^2 = 4x$ and $x^2 = 2by$, then b is equal to :

(1) 128 (2) –64 (3) –128 (4) –32

7. If the distance between the foci of an ellipse is 6 and the distance between its directrices is 12, then the length of its latus rectum is :

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

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

8. An unbiased coin is tossed 5 times. Suppose that a variable X is assigned the value k when k consecutive heads are obtained for k = 3, 4, 5 otherwise X takes the value –1. Then the expected value of X, is :

(1) $\frac{3}{16}$ (2) $-\frac{3}{16}$ (3) $\frac{1}{8}$ (4) $-\frac{1}{8}$

9. The area of the region, enclosed by the circle $x^2 + y^2 = 2$ which is not common to the region bounded by the parabola $y^2 = x$ and the straight line y = x, is :

(1) $\frac{1}{3}(12\pi - 1)$ (2) $\frac{1}{6}(12\pi - 1)$

(3) $\frac{1}{6}(24\pi - 1)$ (4) $\frac{1}{3}(6\pi - 1)$

10. Let $x^k + y^k = a^k$, (a, K > 0) and $\frac{dy}{dx}+\left(\frac{y}{x}\right)^{\frac{1}{3}} = 0$, then k is :

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

11. If y = y(x) is the solution of the differential equation, $e^y\left(\frac{dy}{dx}-1\right) = e^x$ such that y(0) = 0, then y(1) is equal to :

(1) $2 + \log_e 2$ (2) 2e

(3) $\log_e 2$ (4) $1 + \log_e 2$

12. Total number of 6-digit numbers in which only and all the five digits 1, 3, 5, 7 and 9 appear, is:

(1) $\frac{5}{2}(6!)$ (2) 5^6 (3) $\frac{1}{2}(6!)$ (4) 6!

13. Let P be a plane passing through the points (2, 1, 0), (4, 1, 1) and (5, 0, 1) and R be any point (2, 1, 6). Then the image of R in the plane P is :

(1) (6, 5, –2) (2) (4, 3, 2)

(3) (3, 4, –2) (4) (6, 5, 2)

14. A vector $\vec{a} = \alpha\hat{i} + 2\hat{j} + \beta\hat{k}(\alpha,\beta \in R)$ lies in the plane of the vectros $\vec{b} = \hat{i} + \hat{j}$ and $\vec{c} = \hat{i} - \hat{j} + 4\hat{k}$. If $\vec{a}$ bisects the angle between $\vec{b}$ and $\vec{c}$, then:

(1) $\vec{a}.\hat{i} + 1 = 0$ (2) $\vec{a}.\hat{i} + 3 = 0$

(3) $\vec{a}.\hat{k} + 4 = 0$ (4) $\vec{a}.\hat{k} + 2 = 0$

15. If $f(a + b + 1 - x) = f(x)$, for all x, where a and b are fixed positive real numbers, then $\frac{1}{a+b}\int_a^b x(f(x)+f(x+1))dx$ is equal to :

(1) $\int_{a+1}^{b+1} f(x)dx$ (2) $\int_{a+1}^{b+1} f(x+1)dx$

(3) $\int_{a-1}^{b-1} f(x+1)dx$ (4) $\int_{a-1}^{b-1} f(x)dx$

16. Let the function, $f : [-7, 0] \to R$ be continuous on [–7, 0] and differentiable on (–7, 0). If $f(-7) = -3$ and $f'(x) \le 2$, for all $x \in (-7, 0)$, then for all such functions f, $f(-1) + f(0)$ lies in the interval :

(1) [–6, 20] (2) (–∞, 20]

(3) (– ∞, 11] (4) [–3, 11]

17. If the system of linear equations

2x + 2ay + az = 0

2x + 3by + bz = 0

2x + 4cy + cz = 0,

where a, b, c ∈ R are non-zero and distinct; has a non-zero solution, then :

(1) a, b, c are in A.P.

(2) a + b + c = 0

(3) a, b, c are in G.P.

(4) $\frac{1}{a},\frac{1}{b},\frac{1}{c}$ are in A.P.

18. Let α and β be two real roots of the equation $(k + 1)\tan^2 x - \sqrt{2}\,.\,\lambda\tan x = (1 - k)$, where $k(\neq -1)$ and λ are real numbers. If $\tan^2(\alpha + \beta) = 50$, then a value of λ is ;

(1) 5 (2) 10 (3) $5\sqrt{2}$ (4) $10\sqrt{2}$

19. The logical statement $(p \Rightarrow q) \wedge (q \Rightarrow \sim p)$ is equivalent to :

(1) p (2) q (3) ~p (4) ~q

20. The greatest positive integer k, fr which $49^k + 1$ is a factor of the sum $49^{125} + 49^{124} + ... 49^2 + 49 + 1$, is :

(1) 32 (2) 60 (3) 63 (4) 65

21. $\lim_{x\to 2}\frac{3^x + 3^{3-x} - 12}{3^{-x/2} - 3^{1-x}}$ is equal to _____.

22. If the variance of the first n natural numbers is 10 and the variance of the first m even natural numbers is 16, then m + n is equal to _____.

23. If the sum of the coefficients of all even powers of x in the product $(1 + x + x^2 + ... + x^{2n})(1 - x + x^2 - x^3 + ... + x^{2n})$ is 61, then n is equal to _____.

24. Let A(1, 0), B(6, 2) and $C\left(\frac{3}{2},6\right)$ be the vertices of a triangle ABC. If P is a point inside the triangle ABC such that the triangles APC, APB and BPC have equal areas, then the length of the line segment PQ, where Q is the point $\left(-\frac{7}{6},-\frac{1}{3}\right)$, is _____.

25. Let S be the set of points where the function, $f(x) = |2 - |x - 3||$, $x \in R$, is not differentiable.

Then $\sum_{x\in S} f(f(x))$ is equal to _____.

SET # 02

PHYSICS

1. A stationary observer receives sound from two identical tuning forks, one of which approaches and the other one recedes with the same speed (much less than the speed of sound). The observer hears 2 beats/sec. The oscillation frequency of each tuning fork is ν_0 = 1400 Hz and the velocity of sound in air is 350 m/s. The speed of each tuning fork is close to :

(1) $\frac{1}{8}$ m/s (2) $\frac{1}{2}$ m/s

(3) 1 m/s (4) $\frac{1}{4}$ m/s

2. An elevator in a building can carry a maximum of 10 persons, with the average mass of each person being 68 kg. The mass of the elevator itself is 920 kg and it moves with a constant speed 3 m/s. The frictional force opposing the motion is 6000 N. If the elevator is moving up with its full capacity, the power delivered by the motor to the elevator ($g = 10\ m/s^2$) must be at least :

(1) 56300 W (2) 48000 W

(3) 66000 W (4) 62360 W

3. The activity of a radioactive sample falls from 700 s^{-1} to 500 s^{-1} in 30 minutes. Its half life is close to :

(1) 66 min (2) 52 min

(3) 72 min (4) 62 min

4. Mass per unit area of a circular disc of radius a depends on the distance r from its centre as $\sigma(r) = A + Br$. The moment of inertia of the disc about the the axis, perpendicular to the plane and passing through its centre is :

(1) $2\pi a^4\left(\frac{A}{4}+\frac{aB}{5}\right)$

(2) $\pi a^4\left(\frac{A}{4}+\frac{aB}{5}\right)$

(3) $2\pi a^4\left(\frac{aA}{4}+\frac{B}{5}\right)$

(4) $2\pi a^4\left(\frac{A}{4}+\frac{B}{5}\right)$

5. The electric field of a plane electromagnetic wave is given by $\vec{E} = E_0\frac{\hat{i}+\hat{j}}{\sqrt{2}}\cos(kz + \omega t)$

At t = 0, a positively charged particle is at the point (x, y, z) = $\left(0,0,\frac{\pi}{k}\right)$. If its instantaneous velocity at (t = 0) is $\upsilon_0\,\hat{k}$, the force acting on it due to the wave is :

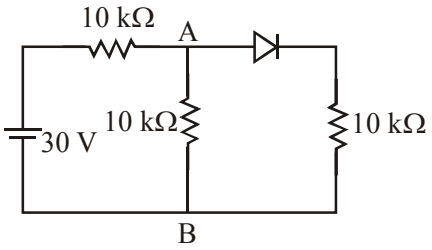
(1) zero (2) parallel to $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$

(3) antiparallel to $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ (4) parallel to $\hat{k}$

6. A particle of mass m and charge q has an initial velocity $\vec{\upsilon} = \upsilon_0\hat{j}$. If an electric field $\vec{E} = E_0\hat{i}$ and magnetic field $\vec{B} = B_0\hat{i}$ act on the particle, its speed will double after a time:

(1) $\frac{2m\upsilon_0}{qE_0}$ (2) $\frac{3m\upsilon_0}{qE_0}$ (3) $\frac{\sqrt{3}m\upsilon_0}{qE_0}$ (4) $\frac{\sqrt{2}m\upsilon_0}{qE_0}$

7. In the figure, potential difference between A and B is :



(1) 5V (2) 10 V

(3) zero (4) 15 V

8. The dimension of $\frac{B^2}{2\mu_0}$, where B is magnetic field and μ_0 is the magnetic permeability of vacuum, is:

(1) $ML^{-1}T^{-2}$ (2) ML^2T^{-1}

(3) MLT^{-2} (4) ML^2T^{-2}

9. In a building there are 15 bulbs of 45 W, 15 bulbs of 100 W, 15 small fans of 10 W and 2 heaters of 1 kW. The voltage of electric main is 220 V. The minimum fuse capacity (rated value) of the building will be:

(1) 10 A (2) 25 A

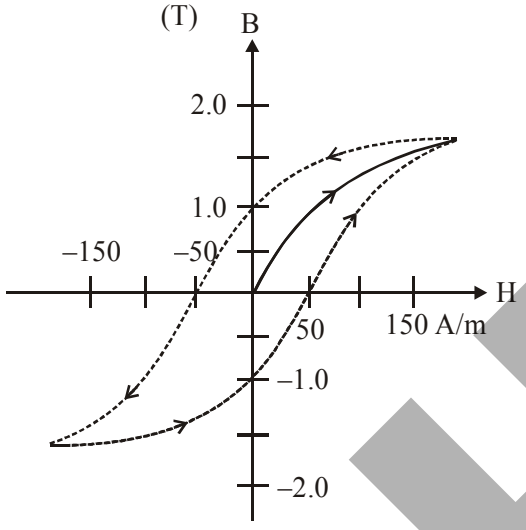
(3) 15 A (4) 20 A

10. An emf of 20 V is applied at time t=0 to a circuit containing in series 10 mH inductor and 5 Ω resistor. The ratio of the currents at time $t = \infty$ and at t = 40 s is close to : (Take $e^2 = 7.389$)

(1) 1.06 (2) 1.15

(3) 1.46 (4) 0.84

11.



The figure gives experimentally measured B vs. H variation in a ferromagnetic material. The retentivity, co-ercivity and saturation, respectively, of the material are:

(1) 150 A/m, 1.0 T and 1.5 T

(2) 1.0 T, 50 A/m and 1.5 T

(3) 1.5 T, 50 A/m and 1.0 T

(4) 1.5 T, 50 A/m and 1.0 T

12. In a Young's double slit experiment, the separation between the slits is 0.15 mm. In the experiment, a source of light of wavelength 589 nm is used and the interference pattern is observed on a screen kept 1.5 m away. The separation between the successive bright fringes on the screen is:

(1) 6.9 mm (2) 5.9 mm

(3) 4.9 mm (4) 3.9 mm

13. A mass of 10 kg is suspended by a rope of length 4 m, from the ceiling. A force F is applied horizontally at the mid-point of the rope such that the top half of the rope makes an angle of 45° with the vertical. Then F equals: (Take g= 10 ms^{-2} and the rope to be massless)

(1) 100 N (2) 90 N

(3) 75 N (4) 70 N

14. A thin lens made of glass (refractive index = 1.5) of focal length f = 16 cm is immersed in a liquid of refractive index 1.42. If its focal length in liquid is f_l, then the ratio f_l/f is closest to the integer :

(1) 1 (2) 5 (3) 9 (4) 17

15. A planar loop of wire rotates in a uniform magnetic field. Initially, at t = 0, the plane of the loop is perpendicular to the magnetic field. If it rotates with a period of 10 s about an axis in its plane then the magnitude of induced emf will be maximum and minimum, respectively at :

(1) 2.5 s and 7.5 s (2) 5.0 s and 7.5s

(3) 5.0 s and 10.0 s (4) 2.5s and 5.0 s

16. Two ideal Carnot engines operate in cascade (all heat given up by one engine is used by the other engine to produce work) between temperatures, T_1 and T_2. The temperature of the hot reservoir of the first engine is T_1 and the temperature of the cold reservoir of the second engine is T_2. T is temperature of the sink of first engine which is also the source for the second engine. How is T related to T_1 and T_2, if both the engines perform equal amount of work ?

(1) $T = \frac{2T_1T_2}{T_1+T_2}$ (2) $T = \sqrt{T_1T_2}$

(3) $T = \frac{T_1+T_2}{2}$ (4) T = 0

17. A box weighs 196 N on a spring balance at the north pole. Its weight recorded on the same balance if it is shifted to the equator is close to (Take g = 10 ms^{-2} at the north pole and the radius of the earth = 6400 km):

(1) 195.66 N (2) 194.66 N

(3) 194.32 N (4) 195.32 N

18. Under an adiabatic process, the volume of an ideal gas gets doubled. Consequently the mean collision time between the gas molecule changes from τ_1 to τ_2. If $\frac{C_p}{C_v}=\gamma$ for this gas then a good estimate for $\frac{\tau_2}{\tau_1}$ is given by :

(1) $\left(\frac{1}{2}\right)^{\frac{\gamma+1}{2}}$ (2) 2

(3) $\frac{1}{2}$ (4) $\left(\frac{1}{2}\right)^{\gamma}$

19. An ideal fluid flows (laminar flow) through a pipe of non-uniform diameter. The maximum and minimum diameters of the pipes are 6.4 cm and 4.8 cm, respectively. The ratio of the minimum and the maximum velocities of fluid in this pipe is:

(1) $\frac{\sqrt{3}}{2}$ (2) $\frac{3}{4}$ (3) $\frac{81}{256}$ (4) $\frac{9}{16}$

20. An electron (of mass m) and a photon have the same energy E in the range of a few eV. The ratio of the de-Broglie wavelength associated with the electron and the wavelength of the photon is (c = speed of light in vacuum)

(1) $\left(\frac{E}{2m}\right)^{1/2}$

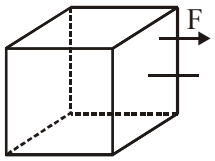
(2) $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$

(3) $c(2mE)^{1/2}$

(4) $\frac{1}{c}\left(\frac{2E}{m}\right)^{1/2}$

21. A 60 pF capacitor is fully charged by a 20 V supply. It is then disconnected from the supply and is connected to another uncharged 60 pF capactior is parallel. The electrostatic energy that is lost in this process by the time the charge is redistributed between them is (in nJ) ____.

22.



Consider a uniform cubical box of side a on a rough floor that is to be moved by applying minimum possible force F at a point b above its centre of mass (see figure). If the coefficient of friction is μ = 0.4, the maximum possible value of $100 \times \frac{b}{a}$ for a box not to topple before moving is _____ .

23. The balancing length for a cell is 560 cm in a potentiometer experiment. When an external resistance of 10 Ω is connected in parallel to the cell, the balancing length changes by 60cm. If the internal resistance of the cell is $\frac{N}{10}\Omega$, where N is an integer then value of N is____ .

24. The sum of two forces $\vec{P}$ and $\vec{Q}$ is $\vec{R}$ such that $|\vec{R}|=|\vec{P}|$. The angle θ (in degrees) that the resultant of $2\vec{P}$ and $\vec{Q}$ will make with $\vec{Q}$ is, ____ .

25. M grams of steam at 100°C is mixed with 200 g of ice at its melting point in a thermally insulated container. If it produces liquid water at 40°C [heat of vaporization of water is 540 cal/ g and heat of fusion of ice is 80 cal/g], the value of M is_____.

CHEMISTRY

1. Within each pair of elements of F & Cl , S & Se, and Li & Na, respectively, the elements that release more energy upon an electron gain are-

(1) F, Se and Na

(2) F, S and Li

(3) Cl, S and Li

(4) Cl, Se and Na

2. The redox reaction among the following is :

(1) Combination of dinitrogen with dioxygen at 2000 K

(2) Formation of ozone from atmosphereic oxygen in the presence of sunlight

(3) Reaction of H_2SO_4 with NaOH

(4) Reaction of $[Co(H_2O)_6]Cl_3$ with $AgNO_3$

3. Among the statements(a)-(d), the incorrect ones are-

(a) Octahedral Co(III) complexes with strong field ligands have very high magnetic moments

(b) When $\Delta_0 < P$, the d-electron configuration of Co(III) in an octahedral complex is $t_{eg}^4 e_g^2$

(c) Wavelength of light absorbed by $[Co(en)_3]^{3+}$ is lower than that of $[CoF_6]^{3-}$

(d) If the Δ_0 for an octahedral complex of Co(III) is 18,000 cm^{-1}, the Δ_t for its tetrahedral complex with the same ligand will be 16,000 cm^{-1}

(1) (a) and (b) only

(2) (c) and (d) only

(3) (b) and (c) only

(4) (a) and (d) only

4. The number of possible optical isomers for the complexes MA_2B_2 with sp^3 and dsp^2 hybridised metal atom, respectively, is :

Note : A and B are unidentate neutral and unidentate monoanionic ligands, respectively

(1) 0 and 0 (2) 0 and 2

(3) 0 and 1 (4) 2 and 2

5. In the following reactions products(A) and (B), respectively , are :

$NaOH + Cl_2 \rightarrow (A) +$ side products

(hot and conc.)

$Ca(OH)_2 + Cl_2 \rightarrow (B) +$ side products

(dry)

(1) $NaClO_3$ and $Ca(OCl)_2$

(2) NaOCl and $Ca(ClO_3)_2$

(3) $NaClO_3$ and $Ca(ClO_3)_2$

(4) NaOCl and $Ca(OCl)_2$

6. Which of the following statements is correct-

(1) Gluconic acid can form cyclic (acetal/ hemiacetal) structure

(2) Gluconic acid is a partial oxidation product of glucose

(3) Gluconic acid is obtained by oxidation of glucose with HNO_3

(4) Gluconic acid is a dicarboxylic acid

7. The bond order and the magnetic characteristics of CN^- are :

(1) 3, diamagnetic

(2) $2\frac{1}{2}$, paramagnetic

(3) 3, paramagnetic

(4) $2\frac{1}{2}$, diamagnetic

8. The equation that is incorrect is -

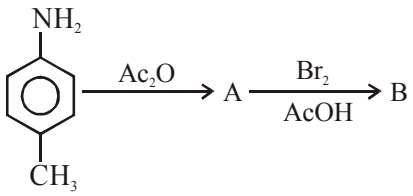
(1) $(\Lambda_m^0)_{NaBr} - (\Lambda_m^0)_{NaI} = (\Lambda_m^0)_{KBr} - (\Lambda_m^0)_{NaBr}$

(2) $(\Lambda_m^0)_{H_2O} = (\Lambda_m^0)_{HCl} + (\Lambda_m^0)_{NaOH} - (\Lambda_m^0)_{NaCl}$

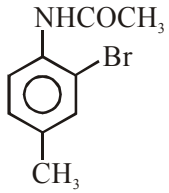
(3) $(\Lambda_m^0)_{KCl} - (\Lambda_m^0)_{NaCl} = (\Lambda_m^0)_{KBr} - (\Lambda_m^0)_{NaBr}$

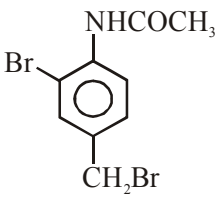
(4) $(\Lambda_m^0)_{NaBr} - (\Lambda_m^0)_{NaCl} = (\Lambda_m^0)_{KBr} - (\Lambda_m^0)_{KCl}$

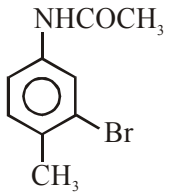
9. In the following reaction sequence

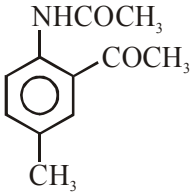


the major products B is -

(1) 

(2) 

(3) 

(4) 

10. Two open beakers one containing a solvent and the other containing a mixture of that solvent with a non volatile solute are together sealed in a container. Over time -

(1) The volume of the solution does not change and the volume of the solvent decreases

(2) The volume of the solution decrease and the volume of the solvent increases

(3) The volume of the solution increase and the volume of the solvent decreases

(4) The volume of the solution and the solvent does not change

11. A chromatography column, packed with silica gel as stationary phase, was used to separate a mixture of compounds consisting of (A) benzanilide (B) aniline and (C) acetophenone. When the column is eluted with a mixture of solvents, hexane : ethyl acetate (20 : 80), the sequence of obtained compounds :

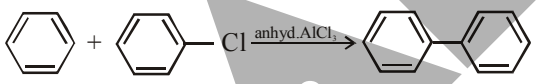
(1) (B), (C) and (A)

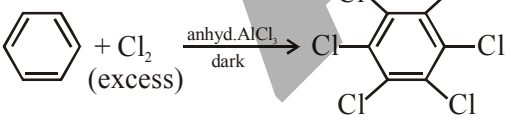
(2) (C), (A) and (B)

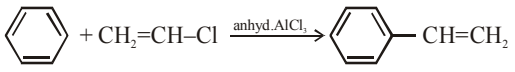
(3) (A), (B) and (C)

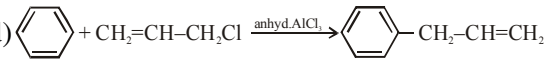
(4) (B), (A) and (C)

12. Consider the following reactions :

(a) 

(b) 

(c) 

(d) 

Which of these reactions are possible ?

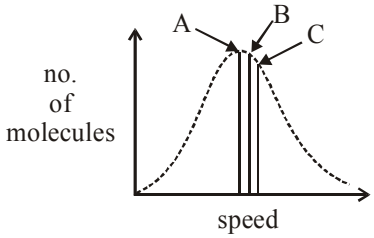
(1) (a) and (d)

(2) (b) and (d)

(3) (a) and (b)

(4) (b) , (c) and (d)

13. Identify the correct labels of A, B and C in the following graph from the options given below:



Root mean square speed (V_{rms}) ; most probable speed (V_{mp}) ; Average speed ($V_{av.}$)

(1) A – V_{rms} ; B –V_{mp} ; C – V_{av}

(2) A – V_{av} ; B –V_{rms} ; C – V_{mp}

(3) A – V_{mp} ; B –V_{rms} ; C – V_{av}

(4) A – V_{mp} ; B –V_{av} ; C – V_{rms}

14. Among the statements (a) - (d), the correct ones are -

(a) Decomposition of hydrogen peroxide gives dioxygen

(b) Like hydrogen peroxide, compounds , such as $KClO_3$, $Pb(NO_3)_2$ and $NaNO_3$when heated liberated dioxygen

(c) 2-Ethylanthraquinone is useful for the industrial preparation of hydrogen peroxide.

(d) Hydrogen peroxide is used for the manufacture of sodium perborate

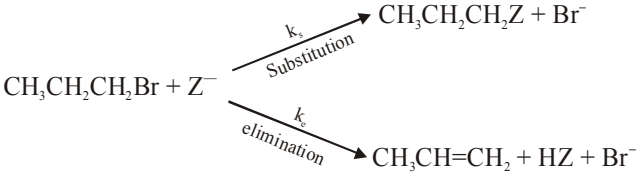
(1) (a), (b) and (c) only

(2) (a) and (c) only

(3) (a), (b) , (c) and (d)

(4) (a), (c) and (d) only

15. For the following reactions :



where

$Z^- = CH_3CH_2O^-$ (A) or $H_3C-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-O^-$ (B),

k_s and k_e , are , respectively, the rate constants for the substitution and elimination, and $\mu = \frac{k_s}{k_e}$, the correct options is -

(1) $\mu_B > \mu_A$ and $k_e(B) > k_e(A)$

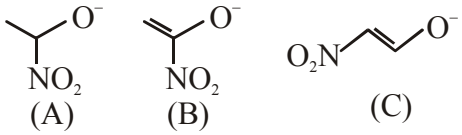
(2) $\mu_B > \mu_A$ and $k_e(A) > k_e(B)$

(3) $\mu_A > \mu_B$ and $k_e(B) > k_e(A)$

(4) $\mu_A > \mu_B$ and $k_e(A) > k_e(B)$

16. The refining method used when the metal and the impurities have low and high melting temperatures, respectively, is -
(1) zone refining
(2) liquation
(3) vapour phase refining
(4) distillation

17. The correct order of stability for the following alkoxides is :

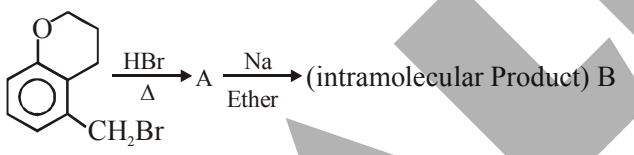


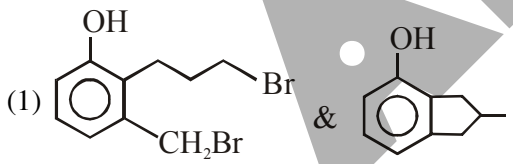
(A) (B) (C)

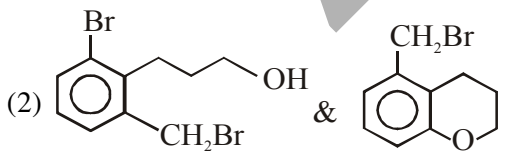
(1) (C) > (B) > (A) (2) (C) > (A) > (B)
(3) (B) > (C) > (A) (4) (B) > (A) > (C)

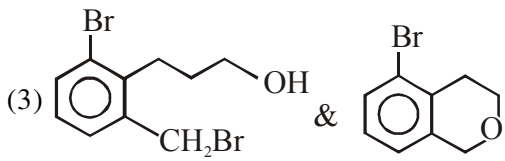
18. The ammonia (NH_3) released on quantitative reaction of 0.6 g urea (NH_2CONH_2) with sodium hydroxide (NaOH) can be neutralized by :
(1) 100 ml of 0.1 N HCl
(2) 200 ml of 0.4 N HCl
(3) 100 ml of 0.2 N HCl
(4) 200 ml of 0.2 N HCl

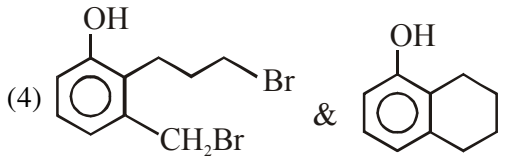
19. In the following reaction squence, structures of A and B, respectively will be :











20. For the reaction
$2H_2(g) + 2NO(g) \rightarrow N_2(g) + 2H_2O(g)$
the observed rate expression is, rate = $k_f[NO]^2[H_2]$. The rate expression of the reverse reaction is :
(1) $k_b[N_2][H_2O]^2/[NO]$ (2) $k_b[N_2][H_2O]$
(3) $k_b[N_2][H_2O]^2$ (4) $k_b[N_2][H_2O]^2/[H_2]$

21. Consider the following reactions :
$NaCl + K_2Cr_2O_7 + H_2SO_4(Conc.) \rightarrow (A) + Side\ products$
$(A) + NaOH \rightarrow (B) + Side\ product$
$(B) + H_2SO_4(dilute) + H_2O_2 \rightarrow (C) + Side\ product$
The sum of the total number of atoms in one molecule each of (A), (B) and (C) is

22. 3g of acetic acid is added to 250 mL of 0.1 M HCl and the solution made up to 500 mL. To 20 mL of this solution $\frac{1}{2}$ mL of 5 M NaOH is added. The pH of the solution is _____.
[Given : pK_a of acetic acid = 4.75, molar mass of acetic acid = 60 g/mol, log3 = 0.4771]
Neglect any changes in volume

23. The standard heat of formation $\left(\Delta_f H^0_{298}\right)$ of ethane in (kJ/mol), if the heat of combustion of ethane, hydrogen and graphite are –1560, –393.5 and –286 kJ/mol, respectively is _____

24. The flucculation value of HCl for arsenic sulphide sol. is 30 m mole L^{-1}. If H_2SO_4 is used for the flocculation of arsenic sulphide, the amount, in grams, of H_2SO_4 in 250 ml required for the above purpose is _____.
(molecular mass of H_2SO_4 = 98 g/mol)

25. The number of sp^2 hybridised carbons present in "Aspartame" is _____.

MATHEMATICS

1. Let y = y(x) be a function of x satisfying $y\sqrt{1-x^2} = k - x\sqrt{1-y^2}$ where k is a constant and $y\left(\frac{1}{2}\right) = -\frac{1}{4}$. Then $\frac{dy}{dx}$ at $x = \frac{1}{2}$, is equal to:

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

2. The area (in sq. units) of the region $\{(x, y) \in R^2 | 4x^2 \le y \le 8x + 12\}$ is :

(1) $\frac{127}{3}$ (2) $\frac{125}{3}$ (3) $\frac{124}{3}$ (4) $\frac{128}{3}$

3. Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three units vectors such that $\vec{a}+\vec{b}+\vec{c}=\vec{0}$. If $\lambda = \vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a}$ and $\vec{d}=\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a}$, then the ordered pair, $(\lambda,\vec{d})$ is equal to :

(1) $\left(-\frac{3}{2},3\vec{a}\times\vec{b}\right)$ (2) $\left(-\frac{3}{2},3\vec{c}\times\vec{b}\right)$

(3) $\left(\frac{3}{2},3\vec{b}\times\vec{c}\right)$ (4) $\left(\frac{3}{2},3\vec{a}\times\vec{c}\right)$

4. If the sum of the first 40 terms of the series, $3 + 4 + 8 + 9 + 13 + 14 + 18 + 19 + \ldots$ is (102)m, then m is equal to :

(1) 20 (2) 5 (3) 10 (4) 25

5. The value of c in the Lagrange's mean value theorem for the function $f(x) = x^3 - 4x^2 + 8x + 11$, when $x \in [0, 1]$ is :

(1) $\frac{2}{3}$ (2) $\frac{\sqrt{7}-2}{3}$

(3) $\frac{4-\sqrt{5}}{3}$ (4) $\frac{4-\sqrt{7}}{3}$

6. If θ_1 and θ_2 be respectively the smallest and the largest values of θ in $(0, 2\pi) - \{\pi\}$ which satisfy the equation, $2\cot^2\theta - \frac{5}{\sin\theta} + 4 = 0$, then $\int_{\theta_1}^{\theta_2} \cos^2 3\theta d\theta$ is equal to :

(1) $\frac{2\pi}{3}$ (2) $\frac{\pi}{3}+\frac{1}{6}$ (3) $\frac{\pi}{9}$ (4) $\frac{\pi}{3}$

7. The number of ordered pairs (r, k) for which $6\cdot{}^{35}C_r = (k^2 - 3)\cdot{}^{36}C_{r+1}$, where k is an integer, is :

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

8. Let $A = [a_{ij}]$ and $B = [b_{ij}]$ be two 3×3 real matrices such that $b_{ij} = (3)^{(i+j-2)}a_{ji}$, where i, j = 1, 2, 3. If the determinant of B is 81, then the determinant of A is :

(1) 3 (2) 1/3 (3) 1/81 (4) 1/9

9. Let $a_1, a_2, a_3, \ldots$ be a G.P. such that $a_1 < 0$, $a_1 + a_2 = 4$ and $a_3 + a_4 = 16$. If $\sum_{i=1}^{9} a_i = 4\lambda$, then λ is equal to :

(1) –171 (2) 171 (3) $\frac{511}{3}$ (4) –513

10. Let A, B, C and D be four non-empty sets. The contrapositive statement of "If $A \subseteq B$ and $B \subseteq D$, then $A \subseteq C$" is :

(1) If $A \subseteq C$, then $B \subset A$ or $D \subset B$

(2) If $A \not\subseteq C$, then $A \not\subseteq B$ or $B \not\subseteq D$

(3) If $A \not\subseteq C$, then $A \subseteq B$ and $B \subseteq D$

(4) If $A \not\subseteq C$, then $A \not\subseteq B$ and $B \subseteq D$

11. If $3x + 4y = 12\sqrt{2}$ is a tangent to the ellipse $\frac{x^2}{a^2}+\frac{y^2}{9} = 1$ for some $a \in R$, then the distance between the foci of the ellipse is :

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

12. The value of α for which $4\alpha\int_{-1}^{2} e^{-\alpha|x|}dx = 5$, is :

(1) $\log_e\left(\frac{3}{2}\right)$ (2) $\log_e\left(\frac{4}{3}\right)$

(3) $\log_e 2$ (4) $\log_e\sqrt{2}$

13. The coefficient of x^7 in the expression $(1 + x)^{10} + x(1 + x)^9 + x^2(1 + x)^8 + \ldots + x^{10}$ is :

(1) 120 (2) 330 (3) 210 (4) 420

14. Let α and β be the roots of the equation $x^2 - x - 1 = 0$. If $p_k = (\alpha)^k + (\beta)^k$, $k \ge 1$, then which one of the following statements is not true ?

(1) $(p_1 + p_2 + p_3 + p_4 + p_5) = 26$

(2) $p_5 = 11$

(3) $p_3 = p_5 - p_4$

(4) $p_5 = p_2 \cdot p_3$

15. The locus of the mid-points of the perpendiculars drawn from points on the line, $x = 2y$ to the line $x = y$ is :

(1) $2x - 3y = 0$ (2) $7x - 5y = 0$

(3) $5x - 7y = 0$ (4) $3x - 2y = 0$

16. If $\frac{3+i\sin\theta}{4-i\cos\theta}, \theta \in [0, 2\pi]$, is a real number, then an argument of $\sin\theta + i\cos\theta$ is :

(1) $-\tan^{-1}\left(\frac{3}{4}\right)$ (2) $\tan^{-1}\left(\frac{4}{3}\right)$

(3) $\pi - \tan^{-1}\left(\frac{4}{3}\right)$ (4) $\pi - \tan^{-1}\left(\frac{3}{4}\right)$

17. Let $y = y(x)$ be the solution curve of the differential equation, $(y^2 - x)\frac{dy}{dx} = 1$, satisfying $y(0) = 1$. This curve intersects the x-axis at a point whose abscissa is :

(1) $2 + e$ (2) 2 (3) $2 - e$ (4) $-e$

18. Let $f(x)$ be a polynomial of degree 5 such that $x = \pm 1$ are its critical points. If $\lim\limits_{x\to 0}\left(2 + \frac{f(x)}{x^3}\right) = 4$, then which one of the following is not true?

(1) f is an odd function

(2) $x = 1$ is a point of minima and $x = -1$ is a point of maxima of f.

(3) $x = 1$ is a point of maxima and $x = -1$ is a point of minimum of f.

(4) $f(1) - 4f(-1) = 4$

19. In a workshop, there are five machines and the probability of any one of them to be out of service on a day is $\frac{1}{4}$. If the probability that at most two machines will be out of service on the same day is $\left(\frac{3}{4}\right)^3 k$, then k is equal to :

(1) $\frac{17}{2}$ (2) 4 (3) $\frac{17}{8}$ (4) $\frac{17}{4}$

20. Let the tangents drawn from the origin to the circle, $x^2 + y^2 - 8x - 4y + 16 = 0$ touch it at the points A and B. The $(AB)^2$ is equal to :

(1) $\frac{52}{5}$

(2) $\frac{32}{5}$

(3) $\frac{56}{5}$

(4) $\frac{64}{5}$

21. If the system of linear equations,

$$x + y + z = 6$$
$$x + 2y + 3z = 10$$
$$3x + 2y + \lambda z = \mu$$

has more two solutions, then $\mu - \lambda^2$ is equal to _____

22. If the function f defined on $\left(-\frac{1}{3}, \frac{1}{3}\right)$ by

$$f(x) = \begin{cases} \frac{1}{x}\log_e\left(\frac{1+3x}{1-2x}\right), & \text{when } x \neq 0 \\ k, & \text{when } x = 0 \end{cases}$$

is continuous, then k is equal to_____

23. If the mean and variance of eight numbers 3, 7, 9, 12, 13, 20, x and y be 10 and 25 respectively, then $x \cdot y$ is equal to_____

24. If the foot of the perpendicular drawn from the point (1, 0, 3) on a line passing through $(\alpha, 7, 1)$ is $\left(\frac{5}{3}, \frac{7}{3}, \frac{17}{3}\right)$, then α is equal to_____

25. Let $X = \{n \in N : 1 \le n \le 50\}$. If

$A = \{n \in X : n \text{ is a multiple of } 2\}$ and

$B = \{n \in X : n \text{ is a multiple of } 7\}$, then the number of elements in the smallest subset of X containing both A and B is_____

SET # 03

PHYSICS

1. Consider a solid sphere of radius R and mass density $\rho(r)=\rho_0\left(1-\frac{r^2}{R^2}\right)$, $0<r\le R$. The minimum density of a liquid in which it will float is :

(1) $\frac{\rho_0}{5}$ (2) $\frac{\rho_0}{3}$

(3) $\frac{2\rho_0}{3}$ (4) $\frac{2\rho_0}{5}$

2. When photon of energy 4.0 eV strikes the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV end de-Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photon of energy 4.50 eV is $T_B = (T_A - 1.5)$ eV. If the de-Broglie wavelength of these photoelectrons $\lambda_B = 2\lambda_A$, then the work function of metal B is :

(1) 3eV
(2) 2eV
(3) 4eV
(4) 1.5eV

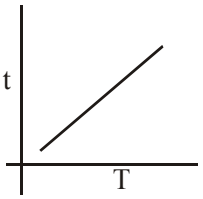
3. The length of a potentiometer wire is 1200 cm and it carries a current of 60 mA. For a cell of emf 5V and internal resistance of 20Ω, the null point on it is found to be a 1000cm. The resistance of whole wire is :

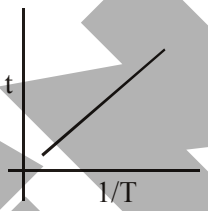
(1) 120Ω
(2) 60Ω
(3) 80Ω
(4) 100Ω

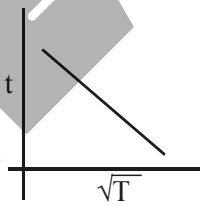
4. Photon with kinetic energy of 1MeV moves from south to north. It gets an acceleration of 10^{12} m/s^2 by an applied magnetic field (west to east). The value of magnetic field : (Rest mass of proton is 1.6×10^{-27} kg) :

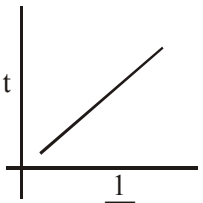
(1) 71mT
(2) 7.1mT
(3) 0.071mT
(4) 0.71mT

5. The plot that depicts the behavior of the mean free time t (time between two successive collisions) for the molecules of an ideal gas, as a function of temperature (T), qualitatively, is: (Graphs are schematic and not drawn to scale)

(1) 

(2) 

(3) 

(4) 

6. Consider a uniform rod of mass M = 4m and length ℓ pivoted about its centre. A mass m moving with velocity v making angle $\theta=\frac{\pi}{4}$ to the rod's long axis collides with one end of the rod and sticks to it. The angular speed of the rod-mass system just after the collision is :

(1) $\frac{3}{7\sqrt{2}}\frac{v}{\ell}$ (2) $\frac{3\sqrt{2}}{7}\frac{v}{\ell}$

(3) $\frac{4}{7}\frac{v}{\ell}$ (4) $\frac{3}{7}\frac{v}{\ell}$

7. The dimension of stopping potential V_0 in photoelectric effect in units of Planck's constant 'h', speed of light 'c' and Gravitational constant 'G' and ampere A is :

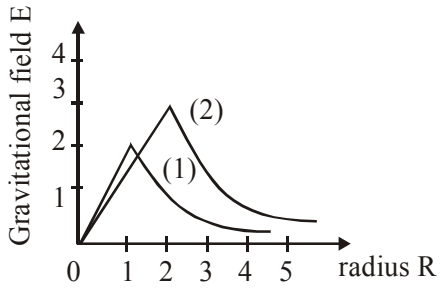
(1) $h^2\ G^{3/2}\ c^{1/3}\ A^{-1}$

(2) $h^{-2/3}\ c^{-1/3}\ G^{4/3}\ A^{-1}$

(3) $h^{1/3}\ G^{2/3}\ c^{1/3}\ A^{-1}$

(4) $h^{2/3}\ c^{5/3}\ G^{1/3}\ A^{-1}$

8. Consider two solid spheres of radii $R_1 = 1m$, $R_2 = 2m$ and masses M_1 and M_2, respectively. The gravitational field due to sphere (1) and (2) are shown. The value of $\frac{M_1}{M_2}$ is :



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

(3) $\frac{1}{3}$ (4) $\frac{1}{6}$

9. In finding the electric field using Gauss Law the formula $|\vec{E}| = \frac{q_{enc}}{\varepsilon_0 |A|}$ is applicable. In the formula ε_0 is permittivity of free space, A is the area of Gaussian surface and q_{enc} is charge enclosed by the Gaussian surface. The equation can be used in which of the following situation?

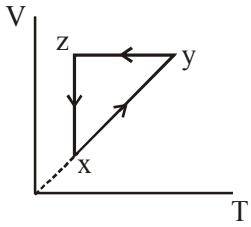
(1) Only when the Gaussian surface is an equipotential surface.

(2) Only when $|\vec{E}|$ = constant on the surface.

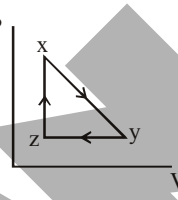
(3) For any choice of Gaussian surface.

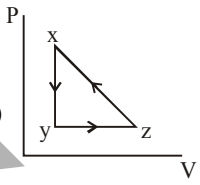
(4) Only when the Gaussian surface is an equipotential surface and $|\vec{E}|$ is constant on the surface.

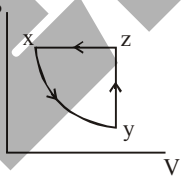
10. A thermodynamic cycle xyzx is shown on a V-T diagram.

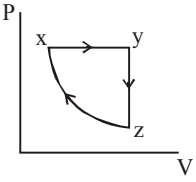


The P-V diagram that best describes this cycle is : (Diagrams are schematic and not to scale)

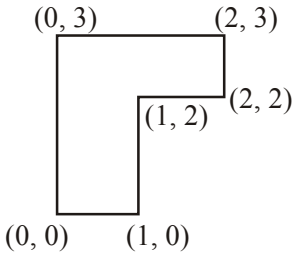
(1)


(2)


(3)


(4)


11. The coordinates of centre of mass of a uniform flag shaped lamina (thin flat plate) of mass 4kg. (The coordinates of the same are shown in figure) are :



(1) (1.25m, 1.50m) (2) (1m, 1.75m)

(3) (0.75m, 0.75m) (4) (0.75m, 1.75m)

12. The magnifying power of a telescope with tube 60 cm is 5. What is the focal length of its eye piece ?

(1) 30 cm (2) 40 cm

(3) 20 cm (4) 10 cm

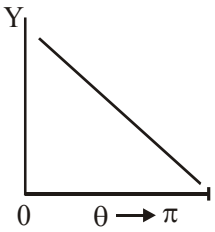
13. The graph which depicts the results of Rutherform gold foil experiment with α-particales is :

θ : Scattering angle

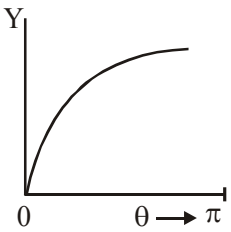
Y : Number of scattered α-particles detected

(Plots are schematic and not to scale)

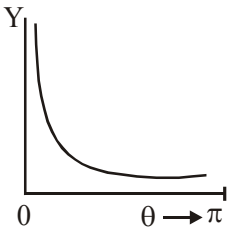
(1)



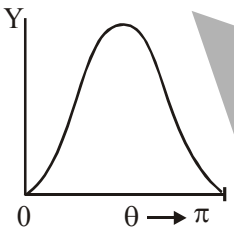
(2)



(3)



(4)



14. A particle of mass m is fixed to one end of a light spring having force constant k and unstretched length ℓ. The other end is fixed. The system is given an angular speed ω about the fixed end of the spring such that it rotates in a circle in gravity free space. Then the stretch in the spring is :

(1) $\frac{m\ell\omega^2}{k+m\omega^2}$ (2) $\frac{m\ell\omega^2}{k-m\omega^2}$

(3) $\frac{m\ell\omega^2}{k-\omega m}$ (4) $\frac{m\ell\omega^2}{k+m\omega}$

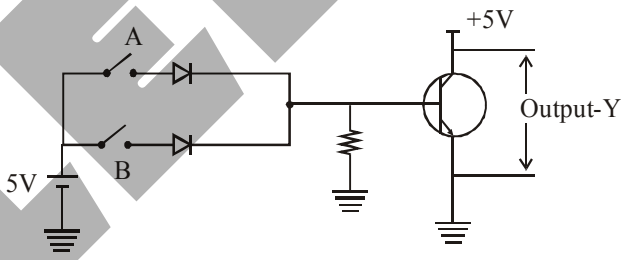
15. The critical angle of a medium for a specific wavelength, if the medium has relative permittivity 3 and relative permeability $\frac{4}{3}$ for this wavelength, will be :

(1) 60° (2) 15° (3) 45° (4) 30°

16. A leak proof cylinder of length 1m, made of a metal which has very low coefficient of expansion is floating vertically in water at 0°C such that its height above the water surface is 20 cm. When the temperature of water is increased to 4°C, the height of the cylinder above the water surface becomes 21 cm. The density of water at T = 4°C, relative to the density at T = 0°C is close to :

(1) 1.01 (2) 1.04 (3) 1.03 (4) 1.26

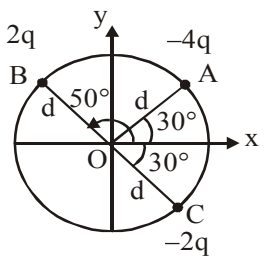
17. Boolean relation at the output stage-Y for the following circuit is :



(1) A + B (2) $\overline{A}+\overline{B}$

(3) $\overline{A}\cdot\overline{B}$ (4) $A\cdot B$

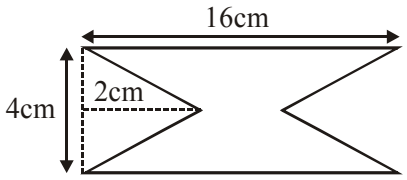
18. Three charged particle A, B and C with charges –4q, 2q and –2q are present on the circumference of a circle of radius d. the charged particles A, C and centre O of the circle formed an equilateral triangle as shown in figure. Electric field at O along x-direction is :



(1) $\frac{2\sqrt{3}\,q}{\pi\varepsilon_0 d^2}$ (2) $\frac{\sqrt{3}\,q}{4\pi\varepsilon_0 d^2}$

(3) $\frac{3\sqrt{3}\,q}{4\pi\varepsilon_0 d^2}$ (4) $\frac{\sqrt{3}\,q}{\pi\varepsilon_0 d^2}$

19. At time t = 0 magnetic field of 100 Gauss is passing perpendicularly through the area defined by the closed loop shown in the figure. If the magnetic field reduces linearly to 500 Gauss, in the next 5s, then induced EMF in the loop is :



(1) 36 μV (2) 48 μV
(3) 56 μV (4) 28 μV

20. Effective capacitance of parallel combination of two capacitors C_1 and C_2 is 10 μF. When these capacitors are individually connected to a voltage source of 1V, the energy stored in the capacitor C_2 is 4 times that of C_1. If these capacitors are connected in series, their effective capacitance will be :

(1) 3.2 μF (2) 8.4 μF
(3) 1.6 μF (4) 4.2 μF

21. Four resistances of 15Ω, 12Ω, 4Ω and 10Ω respectively in cyclic order to form Wheatstone's network. The resistance that is to be connected in parallel with the resistance of 10Ω to balance the network is _____ Ω.

22. A point object in air is in front of the curved surface of a plano-convex lens. The radius of curvature of the curved surface is 30 cm and the refractive index of the lens material is 1.5, then the focal length of the lens (in cm) is ——.

23. A body A, of mass m = 0.1 kg has an initial velocity of $3\hat{i}\,ms^{-1}$. It collides elastically with another body, B of the same mass which has an initial velocity of $5\hat{j}\,ms^{-1}$. After collision, A moves with a velocity $\vec{v} = 4(\hat{i}+\hat{j})$. The energy of B after collision is written as $\frac{x}{10}J$. The value of x is _____.

24. A particle is moving along the x-axis with its coordinate with the time 't' given be $x(t) = 10 + 8t - 3t^2$. Another particle is moving the y-axis with its coordinate as a function of time given by $y(t) = 5 - 8t^3$. At t = 1s, the speed of the second particle as measured in the frame of the first particle is given as $\sqrt{v}$. Then v (in m/s) is _____.

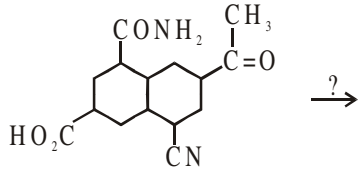
25. A one metre long (both ends open) organ pipe is kept in a gas that has double the density of air at STP. Assuming the speed of sound in air at STP is 300 m/s, the frequency difference between the fundamental and second harmonic of this pipe is _____ Hz.

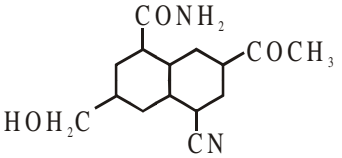
CHEMISTRY

1. A flask contains a mixture of isohexane and 3-methylpentane. One of the liquids boils at 63°C while the other boils at 60°C. What is the best way to seprate the two liquids and which one will be distilled out first?
(1) simple distillation, 3-methylpentane
(2) simple distillation, isohexane
(3) fractional distillation, isohexane
(4) fractional distillation, 3-methylpentane

2. The first ionization energy (in kJ/mol) of Na, Mg, Al and Si respectively, are :
(1) 496, 737, 577, 786
(2) 786, 737, 577, 496
(3) 496, 577, 737, 786
(4) 496, 577, 786, 737

3. The most suitable reagent for the given conversion is :





(1) $LiAlH_4$ (2) $NaBH_4$
(3) H_2/Pd (4) B_2H_6

4. The third ionization enthalpy is minimum for :
(1) Fe (2) Ni (3) Co (4) Mn

5. The predominant intermolecular forces present in ethyl acetate, a liquid, are :

(1) hydrogen bonding and London dispersion
(2) Dipole-dipole and hydrogen bonding
(3) London dispersion and dipole-dipole
(4) London dispersion, dipole-dipole and hydrogen bonding

6. The strength of an aqueous NaOH solution is most accurately determined by titrating :

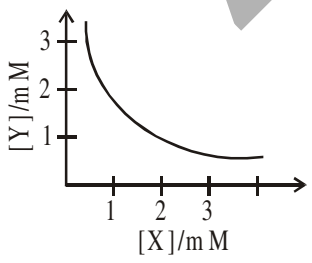
(Note : consider that an appropriate indicator is used)

(1) Aq. NaOH in a volumetric flask and concentrated H_2SO_4 in a conical flask
(2) Aq. NaOH in a pipette and aqueous oxalic acid in a burette
(3) Aq. NaOH in a burette and concentrated H_2SO_4 in a conical flask
(4) Aq. NaOH in a burette and aqueous oxalic acid in a conical flask

7. The complex that can show fac-and mer-isomers is :

(1) $[Pt(NH_3)_2Cl_2]$ (2) $[Co(NH_3)_4Cl_2]^+$
(3) $[Co(NH_3)_3(NO_2)_3]$ (4) $[CoCl_2(en)_2]$

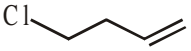
8. The stoichiometry and solubility product of a salt with the solubility curve given below is, respectively :

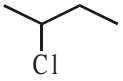


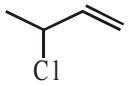
(1) X_2Y, $2\times10^{-9}M^3$
(2) XY_2, $1\times10^{-9}M^3$
(3) XY_2, $4\times10^{-9}M^3$
(4) XY, $2\times10^{-6}M^3$

9. The decreasing order of reactivity towards dehydrohalogenation (E_1) reaction of the following compounds is :

(A) 

(B) 

(C) 

(D) 

(1) B > D > A > C
(2) B > D > C > A
(3) D > B > C > A
(4) B > A > D > C

10. The number of bonds between sulphur and oxygen atoms in $S_2O_8^{2-}$ and the number of bonds between sulphur and sulphur atoms in rhombic sulphur, respectively, are :

(1) 4 and 8
(2) 4 and 6
(3) 8 and 8
(4) 8 and 6

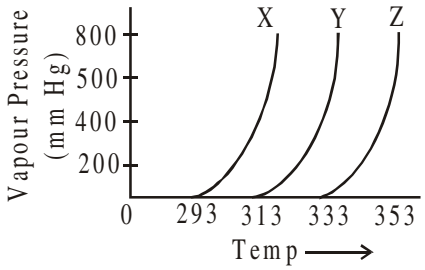
11. The rate of a certain biochemical reaction at physiological temperature (T) occurs 10^6 times faster with enzyme than without. The change in the activation energy upon adding enzyme is :

(1) –6RT
(2) +6RT
(3) +6(2.303)RT
(4) –6(2.303)RT

12. Which of the following statement is not true for glucose?

(1) The pentaacetate of glucose does not react with hydroxylamine to give oxime
(2) Glucose gives Schiff's test for aldehyde
(3) Glucose exists in two crystalline forms α and β
(4) Glucose reacts with hydroxylamine to form oxime

13. A graph of vapour pressure and temperature for three different liquids X, Y and Z is shown below :



The following inferences are made :

(A) X has higher intermolecular interactions compared to Y.

(B) X has lower intermolecular interactions compared to Y.

(C) Z has lower intermolecular interactions compared to Y.

The correct inference(s) is/are :

(1) A

(2) (C)

(3) (B)

(4) (A) and (C)

14. Among the gases (a) - (e), the gases that cause greenhouse effect are :

(a) CO_2 (b) H_2O

(c) CFCs (d) O_2

(e) O_3

(1) (a), (b), (c) and (d)

(2) (a), (c), (d) and (e)

(3) (a) and (d)

(4) (a), (b), (c) and (e)

15. As per Hardy-Schulze formulation, the flocculation values of the following for ferric hydroxide sol are in the order :

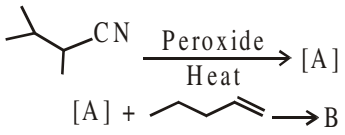
(1) $AlCl_3 > K_3[Fe(CN)_6] > K_2CrO_4 > KBr=KNO_3$

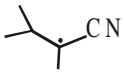
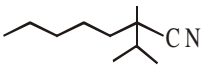
(2) $K_3[Fe(CN)_6] < K_2CrO_4 < AlCl_3 < KBr < KNO_3$

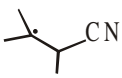
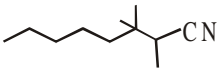
(3) $K_3[Fe(CN)_6] > AlCl_3 > K_2CrO_4 > KBr > KNO_3$

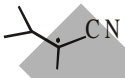
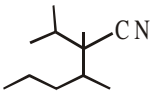
(4) $K_3[Fe(CN)_6] < K_2CrO_4 < KBr=KNO_3=AlCl_3$

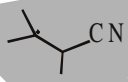
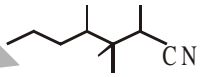
16. The major products A and B in the following reactions are :



(1) A =  and B = 

(2) A =  and B = 

(3) A =  and B = 

(4) A =  and B = 

17. For the Balmer series in the spectrum of H atom, $\bar{\nu} = R_H \left\{ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right\}$, the correct statements among (I) and (IV) are :

(I) As wavelength decreases, the lines in the series converge

(II) The integer n_1 is equal to 2

(III) The lines of longest wavelength corresponds to $n_2 = 3$

(IV) The ionization energy of hydrogen can be calculated from wave number of these lines

(1) (II), (III), (IV)

(2) (I), (II), (III)

(3) (I), (III), (IV)

(4) (I), (II), (IV)

18. Arrange the following compounds in increasing order of C–OH bond length :

methanol, phenol, p-ethoxyphenol

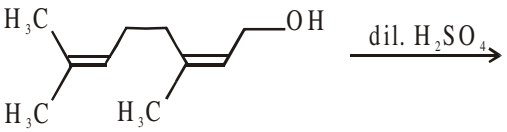
(1) phenol < methanol < p-ethoxyphenol

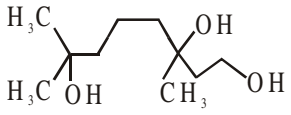
(2) phenol < p-ethoxyphenol < methanol

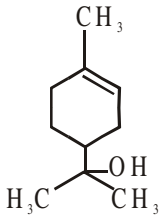
(3) methanol < p-ethoxyphenol < phenol

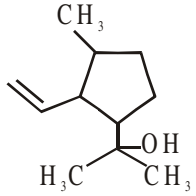
(4) methanol < phenol < p-ethoxyphenol

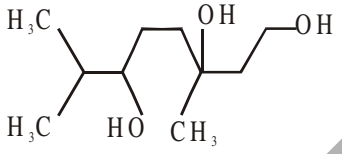
19. The major product of the following reaction is :



(1) 

(2) 

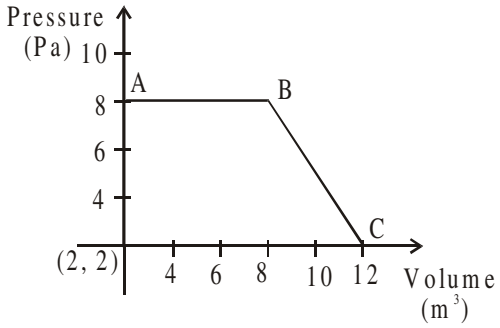
(3) 

(4) 

20. When gypsum is heated to 393 K, it forms :
(1) Dead burnt plaster
(2) Anhydrous $CaSO_4$
(3) $CaSO_4.5H_2O$
(4) $CaSO_4.0.5H_2O$

21. The number of chiral centres in penicillin is _____.

22. The magnitude of work done by a gas that undergoes a reversible expansion along the path ABC shown in the figure is _____



23. The volume (in mL) of 0.125 M $AgNO_3$ required to quantitatively precipitate chloride ions in 0.3 g of $[Co(NH_3)_6]Cl_3$ is _____.
$^M[Co(NH_3)_6]Cl_3$ = 267.46 g/mol
$^MAgNO_3$ = 169.87 g/mol

24. What would be the electrode potential for the given half cell reaction at pH = 5 ?_____

$2H_2O \rightarrow O_2 + 4H^{\oplus} + 4e^-$; E^0_{red} = 1.23 V

(R = 8.314 J mol^{-1} K^{-1} ; Temp = 298 K; oxygen under std. atm. pressure of 1 bar)

25. Ferrous sulphate heptahydrate is used to fortify foods with iron. The amount (in grams) of the salt required to achieve 10 ppm of iron in 100 kg of wheat is _____.
Atomic weight : Fe = 55.85 ; S = 32.0 ; O = 16.00

MATHEMATICS

1. Let the line y = mx and the ellipse $2x^2 + y^2 = 1$ intersect at a ponit P in the first quadrant. If the normal to this ellipse at P meets the co-ordinate axes at $\left(-\frac{1}{3\sqrt{2}}, 0\right)$ and $(0,\beta)$, then β is equal to

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

2. Let $f : R \rightarrow R$ be such that for all $x \in R$ $(2^{1+x} + 2^{1-x})$, $f(x)$ and $(3^x + 3^{-x})$ are in A.P., then the minimum value of $f(x)$ is
(1) 0 (2) 3 (3) 2 (4) 4

3. Let the volume of a parallelopiped whose coterminous edges are given by $\vec{u} = \hat{i} + \hat{j} + \lambda\hat{k}, \vec{v} = \hat{i} + \hat{j} + 3\hat{k}$ and $\vec{w} = 2\hat{i} + \hat{j} + \hat{k}$ be 1 cu. unit. If θ be the angle between the edges $\vec{u}$ and $\vec{w}$, then $\cos\theta$ can be

(1) $\frac{7}{6\sqrt{3}}$ (2) $\frac{5}{7}$

(3) $\frac{7}{6\sqrt{6}}$ (4) $\frac{5}{3\sqrt{3}}$

4. If a,b and c are the greatest value of ${}^{19}C_p, {}^{20}C_q$ and ${}^{21}C_r$ respectively, then

(1) $\frac{a}{11}=\frac{b}{22}=\frac{c}{21}$

(2) $\frac{a}{10}=\frac{b}{11}=\frac{c}{21}$

(3) $\frac{a}{10}=\frac{b}{11}=\frac{c}{42}$

(4) $\frac{a}{11}=\frac{b}{22}=\frac{c}{42}$

5. Let $f(x) = (\sin(\tan^{-1}x) + \sin(\cot^{-1}x))^2 - 1$, $|x| > 1$.

If $\frac{dy}{dx}=\frac{1}{2}\frac{d}{dx}\left(\sin^{-1}\left(f(x)\right)\right)$ and $y\left(\sqrt{3}\right)=\frac{\pi}{6}$, then $y\left(-\sqrt{3}\right)$ is equal to

(1) $\frac{5\pi}{6}$ (2) $-\frac{\pi}{6}$

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

6. $\lim\limits_{x\to 0}\left(\frac{3x^2+2}{7x^2+2}\right)^{\frac{1}{x^2}}$ is equal to

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

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

7. Let two points be A(1,–1) and B(0,2). If a point P(x',y') be such that the area of ΔPAB = 5 sq. units and it lies on the line, $3x + y - 4\lambda = 0$, then a value of λ is

(1) 1 (2) 4

(3) 3 (4) –3

8. The mean and the standard deviation (s.d.) of 10 observations are 20 and 2 resepectively. Each of these 10 observations is multiplied by p and then reduced by q, where $p \neq 0$ and $q \neq 0$. If the new mean and new s.d. become half of their original values, then q is equal to

(1) –20 (2) 10

(3) –10 (4) –5

9. Let y = y(x) be a solution of the differential equation, $\sqrt{1-x^2}\frac{dy}{dx}+\sqrt{1-y^2}=0, |x|<1$.

If $y\left(\frac{1}{2}\right)=\frac{\sqrt{3}}{2}$, then $y\left(\frac{-1}{\sqrt{2}}\right)$ is equal to

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

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

10. If the equation, $x^2 + bx + 45 = 0$ ($b \in R$) has conjugate complex roots and they satisfy $|z+1| = 2\sqrt{10}$, then

(1) $b^2 - b = 42$
(2) $b^2 + b = 12$
(3) $b^2 + b = 72$
(4) $b^2 - b = 30$

11. For $a > 0$, let the curves $C_1 : y^2 = ax$ and $C_2 : x^2 = ay$ intersect at origin O and a point P. Let the line $x = b (0 < b < a)$ intersect the chord OP and the x-axis at points Q and R, respectively. If the line x = b bisects the area bounded by the curves, C_1 and C_2, and the area of $\Delta OQR = \frac{1}{2}$, then 'a' satisfies the equation

(1) $x^6 - 12x^3 + 4 = 0$
(2) $x^6 - 12x^3 - 4 = 0$
(3) $x^6 + 6x^3 - 4 = 0$
(4) $x^6 - 6x^3 + 4 = 0$

12. Which one of the following is a tautology ?

(1) $P \wedge (P \vee Q)$

(2) $P \vee (P \wedge Q)$

(3) $Q \rightarrow (P \wedge (P \rightarrow Q))$

(4) $(P \wedge (P \rightarrow Q)) \rightarrow Q$

13. The locus of a point which divides the line segment joining the point (0,–1) and a point on the parabola, $x^2 = 4y$, internally in the ratio 1 : 2, is-

(1) $9x^2 - 3y = 2$ (2) $9x^2 - 12y = 8$

(3) $x^2 - 3y = 2$ (4) $4x^2 - 3y = 2$

14. If c is a point at which Rolle's theorem holds for the function, $f(x)=\log_e\left(\frac{x^2+\alpha}{7x}\right)$ in the interval [3,4], where $\alpha \in R$, then $f''(c)$ is equal to

(1) $\frac{\sqrt{3}}{7}$ (2) $\frac{1}{12}$ (3) $-\frac{1}{24}$ (4) $-\frac{1}{12}$

15. For which of the following ordered pairs (μ,δ), the system of linear equations
$x + 2y + 3z = 1$
$3x + 4y + 5z = \mu$
$4x + 4y + 4z = \delta$
is inconsistent ?
(1) (1,0) (2) (4,6) (3) (3,4) (4) (4,3)

16. Let A and B be two independent events such that $P(A)=\frac{1}{3}$ and $P(B)=\frac{1}{6}$. Then, which of the following is TRUE ?

(1) $P(A/B)=\frac{2}{3}$ (2) $P(A/(A\cup B))=\frac{1}{4}$

(3) $P(A/B')=\frac{1}{3}$ (4) $P(A'/B')=\frac{1}{3}$

17. The inverse function of
$f(x)=\frac{8^{2x}-8^{-2x}}{8^{2x}+8^{-2x}}, x\in(-1,1)$, is

(1) $\frac{1}{4}(\log_8 e)\log_e\left(\frac{1-x}{1+x}\right)$

(2) $\frac{1}{4}\log_e\left(\frac{1-x}{1+x}\right)$

(3) $\frac{1}{4}(\log_8 e)\log_e\left(\frac{1+x}{1-x}\right)$

(4) $\frac{1}{4}\log_e\left(\frac{1+x}{1-x}\right)$

18. If $\int\frac{\cos x\,dx}{\sin^3 x\left(1+\sin^6 x\right)^{2/3}}=f(x)\left(1+\sin^6 x\right)^{1/\lambda}+c$ where c is a constant of integration, then $\lambda f\left(\frac{\pi}{3}\right)$ is equal to

(1) –2 (2) $-\frac{9}{8}$ (3) 2 (4) $\frac{9}{8}$

19. The shortest distance between the lines
$\frac{x-3}{3}=\frac{y-8}{-1}=\frac{z-3}{1}$ and
$\frac{x+3}{-3}=\frac{y+7}{2}=\frac{z-6}{4}$ is

(1) $\frac{7}{2}\sqrt{30}$ (2) $3\sqrt{30}$ (3) 3 (4) $2\sqrt{30}$

20. Let $f(x) = x\cos^{-1}(-\sin|x|)$, $x\in\left[-\frac{\pi}{2},\frac{\pi}{2}\right]$, then which of the following is true ?

(1) f' is decreasing in $\left(-\frac{\pi}{2},0\right)$ and increasing in $\left(0,\frac{\pi}{2}\right)$

(2) f is not differentiable at x = 0

(3) $f'(0)=-\frac{\pi}{2}$

(4) f' is increasing in $\left(-\frac{\pi}{2},0\right)$ and decreasing in $\left(0,\frac{\pi}{2}\right)$

21. The number of all 3 × 3 matrices A, with enteries from the set {–1,0,1} such that the sum of the diagonal elements of AA^T is 3, is

22. The least positive value of 'a' for which the equation $2x^2 + (a - 10)x + \frac{33}{2} = 2a$ has real roots is

23. Let the normal at a point P on the curve $y^2 - 3x^2 + y + 10 = 0$ intersect the y-axis at $\left(0,\frac{3}{2}\right)$. If m is the slope of the tangent at P to the curve, then |m| is equal to

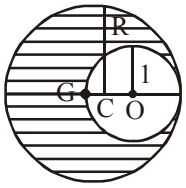
24. The sum $\sum_{k=1}^{20}(1+2+3+...+k)$ is ....

25. An urn contains 5 red marbles, 4 black marbles and 3 white marbles. Then the number of ways in which 4 marbles can be drawn so that at the most three of them are red is ....

SET # 04

PHYSICS

1. As shown in figure, when a spherical cavity (centred at O) of radius 1 is cut out of a uniform sphere of radius R (centred at C), the centre of mass of remaining (shaded) part of sphere is at G, i.e, on the surface of the cavity. R can be detemined by the equation :



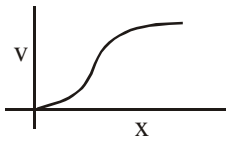
(1) $(R^2 - R + 1)(2 - R) = 1$
(2) $(R^2 + R - 1)(2 - R) = 1$
(3) $(R^2 + R + 1)(2 - R) = 1$
(4) $(R^2 - R - 1)(2 - R) = 1$

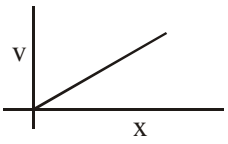
2. In a double slit experiment, at a certain point on the screen the path difference between the two interfering waves is $\frac{1}{8}$th of a wavelength. The ratio of the intensity of light at that point to that at the centre of a bright fringe is :
(1) 0.568 (2) 0.672 (3) 0.760 (4) 0.853

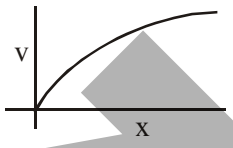
3. A plane electromagnetic wave of frequency 25 GHz is propagating in vacuum along the z-direction. At a particular point in space and time, the magnetic field is given by $\vec{B} = 5\times10^{-8}\hat{j}\,T$. The corresponding electric field $\vec{E}$ is (speed of light c = 3×10^8 ms^{-1})
(1) $1.66 \times 10^{-16}\ \hat{i}\,V/m$
(2) $15\,\hat{i}\,V/m$
(3) $-1.66\times10^{-16}\,\hat{i}\,V/m$
(4) $-15\,\hat{i}\,V/m$

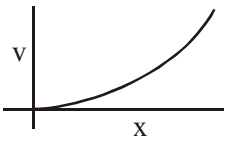
4. A galvanometer having a coil resistance 100 Ω gives a full scale deflection when a current of 1 mA is passed through it. What is the value of the resistance which can convert this galvanometer into a voltmeter giving full scale deflection for a potential difference of 10 V?
(1) 9.9 kΩ (2) 8.9 kΩ
(3) 7.9 kΩ (4) 10 kΩ

5. A particle of mass m and charge q is released from rest in a uniform electric field. If there is no other force on the particle, the dependence of its speed v on the distance x travelled by it is correctly given by (graphs are schematic and not drawn to scale)

(1) 

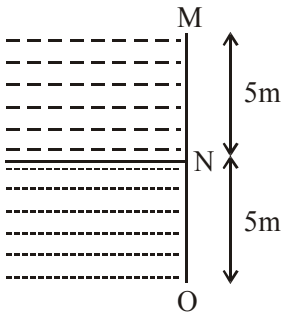
(2) 

(3) 

(4) 

6. A simple pendulum is being used to determine th value of gravitational acceleration g at a certain place. Th length of the pendulum is 25.0 cm and a stop watch with 1s resolution measures the time taken for 40 oscillations to be 50 s. The accuracy in g is :
(1) 3.40% (2) 5.40%
(3) 4.40% (4) 2.40%

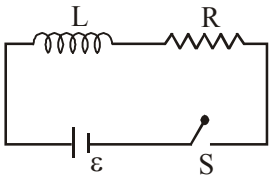
7. Two liquids of densities ρ_1 an ρ_2 ($\rho_2 = 2\rho_1$) are filled up behind a square wall of side 10 m as shown in figure. Each liquid has a height of 5 m. The ratio of the forces due to these liquids exerted on upper part MN to that at the lower part NO is (Assume that the liquids are not mixing)



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

8. A transverse wave travels on a taut steel wire with a velocity of v when tension in it is 2.06×10^4 N. When the tension is changed to T, the velocity changed to v/2. The value of T is close to :
(1) 10.2×10^2 N (2) 5.15×10^3 N
(3) 2.50×10^4 N (4) 30.5×10^4 N

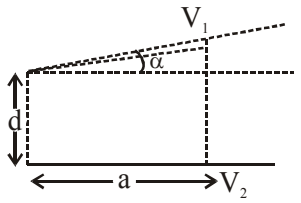
9. A shown in the figure, a battery of emf ε is connected to an inductor L and resistance R in series. The switch is closed at t = 0. The total charge that flows from the battery, between t = 0 and t = t_c (t_c is the time constant of the circuit) is :



(1) $\frac{\varepsilon L}{R^2}\left(1-\frac{1}{e}\right)$ (2) $\frac{\varepsilon R}{eL^2}$

(3) $\frac{\varepsilon L}{R^2}$ (4) $\frac{\varepsilon L}{eR^2}$

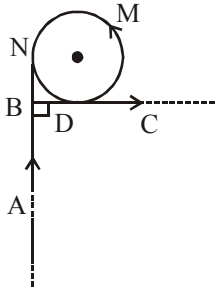
10. A capacitor is made of two square plates each of side 'a' making a very small angle α between them, as shown in figure. The capacitance will be close to :



(1) $\frac{\varepsilon_0 a^2}{d}\left(1-\frac{3\alpha a}{2d}\right)$ (2) $\frac{\varepsilon_0 a^2}{d}\left(1-\frac{\alpha a}{4d}\right)$

(3) $\frac{\varepsilon_0 a^2}{d}\left(1+\frac{\alpha a}{d}\right)$ (4) $\frac{\varepsilon_0 a^2}{d}\left(1-\frac{\alpha a}{2d}\right)$

11. A very long wire ABDMNDC is shown in figure carrying current I. AB and BC parts are straight, long and at right angle. At D wire forms a circular turn DMND of radius R. AB, BC parts are tangential to circular turn at N and D. Magnetic field at the centre of circle is :



(1) $\frac{\mu_0 I}{2R}$ (2) $\frac{\mu_0 I}{2\pi R}(\pi+1)$

(3) $\frac{\mu_0 I}{2\pi R}\left(\pi+\frac{1}{\sqrt{2}}\right)$ (4) $\frac{\mu_0 I}{2\pi R}\left(\pi-\frac{1}{\sqrt{2}}\right)$

12. A particle of mass m is dropped from a height h above the ground. At the same time another particle of the same mass is thrown vertically upwards from the ground with a speed of $\sqrt{2gh}$. If they collide head-on completely inelastically, the time taken for the combined mass to reach the ground, in units of $\sqrt{\frac{h}{g}}$ is :

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

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

13. A carnot engine having an efficiency of $\frac{1}{10}$ is being used as a refrigerator. If the work done on the refrigerator is 10 J, the amount of heat absorbed from the reservoir at lower temperature is :

(1) 99 J (2) 100 J

(3) 90 J (4) 1 J

14. Consider a mixture of n moles of helium gas and 2 n moles of oxygen gas (molecules taken to be rigid) as an ideal gas. Its C_P/C_V value will be :

(1) 67/45 (2) 19/13

(3) 23/15 (4) 40/27

15. An electron (mass m) with initial velocity $\vec{v} = v_0\hat{i} + v_0\hat{j}$ is in an electric field $\vec{E} = -E_0\hat{k}$. If λ_0 is initial de-Broglie wavelength of electron, its de-Broglie wave length at time t is given by :

(1) $\frac{\lambda_0\sqrt{2}}{\sqrt{1+\frac{e^2E^2t^2}{m^2v_0^2}}}$ (2) $\frac{\lambda_0}{\sqrt{2+\frac{e^2E^2t^2}{m^2v_0^2}}}$

(3) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E^2t^2}{2m^2v_0^2}}}$ (4) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$

16. A uniform sphere of mass 500 g rolls without slipping on a plane horizontal surface with its centre moving at a speed of 5.00 cm/s. Its kinetic energy is :

(1) 8.75×10^{-4} J (2) 8.75×10^{-3} J

(3) 6.25×10^{-4} J (4) 1.13×10^{-3} J

17. Consider two charged metallic spheres S_1 and S_2 of radii R_1 and R_2, respectively. The electric fields E_1 (on S_1) and E_2 (on S_2) on their surfaces are such that $E_1/E_2 = R_1/R_2$. Then the ratio V_1 (on S_1) / V_2 (on S_2) of the electrostatic potentials on each sphere is :

(1) (R_2/R_1) (2) $\left(\frac{R_1}{R_2}\right)^3$

(3) R_1/R_2 (4) $(R_1/R_2)^2$

18. A particle moves such that its position vector $\vec{r}(t) = \cos\omega t\,\hat{i} + \sin\omega t\,\hat{j}$ where ω is a constant and t is time. Then which of the following statements is true for the velocity $\vec{v}(t)$ and acceleration $\vec{a}(t)$ of the particle :

(1) $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed towards the origin

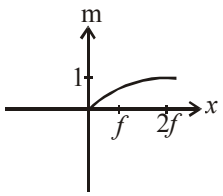
(2) $\vec{v}$ and $\vec{a}$ both are parallel to $\vec{r}$

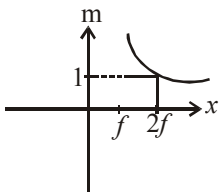
(3) $\vec{v}$ and $\vec{a}$ both are perpendicular to $\vec{r}$

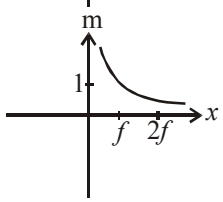
(4) $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed away from the origin

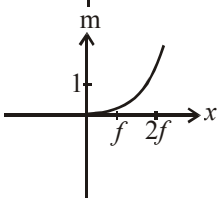
19. An object is gradually moving away from the focal point of a concave mirror along the axis of the mirror. The graphical representation of the magnitude of linear magnification (m) versus distance of the object from the mirror (x) is correctly given by :

(Graphs are drawn schematically and are not to scale)

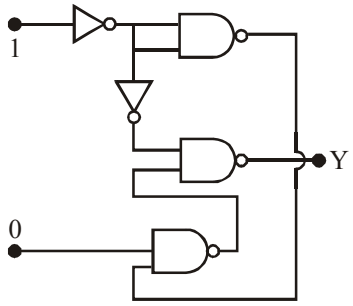
(1) 

(2) 

(3) 

(4) 

20. In the given circuit, value of Y is :



(1) will not execute

(2) 0

(3) toggles between 0 and 1

(4) 1

21. Three containers C_1, C_2 and C_3 have water at different temperatures. The table below shows the final temperature T when different amounts of water (given in litres) are taken from each containers and mixed (assume no loss of heat during the process)

C_1	C_2	C_3	T
$1l$	$2l$	–	60°C
–	$1l$	$2l$	30°C
$2l$	–	$1l$	60°C
$1l$	$1l$	$1l$	θ

The value of θ (in °C to the nearest integer) is .....

22. A ball is dropped from the top of a 100 m high tower on a planet. In the last $\frac{1}{2}$s before hitting the ground, it covers a distance of 19 m. Acceleration due to gravity (in ms^{-2}) near the surface on that planet is _____

23. The first member of the Balmer series of hydrogen atom has a wavelength of 6561 Å. The wavelength of the second member of the Balmer series (in nm) is:

24. An asteroid is moving directly towards the centre of the earth. When at a distance of 10R (R is the radius of the earth) from the earths centre, it has a speed of 12 km/s. Neglecting the effect of earths atmosphere, what will be the speed of the asteroid when it hits the surface of the earth (escape velocity from the earth is 11.2 km/s) ? Give your answer to the nearest integer in kilometer/s _____.

25. The series combination of two batteries, both of the same emf 10 V, but different internal resistance of 20Ω and 5Ω, is connected to the parallel combination of two resistors 30 Ω and R Ω. The voltage difference across the battery of internal resistance 20Ω is zero, the value of R (in Ω) is : _____

CHEMISTRY

1. Among the reactions (a) - (d), the reaction(s) that does/do not occur in the blast furnace during the extraction of iron is/are :

(a) $CaO + SiO_2 \rightarrow CaSiO_3$

(b) $3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$

(c) $FeO + SiO_2 \rightarrow FeSiO_3$

(d) $FeO \rightarrow Fe + \frac{1}{2}O_2$

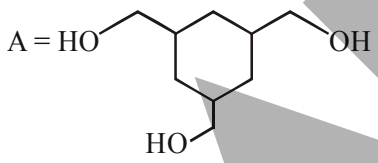
(1) (c) and (d)

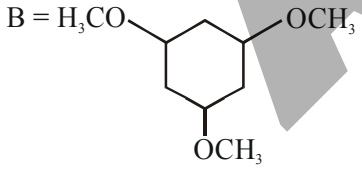
(2) (a) and (d)

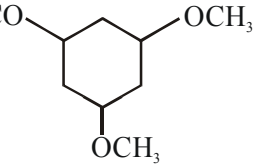
(3) (d)

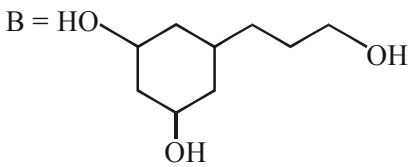
(4) (a)

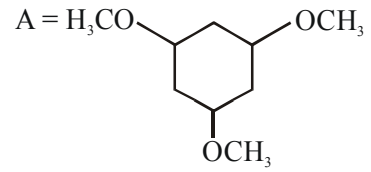
2. Among the compounds A and B with molecular formula $C_9H_{18}O_3$, A is having higher boiling point the B. The possible structures of A and B are :

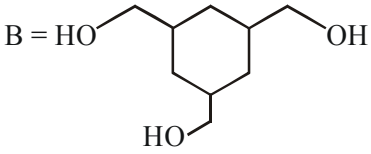
(1) A = 

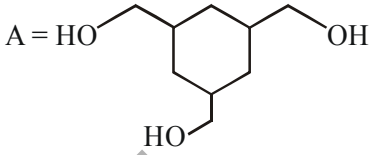
B = 

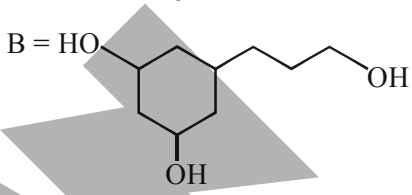
(2) A = 

B = 

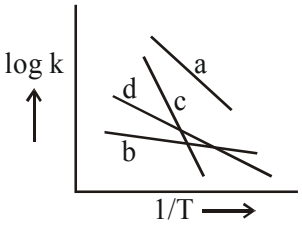
(3) A = 

B = 

(4) A = 

B = 

3. Consider the following plots of rate constant versus $\frac{1}{T}$ for four different reactions. Which of the following orders is correct for the activation energies of these reactions?



(1) $E_b > E_d > E_c > E_a$ (2) $E_a > E_c > E_d > E_b$

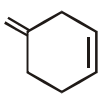
(3) $E_c > E_a > E_d > E_b$ (4) $E_b > E_a > E_d > E_c$

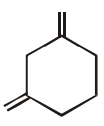
4. An unsaturated hydrocarbon X absorbs two hydrogen molecules on catalytic hydrogenattion, and also gives following reaction :

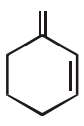
$$X \xrightarrow[Zn/H_2O]{O_3} A \xrightarrow{[Ag(NH_3)_2]^+}$$

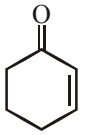
B(3 - oxo - hexanedicarboxylic acid)

X will be :-

(1) 

(2) 

(3) 

(4) 

5. The increasing order of the atomic radii of the following elements is :-

(a) C (b) O (c) F (d) Cl

(e) Br

(1) (b) < (c) < (d) < (a) < (e)

(2) (a) < (b) < (c) < (d) < (e)

(3) (d) < (c) < (b) < (a) < (e)

(4) (c) < (b) < (a) < (d) < (e)

6. Kjeldahl's method cannot be used to estimate nitrogen for which of the following compounds?

(1) $C_6H_5NO_2$ (2) $C_6H_5NH_2$

(3) $CH_3CH_2-C\equiv N$ (4) $NH_2-\overset{\overset{O}{\|}}{C}-NH_2$

7. The major product [B] in the following sequence of reactions is :-

$$CH_3-\underset{\underset{CH(CH_3)_2}{|}}{C}=CH-CH_2CH_3 \xrightarrow[(ii)\ H_2O_2,OH^{\ominus}]{(i)\ B_2H_6} [A] \xrightarrow[\Delta]{dil.\ H_2SO_4} [B]$$

(1) $CH_3-\underset{\underset{C}{\|}}{C}-CH_2CH_2CH_3$ with C bonded to H_3C and CH_3

(2) $CH_2=\underset{\underset{CH(CH_3)_2}{|}}{C}-CH_2CH_2CH_3$

(3) $CH_3-\underset{\underset{CH(CH_3)_2}{|}}{CH}-CH=CH-CH_3$

(4) $CH_3-\underset{\underset{CH(CH_3)_2}{|}}{C}=CH-CH_2CH_3$

8. A metal (A) on heating in nitrogen gas gives compound B. B on treatment with H_2O gives a colourless gas which when passed through $CuSO_4$ solution gives a dark blue-violet coloured solution. A and B respectively, are :

(1) Mg and Mg_3N_2 (2) Na and $NaNO_3$

(3) Mg and $Mg(NO_3)_2$ (4) Na and Na_3N

9. Which of the following compounds is likely to show both Frenkel and Schottky defects in its crystalline form?

(1) AgBr (2) ZnS (3) KBr (4) CsCl

10. For the following Assertion and Reason, the correct option is :

Assertion : The pH of water increases with increase in temperature.

Reason : The dissociation of water into H^+ and OH^- is an exothermic reaction.

(1) Both assertion and reason are true, but the reason is not the correct explanation for the assertion.

(2) Both assertion and reason are false.

(3) Assertion is not true, but reason is true.

(4) Both assertion and reason are true, and the reason is the correct explanation for the assertion.

11. Arrange the following bonds according to their average bond energies in descending order :

C–Cl, C–Br, C–F, C–I

(1) C–I > C–Br > C–Cl > C–F

(2) C–Br > C–I > C–Cl > C–F

(3) C–F > C–Cl > C–Br > C–I

(4) C–Cl > C–Br > C–I > C–F

12. White Phosphorus on reaction with concentrated NaOH solution in an inert atmosphere of CO_2 gives phosphine and compound (X). (X) on acidification with HCl gives compound (Y). The basicity of compound (Y) is :

(1) 4 (2) 1

(3) 2 (4) 3

13. The radius of the second Bohr orbit, in terms of the Bohr radius, a_0, in Li^{2+} is :

(1) $\frac{4a_0}{9}$ (2) $\frac{2a_0}{9}$

(3) $\frac{2a_0}{3}$ (4) $\frac{4a_0}{3}$

14. Among (a) – (d) the complexes that can display geometrical isomerism are :

(a) $[Pt(NH_3)_3Cl]^+$

(b) $[Pt(NH_3)Cl_5]^-$

(c) $[Pt(NH_3)_2Cl(NO_2)]$

(d) $[Pt(NH_3)_4ClBr]^{2+}$

(1) (d) and (a) (2) (a) and (b)

(3) (b) and (c) (4) (c) and (d)

15. Two monomers in maltose are :

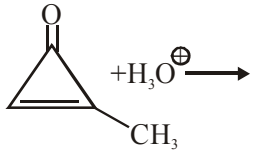
(1) α-D-glucose and β-D-glucose

(2) α-D-glucose and α-D-Fructose

(3) α-D-glucose and α-D-glucose

(4) α-D-glucose and α-D-galactose

16. The major product in the following reaction is:



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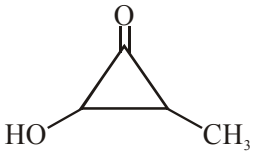

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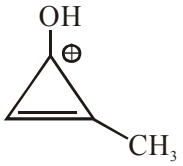

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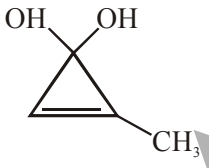

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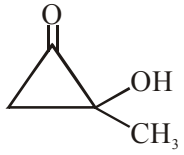


17. Hydrogen has three isotopes (A), (B) and (C). If the number of neutron(s) in (A), (B) and (C) respectively, are (x), (y) and (z), the sum of (x), (y) an (z) is :

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

18. Preparation of Bakelite proceeds via reactions.

(1) Condensation and elimination

(2) Electrophilic addition and dehydration

(3) Electrophilic substitution and dehydration

(4) Nucleophilic addition and dehydration

19. For the following Assertion and Reason, the correct option is

Assertion : For hydrogenation reactions, the catalytic activity increases from Group 5 to Group 11 metals with maximum activity shown by Group 7-9 elements.

Reason : The reactants are most strongly adsorbed on group 7-9 elements.

(1) Both assertion and reason are true but the reason is not the correct explanation for the assertion.

(2) Both assertion and reason are false.

(3) Both assertion and reason are true and the reason is the correct explanation for the assertion.

(4) The assertion is true, but the reason is false.

20. The correct order of the calculated spin-only magnetic moments of complexs (A) to (D) is:

(A) $Ni(CO)_4$ (B) $[Ni(H_2O)_6]Cl_2$

(C) $Na_2[Ni(CN)_4]$ (D) $PdCl_2(PPh_3)_2$

(1) (A) ≈ (C) ≈ (D) < (B)

(2) (A) ≈ (C) < (B) ≈ (D)

(3) (C) < (D) < (B) < (A)

(4) (C) ≈ (D) < (B) < (A)

21. For an electrochemical cell

$Sn(s) \mid Sn^{2+}(aq,1M) \| Pb^{2+}(aq,1M) \mid Pb(s)$

the ratio $\frac{[Sn^{2+}]}{[Pb^{2+}]}$ when this cell attains equilibrium is _____.

(Given $E^0_{Sn^{2+}|Sn} = -0.14V$,

$E^0_{Pb^{2+}|Pb} = -0.13V, \frac{2.303RT}{F} = 0.06$)

22. At constant volume, 4 mol of an ideal gas when heated from 300 K to 500K changes its internal energy by 5000 J. The molar heat capacity at constant volume is _____.

23. $NaClO_3$ is used, even in spacecrafts, to produce O_2. The daily consumption of pure O_2 by a person is 492L at 1 atm, 300K. How much amount of $NaClO_3$, in grams, is required to produce O_2 for the daily consumption of a person at 1 atm, 300 K ?

$NaClO_3(s) + Fe(s) \rightarrow O_2(g) + NaCl(s) + FeO(s)$

$R = 0.082\ L\ atm\ mol^{-1}\ K^{-1}$

24. In the following sequence of reactions the maximum number of atoms present in molecule 'C' in one plane is _____.

$$A \xrightarrow[\text{Cu tube}]{\text{Red hot}} B \xrightarrow[\text{Anhydrous } AlCl_3]{CH_3Cl(1.eq.)} C$$

(A is a lowest molecular weight alkyne)

25. Complexes (ML_5) of metals Ni and Fe have ideal square pyramidal and trigonal bipyramidal grometries, respectively. The sum of the 90°, 120° and 180° L-M L angles in the two complexes is _____.

MATHEMATICS

1. Let $\vec{a}=\hat{i}-2\hat{j}+\hat{k}$ and $\vec{b}=\hat{i}-\hat{j}+\hat{k}$ be two vectors. If $\vec{c}$ is a vector such that $\vec{b}\times\vec{c}=\vec{b}\times\vec{a}$ and $\vec{c}\cdot\vec{a}=0$, then $\vec{c}\cdot\vec{b}$ is equal to

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

2. The area (in sq. units) of the region $\{(x,y)\in R^2 : x^2 \le y \le 3-2x\}$, is

(1) $\frac{29}{3}$ (2) $\frac{31}{3}$ (3) $\frac{34}{3}$ (4) $\frac{32}{3}$

3. The length of the perpendicular from the origin, on the normal to the curve, $x^2 + 2xy - 3y^2 = 0$ at the point (2,2) is

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

4. If $I=\int_1^2 \frac{dx}{\sqrt{2x^3-9x^2+12x+4}}$, then :

(1) $\frac{1}{9}<I^2<\frac{1}{8}$ (2) $\frac{1}{16}<I^2<\frac{1}{9}$

(3) $\frac{1}{6}<I^2<\frac{1}{2}$ (4) $\frac{1}{8}<I^2<\frac{1}{4}$

5. If a line, y = mx + c is a tangent to the circle, $(x-3)^2 + y^2 = 1$ and it is perpendicular to a line L_1, where L_1 is the tangent to the circle, $x^2 + y^2 = 1$ at the point $\left(\frac{1}{\sqrt{2}},\frac{1}{\sqrt{2}}\right)$, then

(1) $c^2 - 6c + 7 = 0$
(2) $c^2 + 6c + 7 = 0$
(3) $c^2 + 7c + 6 = 0$
(4) $c^2 - 7c + 6 = 0$

6. Let S be the set of all functions $f : [0,1] \to R$, which are continuous on [0,1] and differentiable on (0,1). Then for every f in S, there exists a $c \in (0,1)$, depending on f, such that

(1) $|f(c) - f(1)| < (1 - c)|f'(c)|$
(2) $|f(c) - f(1)| < |f'(c)|$
(3) $|f(c) + f(1)| < (1 + c)|f'(c)|$
(4) $\frac{f(1)-f(c)}{1-c}=f'(c)$

7. Which of the following statements is a tautology?

(1) $\sim(p \vee \sim q) \to p \vee q$
(2) $\sim(p \wedge \sim q) \to p \vee q$
(3) $\sim(p \vee \sim q) \to p \wedge q$
(4) $p \vee (\sim q) \to p \wedge q$

8. If the 10^{th} term of an A.P. is $\frac{1}{20}$ and its 20^{th} term is $\frac{1}{10}$, then the sum of its first 200 terms is

(1) $50\frac{1}{4}$ (2) $100\frac{1}{2}$

(3) 50 (4) 100

9. Let $f : (1,3) \to R$ be a function defined by $f(x)=\frac{x[x]}{1+x^2}$, where [x] denotes the greatest integer ≤ x. Then the range of f is

(1) $\left(\frac{3}{5},\frac{4}{5}\right)$ (2) $\left(\frac{2}{5},\frac{3}{5}\right]\cup\left(\frac{3}{4},\frac{4}{5}\right)$

(3) $\left(\frac{2}{5},\frac{4}{5}\right]$ (4) $\left(\frac{2}{5},\frac{1}{2}\right)\cup\left(\frac{3}{5},\frac{4}{5}\right]$

10. The system of linear equations

$\lambda x + 2y + 2z = 5$
$2\lambda x + 3y + 5z = 8$
$4x + \lambda y + 6z = 10$ has

(1) infinitely many solutions when $\lambda = 2$
(2) a unique solution when $\lambda = -8$
(3) no solution when $\lambda = 8$
(4) no solution when $\lambda = 2$

11. If α and β be the coefficients of x^4 and x^2 respectively in the expansion of

$\left(x+\sqrt{x^2-1}\right)^6+\left(x-\sqrt{x^2-1}\right)^6$, then

(1) $\alpha+\beta=60$ (2) $\alpha+\beta=-30$

(3) $\alpha-\beta=-132$ (4) $\alpha-\beta=60$

12. $\lim\limits_{x\to 0}\dfrac{\int_0^x t\sin(10t)dt}{x}$ is equal to

(1) 0 (2) $-\dfrac{1}{5}$

(3) $-\dfrac{1}{10}$ (4) $\dfrac{1}{10}$

13. If $A=\begin{pmatrix}2 & 2\\ 9 & 4\end{pmatrix}$ and $I=\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}$, then $10A^{-1}$ is equal to

(1) 4I – A (2) A – 6I

(3) 6I – A (4) A – 4I

14. The mean and variance of 20 observations are found to be 10 and 4, respectively. On rechecking, it was found that an observation 9 was incorrect and the correct observation was 11. Then the correct variance is

(1) 3.99 (2) 3.98

(3) 4.02 (4) 4.01

15. If a hyperbola passes through the point P(10,16) and it has vertices at (±6,0), then the equation of the normal to it at P is

(1) x + 2y = 42 (2) 3x + 4y = 94

(3) 2x + 5y = 100 (4) x + 3y = 58

16. Let A and B be two events such that the probability that exactly one of them occurs is $\dfrac{2}{5}$ and the probability that A or B occurs is $\dfrac{1}{2}$, then the probability of both of them occur together is

(1) 0.02 (2) 0.01 (3) 0.20 (4) 0.10

17. The mirror image of the point (1,2,3) in a plane is $\left(-\dfrac{7}{3},-\dfrac{4}{3},-\dfrac{1}{3}\right)$. Which of the following points lies on this plane ?

(1) (–1, –1, –1) (2) (–1, –1, 1)

(3) (1, 1, 1) (4) (1, –1, 1)

18. Let S be the set of all real roots of the equation, $3^x(3^x-1)+2=|3^x-1|+|3^x-2|$. Then S :

(1) is an empty set.

(2) contains at least four elements.

(3) contains exactly two elements.

(4) is a singleton.

19. Let $\alpha=\dfrac{-1+i\sqrt{3}}{2}$. If $a=(1+\alpha)\sum\limits_{k=0}^{100}\alpha^{2k}$ and $b=\sum\limits_{k=0}^{100}\alpha^{3k}$, then a and b are the roots of the quadratic equation :

(1) $x^2-102x+101=0$

(2) $x^2+101x+100=0$

(3) $x^2-101x+100=0$

(4) $x^2+102x+101=0$

20. The differential equation of the family of curves, $x^2=4b(y+b)$, $b\in R$, is

(1) $x(y')^2=x+2yy'$

(2) $x(y')^2=2yy'-x$

(3) $xy''=y'$

(4) $x(y')^2=x-2yy'$

21. If $\dfrac{\sqrt{2}\sin\alpha}{\sqrt{1+\cos 2\alpha}}=\dfrac{1}{7}$ and $\sqrt{\dfrac{1-\cos 2\beta}{2}}=\dfrac{1}{\sqrt{10}}$, $\alpha,\beta\in\left(0,\dfrac{\pi}{2}\right)$, then $\tan(\alpha+2\beta)$ is equal to _____.

22. Let $f(x)$ be a polynomial of degree 3 such that $f(-1)=10$, $f(1)=-6$, $f(x)$ has a critical point at $x=-1$ and $f'(x)$ has a critical point at $x=1$. Then $f(x)$ has a local minima at x = _____.

23. Let a line $y=mx$ $(m>0)$ intersect the parabola, $y^2=x$ at a point P, other than the origin. Let the tangent to it at P meet the x-axis at the point Q. If area $(\Delta OPQ)=4$ sq. units, then m is equal to _____.

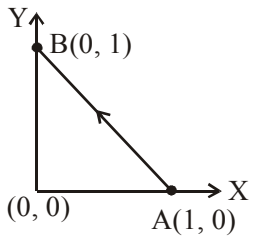
24. The sum, $\sum\limits_{n=1}^{7}\dfrac{n(n+1)(2n+1)}{4}$ is equal to _____.

25. The number of 4 letter words (with or without meaning) that can be formed from the eleven letters of the word 'EXAMINATION' is _____.

SET # 05

PHYSICS

1. Consider a force $\vec{F} = -x\hat{i} + y\hat{j}$. The work done by this force in moving a particle from point A(1, 0) to B(0, 1) along the line segment is : (all quantities are in SI units)



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

2. A quantity f is given by $f = \sqrt{\frac{hc^5}{G}}$ where c is speed of light, G universal gravitational constant and h is the Planck's constant. Dimension of f is that of :

(1) Momentum (2) Area

(3) Energy (4) Volume

3. A body A of mass m is moving in a circular orbit of radius R about a planet. Another body B of mass $\frac{m}{2}$ collides with A with a velocity which is half $\left(\frac{\vec{v}}{2}\right)$ the instantaneous velocity $\vec{v}$ of A. The collision is completely inelastic. Then, the combined body :

(1) starts moving in an elliptical orbit around the planet.

(2) continues to move in a circular orbit

(3) Falls vertically downwards towards the planet

(4) Escapes from the Planet's Gravitational field.

4. The electric fields of two plane electromagnetic plane waves in vacuum are given by

$\vec{E}_1 = E_0\hat{j}\cos(\omega t - kx)$ and

$\vec{E}_2 = E_0\hat{k}\cos(\omega t - ky)$

At t = 0, a particle of charge q is at origin with a velocity $\vec{v} = 0.8c\hat{j}$ (c is the speed of light in vacuum). The instantaneous force experienced by the particle is :

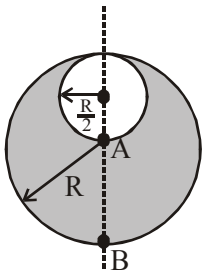
(1) $E_0q(-0.8\hat{i} + \hat{j} + \hat{k})$

(2) $E_0q(0.8\hat{i} - \hat{j} + 0.4\hat{k})$

(3) $E_0q(0.8\hat{i} + \hat{j} + 0.2\hat{k})$

(4) $E_0q(0.4\hat{i} - 3\hat{j} + 0.8\hat{k})$

5. Consider a sphere of radius R which carries a uniform charge density ρ. If a sphere of radius $\frac{R}{2}$ is carved out of it, as shown, the ratio $\frac{|\vec{E}_A|}{|\vec{E}_B|}$ of magnitude of electric field $\vec{E}_A$ and $\vec{E}_B$, respectively, at points A and B due to the remaining portion is :



(1) $\frac{18}{54}$ (2) $\frac{21}{34}$

(3) $\frac{17}{54}$ (4) $\frac{18}{34}$

6. A long, straight wire of radius a carries a current distributed uniformly over its cross-section. The ratio of the magnetic fields due to the wire at distance $\frac{a}{3}$ and 2a, respectively from the axis of the wire is :

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

7. Consider two ideal diatomic gases A and B at some temperature T. Molecules of the gas A are rigid, and have a mass m. Molecules of the gas B have an additional vibrational mode, and have a mass $\frac{m}{4}$. The ratio of the specific heats (C_V^A and C_V^B) of gas A and B, respectively is :

(1) 7 : 9 (2) 5 : 7 (3) 3 : 5 (4) 5 : 9

8. A particle moving with kinetic energy E has de Broglie wavelength λ. If energy ΔE is added to its energy, the wavelength become λ/2. Value of ΔE, is :

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

9. If the screw on a screw-gauge is given six rotations, it moves by 3 mm on the main scale. If there are 50 divisions on the circular scale the least count of the screw gauge is :

(1) 0.001 mm (2) 0.001 cm

(3) 0.02 mm (4) 0.01 cm

10. A vessel of depth 2h is half filled with a liquid of refractive index $2\sqrt{2}$ and the upper half with another liquid of refractive index $\sqrt{2}$. The liquids are immiscible. The apparent depth of the inner surface of the bottom of vessel will be :

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

(3) $\frac{h}{2\left(\sqrt{2}+1\right)}$ (4) $\frac{h}{3\sqrt{2}}$

11. Radiation, with wavelength 6561 Å falls on a metal surface to produce photoelectrons. The electrons are made to enter a uniform magnetic field of 3×10^{-4} T. If the radius of the largest circular path followed by the electrons is 10 mm, the work function of the metal is close to :

(1) 1.8eV (2) 1.1eV

(3) 0.8eV (4) 1.6eV

12. The aperture diameter of a telescope is 5m. The separation between the moon and the earth is 4×10^5 km. With light of wavelength of 5500 Å, the minimum separation between objects on the surface of moon, so that they are just resolved, is close to :

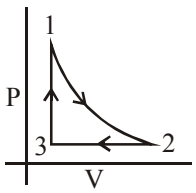
(1) 20 m (2) 600 m

(3) 60 m (4) 200 m

13. Two particles of equal mass m have respective initial velocities $u\hat{i}$ and $u\left(\frac{\hat{i}+\hat{j}}{2}\right)$. They collide completely inelastically. The energy lost in the process is :

(1) $\frac{3}{4}mu^2$ (2) $\frac{1}{8}mu^2$ (3) $\sqrt{\frac{2}{3}}mu^2$ (4) $\frac{1}{3}mu^2$

14. Which of the following is an equivalent cyclic process corresponding to the thermodynamic cyclic given in the figure ? where, $1 \rightarrow 2$ is adiabatic.
(Graphs are schematic and are not to scale)



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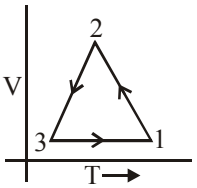

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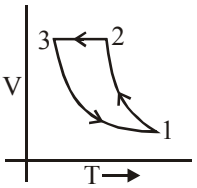

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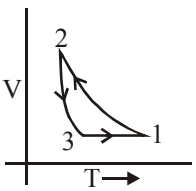
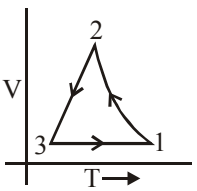
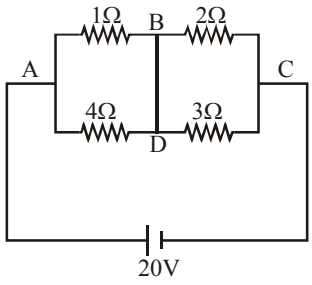


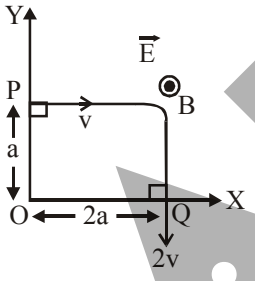
(4)


15. In the given circuit diagram, a wire is joining points B and D. The current in this wire is :



(1) 4A (2) 2A (3) 0.4A (4) Zero

16. A charged particle of mass 'm' and charge 'q' moving under the influence of uniform electric field $E\hat{i}$ and a uniform magnetic field $B\hat{k}$ follows a trajectory from point P to Q as shown in figure. The velocities at P and Q are respectively, $v\hat{i}$ and $-2v\hat{j}$. Then which of the following statements (A, B, C, D) are the correct ? (Trajectory shown is schematic and not to scale) :



(A) $E=\frac{3}{4}\left(\frac{mv^2}{qa}\right)$

(B) Rate of work done by the electric field at P is $\frac{3}{4}\left(\frac{mv^3}{a}\right)$

(C) Rate of work done by both the fields at Q is zero

(D) The difference between the magnitude of angular momentum of the particle at P and Q is 2 mav.

(1) (A), (B), (C), (D) (2) (A), (B), (C)
(3) (B), (C), (D) (4) (A), (C), (D)

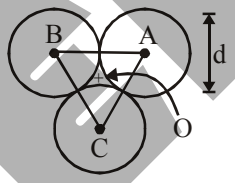
17. Three harmonic waves having equal frequency ν and same intensity I_0, have phase angles 0, $\frac{\pi}{4}$ and $-\frac{\pi}{4}$ respectively. When they are superimposed the intensity of the resultant wave is close to :

(1) 5.8 I_0 (2) 0.2 I_0
(3) I_0 (4) 3 I_0

18. An electric dipole of moment $\vec{p}=(-\hat{i}-3\hat{j}+2\hat{k})\times10^{-29}$ C .m is at the origin (0, 0, 0). The electric field due to this dipole at $\vec{r}=+\hat{i}+3\hat{j}+5\hat{k}$ (note that $\vec{r}.\vec{p}=0$) is parallel to:

(1) $(-\hat{i}+3\hat{j}-2\hat{k})$ (2) $(+\hat{i}-3\hat{j}-2\hat{k})$
(3) $(+\hat{i}+3\hat{j}-2\hat{k})$ (4) $(-\hat{i}-3\hat{j}+2\hat{k})$

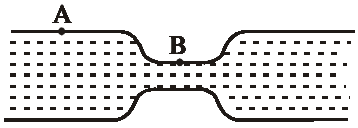
19.



Three solid spheres each of mass m and diameter d are stuck together such that the lines connecting the centres form an equilateral triangle of side of length d. The ratio I_0/I_A of moment of inertia I_0 of the system about an axis passing the centroid and about center of any of the spheres I_A and perpendicular to the plane of the triangle is :

(1) $\frac{13}{23}$ (2) $\frac{15}{13}$ (3) $\frac{23}{13}$ (4) $\frac{13}{15}$

20. Water flows in a horizontal tube (see figure). The pressure of water changes by 700 Nm^{-2} between A and B where the area of cross section are 40 cm^2 and 20 cm^2, respectively. Find the rate of flow of water through the tube. (density of water = 1000 kgm^{-3})

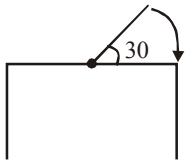


(Fig.)

(1) 1810 cm^3/s (2) 3020 cm^3/s
(3) 2720 cm^3/s (4) 2420 cm^3/s

21. In a fluorescent lamp choke (a small transformer) 100 V of reverse voltage is produced when the choke current changes uniformly from 0.25 A to 0 in a duration of 0.025 ms. The self-inductance of the choke (in mH) is estimated to be _____ .

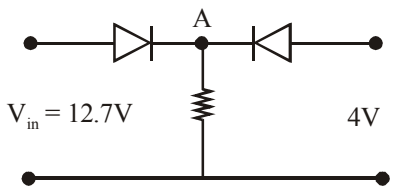
22. One end of a straight uniform 1m long bar is pivoted on horizontal table. It is released from rest when it makes an angle 30° from the horizontal (see figure). Its angular speed when it hits the table is given as $\sqrt{n}\,s^{-1}$, where n is an integer. The value of n is _____ .



23. The distance x covered by a particle in one dimensional motion varies with time t as $x^2 = at^2 + 2bt + c$. If the acceleration of the particle depends on x as x^{-n}, where n is an integer, the value of n is _____ .

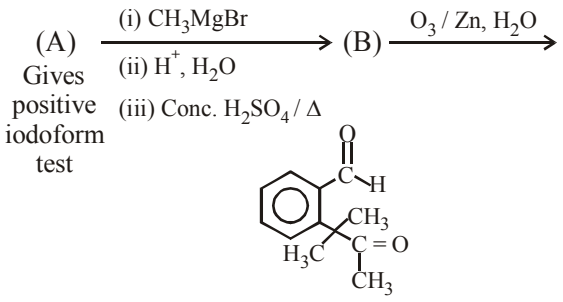
24. A body of mass m = 10 kg is attached to one end of a wire of length 0.3 m. The maximum angular speed (in rad s^{-1}) with which it can be rotated about its other end in space station is (Breaking stress of wire = 4.8×10^7 Nm^{-2} and area of cross-section of the wire = 10^{-2} cm^2) is:

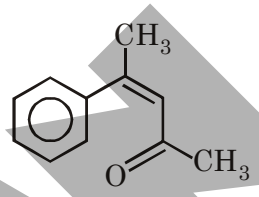
25. Both the diodes used in the circuit shown are assumed to be ideal and have negligible resistance when these are forward biased. Built in potential in each diode is 0.7 V. For the input voltages shown in the figure, the voltage (in Volts) at point A is _____ .

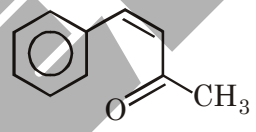


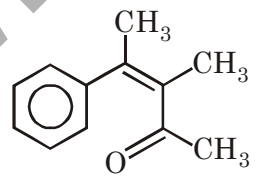
CHEMISTRY

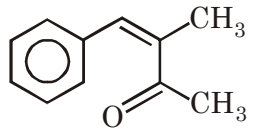
1. Identify (A) in the following reaction sequence :



(1) 

(2) 

(3) 

(4) 

2. For the following reactions

$A \xrightarrow{700K} Product$

$A \xrightarrow[catalyst]{500K} Product$

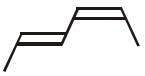
it was found that E_a is decreased by 30 kJ/mol in the presence of catalyst.

If the rate remains unchanged, the activation energy for catalysed reaction is (Assume pre exponential factor is same):

(1) 135 kJ/mol (2) 105 kJ/mol

(3) 198 kJ/mol (4) 75 kJ/mol

3. The correct order of heat of combustion for following alkadienes is :

(a)  (b)  (c) 

(1) (a) < (b) < (c) (2) (b) < (c) < (a)
(3) (c) < (b) < (a) (4) (a) < (c) < (b)

4. A chemist has 4 samples of artificial sweetener A, B, C and D. To identify these samples, he performed certain experiments and noted the following observations :

(i) A and D both form blue-violet colour with ninhydrin.
(ii) Lassaigne extract of C gives positive $AgNO_3$ test and negative $Fe_4[Fe(CN)_6]_3$ test.
(iii) Lassaigne extract of B and D gives positive sodium nitroprusside test

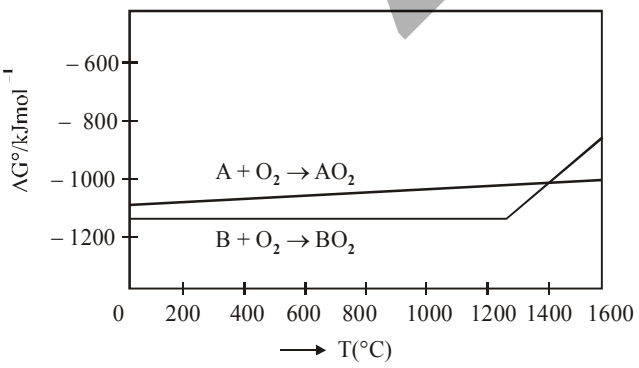
Based on these observations which option is correct ?

(1) A : Aspartame ; B : Saccharin ; C : Sucralose ; D ; Alitame
(2) A : Alitame ; B : Saccharin ; C : Aspartame ; D ; Sucralose
(3) A : Saccharin ; B : Alitame ; C : Sucralose ; D ; Aspartame
(4) A : Aspartame ; B : Alitame ; C : Saccharin ; D ; Sucralose

5. 'X' melts at low temperature and is a bad conductor of electricity in both liquid and solid state. X is :

(1) Carbon tetrachloride (2) Mercury
(3) Silicon carbide (4) Zinc sulphide

6. According to the following diagram, A reduces BO_2 when the temperature is :



(1) < 1400 °C
(2) > 1400 °C
(3) < 1200 °C
(4) > 1200 °C but < 1400 °C

7. The K_{sp} for the following dissociation is 1.6×10^{-5}

$$PbCl_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^{-}_{(aq)}$$

Which of the following choices is correct for a mixture of 300 mL 0.134 M $Pb(NO_3)_2$ and 100 mL 0.4 M NaCl ?

(1) $Q < K_{sp}$
(2) $Q > K_{sp}$
(3) $Q = K_{sp}$
(4) Not enough data provided

8. $[Pd(F)(Cl)(Br)(I)]^{2-}$ has n number of geometrical isomers. Then, the spin-only magnetic moment and crystal field stabilisation energy [CFSE] of $[Fe(CN)_6]^{n-6}$, respectively, are:

[Note : Ignore the pairing energy]

(1) 2.84 BM and $-1.6\ \Delta_0$
(2) 1.73 BM and $-2.0\ \Delta_0$
(3) 0 BM and $-2.4\ \Delta_0$
(4) 5.92 BM and 0

9. If the magnetic moment of a dioxygen species is 1.73 B.M, it may be :

(1) O_2^- or O_2^+ (2) O_2 or O_2^+
(3) O_2 or O_2^- (4) O_2, O_2^- or O_2^+

10. If enthalpy of atomisation for $Br_{2(1)}$ is x kJ/mol and bond enthalpy for Br_2 is y kJ/mol, the relation between them :

(1) is x = y (2) is x < y
(3) does not exist (4) is x > y

11. The increasing order of basicity for the following intermediates is (from weak to strong)

(i)

(ii) $H_2C = CH - \overset{\ominus}{C}H_2$

(iii) $HC \equiv \overset{\ominus}{C}$ (iv) $\overset{\ominus}{C}H_3$ (v) $\overset{\ominus}{C}N$

(1) (v) < (i) < (iv) < (ii) < (iii)
(2) (iii) < (i) < (ii) < (iv) < (v)
(3) (v) < (iii) < (ii) < (iv) < (i)
(4) (iii) < (iv) < (ii) < (i) < (v)

12. B has a smaller first ionization enthalpy than Be. Consider the following statements :

(I) It is easier to remove 2p electron than 2s electron

(II) 2p electron of B is more shielded from the nucleus by the inner core of electrons than the 2s electrons of Be.

(III) 2s electron has more penetration power than 2p electron.

(IV) atomic radius of B is more than Be

(Atomic number B = 5, Be = 4)

The correct statements are :

(1) (I), (II) and (III) (2) (II), (III) and (IV)

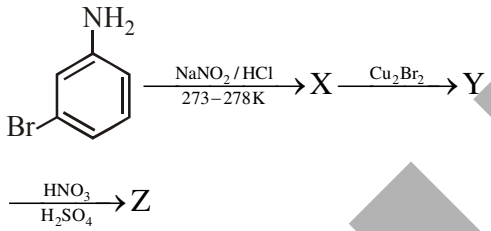
(3) (I), (III) and (IV) (4) (I), (II) and (IV)

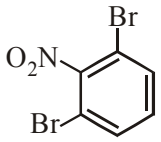
13. The acidic, basic and amphoteric oxides, respectively, are :

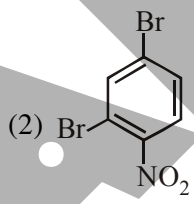
(1) MgO, Cl_2O, Al_2O_3 (2) Cl_2O, CaO, P_4O_{10}

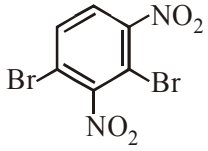
(3) Na_2O, SO_3, Al_2O_3 (4) N_2O_3, Li_2O, Al_2O_3

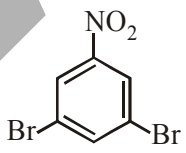
14. The major product Z obtained in the following reaction scheme is :



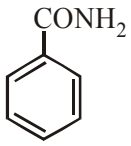
(1) 

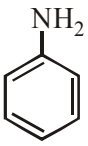
(2) 

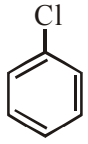
(3) 

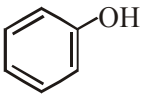
(4) 

15. Which of these will produce the highest yield in Friedel Crafts reaction?

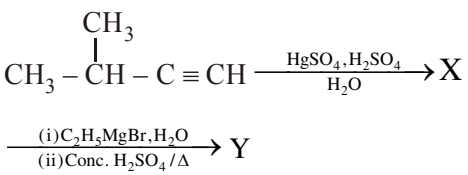
(1) 

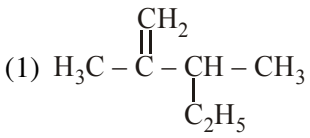
(2) 

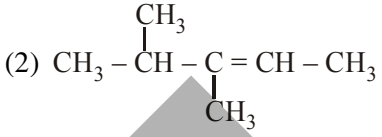
(3) 

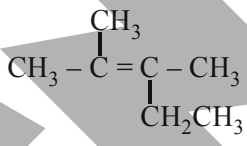
(4) 

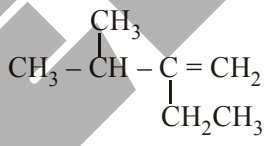
16. The major product (Y) in the following reactions is :



(1) 

(2) 

(3) 

(4) 

17. Complex X of composition $Cr(H_2O)_6Cl_n$ has a spin only magnetic moment of 3.83 BM. It reacts with $AgNO_3$ and shows geometrical isomerism. The IUPAC nomenclature of X is :

(1) Tetraaquadichlorido chromium (III) chloride dihydrate

(2) Hexaaqua chromium (III) chloride

(3) Dichloridotetraaqua chromium (IV) chloride dihydrate

(4) Tetraaquadichlorido chromium(IV) chloride dihydrate

18. The compound that cannot act both as oxidising and reducing agent is :

(1) H_2O_2

(2) H_2SO_3

(3) HNO_2

(4) H_3PO_4

19. The de Broglie wavelength of an electron in the 4^{th} Bohr orbit is :

(1) $8\pi a_0$

(2) $2\pi a_0$

(3) $4\pi a_0$

(4) $6\pi a_0$

20. The electronic configurations of bivalent europium and trivalent cerium are
(atomic number : Xe = 54, Ce = 58, Eu = 63)
(1) [Xe] $4f^4$ and [Xe] $4f^9$
(2) [Xe] $4f^7$ and [Xe] $4f^1$
(3) [Xe] $4f^7$ $6s^2$ and [Xe] $4f^2$ $6s^2$
(4) [Xe] $4f^2$ and [Xe] $4f^7$

21. The hardness of a water sample containing 10^{-3} M $MgSO_4$ expressed as $CaCO_3$ equivalents (in ppm) is _____.
(molar mass of $MgSO_4$ is 120.37 g/mol)

22. The molarity of HNO_3 in a sample which has density 1.4 g/mL and mass percentage of 63% is _____. (Molecular Weight of HNO_3 = 63)

23. 108 g of silver (molar mass 108 g mol^{-1}) is deposited at cathode from $AgNO_3$(aq) solution by a certain quantity of electricity. The volume (in L) of oxygen gas produced at 273 K and 1 bar pressure from water by the same quantity of electricity is _____.

24. The mass percentage of nitrogen in histamine is _____.

25. How much amount of NaCl should be added to 600 g of water (ρ = 1.00 g/mL) to decrease the freezing point of water to – 0.2 °C ? _____. (The freezing point depression constant for water = 2K kg mol^{-1})

MATHEMATICS

1. A spherical iron ball of 10 cm radius is coated with a layer of ice of uniform thickness the melts at a rate of 50 cm^3/min. When the thickness of ice is 5 cm, then the rate (in cm/min.) at which of the thickness of ice decreases, is :

(1) $\frac{1}{36\pi}$ (2) $\frac{5}{6\pi}$ (3) $\frac{1}{18\pi}$ (4) $\frac{1}{54\pi}$

2. If the number of five digit numbers with distinct digits and 2 at the 10^{th} place is 336 k, then k is equal to :

(1) 8 (2) 6 (3) 4 (4) 7

3. Let z be complex number such that $\left|\frac{z-i}{z+2i}\right|=1$ and $|z|=\frac{5}{2}$. Then the value of |z + 3i| is :

(1) $\sqrt{10}$ (2) $2\sqrt{3}$ (3) $\frac{7}{2}$ (4) $\frac{15}{4}$

4. In a box, there are 20 cards, out of which 10 are lebelled as A and the remaining 10 are labelled as B. Cards are drawn at random, one after the other and with replacement, till a second A-card is obtained. The probability that the second A-card appears before the third B-card is :

(1) $\frac{11}{16}$ (2) $\frac{13}{16}$ (3) $\frac{9}{16}$ (4) $\frac{15}{16}$

5. The value of $\int_0^{2\pi}\frac{x\sin^8 x}{\sin^8 x+\cos^8 x}dx$ is equal to :

(1) 2π (2) 4π (3) $2\pi^2$ (4) π^2

6. If $f'(x) = \tan^{-1}(\sec x + \tan x)$, $-\frac{\pi}{2}<x<\frac{\pi}{2}$, and $f(0) = 0$, then $f(1)$ is equal to :

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

7. If the matrices $A=\begin{bmatrix}1 & 1 & 2\\ 1 & 3 & 4\\ 1 & -1 & 3\end{bmatrix}$, B = adjA and C = 3A, then $\frac{|adjB|}{|C|}$ is equal to :

(1) 72 (2) 2 (3) 8 (4) 16

8. The number of real roots of the equation, $e^{4x} + e^{3x} - 4e^{2x} + e^x + 1 = 0$ is :

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

9. Negation of the statement :
$\sqrt{5}$ is an integer or 5 is irrational is :

(1) $\sqrt{5}$ is irrational or 5 is an integer.

(2) $\sqrt{5}$ is not an integer and 5 is not irrational.

(3) $\sqrt{5}$ is an integer and 5 is irrational.

(4) $\sqrt{5}$ is not an integer or 5 is not irrational.

10. Let the observations $x_i (1 \le i \le 10)$ satisfy the equations, $\sum_{i=1}^{10}(x_i-5)=10$ and $\sum_{i=1}^{10}(x_i-5)^2=40$.
If μ and λ are the mean and the variance of the observations, $x_1 - 3$, $x_2 - 3$, ..., $x_{10} - 3$, then the ordered pair (μ, λ) is equal to :

(1) (6, 6) (2) (3, 6) (3) (6, 3) (4) (3, 3)

11. The product $2^{\frac{1}{4}}\cdot 4^{\frac{1}{16}}\cdot 8^{\frac{1}{48}}\cdot 16^{\frac{1}{128}}\cdot \ldots$ to ∞ is equal to :

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

12. A circle touches the y-axis at the point (0, 4) and passes through the point (2, 0). Which of the following lines is not a tangent to this circle ?

(1) $3x - 4y - 24 = 0$ (2) $3x + 4y - 6 = 0$

(3) $4x + 3y - 8 = 0$ (4) $4x - 3y + 17 = 0$

13. If e_1 and e_2 are the eccentricities of the ellipse, $\frac{x^2}{18}+\frac{y^2}{4}=1$ and the hyperbola, $\frac{x^2}{9}-\frac{y^2}{4}=1$ respectively and (e_1, e_2) is a point on the ellipse, $15x^2 + 3y^2 = k$, then k is equal to :

(1) 15 (2) 14 (3) 17 (4) 16

14. Let f be any function continuous on [a, b] and twice differentiable on (a, b). If for all $x \in (a, b)$, $f'(x) > 0$ and $f''(x) < 0$, then for any $c \in (a, b)$, $\frac{f(c)-f(a)}{f(b)-f(c)}$ is greater than :

(1) $\frac{b+a}{b-a}$ (2) $\frac{b-c}{c-a}$ (3) $\frac{c-a}{b-c}$ (4) 1

15. If for some α and β in R, the intersection of the following three places

$x + 4y - 2z = 1$

$x + 7y - 5z = \beta$

$x + 5y + \alpha z = 5$

is a line in R^3, then $\alpha + \beta$ is equal to :

(1) 10 (2) –10 (3) 2 (4) 0

16. The integral $\int \frac{dx}{(x+4)^{\frac{8}{7}}(x-3)^{\frac{6}{7}}}$ is equal to :

(where C is a constant of integration)

(1) $\left(\frac{x-3}{x+4}\right)^{\frac{1}{7}}+C$ (2) $-\left(\frac{x-3}{x+4}\right)^{-\frac{1}{7}}+C$

(3) $\frac{1}{2}\left(\frac{x-3}{x+4}\right)^{\frac{3}{7}}+C$ (4) $-\frac{1}{13}\left(\frac{x-3}{x+4}\right)^{-\frac{13}{7}}+C$

17. Let C be the centroid of the triangle with vertices (3, –1), (1, 3) and (2, 4). Let P be the point of intersection of the lines $x + 3y - 1 = 0$ and $3x - y + 1 = 0$. Then the line passing through the points C and P also passes through the point :

(1) (7, 6) (2) (–9, –6)

(3) (–9, –7) (4) (9, 7)

18. If $f(x)=\begin{cases}\frac{\sin(a+2)x+\sin x}{x} & ; x<0\\ b & ; x=0\\ \frac{(x+3x^2)^{\frac{1}{3}}-x^{-\frac{1}{3}}}{x^{\frac{4}{3}}} & ; x>0\end{cases}$

is continuous at x = 0, then a + 2b is equal to :

(1) –1 (2) 1 (3) –2 (4) 0

19. The value of

$\cos^3\left(\frac{\pi}{8}\right)\cdot\cos\left(\frac{3\pi}{8}\right)+\sin^3\left(\frac{\pi}{8}\right)\cdot\sin\left(\frac{3\pi}{8}\right)$

is :

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

20. If for all real triplets (a, b, c), $f(x) = a + bx + cx^2$; then $\int_0^1 f(x)dx$ is equal to :

(1) $\frac{1}{2}\left\{f(1)+3f\left(\frac{1}{2}\right)\right\}$

(2) $2\left\{3f(1)+2f\left(\frac{1}{2}\right)\right\}$

(3) $\frac{1}{6}\left\{f(0)+f(1)+4f\left(\frac{1}{2}\right)\right\}$

(4) $\frac{1}{3}\left\{f(0)+f\left(\frac{1}{2}\right)\right\}$

21. The coefficient of x^4 is the expansion of $(1 + x + x^2)^{10}$ is ———.

22. The number of distinct solutions of the equation $\log_{\frac{1}{2}}|\sin x| = 2 - \log_{\frac{1}{2}}|\cos x|$ in the interval $[0, 2\pi]$, is ———.

23. If for $x \geq 0$, $y = y(x)$ is the solution of the differential equation $(x + 1)dy = ((x + 1)^2 + y - 3)dx$, $y(2) = 0$, then $y(3)$ is equal to ———.

24. If the vectors, $\vec{p}=(a+1)\hat{i}+a\hat{j}+a\hat{k}$, $\vec{q}=a\hat{i}+(a+1)\hat{j}+a\hat{k}$ and $\vec{r}=a\hat{i}+a\hat{j}+(a+1)\hat{k}$ $(a \in R)$ are coplanar and $3(\vec{p}.\vec{q})^2-\lambda|\vec{r}\times\vec{q}|^2=0$, then the value of λ is ———.

25. The projection of the line segment joining the points (1, –1, 3) and (2, –4, 11) on the line joining the points (–1, 2, 3) and (3, –2, 10) is ———.

SET # 06

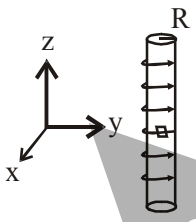
PHYSICS

1. A spring mass system (mass m, spring constant k and natural length l) rest in equilibrium on a horizontal disc. The free end of the spring is fixed at the centre of the disc. If the disc together with spring mass system, rotates about it's axis with an angular velocity ω, ($k >> m\omega^2$) the relative change in the length of the spring is best given by the option :

(1) $\frac{2m\omega^2}{k}$ (2) $\frac{m\omega^2}{3k}$

(3) $\sqrt{\frac{2}{3}}\left(\frac{m\omega^2}{k}\right)$ (4) $\frac{m\omega^2}{k}$

2. An electron gun is placed inside a long solenoid of radius R on its axis. The solenoid has n turns/length and carries a current I. The electron gun shoots an electron along the radius of the solenoid with speed v. If the electron does not hit the surface of the solenoid, maximum possible value of v is (all symbols have their standard meaning) :



(1) $\frac{e\mu_0 nIR}{m}$ (2) $\frac{e\mu_0 nIR}{2m}$

(3) $\frac{2e\mu_0 nIR}{m}$ (4) $\frac{e\mu_0 nIR}{4m}$

3. A rod of length L has non-uniform linear mass density given by $\rho(x) = a + b\left(\frac{x}{L}\right)^2$, where a and b are constants and $0 \le x \le L$. The value of x for the centre of mass of the rod is at :

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

(3) $\frac{3}{2}\left(\frac{2a+b}{3a+b}\right)L$ (4) $\frac{3}{4}\left(\frac{2a+b}{3a+b}\right)L$

4. A plane electromagnetic wave is propagating along the direction $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$, with its polarization along the direction $\hat{k}$. The correct form of the magnetic field of the wave would be (here B_0 is an appropriate constant) :

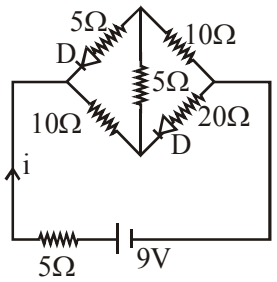
(1) $B_0\frac{\hat{i}-\hat{j}}{\sqrt{2}}\cos\left(\omega t - k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

(2) $B_0\frac{\hat{i}+\hat{j}}{\sqrt{2}}\cos\left(\omega t - k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

(3) $B_0\hat{k}\cos\left(\omega t - k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

(4) $B_0\frac{\hat{j}-\hat{i}}{\sqrt{2}}\cos\left(\omega t + k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

5. The current i in the network is :



(1) 0 A (2) 0.6 A

(3) 0.3 A (4) 0.2 A

6. A small spherical droplet of density d is floating exactly half immersed in a liquid of density ρ and surface tension T. The radius of the droplet is (take note that the surface tension applies an upward force on the droplet) :

(1) $r = \sqrt{\frac{2T}{3(d+\rho)g}}$ (2) $r = \sqrt{\frac{3T}{(2d-\rho)g}}$

(3) $r = \sqrt{\frac{T}{(d-\rho)g}}$ (4) $r = \sqrt{\frac{T}{(d+\rho)g}}$

7. A small circular loop of conducting wire has radius a and carries current I. It is placed in a uniform magnetic field B perpendicular to its plane such that when rotated slightly about its diameter and released, it starts performing simple harmonic motion of time period T. If the mass of the loop is m then :

(1) $T=\sqrt{\frac{\pi m}{2IB}}$ (2) $T=\sqrt{\frac{2\pi m}{IB}}$

(3) $T=\sqrt{\frac{\pi m}{IB}}$ (4) $T=\sqrt{\frac{2m}{IB}}$

8. A wire of length L and mass per unit length 6.0×10^{-3} kgm^{-1} is put under tension of 540 N. Two consecutive frequencies that it resonates at are : 420 Hz and 490 Hz. Then L in meters is :

(1) 8.1 m (2) 5.1 m (3) 1.1 m (4) 2.1 m

9. In LC circuit the inductance L = 40 mH and capacitance C = 100 μF. If a voltage V(t) = 10sin(314 t) is applied to the circuit, the current in the circuit is given as :

(1) 0.52 cos 314 t (2) 0.52 sin 314 t

(3) 10 cos 314 t (4) 5.2 cos 314 t

10. There is a small source of light at some depth below the surface of water (refractive index = $\frac{4}{3}$) in a tank of large cross sectional surface area. Neglecting any reflection from the bottom and absorption by water, percentage of light that emerges out of surface is (nearly) : [Use the fact that surface area of a spherical cap of height h and radius of curvature r is 2πrh]:

(1) 17% (2) 21%

(3) 34% (4) 50%

11. Two gases-argon (atomic radius 0.07 nm, atomic weight 40) and xenon (atomic radius 0.1 nm, atomic weight 140) have the same number density and are at the same temperature. The raito of their respective mean free times is closest to :

(1) 3.67 (2) 4.67

(3) 1.83 (4) 2.3

12. A particle starts from the origin at t = 0 with an initial velocity of $3.0\hat{i}$ m/s and moves in the x-y plane with a constant acceleration $\left(6.0\hat{i}+4.0\hat{j}\right)m/s^2$. The x-coordinate of the particle at the instant when its y-coordinate is 32 m is D meters. The value of D is :-

(1) 50 (2) 32 (3) 60 (4) 40

13. A particle of mass m is projected with a speed u from the ground at an angle $\theta=\frac{\pi}{3}$ w.r.t. horizontal (x-axis). When it has reached its maximum height, it collides completely inelastically with another particle of the same mass and velocity $u\hat{i}$. The horizontal distance covered by the combined mass before reaching the ground is:

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

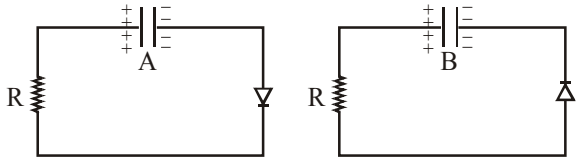
(3) $\frac{3\sqrt{3}}{8}\frac{u^2}{g}$ (4) $\frac{5}{8}\frac{u^2}{g}$

14. The energy required to ionise a hydrogen like ion in its ground state is 9 Rydbergs. What is the wavelength of the radiation emitted when the electron in this ion jumps from the second excited state to the ground state ?

(1) 35.8 nm (2) 24.2 nm

(3) 8.6 nm (4) 11.4 nm

15. Two identical capacitors A and B, charged to the same potential 5V are connected in two different circuits as shown below at time t = 0. If the charge on capacitors A and B at time t = CR is Q_A and Q_B respectively, then (Here e is the base of natural logarithm)



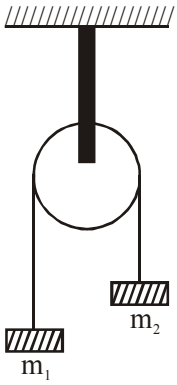
(1) $Q_A=VC, Q_B=\frac{VC}{e}$

(2) $Q_A=\frac{CV}{2}, Q_B=\frac{VC}{e}$

(3) $Q_A = VC,\ Q_B = CV$

(4) $Q_A=\frac{VC}{e}, Q_B=\frac{CV}{2}$

16. A uniformly thick wheel with moment of inertia I and radius R is free to rotate about its centre of mass (see fig). A massless string is wrapped over its rim and two blocks of masses m_1 and m_2 ($m_1 > m_2$) are attached to the ends of the string. The system is released from rest. The angular speed of the wheel when m_1 descents by a distance h is :



(1) $\left[\frac{m_1+m_2}{(m_1+m_2)R^2+I}\right]^{\frac{1}{2}} gh$

(2) $\left[\frac{2(m_1-m_2)gh}{(m_1+m_2)R^2+I}\right]^{\frac{1}{2}}$

(3) $\left[\frac{2(m_1+m_2)gh}{(m_1+m_2)R^2+I}\right]^{\frac{1}{2}}$

(4) $\left[\frac{(m_1-m_2)}{(m_1+m_2)R^2+I}\right]^{\frac{1}{2}} gh$

17. Planet A has mass M and radius R. Planet B has half the mass and half the radius of Planet A. If the escape velocities from the Planets A and B are v_A and v_B, respectively, then $\frac{v_A}{v_B}=\frac{n}{4}$.

The value of n is :

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

18. Two steel wires having same length are suspended from a ceiling under the same load. If the ratio of their energy stored per unit volume is 1 : 4, the ratio of their diameters is:

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

19. For the four sets of three measured physical quantities as given below. Which of the following options is correct ?

(i) $A_1 = 24.36$, $B_1 = 0.0724$, $C_1 = 256.2$

(ii) $A_2 = 24.44$, $B_2 = 16.082$, $C_2 = 240.2$

(iii) $A_3 = 25.2$, $B_3 = 19.2812$, $C_3 = 236.183$

(iv) $A_4 = 25$, $B_4 = 236.191$, $C_4 = 19.5$

(1) $A_4 + B_4 + C_4 < A_1 + B_1 + C_1 < A_3 + B_3 + C_3 < A_2 + B_2 + C_2$

(2) $A_1 + B_1 + C_1 < A_3 + B_3 + C_3 < A_2 + B_2 + C_2 < A_4 + B_4 + C_4$

(3) $A_1 + B_1 + C_1 = A_2 + B_2 + C_2 = A_3 + B_3 + C_3 = A_4 + B_4 + C_4$

(4) $A_4 + B_4 + C_4 < A_1 + B_1 + C_1 = A_2 + B_2 + C_2 = A_3 + B_3 + C_3$

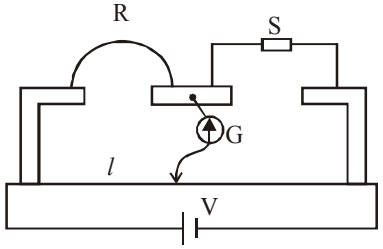
20. An electron of mass m and magnitude of charge |e| initially at rest gets accelerated by a constant electric field E. The rate of change of de-Broglie wavelength of this electron at time t ignoring relativistic effects is :

(1) $\frac{-h}{|e|Et^2}$ (2) $\frac{|e|Et}{h}$

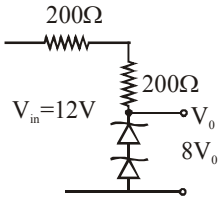
(3) $-\frac{h}{|e|E\sqrt{t}}$ (4) $-\frac{h}{|e|Et}$

21. Starting at temperature 300 K, one mole of an ideal diatomic gas ($\gamma = 1.4$) is first compressed adiabatically from volume V_1 to $V_2 = \frac{V_1}{16}$. It is then allowed to expand isobarically to volume $2V_2$. If all the processes are the quasi-static then the final temperature of the gas (in °K) is (to the nearest integer) _____.

22. In a meter bridge experiment S is a standard resistance. R is a resistance wire. It Is found that balancing length is l = 25 cm. If R is replaced by a wire of half length and half diameter that of R of same material, then the balancing distance l' (in cm) will now be_____.

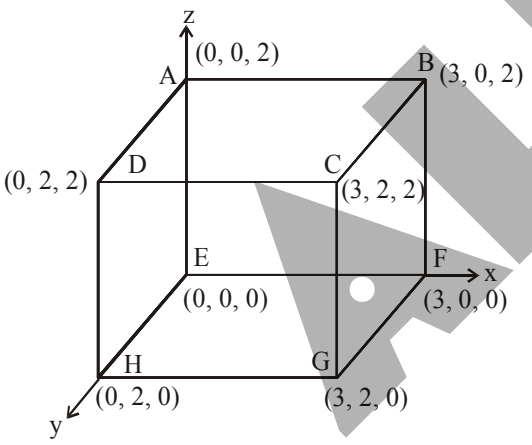


23. The circuit shown below is working as a 8 V dc regulated voltage source. When 12 V is used as input, the power dissipated (in mW) in each diode is; (considering both zener diodes are identical) _____.



24. In a Young's double slit experiment 15 fringes are observed on a small portion of the screen when light of wavelength 500 nm is used. Ten fringes are observed on the same section of the screen when another light source of wavelength λ is used. Then the value of λ is (in nm) _____.

25. An electric field $\vec{E} = 4x\hat{i} - (y^2+1)\hat{j}\,N/C$ passes through the box shown in figure. The flux of the electric field through surfaces ABCD and BCGF are marked as ϕ_I and ϕ_{II} respectively. The difference between $(\phi_I - \phi_{II})$ is (in Nm^2/C) _____.



CHEMISTRY

1. The correct order of the spin-only magnetic moments of the following complexes is :

(I) $[Cr(H_2O)_6]Br_2$

(II) $Na_4[Fe(CN)_6]$

(III) $Na_3[Fe(C_2O_4)_3]$ ($\Delta_0 > P$)

(IV) $(Et_4N)_2[CoCl_4]$

(1) (III) > (I) > (II) > (IV)

(2) (I) > (IV) > (III) > (II)

(3) (II) ≈ (I) > (IV) > (III)

(4) (III) > (I) > (IV) > (II)

2. The first and second ionisation enthalpies of a metal are 496 and 4560 kJ mol^{-1}, respectively. How many moles of HCl and H_2SO_4, respectively, will be needed to react completely with 1 mole of the metal hydroxide ?

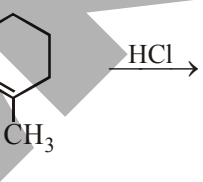
(1) 1 and 0.5 (2) 2 and 0.5

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

3. Which of the following reactions will not produce a racemic product ?

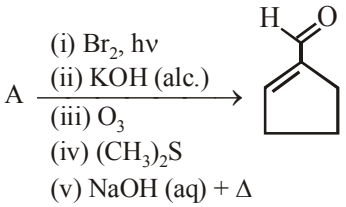
(1) $CH_3-\underset{H}{\overset{CH_3}{C}}-CH=CH_2 \xrightarrow{HCl}$

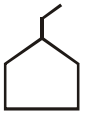
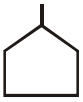
(2) $CH_3-\overset{O}{\overset{\|}{C}}-CH_2CH_3 \xrightarrow{HCN}$

(3) 

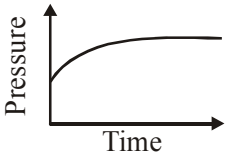
(4) $CH_3CH_2CH=CH_2 \xrightarrow{HBr}$

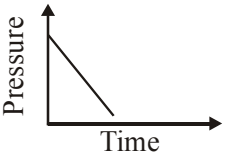
4. In the following reaction A is :

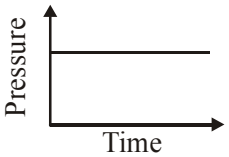


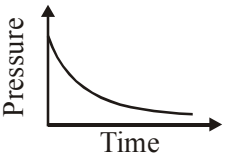
(1)  (2)  (3)  (4) 

5. A mixture of gases O_2, H_2 and CO are taken in a closed vessel containing charcoal. The graph that represents the correct behaviour of pressure with time is :

(1) 

(2) 

(3) 

(4) 

6. Which polymer has 'chiral' monomer(s) ?
(1) Buna-N (2) Nylon 6,6
(3) Neoprene (4) PHBV

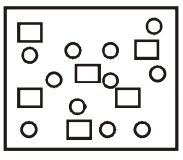
7. Biochemical Oxygen Demand (BOD) is the amount of oxygen required (in ppm):
(1) by anaerobic bacteria to breakdown inorganic waste present in a water body.
(2) for the photochemical breakdown of waste present in 1 m^3 volume of a water body.
(3) by bacteria to break-down organic waste in a certain volume of a water sample.
(4) for sustaining life in a water body.

8. Among the statements (a)-(d) the correct ones are:
(a) Lithium has the highest hydration enthalpy among the alkali metals.
(b) Lithium chloride is insoluble in pyridine.
(c) Lithium cannot form ethynide upon its reaction with ethyne.
(d) Both lithium and magnesium react slowly with H_2O.
(1) (a), (b) and (d) only
(2) (b) and (c) only
(3) (a), (c) and (d) only
(4) (a) and (d) only

9. Amongst the following, the form of water with the lowest ionic conductance at 298 K is:
(1) distilled water
(2) water from a well
(3) saline water used for intravenous injection
(4) sea water

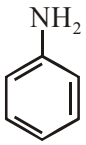
10. Which of the following has the shortest C-Cl bond?
(1) Cl–CH=CH–OCH_3
(2) C1–CH=CH–CH_3
(3) C1–CH=CH_2
(4) C1–CH=CH–NO_2

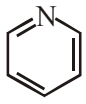
11. In the figure shown below reactant A (represented by square) is in equilibrium with product B (represented by circle). The equilibrium constant is :

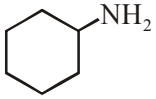


(1) 2 (2) 1 (3) 8 (4) 4

12. The decreasing order of basicity of the following amines is :


(I)


(II)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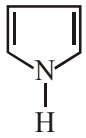
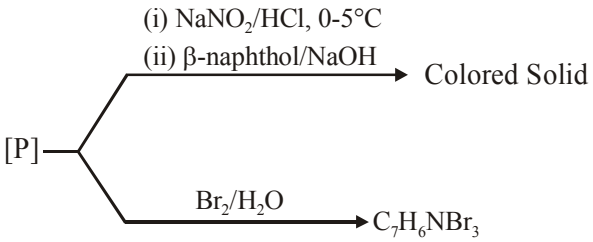

(IV)

(1) (I) > (III) > (IV) > (II)
(2) (III) > (I) > (II) > (IV)
(3) (III) > (II) > (I) > (IV)
(4) (II) > (III) > (IV) > (I)

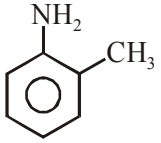
13. The solubility product of $Cr(OH)_3$ at 298 K is 6.0×10^{-31}. The concentration of hydroxide ions in a saturated solution of $Cr(OH)_3$ will be :
(1) $(18 \times 10^{-31})^{1/4}$ (2) $(2.22 \times 10^{-31})^{1/4}$
(3) $(4.86 \times 10^{-29})^{1/4}$ (4) $(18 \times 10^{-31})^{1/2}$

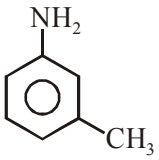
14. 5 g of zinc is treated separately with an excess of
(a) dilute hydrochloric acid and
(b) aqueous sodium hydroxide.
The ratio of the volumes of H_2 evolved in these two reactions is :
(1) 1 : 4 (2) 1 : 2 (3) 2 : 1 (4) 1 : 1

15. Consider the following reactions,

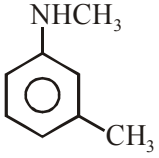


The compound [P] is :

(1) 

(2) 

(3) 

(4) 

16. A, B and C are three biomolecules. The results of the tests performed on them are given below:

	Molisch's Test	Barfoed Test	Biuret Test
A	Positive	Negative	Negative
B	Positive	Positive	Negative
C	Negative	Negative	Positive

A, B and C are respectively :

(1) A = Glucose, B = Fructose, C = Albumin

(2) A = Lactose, B = Fructose, C = Alanine

(3) A = Lactose, B = Glucose, C = Alanine

(4) A = Lactose, B = Glucose, C = Albumin

17. The reaction of $H_3N_3B_3Cl_3$ (A) with $LiBH_4$ in tetrahydrofuran gives inorganic benzene (B). Further, the reaction of (A) with (C) leads to $H_3N_3B_3(Me)_3$. Compounds (B) and (C) respectively, are:

(1) Boron nitride and MeBr

(2) Borazine and MeMgBr

(3) Borazine and MeBr

(4) Diborane and MeMgBr

18. The isomer(s) of $[Co(NH_3)_4Cl_2]$ that has/have a Cl–Co–Cl angle of 90°, is/are :

(1) meridional and trans

(2) cis and trans

(3) trans only

(4) cis only

19. The number of sp^2 hybrid orbitals in a molecule of benzene is :

(1) 24 (2) 6 (3) 12 (4) 18

20. The true statement amongst the following is:

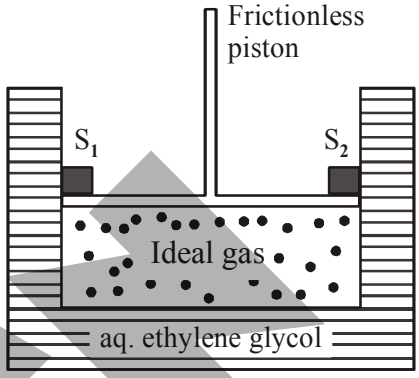
(1) Both ΔS and S are functions of temperature.

(2) S is not a function of temperature but ΔS is a function of temperature.

(3) Both S and ΔS are not functions of temperature.

(4) S is a function of temperature but ΔS is not a function of temperature.

21. A cylinder containing an ideal gas (0.1 mol of 1.0 dm^3) is in thermal equilibrium with a large volume of 0.5 molal aqueous solution of ethylene glycol at its freezing point. If the stoppers S_1 and S_2 (as shown in the figure) are suddenly withdrawn, the volume of the gas in litres after equilibrium is achieved will be____.
(Given, K_f (water) = 2.0 K kg mol^{-1},
R = 0.08 dm^3 atm K^{-1} mol^{-1})



22. 10.30 mg of O_2 is dissolved into a liter of sea water of density 1.03 g/mL. The concentration of O_2 in ppm is_____.

23. A sample of milk splits after 60 min. at 300 K and after 40 min. at 400 K when the population of *lactobacillus acidophilus* in it doubles. The activa tion energy (in kJ/ mol) for this process is closest to_____.

(Given, R = 8.3 J mol^{-1} K^{-1}, $ln\left(\frac{2}{3}\right) = 0.4$,
$e^{-3} = 4.0$)

24. The sum of the total number of bonds between chromium and oxygen atoms in chromate and dichromate ions is _____.

25. Consider the following reactions

$$A \xrightarrow[(ii)H_3O^+]{(i)CH_3MgBr} B \xrightarrow[573K]{Cu} \text{2-methyl 2-butene}$$

The mass percentage of carbon in A is _____.

MATHEMATICS

1. Let [t] denote the greatest integer $\le$ t and $\lim\limits_{x\to 0} x\left[\frac{4}{x}\right] = A$. Then the function, $f(x) = [x^2]\sin(\pi x)$ is discontinuous, when x is equal to :

(1) $\sqrt{A+5}$ (2) $\sqrt{A+1}$

(3) $\sqrt{A}$ (4) $\sqrt{A+21}$

2. The following system of linear equations
$7x + 6y - 2z = 0$
$3x + 4y + 2z = 0$
$x - 2y - 6z = 0$, has
(1) infinitely many solutions, (x, y, z) satisfying $x = 2z$
(2) no solution
(3) only the trivial solution
(4) infinitely many solutions, (x, y, z) satisfying $y = 2z$

3. If $x = 2\sin\theta - \sin 2\theta$ and $y = 2\cos\theta - \cos 2\theta$, $\theta \in [0, 2\pi]$, then $\frac{d^2y}{dx^2}$ at $\theta = \pi$ is :

(1) $\frac{3}{2}$ (2) $-\frac{3}{4}$ (3) $\frac{3}{4}$ (4) $-\frac{3}{8}$

4. The length of the minor axis (along y-axis) of an ellipse in the standard form is $\frac{4}{\sqrt{3}}$. If this ellipse touches the line, $x + 6y = 8$; then its eccentricity is :

(1) $\sqrt{\frac{5}{6}}$ (2) $\frac{1}{2}\sqrt{\frac{11}{3}}$ (3) $\frac{1}{3}\sqrt{\frac{11}{3}}$ (4) $\frac{1}{2}\sqrt{\frac{5}{3}}$

5. Let $a, b \in R$, $a \neq 0$ be such that the equation, $ax^2 - 2bx + 5 = 0$ has a repeated root α, which is also a root of the equation, $x^2 - 2bx - 10 = 0$. If β is the other root of this equation, then $\alpha^2 + \beta^2$ is equal to :

(1) 26 (2) 25 (3) 28 (4) 24

6. Given : $f(x) = \begin{cases} x & , \ 0 \le x < \frac{1}{2} \\ \frac{1}{2} & , \ x = \frac{1}{2} \\ 1-x & , \ \frac{1}{2} < x \le 1 \end{cases}$

and $g(x) = \left(x - \frac{1}{2}\right)^2$, $x \in R$. Then the area (in sq. units) of the region bounded by the curves, $y = f(x)$ and $y = g(x)$ between the lines, $2x = 1$ and $2x = \sqrt{3}$, is :

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

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

7. A random variable X has the following probability distribution :

X	:	1	2	3	4	5
P(X)	:	K^2	2K	K	2K	$5K^2$

Then $P(X > 2)$ is equal to :

(1) $\frac{7}{12}$ (2) $\frac{23}{36}$ (3) $\frac{1}{36}$ (4) $\frac{1}{6}$

8. If $x = \sum_{n=0}^{\infty}(-1)^n \tan^{2n}\theta$ and $y = \sum_{n=0}^{\infty}\cos^{2n}\theta$, for $0 < \theta < \frac{\pi}{4}$, then :

(1) $y(1 + x) = 1$ (2) $x(1 + y) = 1$
(3) $y(1 - x) = 1$ (4) $x(1 - y) = 1$

9. Let a function $f : [0, 5] \to \mathbf{R}$ be continuous, $f(1) = 3$ and F be defined as :

$F(x) = \int_1^x t^2 g(t)\,dt$, where $g(t) = \int_1^t f(u)\,du$.

Then for the function F, the point $x = 1$ is :
(1) a point of local minima.
(2) not a critical point.
(3) a point of inflection.
(4) a point of local maxima.

10. If one end of a focal chord AB of the parabola $y^2 = 8x$ is at $A\left(\frac{1}{2}, -2\right)$, then the equation of the tangent to it at B is :

(1) $2x + y - 24 = 0$ (2) $x - 2y + 8 = 0$
(3) $2x - y - 24 = 0$ (4) $x + 2y + 8 = 0$

11. If 10 different balls are to be placed in 4 distinct boxes at random, then the probability that two of these boxes contain exactly 2 and 3 balls is :

(1) $\frac{945}{2^{11}}$ (2) $\frac{965}{2^{11}}$ (3) $\frac{945}{2^{10}}$ (4) $\frac{965}{2^{10}}$

12. If $A = \{x \in \mathbf{R} : |x| < 2\}$ and $B = \{x \in \mathbf{R} : |x - 2| \geq 3\}$; then :

(1) $A \cup B = \mathbf{R} - (2, 5)$

(2) $A \cap B = (-2, -1)$

(3) $B - A = \mathbf{R} - (-2, 5)$

(4) $A - B = [-1, 2)$

13. If $\frac{dy}{dx} = \frac{xy}{x^2 + y^2}$; $y(1) = 1$; then a value of x satisfying $y(x) = e$ is :

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

14. If $\int \frac{d\theta}{\cos^2\theta(\tan 2\theta + \sec 2\theta)} = \lambda\tan\theta + 2\log_e|f(\theta)| + C$ where C is a constant of integration, then the ordered pair $(\lambda, f(\theta))$ is equal to :

(1) $(-1, 1 + \tan\theta)$ (2) $(-1, 1 - \tan\theta)$

(3) $(1, 1 - \tan\theta)$ (4) $(1, 1 + \tan\theta)$

15. If z be a complex number satisfying $|\text{Re}(z)| + |\text{Im}(z)| = 4$, then $|z|$ cannot be

(1) $\sqrt{\frac{17}{2}}$ (2) $\sqrt{10}$ (3) $\sqrt{8}$ (4) $\sqrt{7}$

16. If $p \rightarrow (p \wedge \sim q)$ is false, then the truth values of p and q are respectively :

(1) F, T (2) T, T (3) F, F (4) T, F

17. Let $a - 2b + c = 1$.

If $f(x) = \begin{vmatrix} x+a & x+2 & x+1 \\ x+b & x+3 & x+2 \\ x+c & x+4 & x+3 \end{vmatrix}$, then :

(1) $f(-50) = 501$ (2) $f(-50) = -1$

(3) $f(50) = 1$ (4) $f(50) = -501$

18. In the expansion of $\left(\frac{x}{\cos\theta} + \frac{1}{x\sin\theta}\right)^{16}$, if ℓ_1 is the least value of the term independent of x when $\frac{\pi}{8} \leq \theta \leq \frac{\pi}{4}$ and ℓ_2 is the least value of the term independent of x when $\frac{\pi}{16} \leq \theta \leq \frac{\pi}{8}$, then the ratio $\ell_2 : \ell_1$ is equal to :

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

19. Let a_n be the n^{th} term of a G.P. of positive terms.

If $\sum_{n=1}^{100} a_{2n+1} = 200$ and $\sum_{n=1}^{100} a_{2n} = 100$, then $\sum_{n=1}^{200} a_n$ is equal to :

(1) 225 (2) 175

(3) 300 (4) 150

20. Let f and g be differentiable functions on $\mathbf{R}$ such that fog is the identity function. If for some $a, b \in \mathbf{R}$, $g'(a) = 5$ and $g(a) = b$, then $f'(b)$ is equal to :

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

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

21. The number of terms common to the two A.P.'s 3, 7, 11, ..., 407 and 2, 9, 16, ..., 709 is _____.

22. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three vectors such that $|\vec{a}| = \sqrt{3}$, $|\vec{b}| = 5$, $\vec{b} \cdot \vec{c} = 10$ and the angle between $\vec{b}$ and $\vec{c}$ is $\frac{\pi}{3}$. If $\vec{a}$ is perpendicular to the vector $\vec{b} \times \vec{c}$, then $|\vec{a} \times (\vec{b} \times \vec{c})|$ is equal to _____.

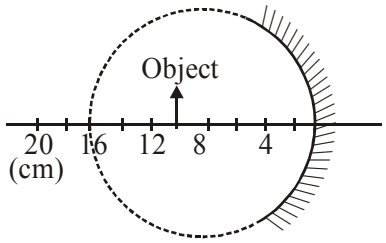
23. If the distance between the plane, $23x - 10y - 2z + 48 = 0$ and the plane containing the lines $\frac{x+1}{2} = \frac{y-3}{4} = \frac{z+1}{3}$ and $\frac{x+3}{2} = \frac{y+2}{6} = \frac{z-1}{\lambda} (\lambda \in R)$ is equal to $\frac{k}{\sqrt{633}}$, then k is equal to _____.

24. If $C_r \equiv {}^{25}C_r$ and $C_0 + 5.C_1 + 9.C_2 + ... + (101).C_{25} = 2^{25}.k$, then k is equal to _____.

25. If the curves, $x^2 - 6x + y^2 + 8 = 0$ and $x^2 - 8y + y^2 + 16 - k = 0$, $(k > 0)$ touch each other at a point, then the largest value of k is _____.

SET # 01

PHYSICS

1. 

A spherical mirror is obtained as shown in the figure from a hollow glass sphere. If an object is positioned in front of the mirror, what will be the nature and magnification of the image of the object ? (Figure drawn as schematic and not to scale)

(1) Inverted, real and magnified
(2) Erect, virtual and magnified
(3) Erect, virtual and unmagnified
(4) Inverted, real and unmagnified

2. A particle of mass m with an initial velocity $u\hat{i}$ collides perfectly elastically with a mass 3m at rest. It moves with a velocity $v\hat{j}$ after collision, then, v is given by :

(1) $v = \sqrt{\frac{2}{3}}u$ (2) $v = \frac{1}{\sqrt{6}}u$

(3) $v = \frac{u}{\sqrt{3}}$ (4) $v = \frac{u}{\sqrt{2}}$

3. A beam of protons with speed 4×10^5 ms^{-1} enters a uniform magnetic field of 0.3 T at an angle of 60° to the magnetic field. The pitch of the resulting helical path of protons is close to: (Mass of the proton = 1.67×10^{-27} kg, charge of the proton = 1.69×10^{-19} C

(1) 12 cm (2) 4 cm
(3) 5 cm (4) 2 cm

4. Consider four conducting materials copper, tungsten, mercury and aluminium with resistivity $\rho_C > \rho_T > \rho_M$ and ρ_A respectively. Then:

(1) $\rho_A > \rho_T > \rho_C$ (2) $\rho_C > \rho_A > \rho_T$
(3) $\rho_A > \rho_M > \rho_C$ (4) $\rho_M > \rho_A > \rho_C$

5. Magnetic materials used for making permanent magnets (P) and magnets in a transformer (T) have different properties of the following, which property best matches for the type of magnet required ?

(1) T : Large retentivity, small coercivity
(2) P : Small retentivity, large coercivity
(3) T : Large retentivity, large coercivity
(4) P : Large retentivity, large coercivity

6. The least count of the main scale of a vernier callipers is 1 mm. Its vernier scale is divided into 10 divisions and coincide with 9 divisions of the main scale. When jaws are touching each other, the 7th division of vernier scale coincides with a division of main scale and the zero of vernier scale is lying right side of the zero of main scale. When this vernier is used to measure length of a cylinder the zero of the vernier scale between 3.1 cm and 3.2 cm and 4th VSD coincides with a main scale division. The length of the cylinder is : (VSD is vernier scale division)

(1) 3.21 cm (2) 2.99 cm
(3) 3.2 cm (4) 3.07 cm

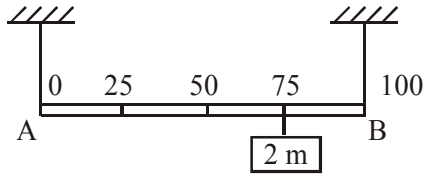
7. The mass density of a spherical galaxy varies as $\frac{K}{r}$ over a large distance 'r' from its centre. In that region, a small star is in a circular orbit of radius R. Then the period of revolution, T depends on R as :

(1) $T \propto R$ (2) $T^2 \propto \frac{1}{R^3}$
(3) $T^2 \propto R$ (4) $T^2 \propto R^3$

8. Interference fringes are observed on a screen by illuminating two thin slits 1 mm apart with a light source (λ = 632.8 nm). The distance between the screen and the slits is 100 cm. If a bright fringe is observed on a screen at a distance of 1.27 mm from the central bright fringe, then the path difference between the waves, which are reaching this point from the slits is close to :

(1) 1.27 μm (2) 2 nm
(3) 2.87 nm (4) 2.05 μm

9.

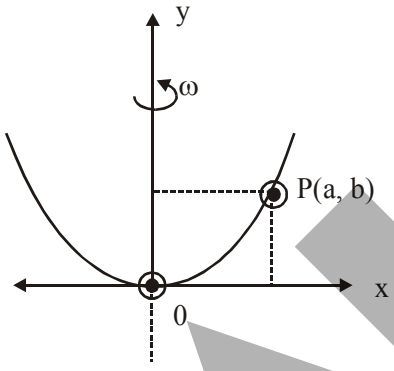


Shown in the figure is rigid and uniform one meter long rod AB held in horizontal position by two strings tied to its ends and attached to the ceiling. The rod is of mass 'm' and has another weight of mass 2 m hung at a distance of 75 cm from A. The tension in the string at A is :

(1) 2 mg (2) 0.5 mg

(3) 0.75 mg (4) 1 mg

10. A bead of mass m stays at point P(a, b) on a wire bent in the shape of a parabola $y = 4Cx^2$ and rotating with angular speed ω (see figure). The value of ω is (neglect friction) :



(1) $\sqrt{\frac{2gC}{ab}}$ (2) $2\sqrt{2gC}$

(3) $\sqrt{\frac{2g}{C}}$ (4) $2\sqrt{gC}$

11. A plane electromagnetic wave, has frequency of 2.0×10^{10} Hz and its energy density is 1.02×10^{-8} J/ m^3 in vacuum. The amplitude of the magnetic field of the wave is close to

($\frac{1}{4\pi\varepsilon_0} = 9\times10^9 \frac{Nm^2}{C^2}$ and speed of light $= 3 \times 10^8$ ms^{-1}) :

(1) 180 nT (2) 160 nT

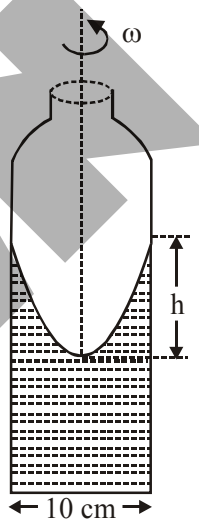
(3) 150 nT (4) 190 nT

12. In a reactor, 2 kg of $_{92}U^{235}$ fuel is fully used up in 30 days. The energy released per fission is 200 MeV. Given that the Avogadro number, $N = 6.023 \times 10^{26}$ per kilo mole and $1 \text{ eV} = 1.6 \times 10^{-19}$ J. The power output of the reactor is close to :

(1) 125 MW (2) 60 MW

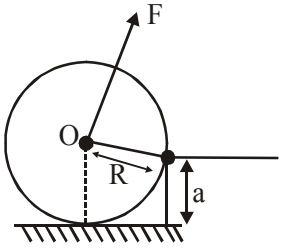
(3) 35 MW (4) 54 MW

13. A cylindrical vessel containing a liquid is rotated about its axis so that the liquid rises at its sides as shown in the figure. The radius of vessel is 5 cm and the angular speed of rotation is ω rad s^{-1}. The difference in the height, h(in cm) of liquid at the centre of vessel and at the side will be:



(1) $\frac{25\omega^2}{2g}$ (2) $\frac{2\omega^2}{5g}$ (3) $\frac{5\omega^2}{2g}$ (4) $\frac{2\omega^2}{25g}$

14. A uniform cylinder of mass M and radius R is to be pulled over a step of height a (a < R) by applying a force F at its centre 'O' perpendicular to the plane through the axes of the cylinder on the edge of the step (see figure). The minimum value of F required is :



(1) $Mg\sqrt{1-\frac{a^2}{R^2}}$ (2) $Mg\sqrt{\left(\frac{R}{R-a}\right)^2-1}$

(3) $Mg\frac{a}{R}$ (4) $Mg\sqrt{1-\left(\frac{R-a}{R}\right)^2}$

15. A gas mixture consists of 3 moles of oxygen and 5 moles of argon at temperature T. Assuming the gases to be ideal and the oxygen bond to be rigid, the total internal energy (in units of RT) of the mixture is :

(1) 11 (2) 15

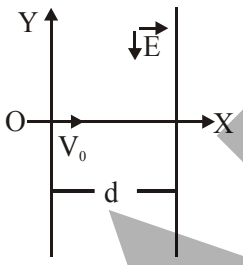
(3) 20 (4) 13

16. If speed V, area A and force F are chosen as fundamental units, then the dimension of Young's modulus will be :

(1) $FA^{-1}V^0$ (2) FA^2V^{-1}

(3) FA^2V^{-3} (4) FA^2V^{-2}

17. A charged particle (mass m and charge q) moves along X axis with velocity V_0. When it passes through the origin it enters a region having uniform electric field $\vec{E} = -E\hat{j}$ which extends upto x = d. Equation of path of electron in the region x > d is :



(1) $y = \frac{qEd}{mV_0^2}\left(\frac{d}{2} - x\right)$ (2) $y = \frac{qEd}{mV_0^2}(x - d)$

(3) $y = \frac{qEd}{mV_0^2}x$ (4) $y = \frac{qEd^2}{mV_0^2}x$

18. An amplitude modulated wave is represented by the expression $v_m = 5(1 + 0.6\cos 6280t)\sin(211 \times 10^4 t)$ volts. The minimum and maximum amplitudes of the amplitude modulated wave are, respectively :

(1) 5V, 8V (2) $\frac{3}{2}$V, 5V

(3) $\frac{5}{2}$V, 8V (4) 3V, 5V

19. Train A and train B are running on parallel tracks in the opposite directions with speeds of 36 km/hour and 72 km/hour, respectively. A person is walking in train A in the direction opposite to its motion with a speed of 1.8 km/hr. Speed (in ms^{-1}) of this person as observed from train B will be close to : (take the distance between the tracks as negligible)

(1) 30.5 ms^{-1} (2) 29.5 ms^{-1}

(3) 31.5 ms^{-1} (4) 28.5 ms^{-1}

20. Two identical strings X and Z made of same material have tension T_X and T_Z in them. It their fundamental frequencies are 450 Hz and 300 Hz, respectively, then the ratio T_X/T_Z is :

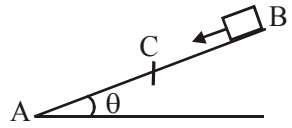
(1) 0.44 (2) 1.5

(3) 2.25 (4) 1.25

21. A 5 μF capacitor is charged fully by a 220 V supply. It is then disconnected from the supply and is connected in series to another uncharged 2.5 μF capacitor. If the energy change during the charge redistribution is $\frac{X}{100}$J then value of X to the nearest integer is_____.

22. An engine takes in 5 moles of air at 20°C and 1 atm, and compresses it adiabaticaly to 1/10th of the original volume. Assuming air to be a diatomic ideal gas made up of rigid molecules, the change in its internal energy during this process comes out to be X kJ. The value of X to the nearest integer is _____.

23.



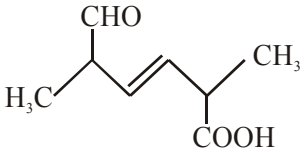
A small block starts slipping down from a point B on an inclined plane AB, which is making an angle θ with the horizontal section BC is smooth and the remaining section CA is rough with a coefficient of friction μ. It is found that the block comes to rest as it reaches the bottom (point A) of the inclined plane. If BC = 2AC, the coefficient of friction is given by $\mu = k\tan\theta$). The value of k is _____.

24. A circular coil of radius 10 cm is placed in a uniform magnetic field of 3.0×10^{-5} T with its plane perpendicular to the field initially. It is rotated at constant angular speed about an axis along the diameter of coil and perpendicular to magnetic field so that it undergoes half of rotation in 0.2s. The maximum value of EMF induced (in μV) in the coil will be close to the integer _____.

25. When radiation of wavelength λ is used to illuminate a metallic surface, the stopping potential is V. When the same surface is illuminated with radiation of wavelength 3λ, the stopping potential is $\frac{V}{4}$. If the threshold wavelength for the metallic surface is nλ then value of n will be _____.

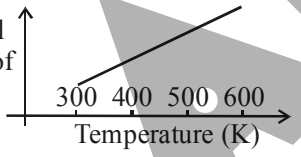
CHEMISTRY

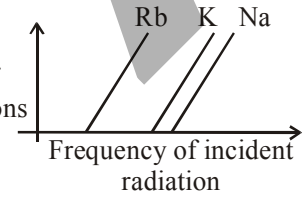
1. The IUPAC name for the following compound is :

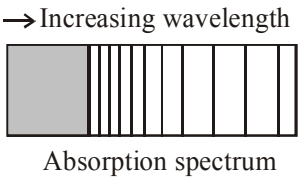


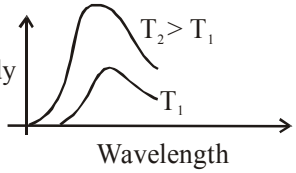
(1) 2, 5-dimethyl-6-carboxy-hex-3-enal
(2) 6-formyl-2-methyl-hex-3-enoic acid
(3) 2, 5-dimethyl-5-carboxy-hex-3-enal
(4) 2, 5-dimethyl-6-oxo-hex-3-enoic acid

2. The figure that is not a direct manifestation of the quantum nature of atoms is :

(1)


(2)


(3)


(4)


3. For the following Assertion and Reason, the correct option is

Assertion (A) : When Cu (II) and sulphide ions are mixed, they react together extremely quickly to give a solid.

Reason (R) : The equilibrium constant of $Cu^{2+}(aq) + S^{2-}(aq) \rightleftharpoons CuS(s)$ is high because the solubility product is low.

(1) Both (A) and (R) are true and (R) is the explanation for (A)
(2) Both (A) and (R) are false
(3) (A) is false and (R) is true
(4) Both (A) and (R) are true but (R) is not the explanation for (A)

4. If AB_4 molecule is a polar molecule, a possible geometry of AB_4 is :

(1) Square pyramidal (2) Tetrahedral
(3) Square planar (4) Rectangular planar

5. On heating compound (A) gives a gas (B) which is constituent of air. This gas when treated with H_2 in the presence of a catalyst gives another gas (C) which is basic in nature. (A) should not be:

(1) $(NH_4)_2Cr_2O_7$ (2) $Pb(NO_3)_2$
(3) NaN_3 (4) NH_4NO_2

6. In general, the property (magnitudes only) that shows an opposite trend in comparison to other properties across a period is

(1) Electronegativity
(2) Electron gain enthalpy
(3) Ionization enthalpy
(4) Atomic radius

7. The statement that is not true about ozone is :

(1) in the stratosphere, it forms a protective shield against UV radiation.
(2) it is a toxic gas and its reaction with NO gives NO_2.
(3) in the atmosphere, it is depleted by CFCs.
(4) in the stratophere, CFCs release chlorine free radicals ($\dot{Cl}$) which reacts with O_3 to give chlorine dioxide radicals.

8. The metal mainly used in devising photoelectric cells is:

(1) Na (2) Rb

(3) Li (4) Cs

9. For octahedral Mn(II) and tetrahedral Ni(II) complexes, consider the following statements :

(I) both the complexes can be high spin

(II) Ni(II) complex can very rarely be low spin.

(III) with strong field ligands, Mn(II) complexes can be low spin.

(IV) aqueous solution of Mn(II) ions is yellow in color.

The **correct** statements are :

(1) (I), (III) and (IV) only

(2) (II), (III) and (IV) only

(3) (I), (II) and (III) only

(4) (I) and (II) only

10. Consider that a d^6 metal ion (M^{2+}) forms a complex with aqua ligands, and the spin only magnetic moment of the complex is 4.90 BM. The geometry and the crystal field stabilization energy of the complex is :

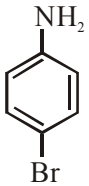
(1) tetrahedral and $-1.6\ \Delta_t + 1P$

(2) tetrahedral and $-0.6\ \Delta_t$

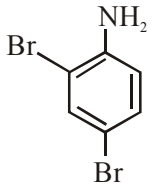
(3) octahedral and $-1.6\ \Delta_0$

(4) octahedral and $-2.4\ \Delta_0 + 2P$

11. In Carius method of estimation of halogen, 0.172g of an organic compound showed presence of 0.08g of bromine. Which of these is the **correct** structure of the compound :

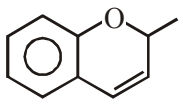
(1) 

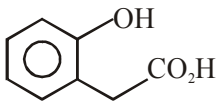
(2) $H_3C–CH_2–Br$

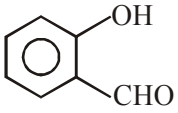
(3) 

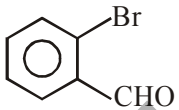
(4) $H_3C–Br$

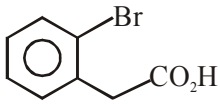
12. The major aromatic product C in the following reaction sequence will be :



(1) 

(2) 

(3) 

(4) 

13. An open beaker of water in equilibrium with water vapour is in a sealed container. When a few grams of glucose are added to the beaker of water, the rate at which water molecules :

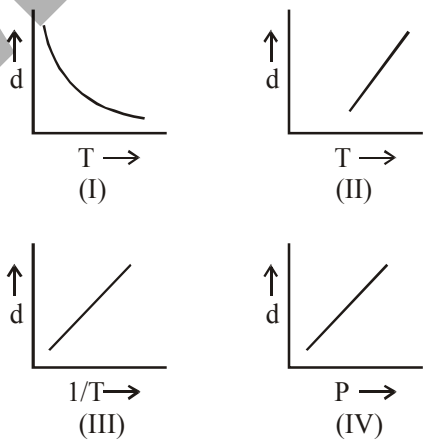
(1) leaves the vapour increases

(2) leaves the solution increases

(3) leaves the solution decreases

(4) leaves the vapour decreases

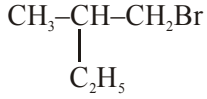
14. Which one of the following graphs is **not correct** for ideal gas ?

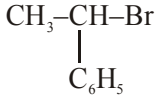


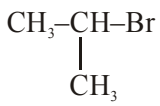
d = Density, P = Pressure, T = Temperature

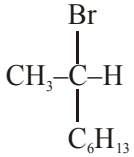
(1) II (2) III (3) I (4) IV

15. Which of the following compounds will show retention in configuration on nucleophic substitution by OH^- ion ?

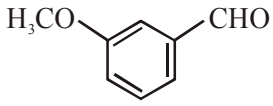
(1) 

(2) 

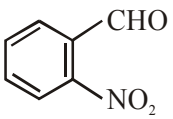
(3) 

(4) 

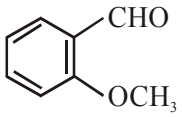
16. The increasing order of the following compounds towards HCN addition is :



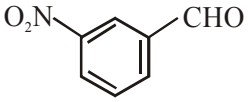
(i)



(ii)



(iii)



(iv)

(1) (iii) < (iv) < (ii) < (i)
(2) (iii) < (iv) < (i) < (ii)
(3) (iii) < (i) < (iv) < (ii)
(4) (i) < (iii) < (iv) < (ii)

17. While titrating dilute HCl solution with aqueous NaOH, which of the following will **not** be required?
(1) Clamp and phenolphthalein
(2) Pipette and distilled water
(3) Burette and porcelain tile
(4) Bunsen burner and measuring cylinder

18. Consider the following reactions :

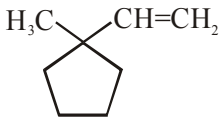
(i) Glucose + ROH $\xrightarrow{\text{dry HCl}}$ Acetal $\xrightarrow[(CH_3CO)_2O]{\text{x eq.of}}$ acetyl derivative

(ii) Glucose $\xrightarrow{Ni/H_2}$ A $\xrightarrow[(CH_3CO)_2O]{\text{y eq.of}}$ acetyl derivative

(iii) Glucose $\xrightarrow[(CH_3CO)_2O]{\text{z eq.of}}$ acetyl derivative

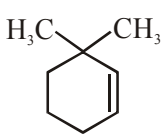
'x', 'y' and 'z' in these reactions are respectively.
(1) 5, 6, & 5 (2) 4, 5 & 5
(3) 5, 4 & 5 (4) 4, 6 & 5

19. The major product in the following reaction is :

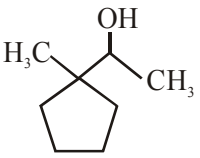


$\xrightarrow[\text{Heat}]{H_3O^+}$

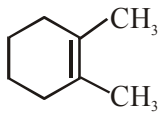
(1)



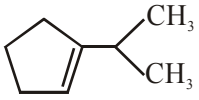
(2)



(3)



(4)



20. Which of the following is used for the preparation of colloids ?
(1) Ostwald Process
(2) Van Arkel Method
(3) Bredig's Arc Method
(4) Mond Process

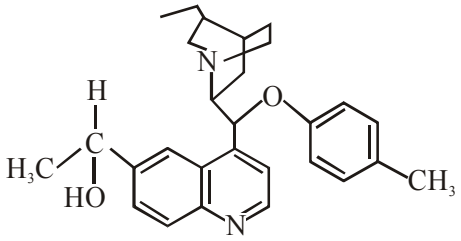
21. The Gibbs energy change (in J) for the given reaction at $[Cu^{2+}] = [Sn^{2+}] = 1$ M and 298K is:
$Cu(s) + Sn^{2+}(aq.) \rightarrow Cu^{2+}(aq.) + Sn(s)$;

$(E^0_{Sn^{2+}|Sn} = -0.16V, E^0_{Cu^{2+}|Cu} = 0.34V,$

Take F = 96500 C mol^{-1})

22. The mass of gas adsorbed, x, per unit mass of adsorbate, m, was measured at various pressures, p. A graph between $\log \frac{x}{m}$ and $\log p$ gives a straight line with slope equal to 2 and the intercept equal to 0.4771. The value of $\frac{x}{m}$ at a pressure of 4 atm is : (Given log 3 = 0.4771)

23. The number of chiral carbons present in the molecule given below is _____ .



24. The oxidation states of iron atoms in compounds (A), (B) and (C), respectively, are x, y and z. The sum of x,y and z is ____.

$Na_4[Fe(CN)_5NOS)]$ (A) $Na_4[FeO_4]$ (B) $[Fe_2(CO)_9]$ (C)

25. The internal energy change (in J) when 90g of water undergoes complete evaporation at 100°C is ____ .
(Given : ΔH_{vap} for water at 373 K = 41 kJ/mol, R = 8.314 JK^{-1} mol^{-1})

MATHEMATICS

1. If $|x| < 1$, $|y| < 1$ and $x \neq y$, then the sum to infinity of the following series
$(x+y) + (x^2+xy+y^2) + (x^3+x^2y + xy^2+y^3)+.....$

(1) $\frac{x+y-xy}{(1-x)(1-y)}$ (2) $\frac{x+y-xy}{(1+x)(1+y)}$

(3) $\frac{x+y+xy}{(1+x)(1+y)}$ (4) $\frac{x+y+xy}{(1-x)(1-y)}$

2. Let $\alpha > 0$, $\beta > 0$ be such that $\alpha^3 + \beta^2 = 4$. If the maximum value of the term independent of x in the binomial expansion of $\left(\alpha x^{\frac{1}{9}} + \beta x^{-\frac{1}{6}}\right)^{10}$ is 10k, then k is equal to :

(1) 176 (2) 336
(3) 352 (4) 84

3. If a function f(x) defined by

$$f(x) = \begin{cases} ae^x + be^{-x}, & -1 \le x < 1 \\ cx^2 \quad\quad , & 1 \le x \le 3 \\ ax^2 + 2cx \ , & 3 < x \le 4 \end{cases}$$

be continuous for some a, b, c $\in$ R and $f'(0) + f'(2) = e$, then the value of of a is :

(1) $\frac{e}{e^2-3e-13}$ (2) $\frac{e}{e^2+3e+13}$

(3) $\frac{1}{e^2-3e+13}$ (4) $\frac{e}{e^2-3e+13}$

4. Box I contains 30 cards numbered 1 to 30 and Box II contains 20 cards numbered 31 to 50. A box is selected at random and a card is drawn from it. The number on the card is found to be a non-prime number. The probability that the card was drawn from Box I is :

(1) $\frac{8}{17}$ (2) $\frac{2}{3}$ (3) $\frac{4}{17}$ (4) $\frac{2}{5}$

5. Area (in sq. units) of the region outside $\frac{|x|}{2}+\frac{|y|}{3}=1$ and inside the ellipse $\frac{x^2}{4}+\frac{y^2}{9}=1$ is :

(1) $3(4 - \pi)$ (2) $6(\pi - 2)$
(3) $3(\pi - 2)$ (4) $6(4 - \pi)$

6. Let S be the set of all $\lambda \in R$ for which the system of linear equations
$2x - y + 2z = 2$
$x - 2y + \lambda z = -4$
$x + \lambda y + z = 4$
has no solution. Then the set S
(1) contains more than two elements.
(2) is a singleton.
(3) contains exactly two elements.
(4) is an empty set.

7. Let A be a 2×2 real matrix with entries from $\{0, 1\}$ and $|A| \neq 0$. Consider the following two statements :
(P) If $A \neq I_2$, then $|A| = -1$
(Q) If $|A| = 1$, then $tr(A) = 2$,
where I_2 denotes 2×2 identity matrix and tr(A) denotes the sum of the diagonal entries of A. Then:
(1) (P) is true and (Q) is false
(2) Both (P) and (Q) are false
(3) Both (P) and (Q) are true
(4) (P) is false and (Q) is true

8. The contrapositive of the statement "If I reach the station in time, then I will catch the train" is:
(1) If I will catch the train, then I reach the station in time.
(2) If I do not reach the station in time, then I will not catch the train.
(3) If I will not catch the train, then I do not reach the station in time.
(4) If I do not reach the station in time, then I will catch the train.

9. Let $y = y(x)$ be the solution of the differential equation,
$\frac{2+\sin x}{y+1}\cdot\frac{dy}{dx} = -\cos x, y > 0, y(0) = 1$. If $y(\pi) = a$ and $\frac{dy}{dx}$ at $x = \pi$ is b, then the ordered pair (a, b) is equal to :

(1) (2, 1) (2) $\left(2, \frac{3}{2}\right)$
(3) (1, –1) (4) (1, 1)

10. Let $X = \{x \in N : 1 \le x \le 17\}$ and $Y = \{ax + b: x \in X \text{ and } a, b \in R, a > 0\}$. If mean and variance of elements of Y are 17 and 216 respectively then a + b is equal to :

(1) –7 (2) 7 (3) 9 (4) –27

11. If the tangent to the curve $y = x + \sin y$ at a point (a, b) is parallel to the line joining $\left(0,\frac{3}{2}\right)$ and $\left(\frac{1}{2},2\right)$, then :

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

(3) |b – a| = 1 (4) |a+b| = 1

12. Let P(h, k) be a point on the curve $y = x^2 + 7x + 2$, nearest to the line, y = 3x – 3. Then the equation of the normal to the curve at P is :

(1) x + 3y – 62 = 0 (2) x – 3y – 11 = 0

(3) x – 3y + 22 = 0 (4) x + 3y + 26 = 0

13. The plane passing through the points (1, 2, 1), (2, 1, 2) and parallel to the line, 2x = 3y, z = 1 also passes through the point :

(1) (0, 6, –2) (2) (–2, 0, 1)

(3) (0, –6, 2) (4) (2, 0, –1)

14. Let α and β be the roots of the equation $5x^2 + 6x – 2 = 0$. If $S_n = \alpha^n + \beta^n$, n = 1,2,3...., then :

(1) $5S_6 + 6S_5 = 2S_4$ (2) $5S_6 + 6S_5 + 2S_4 = 0$

(3) $6S_6 + 5S_5 + 2S_4 = 0$ (4) $6S_6 + 5S_5 = 2S_4$

15. If $R = \{(x,y) : x,y \in Z, x^2 + 3y^2 \le 8\}$ is a relation on the set of integers Z, then the domain of R^{-1} is :

(1) {–2, –1, 1,2} (2) {–1, 0, 1}

(3) {–2, –1, 0, 1, 2} (4) {0, 1}

16. The sum of the first three terms of a G.P. is S and their product is 27. Then all such S lie in:

(1) [–3, ∞) (2) (–∞, 9]

(3) (–∞, –9] ∪ [3, ∞) (4) (–∞, –3] ∪ [9, ∞)

17. A line parallel to the straight line 2x – y = 0 is tangent to the hyperbola $\frac{x^2}{4} - \frac{y^2}{2} = 1$ at the point (x_1, y_1). Then $x_1^2 + 5y_1^2$ is equal to :

(1) 5 (2) 6 (3) 8 (4) 10

18. The domain of the function $f(x) = \sin^{-1}\left(\frac{|x|+5}{x^2+1}\right)$ is $(-\infty, -a] \cup [a, \infty)$. Then a is equal to :

(1) $\frac{1+\sqrt{17}}{2}$ (2) $\frac{\sqrt{17}-1}{2}$

(3) $\frac{\sqrt{17}}{2}+1$ (4) $\frac{\sqrt{17}}{2}$

19. The value of $\left(\frac{1+\sin\frac{2\pi}{9}+i\cos\frac{2\pi}{9}}{1+\sin\frac{2\pi}{9}-i\cos\frac{2\pi}{9}}\right)^3$ is :

(1) $\frac{1}{2}\left(\sqrt{3}-i\right)$ (2) $-\frac{1}{2}\left(\sqrt{3}-i\right)$

(3) $-\frac{1}{2}\left(1-i\sqrt{3}\right)$ (4) $\frac{1}{2}\left(1-i\sqrt{3}\right)$

20. If p(x) be a polynomial of degree three that has a local maximum value 8 at x = 1 and a local minimum value 4 at x = 2; then p(0) is equal to:

(1) 12 (2) –24 (3) 6 (4) –12

21. The integral $\int_0^2 ||x-1|-x|\,dx$ is equal to_____.

22. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three unit vectors such that $|\vec{a}-\vec{b}|^2 + |\vec{a}-\vec{c}|^2 = 8$.

Then $|\vec{a}+2\vec{b}|^2 + |\vec{a}+2\vec{c}|^2$ is equal to _____.

23. If $\lim\limits_{x\to1}\frac{x+x^2+x^3+...+x^n-n}{x-1} = 820, (n \in N)$

then the value of n is equal to_____.

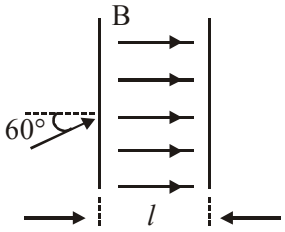
24. If the letters of the word 'MOTHER' be permuted and all the words so formed (with or without meaning) be listed as in a dictionary, then the position of the word 'MOTHER' is _____.

25. The number of integral values of k for which the line, 3x + 4y = k intersects the circle, $x^2 + y^2 – 2x – 4y + 4 = 0$ at two distinct points is _____.

SET # 02

PHYSICS

1. The figure shows a region of length 'l' with a uniform magnetic field of 0.3 T in it and a proton entering the region with velocity 4×10^5 ms^{-1} making an angle 60° with the field. If the proton completes 10 revolution by the time it cross the region shown, 'l' is close to (mass of proton = 1.67×10^{-27} kg, charge of the proton = 1.6×10^{-19} C)

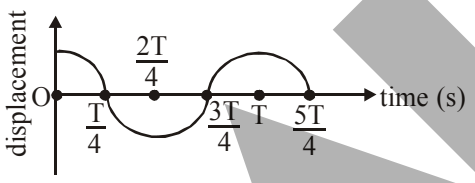


(1) 0.11 m (2) 0.22 m

(3) 0.44 m (4) 0.88 m

2. The displacement time graph of a particle executing S.H.M. is given in figure :

(sketch is schematic and not to scale)



Which of the following statements is/are true for this motion ?

(A) The force is zero $t = \frac{3T}{4}$

(B) The acceleration is maximum at t = T

(C) The speed is maximum at $t = \frac{T}{4}$

(D) The P.E. is equal to K.E. of the oscillation at $t = \frac{T}{2}$

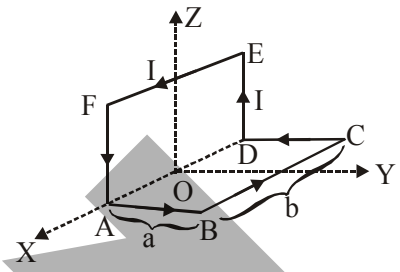
(1) (A), (B) and (D)

(2) (B), (C) and (D)

(3) (A) and (D)

(4) (A), (B) and (C)

3. A wire carrying current I is bent in the shape ABCDEFA as shown, where rectangle ABCDA and ADEFA are perpendicular to each other. If the sides of the rectangles are of lengths a and b, then the magnitude and direction of magnetic moment of the loop ABCDEFA is :



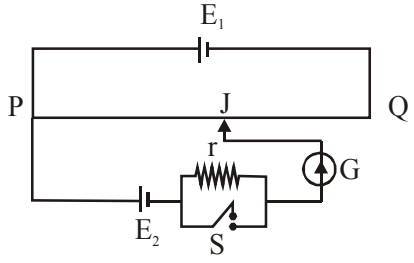
(1) $\sqrt{2}$abI, along $\left(\frac{\hat{j}}{\sqrt{2}} + \frac{\hat{k}}{\sqrt{2}}\right)$

(2) $\sqrt{2}$abI, along $\left(\frac{\hat{j}}{\sqrt{5}} + \frac{2\hat{k}}{\sqrt{5}}\right)$

(3) abI, along $\left(\frac{\hat{j}}{\sqrt{2}} + \frac{\hat{k}}{\sqrt{2}}\right)$

(4) abI, along $\left(\frac{\hat{j}}{\sqrt{5}} + \frac{2\hat{k}}{\sqrt{5}}\right)$

4. A potentiometer wire PQ of 1 m length is connected to a standard cell E_1. Another cell E_2 of emf 1.02 V is connected with a resistance 'r' and switch S (as shown in figure). With switch S open, the null position is obtained at a distance of 49 cm from Q. The potential gradient in the potentiometer wire is :



(1) 0.02 V/cm (2) 0.04 V/cm

(3) 0.01 V/cm (4) 0.03 V/cm

5. A heat engine is involved with exchange of heat of 1915 J, –40 J, +125 J and QJ, during one cycle achieving an efficiency of 50.0%. The value of Q is:

(1) 640 J (2) 400 J

(3) 980 J (4) 40 J

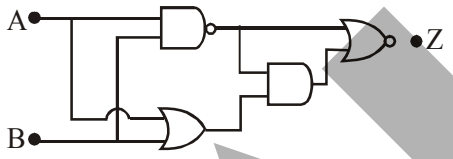
6. In a Young's double slit experiment, 16 fringes are observed in a certain segment of the screen when light of wavelength 700 nm is used. If the wavelength of light is changed to 400 nm, the number of fringes observed in the same segment of the screen would be :

(1) 28 (2) 24 (3) 18 (4) 30

7. In a hydrogen atom the electron makes a transition from $(n + 1)^{th}$ level to the n^{th} level. If n>>l, the frequency of radiation emitted is proportional to :

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

8. In the following digital circuit, what will be the output at 'Z', when the input (A, B) are (1,0), (0,0), (1,1), (0,1):



(1) 1, 0, 1, 1 (2) 0, 1, 0, 0

(3) 0, 0, 1, 0 (4) 1, 1, 0, 1

9. If momentum (P), area (A) and time (T) are taken to be the fundamental quantities then the dimensional formula for energy is :

(1) $[PA^{-1} T^{-2}]$ (2) $[PA^{1/2}T^{-1}]$

(3) $[P^2AT^{-2}]$ (4) $[P^{1/2}AT^{-1}]$

10. A capillary tube made of glass of radius 0.15 mm is dipped vertically in a beaker filled with methylene iodide (surface tension = 0.05 Nm^{-1}, density = 667 kg m^{-3}) which rises to height h in the tube. It is observed that the two tangents drawn from liquid-glass interfaces (from opp. sides of the capillary) make an angle of 60° with one another. Then h is close to (g = 10 ms^{-2}).

(1) 0.137 m (2) 0.172 m

(3) 0.087 m (4) 0.049 m

11. The height 'h' at which the weight of a body will be the same as that at the same depth 'h' from the surface of the earth is (Radius of the earth is R and effect of the rotation of the earth is neglected) :

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

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

12. An ideal gas in a closed container is slowly heated. As its temperature increases, which of the following statements are true ?

(A) the mean free path of the molecules decreases.

(B) the mean collision time between the molecules decreases.

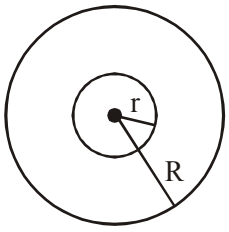
(C) the mean free path remains unchanged.

(D) the mean collision time remains unchanged.

(1) (C) and (D) (2) (A) and (B)

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

13. A charge Q is distributed over two concentric conducting thin spherical shells radii r and R (R > r). If the surface charge densities on the two shells are equal, the electric potential at the common centre is :



(1) $\frac{1}{4\pi\varepsilon_0}\frac{(R+2r)Q}{2(R^2+r^2)}$

(2) $\frac{1}{4\pi\varepsilon_0}\frac{(R+r)}{2(R^2+r^2)}Q$

(3) $\frac{1}{4\pi\varepsilon_0}\frac{(R+r)}{(R^2+r^2)}Q$

(4) $\frac{1}{4\pi\varepsilon_0}\frac{(2R+r)}{(R^2+r^2)}Q$

14. An inductance coil has a reactance of 100 Ω. When an AC signal of frequency 1000 Hz is applied to the coil, the applied voltage leads the current by 45°. The self-inductance of the coil is :-

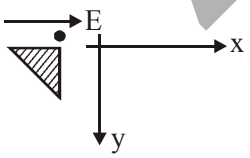
(1) 1.1×10^{-2} H (2) 1.1×10^{-1} H

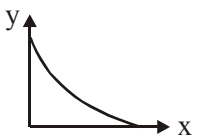
(3) 5.5×10^{-5} H (4) 6.7×10^{-7} H

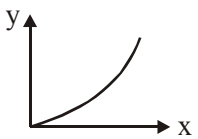
15. Two uniform circular discs are rotating independently in the same direction around their common axis passing through their centres. The moment of inertia and angular velocity of the first disc are 0.1 kg-m^2 and 10 rad s^{-1} respectively while those for the second one are 0.2 kg-m^2 and 5 rad s^{-1} respectively. At some instant they get stuck together and start rotating as a single system about their common axis with some angular speed. The Kinetic energy of the combined system is :

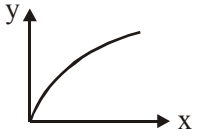
(1) $\frac{10}{3}$J (2) $\frac{2}{3}$J (3) $\frac{5}{3}$J (4) $\frac{20}{3}$J

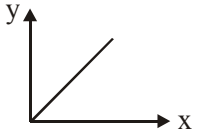
16. A small point mass carrying some positive charge on it, is released from the edge of a table. There is a uniform electric field in this region in the horizontal direction. Which of the following options then correctly describe the trajectory of the mass ? (Curves are drawn schematically and are not to scale).



(1) 

(2) 

(3) 

(4) 

17. A 10 μF capacitor is fully charged to a potential difference of 50 V. After removing the source voltage it is connected to an uncharged capacitor in parallel. Now the potential difference across them becomes 20 V. The capacitance of the second capacitor is:

(1) 10 μF (2) 15 μF

(3) 20 μF (4) 30 μF

18. When the temperature of a metal wire is increased from 0°C to 10°C, its length increases by 0.02%. The percentage change in its mass density will be closest to:

(1) 0.008 (2) 0.06

(3) 0.8 (4) 2.3

19. In a plane electromagnetic wave, the directions of electric field and magnetic field are represented by $\hat{k}$ and $2\hat{i}-2\hat{j}$, respectively. What is the unit vector along direction of propagation of the wave.

(1) $\frac{1}{\sqrt{2}}\left(\hat{i}+\hat{j}\right)$ (2) $\frac{1}{\sqrt{5}}\left(\hat{i}+2\hat{j}\right)$

(3) $\frac{1}{\sqrt{5}}\left(2\hat{i}+\hat{j}\right)$ (4) $\frac{1}{\sqrt{2}}\left(\hat{j}+\hat{k}\right)$

20. A particle is moving 5 times as fast as an electron. The ratio of the de-Broglie wavelength of the particle to that of the electron is 1.878×10^{-4}. The mass of the particle is close to :

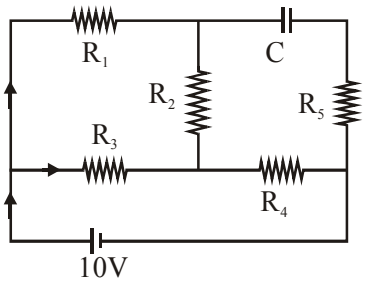
(1) 4.8×10^{-27} kg

(2) 1.2×10^{-28} kg

(3) 9.1×10^{-31} kg

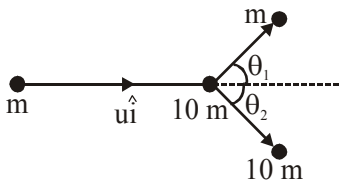
(4) 9.7×10^{-28} kg

21. An ideal cell of emf 10 V is connected in circuit shown in figure. Each resistance is 2 Ω. The potential difference (in V) across the capacitor when it is fully charged is _____.

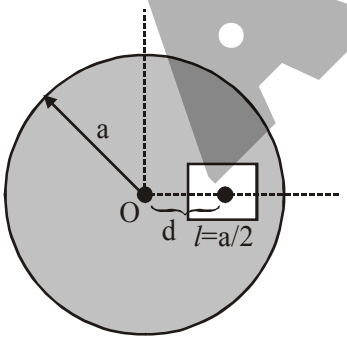


22. A light ray enters a solid glass sphere of refractive index $\mu = \sqrt{3}$ at an angle of incidence 60°. The ray is both reflected and refracted at the farther surface of the sphere. The angle (in degrees) between the reflected and refracted rays at this surface is_____.

23. A particle of mass m is moving along the x-axis with initial velocity $u\hat{i}$. It collides elastically with a particle of mass 10 m at rest and then moves with half its initial kinetic energy (see figure). If $\sin\theta_1 = \sqrt{n}\sin\theta_2$ then value of n is _____.



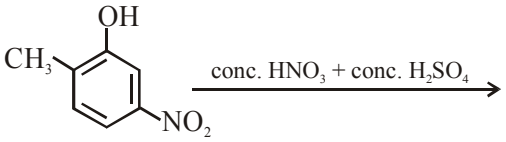
24. A square shaped hole of side $l = \frac{a}{2}$ is carved out at a distance $d = \frac{a}{2}$ from the centre 'O' of a uniform circular disk of radius a. If the distance of the centre of mass of the remaining portion from O is $-\frac{a}{X}$, value of X (to the nearest integer) is _____.

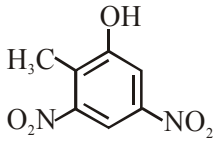


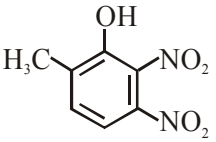
25. A wire of density 9×10^{-3} kg cm^{-3} is stretched between two clamps 1 m apart. The resulting strain in the wire is 4.9×10^{-4}. The lowest frequency of the transverse vibrations in the wire is (Young's modulus of wire Y = 9×10^{10} Nm^{-2}), (to the nearest integer),_____.

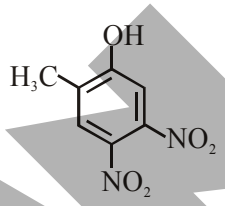
CHEMISTRY

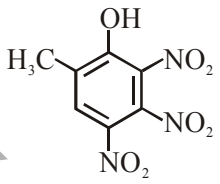
1. The major product of the following reaction is:



(1) 

(2) 

(3) 

(4) 

2. If you spill a chemical toilet cleaning liquid on your hand, your first aid would be :

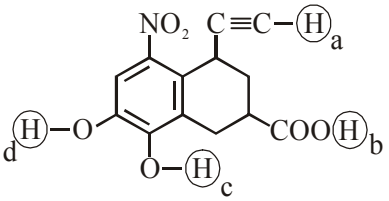
(1) aqueous NH_3

(2) vinegar

(3) aqueous $NaHCO_3$

(4) aqueous NaOH

3. Arrange the following labelled hydrogens in decreasing order of acidity :



(1) b > c > d > a

(2) c > b > a > d

(3) b > a > c > d

(4) c > b > d > a

4. Cast iron is used for the manufacture of :

(1) wrought iron and pig iron

(2) wrought iron and steel

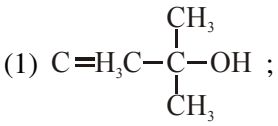
(3) wrought iron, pig iron and steel

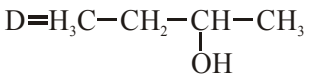
(4) pig iron, scrap iron and steel

5. Two compounds A and B with same molecular formula (C_3H_6O) undergo Grignard's reaction with methylmagnesium bromide to give products C and D. Products C and D show following chemical tests.

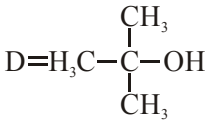
Test	C	D
Ceric ammonium nitrate Test	Positive	Positive
Lucas Test	Turbidity obtained after five minutes	Turbidity obtained immediately
Iodoform Test	Positive	Negative

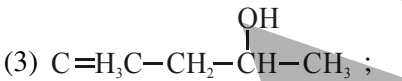
C and D respectively are :

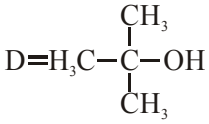
(1)  ;

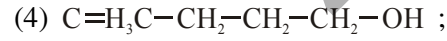
D = 

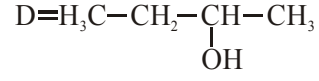
(2) C =  ;

D = 

(3)  ;

D = 

(4) C =  ;

D = 

6. The shape/structure of $[XeF_5]^-$ and XeO_3F_2, respectively, are :

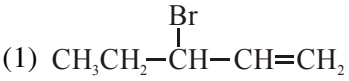
(1) pentagonal planar and trigonal bipyramidal

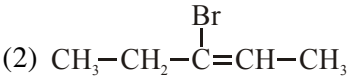
(2) trigonal bipyramidal and pentagonal planar

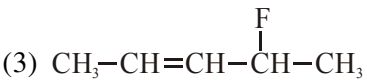
(3) octahedral and square pyramidal

(4) trigonal bipyramidal and trigonal bipyramidal

7. The major product obtained from E_2-elimination of 3-bromo-2-fluoropentane is:

(1) 

(2) 

(3) 

(4) 

8. Three elements X, Y and Z are in the 3rd period of the periodic table. The oxides of X, Y and Z, respectively, are basic, amphoteric and acidic. The correct order of the atomic numbers of X, Y and Z is :

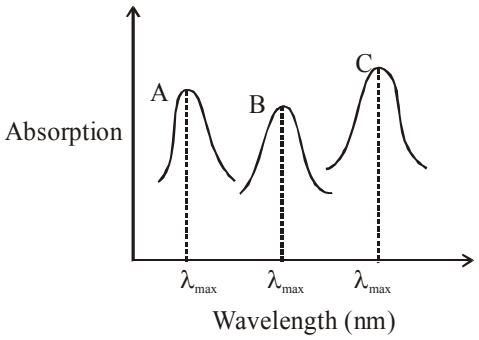
(1) Z < Y < X (2) X < Z < Y

(3) X < Y < Z (4) Y < X < Z

9. The number of subshells associated with n = 4 and m = –2 quantum numbers is :

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

10. Simplified absorption spectra of three complexes ((i), (ii) and (iii)) of M^{n+} ion are provided below; their λ_{max} values are marked as A, B and C respectively. The correct match between the complexes and their λ_{max} values is :



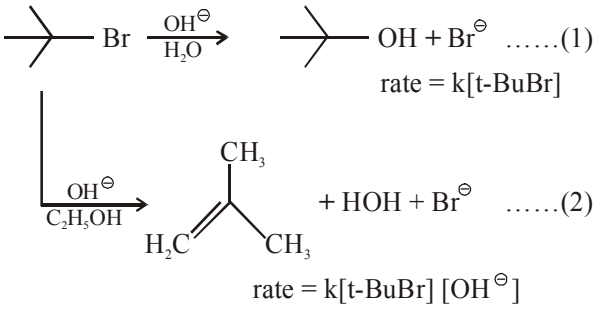
(i) $[M(NCS)_6]^{(-6+n)}$ (ii) $[MF_6]^{(-6+n)}$

(iii) $[M(NH_3)_6]^{n+}$

(1) A-(ii), B-(i), C-(iii) (2) A-(iii), B-(i), C-(ii)

(3) A-(ii), B-(iii), C-(i) (4) A-(i), B-(ii), C-(iii)

11. Consider the reaction sequence given below :



Which of the following statements is true :

(1) Changing the concentration of base will have no effect on reaction (1)

(2) Changing the concentration of base will have no effect on reaction (2)

(3) Changing the base from $OH^{\ominus}$ to $^{\ominus}OR$ will have no effect on reaction (2)

(4) Doubling the concentration of base will double the rate of both the reactions.

12. The results given in the below table were obtained during kinetic studies of the following reaction:

$2A + B \longrightarrow C + D$

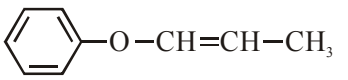
Experiment	[A]/molL^{-1}	[B]/molL^{-1}	Initial rate/molL^{-1} min^{-1}
I	0.1	0.1	6.00×10^{-3}
II	0.1	0.2	2.40×10^{-2}
III	0.2	0.1	1.20×10^{-2}
IV	X	0.2	7.20×10^{-2}
V	0.3	Y	2.88×10^{-1}

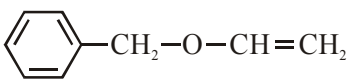
X and Y in the given table are respectively :

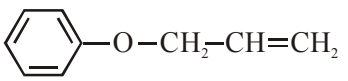
(1) 0.3, 0.4 (2) 0.4, 0.3

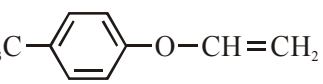
(3) 0.4, 0.4 (4) 0.3, 0.3

13. An organic compound 'A' ($C_9H_{10}O$) when treated with conc. HI undergoes cleavage to yield compounds 'B' and 'C'. 'B' gives yellow precipitate with $AgNO_3$ where as 'C' tautomerizes to 'D'. 'D' gives positive idoform test. 'A' could be :

(1) 

(2) 

(3) 

(4) 

14. The size of a raw mango shrinks to a much smaller size when kept in a concentrated salt solution. Which one of the following processes can explain this ?

(1) Diffusion (2) Dialysis

(3) Osmosis (4) Reverse osmosis

15. Two elements A and B have similar chemical properties. They don't form solid hydrogencarbonates, but react with nitrogen to form nitrides. A and B, respectively, are :

(1) Na and C (2) Li and Mg

(3) Cs and Ba (4) Na and Rb

16. The one that is not expected to show isomerism is :

(1) $[Ni(NH_3)_4(H_2O)_2]^{2+}$ (2) $[Ni(NH_3)_2Cl_2]$

(3) $[Pt(NH_3)_2Cl_2]$ (4) $[Ni(en)_3]^{2+}$

17. Amongst the following statements regarding adsorption, those that are valid are :

(a) ΔH becomes less negative as adsorption proceeds.

(b) On a given adsorbent, ammonia is adsorbed more than nitrogen gas.

(c) On adsorption, the residual force acting along the surface of the adsorbent increases.

(d) With increase in temperature, the equilibrium concentration of adsorbate increases.

(1) (b) and (c) (2) (a) and (b)

(3) (d) and (a) (4) (c) and (d)

18. Match the type of interaction in Column A with the distance dependence of their interaction energy in Column B :

A	B
(I) ion - ion	(a) $\frac{1}{r}$
(II) dipole - dipole	(b) $\frac{1}{r^2}$
(III) London dispersion	(c) $\frac{1}{r^3}$
	(d) $\frac{1}{r^6}$

(1) (I)-(a), (II)-(b), (III)-(c)

(2) (I)-(a), (II)-(c), (III)-(d)

(3) (I)-(a), (II)-(b), (III)-(d)

(4) (I)-(b), (II)-(d), (III)-(c)

19. The correct observation in the following reactions is :

$$\text{Sucrose} \xrightarrow[\text{Cleavage}\\(\text{Hydrolysis})]{\text{Glycosidic bond}} A + B \xrightarrow[\text{reagent}]{\text{Seliwanoff's}} ?$$

(1) Formation of blue colour
(2) Formation of violet colour
(3) Formation of red colour
(4) Gives no colour

20. The molecular geometry of SF_6 is octahedral. What is the geometry of SF_4 (including lone pair(s) of electrons, if any) ?
(1) Trigonal bipyramidal
(2) Square planar
(3) Tetrahedral
(4) Pyramidal

21. The heat of combustion of ethanol into carbon dioxide and water is –327 kcal at constant pressure. The heat evolved (in cal) at constant volume and 27°C (if all gases behave ideally) is (R = 2 cal mol^{-1} K^{-1})

22. For the disproportionation reaction $2Cu^+(aq) \rightleftharpoons Cu(s) + Cu^{2+}(aq)$ at 298 K, ln K (where K is the equilibrium constant) is _____ × 10^{-1} .
Given

$(E^0_{Cu^{2+}/Cu^+} = 0.16V$

$E^0_{Cu^+/Cu} = 0.52V$

$\frac{RT}{F} = 0.025)$

23. The oxidation states of transition metal atoms in $K_2Cr_2O_7$, $KMnO_4$ and K_2FeO_4, respectively, are x, y and z. The sum of x, y and z is ____.

24. The ratio of the mass percentages of 'C & H' and 'C & O' of a saturated acyclic organic compound 'X' are 4 : 1 and 3 : 4 respectively. Then, the moles of oxygen gas required for complete combustion of two moles of organic compound 'X' is _____ .

25. The work function of sodium metal is 4.41 × 10^{-19} J. If the photons of wavelength 300 nm are incident on the metal, the kinetic energy of the ejected electrons will be _____ × 10^{-21} J.
(h = 6.63 × 10^{-34} Js; c = 3 × 10^8 m/s)

MATHEMATICS

1. The area (in sq. units) of an equilateral triangle inscribed in the parabola $y^2 = 8x$, with one of its vertices on the vertex of this parabola, is :

(1) $64\sqrt{3}$ (2) $256\sqrt{3}$

(3) $192\sqrt{3}$ (4) $128\sqrt{3}$

2. Let n > 2 be an integer. Suppose that there are n Metro stations in a city located along a circular path. Each pair of stations is connected by a straight track only. Further, each pair of nearest stations is connected by blue line, whereas all remaining pairs of stations are connected by red line. If the number of red lines is 99 times the number of blue lines, then the value of n is :-

(1) 199 (2) 101

(3) 201 (4) 200

3. If the equation $\cos^4\theta+\sin^4\theta + \lambda = 0$ has real solutions for θ, then λ lies in the interval :

(1) $\left[-\frac{3}{2},-\frac{5}{4}\right]$ (2) $\left(-\frac{1}{2},-\frac{1}{4}\right]$

(3) $\left(-\frac{5}{4},-1\right)$ (4) $\left[-1,-\frac{1}{2}\right]$

4. Let f(x) be a quadratic polynomial such that f(–1) + f(2) = 0. If one of the roots of f(x) = 0 is 3, then its other root lies in :

(1) (–3, –1) (2) (1, 3)

(3) (–1, 0) (4) (0, 1)

5. Let $f : R \to R$ be a function which satisfies $f(x + y) = f(x) + f(y) \forall x,y \in R$. If $f(1) = 2$ and $g(n) = \sum_{k=1}^{(n-1)} f(k), n \in N$ then the value of n, for which $g(n) = 20$, is :

(1) 5 (2) 9

(3) 20 (4) 4

6. Let $a, b, c \in R$ be all non-zero and satisfy $a^3 + b^3 + c^3 = 2$. If the matrix

$$A = \begin{pmatrix} a & b & c \\ b & c & a \\ c & a & b \end{pmatrix}$$

satisfies $A^TA = I$, then a value of abc can be :

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

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

7. Let $f : (-1, \infty) \to R$ be defined by $f(0) = 1$ and $f(x) = \frac{1}{x}\log_e(1+x), x \neq 0$. Then the function f:

(1) decreases in $(-1, \infty)$

(2) decreases in $(-1, 0)$ and increases in $(0, \infty)$

(3) increases in $(-1, \infty)$

(4) increases in $(-1, 0)$ and decreases in $(0, \infty)$

8. If the sum of first 11 terms of an A.P., $a_1 a_2, a_3,...$ is 0 ($a_1 \neq 0$), then the sum of the A.P., $a_1, a_3, a_5,...,a_{23}$ is ka_1, where k is equal to :

(1) $\frac{121}{10}$ (2) $-\frac{72}{5}$

(3) $\frac{72}{5}$ (4) $-\frac{121}{10}$

9. The imaginary part of

$\left(3+2\sqrt{-54}\right)^{1/2} - \left(3-2\sqrt{-54}\right)^{1/2}$ can be :

(1) $-2\sqrt{6}$ (2) 6

(3) $\sqrt{6}$ (4) $-\sqrt{6}$

10. $\lim_{x\to 0}\left(\tan\left(\frac{\pi}{4}+x\right)\right)^{1/x}$ is equal to :

(1) 2 (2) e

(3) 1 (4) e^2

11. The equation of the normal to the curve $y = (1+x)^{2y} + \cos^2(\sin^{-1}x)$ at $x = 0$ is :

(1) $y = 4x + 2$

(2) $x + 4y = 8$

(3) $y + 4x = 2$

(4) $2y + x = 4$

12. For some $\theta \in \left(0, \frac{\pi}{2}\right)$, if the eccentricity of the hyperbola, $x^2 - y^2\sec^2\theta = 10$ is $\sqrt{5}$ times the eccentricity of the ellipse, $x^2\sec^2\theta + y^2 = 5$, then the length of the latus rectum of the ellipse, is:

(1) $\sqrt{30}$ (2) $\frac{4\sqrt{5}}{3}$

(3) $2\sqrt{6}$ (4) $\frac{2\sqrt{5}}{3}$

13. Which of the following is a tautology ?

(1) $(\sim p) \wedge (p \vee q) \to q$ (2) $(q \to p) \vee \sim(p \to q)$

(3) $(p \to q) \wedge (q \to p)$ (4) $(\sim q) \vee (p \wedge q) \to q$

14. A plane passing through the point (3, 1,1) contains two lines whose direction ratios are 1, –2, 2 and 2, 3, –1 respectively. If this plane also passes through the point $(\alpha, -3, 5)$, then α is equal to:

(1) –10 (2) 5

(3) 10 (4) –5

15. Let E^C denote the complement of an event E. Let E_1, E_2 and E_3 be any pairwise independent events with $P(E_1) > 0$ and $P(E_1 \cap E_2 \cap E_3) = 0$.

Then $P(E_2^C \cap E_3^C / E_1)$ is equal to :

(1) $P(E_3^C) - P(E_2)$

(2) $P(E_2^C) + P(E_3)$

(3) $P(E_3^C) - P(E_2^C) = P(E_3^C) - P(E_2)$

(4) $P(E_3) - P(E_2^C)$

16. Let $A = \{X = (x, y, z)^T: PX = 0$ and $x^2 + y^2 + z^2 = 1\}$ where $P = \begin{bmatrix} 1 & 2 & 1 \\ -2 & 3 & -4 \\ 1 & 9 & -1 \end{bmatrix}$, then the set A :

(1) is a singleton

(2) contains exactly two elements

(3) contains more than two elements

(4) is an empty set

17. Consider a region $R = \{(x, y) \in R^2 : x^2 \le y \le 2x\}$. If a line $y = \alpha$ divides the area of region R into two equal parts, then which of the following is true?

(1) $\alpha^3 - 6\alpha^2 + 16 = 0$

(2) $3\alpha^2 - 8\alpha + 8 = 0$

(3) $\alpha^3 - 6\alpha^{3/2} - 16 = 0$

(4) $3\alpha^2 - 8\alpha^{3/2} + 8 = 0$

18. If a curve $y = f(x)$, passing through the point (1,2), is the solution of the differential equation, $2x^2dy = (2xy + y^2)dx$, then $f\left(\frac{1}{2}\right)$ is equal to :

(1) $\frac{1}{1-\log_e 2}$ (2) $\frac{1}{1+\log_e 2}$

(3) $\frac{-1}{1+\log_e 2}$ (4) $1+\log_e 2$

so, $\boxed{f\left(\frac{1}{2}\right) = \frac{1}{1+\log_e 2}}$

19. Let S be the sum of the first 9 terms of the series: $\{x + ka\} + \{x^2 + (k + 2)a\} + \{x^3 + (k+4)a\} + \{x^4 + (k + 6)a\} + \ldots$ where $a \ne 0$ and $x \ne 1$. If $S = \frac{x^{10} - x + 45a(x-1)}{x-1}$, then k is equal to :

(1) –5 (2) 1

(3) –3 (4) 4

20. The set of all possible values of θ in the interval $(0, \pi)$ for which the points (1, 2) and $(\sin\theta, \cos\theta)$ lie on the same side of the line $x + y = 1$ is :

(1) $\left(0, \frac{\pi}{4}\right)$

(2) $\left(0, \frac{3\pi}{4}\right)$

(3) $\left(\frac{\pi}{4}, \frac{3\pi}{4}\right)$

(4) $\left(0, \frac{\pi}{2}\right)$

21. If the variance of the terms in an increasing A.P., $b_1, b_2, b_3, \ldots b_{11}$ is 90, then the common difference of this A.P. is_____.

22. If $y = \sum_{k=1}^{6} k\cos^{-1}\left\{\frac{3}{5}\cos kx - \frac{4}{5}\sin kx\right\}$, then $\frac{dy}{dx}$ at $x = 0$ is_____.

23. Let the position vectors of points 'A' and 'B' be $\hat{i}+\hat{j}+\hat{k}$ and $2\hat{i}+\hat{j}+3\hat{k}$, respectively. A point 'P' divides the line segment AB internally in the ratio $\lambda : 1$ ($\lambda > 0$). If O is the origin and $\overrightarrow{OB}\cdot\overrightarrow{OP} - 3|\overrightarrow{OA}\times\overrightarrow{OP}|^2 = 6$, then λ is equal to_____.

24. For a positive integer n, $\left(1+\frac{1}{x}\right)^n$ is expanded in increasing powers of x. If three consecutive coefficients in this expansion are in the ratio, 2 : 5 : 12, then n is equal to_____.

25. Let [t] denote the greatest integer less than or equal to t. Then the value of $\int_1^2 |2x - [3x]|dx$ is_____.

SET # 03

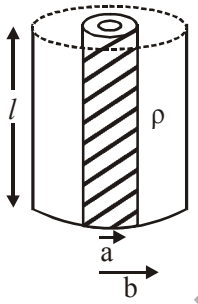
PHYSICS

1. Using screw gauge of pitch 0.1 cm and 50 divisions on its circular scale, the thickness of an object is measured. It should correctly be recorded as :

(1) 2.123 cm (2) 2.125 cm

(3) 2.121 cm (4) 2.124 cm

2. Model a torch battery of length l to be made up of a thin cylindrical bar of radius 'a' and a concentric thin cylindrical shell of radius 'b' filled in between with an electrolyte of resistivity ρ (see figure). If the battery is connected to a resistance of value R, the maximum Joule heating in R will take place for:-



(1) $R=\frac{2\rho}{\pi l}\ln\left(\frac{b}{a}\right)$

(2) $R=\frac{\rho}{\pi l}\ln\left(\frac{b}{a}\right)$

(3) $R=\frac{\rho}{2\pi l}\left(\frac{b}{a}\right)$

(4) $R=\frac{\rho}{2\pi l}\ln\left(\frac{b}{a}\right)$

3. When the wavelength of radiation falling on a metal is changed from 500 nm to 200 nm, the maximum kinetic energy of the photoelectrons becomes three times larger. The work function of the metal is close to :

(1) 0.61 eV (2) 0.52 eV

(3) 0.81 eV (4) 1.02 eV

4. Moment of inertia of a cylinder of mass M, length L and radius R about an axis passing through its centre and perpendicular to the axis of the cylinder is $I=M\left(\frac{R^2}{4}+\frac{L^2}{12}\right)$. If such a cylinder is to be made for a given mass of material, the ratio L/R for it to have minimum possible I is :-

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

5. The magnetic field of a plane electromagnetic wave is

$\vec{B}=3\times10^{-8}\sin[200\pi(y+ct)]\hat{i}$ T

Where c = 3 × 10^8 ms^{-1} is the speed of light. The corresponding electric field is :

(1) $\vec{E}=-10^{-6}\sin[200\pi(y+ct)]\hat{k}$ V / m

(2) $\vec{E}=-9\sin[200\pi(y+ct)]\hat{k}$ V / m

(3) $\vec{E}=9\sin[200\pi(y+ct)]\hat{k}$ V / m

(4) $\vec{E}=3\times10^{-8}\sin[200\pi(y+ct)]\hat{k}$ V / m

6. A charged particle carrying charge 1 μC is moving with velocity $\left(2\hat{i}+3\hat{j}+4\hat{k}\right)$ ms^{-1}. If an external magnetic field of $\left(5\hat{i}+3\hat{j}-6\hat{k}\right)\times10^{-3}$ T exists in the region where the particle is moving then the force on the particle is $\vec{F}\times10^{-9}$ N. The vector $\vec{F}$ is :

(1) $-0.30\hat{i}+0.32\hat{j}-0.09\hat{k}$

(2) $-300\hat{i}+320\hat{j}-90\hat{k}$

(3) $-30\hat{i}+32\hat{j}-9\hat{k}$

(4) $-3.0\hat{i}+3.2\hat{j}-0.9\hat{k}$

7. A 750 Hz, 20 V (rms) source is connected to a resistance of 100 Ω, an inductance of 0.1803 H and a capacitance of 10 μF all in series. The time in which the resistance (heat capacity 2J/°C) will get heated by 10°C. (assume no loss of heat to the surroundings) is close to :

(1) 418 s (2) 245 s (3) 348 s (4) 365 s

8. In a radioactive material, fraction of active material remaining after time t is 9/16. The fraction that was remaining after t/2 is :

(1) $\frac{3}{4}$ (2) $\frac{7}{8}$ (3) $\frac{4}{5}$ (4) $\frac{3}{5}$

9. A balloon filled with helium (32°C and 1.7 atm.) bursts. Immediately afterwards the expansion of helium can be considered as :

(1) Irreversible isothermal
(2) Irreversible adiabatic
(3) Reversible adiabatic
(4) Reversible isothermal

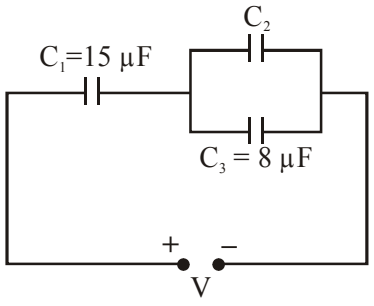
10. Pressure inside two soap bubbles are 1.01 and 1.02 atmosphere, respectively. The ratio of their volumes is :

(1) 8 : 1 (2) 0.8 : 1
(3) 2 : 1 (4) 4 : 1

11. A satellite is moving in a low nearly circular orbit around the earth. Its radius is roughly equal to that of the earth's radius R_e. By firing rockets attached to it, its speed is instantaneously increased in the direction of its motion so that is become $\sqrt{\frac{3}{2}}$ times larger. Due to this the farthest distance from the centre of the earth that the satellite reaches is R, value of R is :

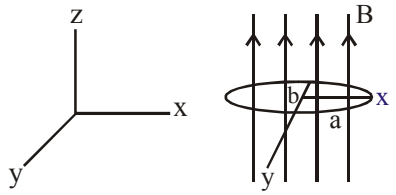
(1) $4R_e$ (2) $3R_e$ (3) $2R_e$ (4) $2.5R_e$

12. In the circuit shown in the figure, the total charge in 750 μC and the voltage across capacitor C_2 is 20 V. Then the charge on capacitor C_2 is :



(1) 590 μC (2) 450 μC
(3) 650 μC (4) 160 μC

13. An elliptical loop having resistance R, of semi major axis a, and semi minor axis b is placed in a magnetic field as shown in the figure. If the loop is rotated about the x-axis with angular frequency ω, the average power loss in the loop due to Joule heating is :



(1) $\frac{\pi^2a^2b^2B^2\omega^2}{2R}$ (2) Zero

(3) $\frac{\pi^2a^2b^2B^2\omega^2}{R}$ (4) $\frac{\pi abB\omega}{R}$

14. When a diode is forward biased, it has a voltage drop of 0.5 V. The safe limit of current through the diode is 10 mA. If a battery of emf 1.5 V is used in the circuit, the value of minimum resistance to be connected in series with the diode so that the current does not exceed the safe limit is :

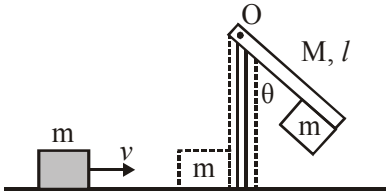
(1) 100 Ω (2) 50 Ω
(3) 300 Ω (4) 200 Ω

15. A uniform thin rope of length 12 m and mass 6 kg hangs vertically from a rigid support and a block of mass 2 kg is attached to its free end. A transverse short wavetrain of wavelength 6 cm is produced at the lower end of the rope. What is the wavelength of the wavetrain (in cm) when it reaches the top of the rope ?

(1) 9 (2) 12 (3) 6 (4) 3

16. A block of mass m = 1 kg slides with velocity v = 6 m/s on a frictionless horizontal surface and collides with a uniform vertical rod and sticks to it as shown. The rod is pivoted about O and swings as a result of the collision making angle θ before momentarily coming to rest. If the rod has mass M = 2 kg, and length l = 1 m, the value of θ is approximately :

(Take g = 10 m/s^2)



(1) 69° (2) 63° (3) 55° (4) 49°

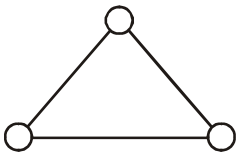
17. In a Young's double slit experiment, light of 500 nm is used to produce an interference pattern. When the distance between the slits is 0.05 mm, the angular width (in degree) of the fringes formed on the distance screen is close to :

(1) 0.07° (2) 0.17° (3) 1.7° (4) 0.57°

18. Magnitude of magnetic field (in SI units) at the centre of a hexagonal shape coil of side 10 cm, 50 turns and carrying current I (Ampere) in units of $\frac{\mu_0 I}{\pi}$ is :

(1) $250\sqrt{3}$ (2) $5\sqrt{3}$ (3) $500\sqrt{3}$ (4) $50\sqrt{3}$

19.



Consider a gas of triatomic molecules. The molecules are assumed to the triangular and made of massless rigid rods whose vertices are occupied by atoms. The internal energy of a mole of the gas at temperature T is :

(1) $\frac{9}{2}RT$ (2) $\frac{3}{2}RT$ (3) $\frac{5}{2}RT$ (4) $3RT$

20. Two isolated conducting spheres S_1 and S_2 of radius $\frac{2}{3}R$ and $\frac{1}{3}R$ have 12 μC and –3 μC charges, respectively, and are at a large distance from each other. They are now connected by a conducting wire. A long time after this is done the charges on S_1 and S_2 are respectively :

(1) 6 μC and 3 μC
(2) +4.5 μC and –4.5 μC
(3) 3 μC and 6 μC
(4) 4.5 μC on both

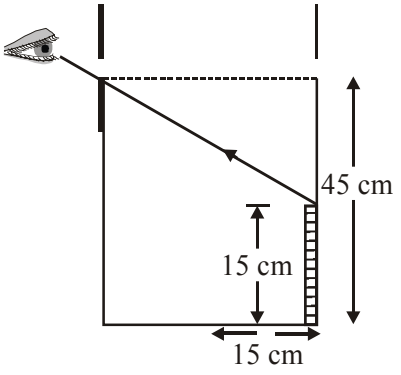
21. A bakelite beaker has volume capacity of 500 cc at 30°C. When it is partially filled with V_m volume (at 30°) of mercury, it is found that the unfilled volume of the beaker remains constant as temperature is varied. If $\gamma_{(beaker)} = 6 \times 10^{-6}\ °C^{-1}$ and $\gamma_{(mercury)} = 1.5 \times 10^{-4}\ °C^{-1}$, where γ is the coefficient of volume expansion, then V_m (in cc) is close to_____.

22. A cricket ball of mass 0.15 kg is thrown vertically up by a bowling machine so that it rises to a maximum height of 20 m after leaving the machine. If the part pushing the ball applies a constant force F on the ball and moves horizontally a distance of 0.2 m while launching the ball, the value of F(in N) is ($g = 10\ ms^{-2}$)_____.

23. When a long glass capillary tube of radius 0.015 cm is dipped in a liquid, the liquid rises to a height of 15 cm within it. If the contact angle between the liquid and glass to close to 0°, the surface tension of the liquid, in milliNewton m^{-1}, is [$\rho_{(liquid)} = 900\ kgm^{-3}$, $g = 10\ ms^{-2}$] (Give answer in closest integer)_____.

24. A person of 80 kg mass is standing on the rim of a circular platform of mass 200 kg rotating about its axis as 5 revolutions per minute (rpm). The person now starts moving towards the centre of the platform. What will be the rotational speed (in rpm) of the platform when the person reaches its centre_____.

25. An observer can see through a small hole on the side of a jar (radius 15 cm) at a point at height of 15 cm from the bottom (see figure). The hole is at a height of 45 cm. When the jar is filled with a liquid up to a height of 30 cm the same observer can see the edge at the bottom of the jar. If the refractive index of the liquid N/100, where N is an integer, the value of N is_____.



CHEMISTRY

1. The complex that can show optical activity is:

(1) trans-$[Fe(NH_3)_2(CN)_4]^-$

(2) cis-$[Fe(NH_3)_2(CN)_4]^-$

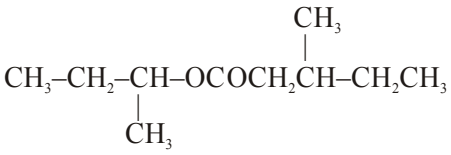
(3) cis-$[CrCl_2(ox)_2]^{3-}$ (ox = oxalate)

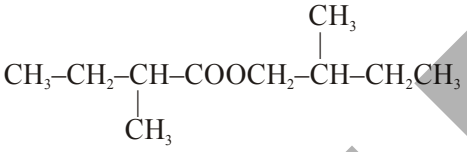
(4) trans-$[Cr(Cl_2)(ox)_2]^{3-}$

2. An organic compound [A], molecular formula $C_{10}H_{20}O_2$ was hydrolyzed with dilute sulphuric acid to give a carboxylic acid [B] and alcohol [C]. Oxidation of [C] with $CrO_3 - H_2SO_4$ produced [B]. Which of the following structures are not possible for [A] ?

(1) $(CH_3)_3–C–COOCH_2C(CH_3)_3$

(2) $CH_3CH_2CH_2COOCH_2CH_2CH_2CH_3$

(3) 

(4) 

3. If the boiling point of H_2O is 373 K, the boiling point of H_2S will be :

(1) Greater than 300 K but less than 373 K

(2) Less than 300 K

(3) Equal to 373 K

(4) More than 373 K

4. In a molecule of pyrophosphoric acid, the number of P–OH, P=O and P–O–P bonds/ moiety(ies) respectivey are :

(1) 3, 3 and 3 (2) 2, 4 and 1

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

5. It is true that :

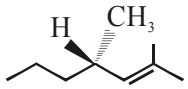
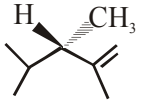
(1) A zero order reaction is a single step reaction

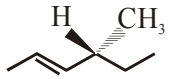
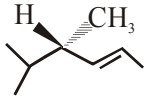
(2) A second order reaction is always a multistep reaction

(3) A first order reaction is always a single step reaction

(4) A zero order reaction is a multistep reaction

6. Which of the following compounds produces an optically inactive compound on hydrogenation ?

(1)  (2) 

(3)  (4) 

7. Henry's constant (in kbar) for four gases α, β, γ and δ in water at 298 K is given below :

	α	β	γ	δ
K_H	50	2	2×10^{-5}	0.5

(density of water = 10^3 kg m^{-3} at 298 K)

This table implies that :

(1) The pressure of a 55.5 molal solution of γ is 1 bar

(2) The pressure of a 55.5 molal solution of δ is 250 bar

(3) Solubility of γ at 308 K is lower than at 298 K

(4) α has the highest solubility in water at a given pressure

8. Tyndall effect of observed when :

(1) The diameter of dispersed particles is much smaller than the wavelength of light used

(2) The diameter of dispersed particles is much larger than the wavelength of light used

(3) The diameter of dispersed particles is similar to the wavelength of light used

(4) The refractive index of dispersed phase is greater than that of the dispersion medium

9. Thermal power plants can lead to :

(1) Ozone layer depletion

(2) Eutrophication

(3) Acid rain

(4) Blue baby syndrome

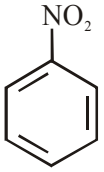
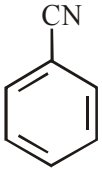
10. The electronic spectrum of $[Ti(H_2O)_6]^{3+}$ shows a single broad peak with a maximum at 20,300 cm^{-1}. The crystal field stabilization energy (CFSE) of the complex ion, in kJ mol^{-1}, is :

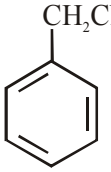
(1) 242.5 (2) 83.7 (3) 145.5 (4) 97

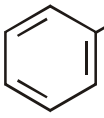
11. Aqua regia is used for dissolving noble metals (Au, Pt, etc). The gas evolved in this process is :

(1) N_2 (2) N_2O_3 (3) NO (4) N_2O_5

12. The Kjeldahl method of Nitrogen estimation fails for which of the following reaction products ?

(a)  $\xrightarrow{Sn/HCl}$ (b)  $\xrightarrow{LiAlH_4}$

(c)  $\xrightarrow[(ii)\ H_2O]{(i)\ SnCl_2 + HCl}$

(d)  $\xrightarrow[HCl]{NaNO_2}$

(1) a and d (2) c and d
(3) a, c and d (4) b and c

13. The mechanism of S_N1 reaction is given as :

$$R-X \rightarrow \underset{\text{Ion pair}}{R^{\oplus}X^{\ominus}} \rightarrow \underset{\text{Solvent separated ion pair}}{R^{\oplus}||X^{\ominus}} \xrightarrow{Y^{\ominus}} R-Y+X^{\ominus}$$

A student writes general characteristics based on the given mechanism as :

(a) The reaction is favoured by weak nucleophiles

(b) $R^{\oplus}$ would be easily formed if the substituents are bulky

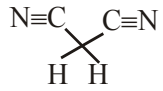
(c) The reaction is accompained by recemization

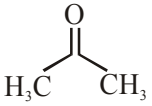
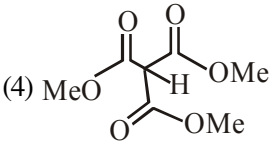
(d) The reaction is favoured by non-polar solvents.

Which observations are correct ?

(1) b and d (2) a and c
(3) a, b and c (4) a and b

14. Which one of the following compounds possesses the most acidic hydrogen ?

(1)  (2) $H_3C-C\equiv C-H$

(3)  (4) 

15. Glycerol is separated in soap industries by :

(1) Steam distillation

(2) Differential extraction

(3) Distillation under reduced pressure

(4) Fractional distillation

16. Of the species, NO, NO^+, NO^{2+}, NO^-, the one with minimum bond strength is :

(1) NO^{2+} (2) NO^+
(3) NO (4) NO^-

17. The atomic number of the element unnilennium is :

(1) 119 (2) 108 (3) 102 (4) 109

18. An acidic buffer is obtained on mixing :

(1) 100 mL of 0.1 M CH_3COOH and 200 mL of 0.1 M NaOH

(2) 100 mL of 0.1 M CH_3COOH and 100 mL of 0.1 M NaOH

(3) 100 mL of 0.1 M HCl and 200 mL of 0.1 M CH_3COONa

(4) 100 mL of 0.1 M HCl and 200 mL of 0.1 M NaCl

19. Let C_{NaCl} and C_{BaSO_4} be the conductances (in S) measured for saturated aqueous solutions of NaCl and $BaSO_4$, respectively, at a temperature T. Which of the following is false ?

(1) Ionic mobilities of ions from both salts increase with T

(2) $C_{NaCl} >> C_{BaSO_4}$ at a given T

(3) $C_{NaCl}(T_2) > C_{NaCl}(T_1)$ for $T_2 > T_1$

(4) $C_{BaSO_4}(T_2) > C_{BaSO_4}(T_1)$ for $T_2 > T_1$

20. The antifertility drug 'Novestrol" can react with :

(1) Br_2/water; $ZnCl_2$/HCl; $FeCl_3$

(2) Alcoholic HCN; NaOCl; $ZnCl_2$/HCl

(3) Br_2/water; $ZnCl_2$/HCl; NaOCl

(4) $ZnCl_2$/HCl; $FeCl_3$; Alcoholic HCN

21. The volume strength of 8.9 M H_2O_2 solution calculated at 273 K and 1 atm is _____. (R=0.0821 L atm K^{-1} mol^{-1}) (rounded off to the nearest integer)

22. The mole fraction of glucose ($C_6H_{12}O_6$) in an aqueous binary solution is 0.1. The mass percentage of water in it, to the nearest integer, is _____.

23. The photoelectric current from Na (work function, w_0 = 2.3 eV) is stopped by the output voltage of the cell

Pt(s)|H_2(g, 1bar)|HCl(aq., pH = 1)|AgCl(s)|Ag(s)

The pH of aq. HCl required to stop the photoelectric current from K(w_0 = 2.25eV), all other conditions remaining the same, is_____ $\times 10^{-2}$ (to the nearest integer).

Given, $2.303\frac{RT}{F}=0.06V; E^0_{AgCl|Ag|Cl^-}=0.22V$

24. An element with molar mass 2.7×10^{-2} $kgmol^{-1}$ forms a cubic unit cell with edge length 405 pm. If its density is 2.7×10^3 kgm^{-3}, the radius of the element is approximately ____ $\times 10^{-12}$ m (to the nearest integer).

25. The total number of monohalogenated organic products in the following (including stereoisomers) reaction is _____.

$$\underset{\text{(simplest optically active alkene)}}{A} \xrightarrow[(ii)\,X_2/\Delta]{(i)\,H_2/Ni/\Delta}$$

MATHEMATICS

1. A die is thrown two times and the sum of the scores appearing on the die is observed to be a multiple of 4. Then the conditional probability that the score 4 has appeared atleast once is :

(1) $\frac{1}{8}$ (2) $\frac{1}{9}$

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

2. The lines

$\vec{r}=(\hat{i}-\hat{j})+\ell(2\hat{i}+\hat{k})$ and

$\vec{r}=(2\hat{i}-\hat{j})+m(\hat{i}+\hat{j}-\hat{k})$

(1) Intersect when ℓ = 1 and m = 2

(2) Intersect when ℓ = 2 and m = $\frac{1}{2}$

(3) Do not intersect for any values of ℓ and m

(4) Intersect for all values of ℓ and m

3. The foot of the perpendicular drawn from the point (4, 2, 3) to the line joining the points (1, –2, 3) and (1, 1, 0) lies on the plane :

(1) x + 2y – z = 1 (2) x – 2y + z = 1

(3) x – y – 2z = 1 (4) 2x + y – z = 1

4. A hyperbola having the transverse axis of length $\sqrt{2}$ has the same foci as that of the ellipse $3x^2 + 4y^2 = 12$, then this hyperbola does not pass through which of the following points ?

(1) $\left(1,-\frac{1}{\sqrt{2}}\right)$ (2) $\left(\sqrt{\frac{3}{2}},\frac{1}{\sqrt{2}}\right)$

(3) $\left(\frac{1}{\sqrt{2}},0\right)$ (4) $\left(-\sqrt{\frac{3}{2}},1\right)$

5. The area (in sq. units) of the region

$\{(x, y) : 0 \le y \le x^2 + 1, 0 \le y \le x + 1, \frac{1}{2} \le x \le 2\}$ is :

(1) $\frac{79}{16}$ (2) $\frac{23}{6}$ (3) $\frac{79}{24}$ (4) $\frac{23}{16}$

6. If the first term of an A.P. is 3 and the sum of its first 25 terms is equal to the sum of its next 15 terms, then the common difference of this A.P. is :

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

7. Let P be a point on the parabola, $y^2 = 12x$ and N be the foot of the perpendicular drawn from P on the axis of the parabola. A line is now drawn through the mid-point M of PN, parallel to its axis which meets the parabola at Q. If the y-intercept of the line NQ is $\frac{4}{3}$, then :

(1) MQ = $\frac{1}{3}$ (2) PN = 3

(3) MQ = $\frac{1}{4}$ (4) PN = 4

8. For the frequency distribution :

Variate (x) : x_1 x_2 x_3 .....x_{15}

Frequency (f) : f_1 f_2 f_3 ....f_{15}

where $0 < x_1 < x_2 < x_3 < .... < x_{15} = 10$ and $\sum_{i=1}^{15} f_i > 0$, the standard deviation cannot be :

(1) 2 (2) 1

(3) 4 (4) 6

9. $\int_{-\pi}^{\pi} |\pi - |x|| dx$ is equal to :

(1) π^2 (2) $2\pi^2$

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

10. Consider the two sets :

A = {m ∈ R : both the roots of $x^2 - (m + 1)x + m + 4 = 0$ are real} and B = [–3, 5).

Which of the following is not true ?

(1) A – B = $(-\infty, -3) \cup (5, \infty)$

(2) A ∩ B = {–3}

(3) B – A = (–3, 5)

(4) A ∪ B = R

11. If $y^2 + \log_e(\cos^2 x) = y$, $x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$, then :

(1) |y"(0)| = 2

(2) |y'(0)| + |y"(0)| = 3

(3) |y'(0)| + |y"(0)| = 1

(4) y"(0) = 0

12. The function, $f(x) = (3x - 7)x^{2/3}$, x ∈ R, is increasing for all x lying in :

(1) $(-\infty, 0) \cup \left(\frac{3}{7}, \infty\right)$

(2) $(-\infty, 0) \cup \left(\frac{14}{15}, \infty\right)$

(3) $\left(-\infty, \frac{14}{15}\right)$

(4) $\left(-\infty, -\frac{14}{15}\right) \cup (0, \infty)$

13. The value of $(2.{}^1P_0 - 3.{}^2P_1 + 4.{}^3P_2 -$ .... up to 51th term) + (1! – 2! + 3! – ..... up to 51th term) is equal to :

(1) 1 + (51)!

(2) 1 – 51(51)!

(3) 1 + (52)!

(4) 1

14. If $\Delta = \begin{vmatrix} x-2 & 2x-3 & 3x-4 \\ 2x-3 & 3x-4 & 4x-5 \\ 3x-5 & 5x-8 & 10x-17 \end{vmatrix} =$

$Ax^3 + Bx^2 + Cx + D$, then B + C is equal to :

(1) –1 (2) 1

(3) –3 (4) 9

15. The solution curve of the differential equation, $(1 + e^{-x})(1 + y^2)\dfrac{dy}{dx} = y^2$, which passes through the point (0, 1), is :

(1) $y^2 = 1 + y\log_e\left(\dfrac{1+e^x}{2}\right)$

(2) $y^2 + 1 = y\left(\log_e\left(\dfrac{1+e^x}{2}\right)+2\right)$

(3) $y^2 = 1 + y\log_e\left(\dfrac{1+e^{-x}}{2}\right)$

(4) $y^2 + 1 = y\left(\log_e\left(\dfrac{1+e^{-x}}{2}\right)+2\right)$

16. If the number of integral terms in the expansion of $(3^{1/2} + 5^{1/8})^n$ is exactly 33, then the least value of n is :

(1) 264 (2) 256

(3) 128 (4) 248

17. If α and β are the roots of the equation $x^2 + px + 2 = 0$ and $\dfrac{1}{\alpha}$ and $\dfrac{1}{\beta}$ are the roots of the equation $2x^2 + 2qx + 1 = 0$, then $\left(\alpha-\dfrac{1}{\alpha}\right)\left(\beta-\dfrac{1}{\beta}\right)\left(\alpha+\dfrac{1}{\beta}\right)\left(\beta+\dfrac{1}{\alpha}\right)$ is equal to:

(1) $\dfrac{9}{4}(9 + p^2)$ (2) $\dfrac{9}{4}(9 - q^2)$

(3) $\dfrac{9}{4}(9 - p^2)$ (4) $\dfrac{9}{4}(9 + q^2)$

18. Let [t] denote the greatest integer $\le$ t. If for some $\lambda \in R - \{0, 1\}$, $\lim\limits_{x\to 0}\left|\dfrac{1-x+|x|}{\lambda-x+[x]}\right| = L$, then L is equal to :

(1) 1 (2) 2

(3) $\dfrac{1}{2}$ (4) 0

19. $2\pi - \left(\sin^{-1}\dfrac{4}{5} + \sin^{-1}\dfrac{5}{13} + \sin^{-1}\dfrac{16}{65}\right)$ is equal to:

(1) $\dfrac{7\pi}{4}$ (2) $\dfrac{5\pi}{4}$

(3) $\dfrac{3\pi}{2}$ (4) $\dfrac{\pi}{2}$

20. The proposition $p \to \sim (p \wedge \sim q)$ is equivalent to:

(1) $(\sim p) \vee q$

(2) q

(3) $(\sim p) \wedge q$

(4) $(\sim p) \vee (\sim q)$

21. Let $A = \begin{bmatrix} x & 1 \\ 1 & 0 \end{bmatrix}$, $x \in R$ and $A^4 = [a_{ij}]$. If $a_{11} = 109$, then a_{22} is equal to _____ .

22. If $\lim\limits_{x\to 0}\left\{\dfrac{1}{x^8}\left(1-\cos\dfrac{x^2}{2}-\cos\dfrac{x^2}{4}+\cos\dfrac{x^2}{2}\cos\dfrac{x^2}{4}\right)\right\} = 2^{-k}$, then the value of k is _____ .

23. The diameter of the circle, whose centre lies on the line x + y = 2 in the first quadrant and which touches both the lines x = 3 and y = 2, is _____ .

24. The value of $(0.16)^{\log_{2.5}\left(\frac{1}{3}+\frac{1}{3^2}+\frac{1}{3^3}+\ldots\text{to }\infty\right)}$ is equal to _____ .

25. If $\left(\dfrac{1+i}{1-i}\right)^{\frac{m}{2}} = \left(\dfrac{1+i}{i-1}\right)^{\frac{n}{3}} = 1$, (m, n $\in$ N) then the greatest common divisor of the least values of m and n is _____ .

SET # 04

PHYSICS

1. A perfectly dimagnetic sphere has a small spherical cavity at its centre, which is filled with a paramagnetic substance. The whole system is placed in a uniform magnetic field $\vec{B}$. Then the field inside the paramagnetic substance is:

(1) Zero

(2) $\vec{B}$

(3) much large than $|\vec{B}|$ but opposite to $\vec{B}$

(4) much large than $|\vec{B}|$ and parallel to $\vec{B}$

2. The radius of R of a nucleus of mass number A can be estimated by the formula $R = (1.3 \times 10^{-15})A^{1/3}$ m. It follows that the mass density of a nucleus is of the order of:

$\left(M_{prot.} \cong M_{neut.} \simeq 1.67 \times 10^{-27}\,kg\right)$

(1) 10^{24} kg m^{-3} (2) 10^{3} kg m^{-3}

(3) 10^{17} kg m^{-3} (4) 10^{10} kg m^{-3}

3. Concentric metallic hollow spheres of radii R and 4R hold charges Q_1 and Q_2 respectively. Given that surface charge densities of the concentric spheres are equal, the potential difference V(R) – V(4R) is:

(1) $\frac{3Q_1}{16\pi\varepsilon_0 R}$ (2) $\frac{Q_2}{4\pi\varepsilon_0 R}$

(3) $\frac{3Q_1}{4\pi\varepsilon_0 R}$ (4) $\frac{3Q_2}{4\pi\varepsilon_0 R}$

4. Hydrogen ion and singly ionized helium atom are accelerated, from rest, through the same potential difference. The ratio of final speeds of hydrogen and helium ions is close to:

(1) 5 : 7 (2) 1 : 2

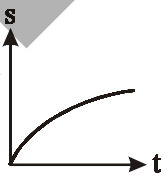
(3) 10 : 7 (4) 2 : 1

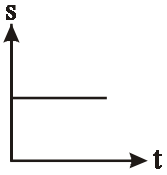
5. The mass density of a planet of radius R varies with the distance r from its centre as $\rho(r) = \rho_0\left(1 - \frac{r^2}{R^2}\right)$. Then the gravitational field is maximum at:

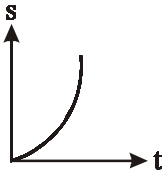
(1) $r = \frac{1}{\sqrt{3}}R$ (2) $r = \sqrt{\frac{5}{9}}R$

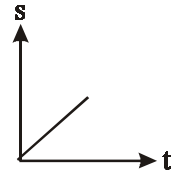
(3) $r = \sqrt{\frac{3}{4}}R$ (4) r = R

6. A particle is moving unidirectionally on a horizontal plane under the action of a constant power supplying energy source. The displacement (s) - time (t) graph that describes the motion of the particle is (graphs are drawn schematically and are not to scale) :

(1) 

(2) 

(3) 

(4) 

7. If a semiconductor photodiode can detect a photon with a maximum wavelength of 400 nm, then its band gap energy is:

Planck's constant $h = 6.63 \times 10^{-34}$ J.s.

Speed of ligh $c = 3 \times 10^{8}$ m/s

(1) 2.0 eV (2) 1.5 eV

(3) 3.1 eV (4) 1.1 eV

8. To raise the temperature of a certain mass of gas by 50°C at a constant pressure, 160 calories of heat is required. When the same mass of gas is cooled by 100°C at constant volume, 240 calories of heat is released. How many degrees of freedom does each molecule of this gas have (assume gas to be ideal) ?

(1) 5 (2) 3 (3) 6 (4) 7

9. A block of mass m attached to massless spring is performing oscillatory motion of amplitude 'A' on a frictionless horizontal plane. If half of the mass of the block breaks off when it is passing through its equilibrium point, the amplitude of oscillation for the remaining system become *f*A. The value of *f* is:

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

10. A block of mass 1.9 kg is at rest at the edge of a table, of height 1 m. A bullet of mass 0.1 kg collides with the block and sticks to it. If the velocity of the bullet is 20 m/s in the horizontal direction just before the collision then the kinetic energy just before the combined system strikes the floor, is [Take g = 10 m/s^2. Assume there is no rotational motion and loss of energy after the collision is negligable.]

(1) 21 J (2) 23 J
(3) 19 J (4) 20 J

11. Two light waves having the same wavelength λ in vacuum are in phase initially. Then the first wave travels a path L_1 through a medium of refractive index n_1 while the second wave travels a path of length L_2 through a medium of refractive index n_2. After this the phase difference between the two waves is:

(1) $\frac{2\pi}{\lambda}(n_1L_1 - n_2L_2)$ (2) $\frac{2\pi}{\lambda}\left(\frac{L_2}{n_1} - \frac{L_1}{n_2}\right)$

(3) $\frac{2\pi}{\lambda}\left(\frac{L_1}{n_1} - \frac{L_2}{n_2}\right)$ (4) $\frac{2\pi}{\lambda}(n_2L_1 - n_1L_2)$

12. The electric field of a plane electromagnetic wave propagating along the x direction in vacuum is $\vec{E} = E_0\hat{j}\cos(\omega t - kx)$. The magnetic field $\vec{B}$, at the moment t = 0 is :

(1) $\vec{B} = E_0\sqrt{\mu_0 \in_0}\cos(kx)\hat{j}$

(2) $\vec{B} = \frac{E_0}{\sqrt{\mu_0 \in_0}}\cos(kx)\hat{k}$

(3) $\vec{B} = E_0\sqrt{\mu_0 \in_0}\cos(kx)\hat{k}$

(4) $\vec{B} = \frac{E_0}{\sqrt{\mu_0 \in_0}}\cos(kx)\hat{j}$

13. A metallic sphere cools from 50°C to 40°C in 300 s. If atmospheric temperature around is 20°C, then the sphere's temperature after the next 5 minutes will be close to :

(1) 33°C (2) 35°C
(3) 31°C (4) 28°C

14. A uniform magnetic field B exists in a direction perpendicular to the plane of a square loop made of a metal wire. The wire has a diameter of 4 mm and a total length of 30 cm. The magnetic field changes with time at a steady rate dB/dt = 0.032 Ts^{-1}.The induced current in the loop is close to

(Resistivity of the metal wire is 1.23×10^{-8} Ωm)

(1) 0.61 A (2) 0.34 A
(3) 0.43 A (4) 0.53 A

15. Amount of solar energy received on the earth's surface per unit area per unit time is defined a solar constant. Dimension of solar constant is:

(1) ML^2T^{-2} (2) MLT^{-2}
(3) $M^2L^0T^{-1}$ (4) ML^0T^{-3}

16. Which of the following will NOT be observed when a multimeter (operating in resistance measuring mode) probes connected across a component, are just reversed?

(1) Multimeter shows NO deflection in both cases i.e. before and after reversing the probes if the chosen component is capacitor.

(2) Multimeter shows a deflection,accompanied by a splash of light out of connected component in one direction and NO deflection on reversing the probes if the chosen component is LED.

(3) Multimeter shows NO deflection in both cases i.e. before and after reversing the probes if the chosen compoenent is metal wire.

(4) Multimeter shows an equal deflection in both cases i.e. before and after reversing the probes if the chosen component is resistor.

17. Two resistors 400Ω and 800Ω are connected in series across a 6 V battery. The potential difference measured by a voltmeter of 10 kΩ across 400 Ω resistor is close to:

(1) 2 V (2) 1.95V

(3) 2.05 V (4) 1.8 V

18. Two sources of light emit X-rays of wavelength 1 nm and visible light of wavelength 500 nm, respectively. Both the sources emit light of the same power 200 W. The ratio of the number density of photons of X-rays to the number densitty of photons of the visible light of the given wavelengths is :

(1) $\frac{1}{500}$ (2) 500

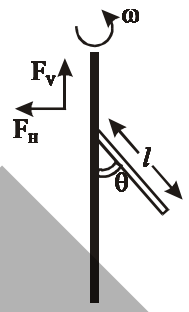
(3) 250 (4) $\frac{1}{250}$

19. A calorimeter of water equivalent 20 g contains 180 g of water at 25°C. 'm' grams of steam at 100°C is mixed in it till the temperature of the mixure is 31°C. The value of 'm' is close to (Latent heat of water = 540 cal g^{-1}, specific heat of water = 1 cal g^{-1} $°C^{-1}$)

(1) 2.6 (2) 2

(3) 4 (4) 3.2

20.



A uniform rod of length '*l*' is pivoted at one of its ends on a vertical shaft of negligible radius. When the shaft rotates at angular speed ω the rod makes an angle θ with it (see figure). To find θ equate the rate of change of angular momentum (direction going into the paper) $\frac{m\ell^2}{12}\omega^2\sin\theta\cos\theta$ about the centre of mass (CM) to the torque provided by the horizontal and vertical forces F_H and F_V about the CM. The value of θ is then such that:

(1) $\cos\theta = \frac{g}{2\ell\omega^2}$

(2) $\cos\theta = \frac{3g}{2\ell\omega^2}$

(3) $\cos\theta = \frac{2g}{3\ell\omega^2}$

(4) $\cos\theta = \frac{g}{\ell\omega^2}$

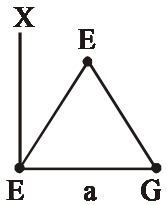
21. When an object is kept at a distance of 30 cm from a concave mirror, the image is formed at a distance of 10 cm from the mirror. If the object is moved with a speed of 9 cms^{-1}, the speed (in cms^{-1}) with which image moves at that instant is _____.

22. A galvanometer coil has 500 turns and each turn has an average area of 3×10^{-4} m^2. If a torque of 1.5 Nm is required to keep this coil parallel to magnetic field when a current of 0.5 A is flowing through it, the strength of the field (in T) is _____ .

23. If minimum possible work is done by a refrigerator in converting 100 grams of water at 0°C to ice, how much heat (in calories) is released to the surrounding at temperature 27°C (Latent heat of ice = 80 Cal/gram) to the nearest integer?

24. A block starts moving up an inclined plane of inclination 30° with an initial velocity of v_0. It comes back to its initial position with velocity $\frac{v_0}{2}$. The value of the coefficient of kinetic friction between the block and the inclined plane is close to $\frac{I}{1000}$, The nearest integer to I is _____.

25. An massless equilateral triangle EFG of side 'a' (As shown in figure) has three particles of mass m situated at its vertices. The moment of intertia of the system about the line EX perpendicular to EG in the plane of EFG is $\frac{N}{20}ma^2$ where N is an integer. The value of N is _____.



CHEMISTRY

1. Among the statements (I – IV), the correct ones are:

(I) Be has smaller atomic radius compared to Mg.

(II) Be has higher ionization enthalpy than Al.

(III) Charge/radius ratio of Be is greater than that of Al.

(IV) Both Be and Al form mainly covalent compounds.

(1) (I), (II) and (IV)

(2) (II), (III) and (IV)

(3) (I), (II) and (III)

(4) (I), (III) and (IV

2. The strengths of 5.6 volume hydrogen peroxide (of density 1 g/mL) in terms of mass percentage and molarity (M), respectively, are:

(Take molar mass of hydrogen peroxide as 34 g/mol)

(1) 1.7 and 0.25

(2) 1.7 and 0.5

(3) 0.85 and 0.5

(4) 0.85 and 0.25

3. Consider the hypothetical situation where the azimuthal quantum number, *l*, takes values 0, 1, 2, ... n + 1, where n is the principal quantum number. Then, the element with atomic number :

(1) 13 has a half-filled valence subshell

(2) 9 is the first alkali metal

(3) 8 is the first noble gas

(4) 6 has a 2p-valence subshell

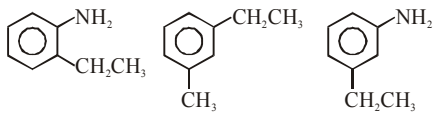
4. Three isomers A, B and C (mol. formula $C_8H_{11}N$) give the following results :

A and C $\xrightarrow{\text{Diazotization}}$ P + Q $\xrightarrow[\substack{\text{(ii) oxidation}\\(KMnO_4+H^+)}]{\text{(i) Hydrolysis}}$ R(product of A) + S(product of C)

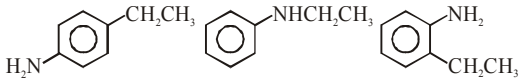
R has lower boiling point than S

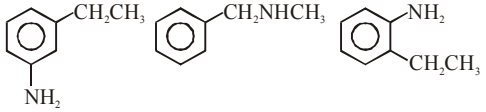
B $\xrightarrow{C_6H_5SO_2Cl}$ alkali-insoluble product

A, B and C, respectively are :

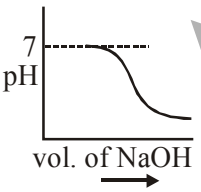
(1) 

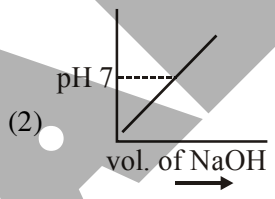
(2) 

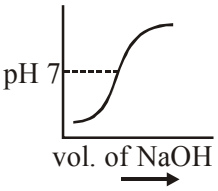
(3) 

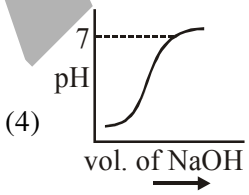
(4) 

5. 100 mL of 0.1 M HCl is taken in a beaker and to it 100 mL of 0.1 M NaOH is added in steps of 2 mL and the pH is continuously measured. Which of the following graphs correctly depicts the change in pH?

(1) 

(2) 

(3) 

(4) 

6. The incorrect statement(s) among (a) – (d) regarding acid rain is (are) :

(a) It can corrode water pipes.

(b) It can damage structures made up of stone.

(c) It cannot cause respiratory ailments in animals.

(d) It is not harmful for trees

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

(3) (c) only (4) (a), (c) and (d)

7. The five successive ionization enthalpies of an element are 800, 2427, 3658, 25024 and 32824 kJ mol^{-1}. The number of valence electrons in the element is :

(1) 2 (2) 3

(3) 4 (4) 5

8. A mixture of one mole each of H_2, He and O_2 each are enclosed in a cylinder of volume V at temperature T. If the partial pressure of H_2 is 2 atm, the total pressure of the gases in the cylinder is :

(1) 14 atm (2) 22 atm

(3) 6 atm (4) 38 atm

9. The d-electron configuration of $[Ru(en)_3]Cl_2$ and $[Fe(H_2O)_6]Cl_2$, respectively are :

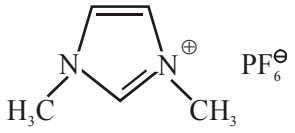
(1) $t_{2g}^4 e_g^2$ and $t_{2g}^6 e_g^0$

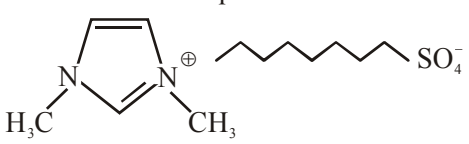
(2) $t_{2g}^6 e_g^0$ and $t_{2g}^6 e_g^0$

(3) $t_{2g}^6 e_g^0$ and $t_{2g}^4 e_g^2$

(4) $t_{2g}^4 e_g^2$ and $t_{2g}^4 e_g^2$

10. An ionic micelle is formed on the addition of :

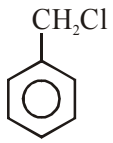
(1) excess water to liquid 

(2) excess water to liquid 

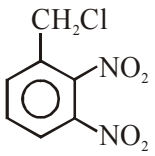
(3) liquid diethyl ether to aqueous NaCl solution

(4) sodium stearate to pure toluene

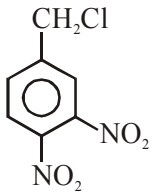
11. The decreasing order of reactivity of the following compounds towards nucleophilic substitution (S_N2) is :



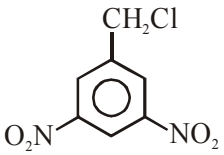
(I)



(II)



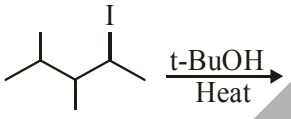
(III)

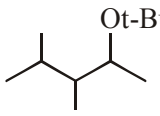


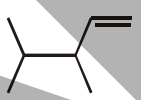
(IV)

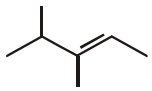
(1) (IV) > (II) > (III) > (I)
(2) (II) > (III) > (IV) > (I)
(3) (II) > (III) > (I) > (IV)
(4) (III) > (II) > (IV) > (I)

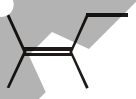
12. The major product in the following reaction is :



(1) 

(2) 

(3) 

(4) 

13. The increasing order of the reactivity of the following compound in nucleophilic addition reaction is :

Propanal, Benzaldehyde, Propanone, Butanone

(1) Butanone < Propanone < Benzaldehyde < Propanal
(2) Benzaldehyde < Butanone < Propanone < Propanal
(3) Propanal < Propanone < Butanone < Benzaldehyde
(4) Benzaldehyde < Propanal < Propanone < Butanone

14. The incorrect statement is :

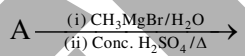
(1) In manganate and permanganate ions, the π-bonding takes place by overlap of p-orbitals of oxygen and d-orbitals of manganese

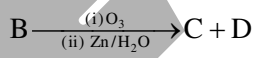
(2) Manganate ion is green in colour and permanganate ion in purple in colour

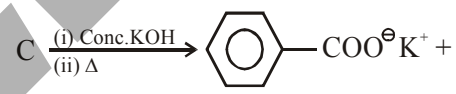
(3) Manganate and permanganate ions are paramagnetic

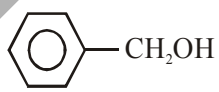
(4) Manganate and permanganate ions are tetrahedral

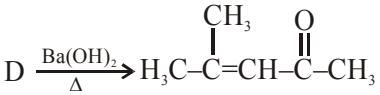
15. The compound A in the following reaction is :

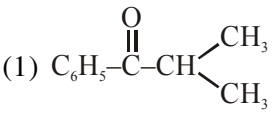


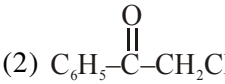


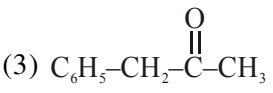


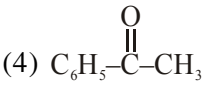




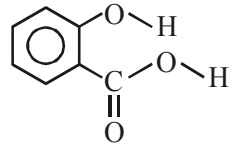
(1) 

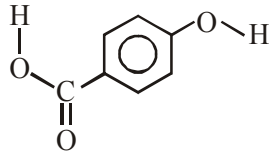
(2) 

(3) 

(4) 

16. Consider the following molecules and statements related to them :

(A) 

(B) 

(a) (B) is more likely to be crystalline than (A)

(b) (B) has higher boiling point than (A)

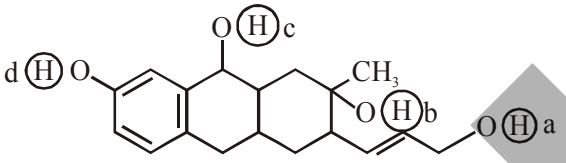
(c) (B) dissolves more readily than (A) in water

Identify the correct option from below :

(1) only (a) is true (2) (a) and (c) are true

(3) (b) and (c) are true (4) (a) and (b) are true

17. Consider the following reaction :



$\xrightarrow[\text{anhydride}]{\text{Chromic}}$ 'P'

The product 'P' gives positive ceric ammonium nitrate test. This is because of the presence of which of these –OH group(s) ?

(1) (c) and (d) (2) (b) only

(3) (d) only (4) (b) and (d)

18. Match the following drugs with their therapeutic actions :

(i) Ranitidine	(a) Antidepressant
(ii) Nardil (Phenelzine)	(b) Antibiotic
(iii)Chloramphenicol	(c) Antihistamine
(iv)Dimetane (Brompheniramine)	(d) Antacid
	(e) Analgesic

(1) (i)-(a); (ii)-(c); (iii)-(b); (iv)-(e)

(2) (i)-(e); (ii)-(a); (iii)-(c); (iv)-(d)

(3) (i)-(d); (ii)-(a); (iii)-(b); (iv)-(c)

(4) (i)-(d); (ii)-(c); (iii)-(a); (iv)-(e)

19. For the reaction $2A + 3B + \frac{3}{2}C \rightarrow 3P$, which statement is correct ?

(1) $\frac{dn_A}{dt} = \frac{dn_B}{dt} = \frac{dn_C}{dt}$

(2) $\frac{dn_A}{dt} = \frac{2}{3}\frac{dn_B}{dt} = \frac{3}{4}\frac{dn_C}{dt}$

(3) $\frac{dn_A}{dt} = \frac{3}{2}\frac{dn_B}{dt} = \frac{3}{4}\frac{dn_C}{dt}$

(4) $\frac{dn_A}{dt} = \frac{2}{3}\frac{dn_B}{dt} = \frac{4}{3}\frac{dn_C}{dt}$

20. Complex A has a composition of $H_{12}O_6Cl_3Cr$. If the complex on treatment with conc. H_2SO_4 loses 13.5% of its original mass, the correct molecular formula of A is :

[Given : atomic mass of Cr = 52 amu and Cl = 35 amu]

(1) $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

(2) $[Cr(H_2O)_3Cl_3] \cdot 3H_2O$

(3) $[Cr(H_2O)_4Cl_2]Cl \cdot 2H_2O$

(4) $[Cr(H_2O)_6]Cl_3$

21. An acidic solution of dichromate is electrolyzed for 8 minutes using 2A current. As per the following equation

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

The amount of Cr^{3+} obtained was 0.104 g. The efficiency of the process(in%) is

(Take : F = 96000 C, At. mass of chromium = 52)

_____.

22. 6.023×10^{22} molecules are present in 10 g of a substance 'x'. The molarity of a solution containing 5 g of substance 'x' in 2 L solution is _____ $\times 10^{-3}$.

23. The volume (in mL) of 0.1 N NaOH required to neutralise 10 mL of 0.1 N phosphinic acid is _____ .

24. If 250 cm^3 of an aqueous solution containing 0.73 g of a protein A is isotonic with one litre of another aqueous solution containing 1.65 g of a protein B, at 298 K, the ratio of the molecular mases of A and B is _____ $\times 10^{-2}$ (to the nearest integer).

25. The number of $\diagup C = O$ groups present in a tripeptide Asp – Glu – Lys is _____ .

MATHEMATICS

1. If the surface area of a cube is increasing at a rate of 3.6 cm^2/sec, retaining its shape; then the rate of change of its volume (in cm^3/sec), when the length of a side of the cube is 10 cm, is :

(1) 9 (2) 18

(3) 10 (4) 20

2. If the value of the integral $\int_0^{1/2} \frac{x^2}{(1-x^2)^{3/2}}dx$ is $\frac{k}{6}$, then k is equal to :

(1) $2\sqrt{3}-\pi$ (2) $3\sqrt{2}+\pi$

(3) $3\sqrt{2}-\pi$ (4) $2\sqrt{3}+\pi$

3. Let R_1 and R_2 be two relations defined as follows :

$R_1 = \{(a, b) \in R^2 : a^2 + b^2 \in Q\}$ and

$R_2 = \{(a, b) \in R^2 : a^2 + b^2 \notin Q\}$,

where Q is the set of all rational numbers. Then:

(1) R_2 is transitive but R_1 is not transitive

(2) R_1 is transitive but R_2 is not transitive

(3) R_1 and R_2 are both transitive

(4) Neither R_1 nor R_2 is transitive

4. Let the latus rectum of the parabola $y^2 = 4x$ be the common chord to the circles C_1 and C_2 each of them having radius $2\sqrt{5}$. Then, the distance between the centres of the circles C_1 and C_2 is:

(1) 8 (2) $4\sqrt{5}$

(3) 12 (4) $8\sqrt{5}$

5. If $\int \sin^{-1}\left(\sqrt{\frac{x}{1+x}}\right)dx = A(x)\tan^{-1}\left(\sqrt{x}\right) + B(x) + C$, where C is a constant of integration, then the ordered pair (A(x), B(x)) can be :

(1) $\left(x-1, \sqrt{x}\right)$ (2) $\left(x+1, \sqrt{x}\right)$

(3) $\left(x+1, -\sqrt{x}\right)$ (4) $\left(x-1, -\sqrt{x}\right)$

6. The probability that a randomly chosen 5-digit number is made from exactly two digits is :

(1) $\frac{121}{10^4}$ (2) $\frac{150}{10^4}$

(3) $\frac{135}{10^4}$ (4) $\frac{134}{10^4}$

7. If a ΔABC has vertices A(–1, 7), B(–7, 1) and C(5, –5), then its orthocentre has coordinates:

(1) (3, –3) (2) $\left(-\frac{3}{5}, \frac{3}{5}\right)$

(3) (–3, 3) (4) $\left(\frac{3}{5}, -\frac{3}{5}\right)$

8. If z_1, z_2 are complex numbers such that $Re(z_1) = |z_1 - 1|$, $Re(z_2) = |z_2 - 1|$ and $\arg(z_1 - z_2) = \frac{\pi}{6}$, then $Im(z_1 + z_2)$ is equal to:

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

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

9. The plane which bisects the line joining the points (4, –2, 3) and (2, 4, –1) at right angles also passes through the point :

(1) (4, 0, –1) (2) (4, 0, 1)

(3) (0, 1, –1) (4) (0, –1, 1)

10. $\lim_{x\to a} \frac{(a+2x)^{\frac{1}{3}} - (3x)^{\frac{1}{3}}}{(3a+x)^{\frac{1}{3}} - (4x)^{\frac{1}{3}}} (a \neq 0)$ is equal to :

(1) $\left(\frac{2}{3}\right)\left(\frac{2}{9}\right)^{\frac{1}{3}}$ (2) $\left(\frac{2}{3}\right)^{\frac{4}{3}}$

(3) $\left(\frac{2}{9}\right)^{\frac{4}{3}}$ (4) $\left(\frac{2}{9}\right)\left(\frac{2}{3}\right)^{\frac{1}{3}}$

11. Let A be a 3 × 3 matrix such that

adj A = $\begin{bmatrix} 2 & -1 & 1 \\ -1 & 0 & 2 \\ 1 & -2 & -1 \end{bmatrix}$ and

B = adj (adj A).

If $|A| = \lambda$ and $|(B^{-1})^T| = \mu$, then the ordered pair, $(|\lambda|, \mu)$ is equal to :

(1) $\left(9, \frac{1}{9}\right)$ (2) $\left(9, \frac{1}{81}\right)$

(3) $\left(3, \frac{1}{81}\right)$ (4) (3, 81)

12. Suppose f(x) is a polynomial of degree four, having critical points at –1, 0, 1. If $T = \{x \in R : f(x) = f(0)\}$, then the sum of squares of all the elements of T is :

(1) 6 (2) 8

(3) 4 (4) 2

13. Let a, b, c ∈ R be such that $a^2 + b^2 + c^2 = 1$. If $a\cos\theta = b\cos\left(\theta + \frac{2\pi}{3}\right) = c\cos\left(\theta + \frac{4\pi}{3}\right)$, where $\theta = \frac{\pi}{9}$, then the angle between the vectors $a\hat{i} + b\hat{j} + c\hat{k}$ and $b\hat{i} + c\hat{j} + a\hat{k}$ is :

(1) $\frac{\pi}{2}$ (2) 0

(3) $\frac{\pi}{9}$ (4) $\frac{2\pi}{3}$

14. If the sum of the series

$20 + 19\frac{3}{5} + 19\frac{1}{5} + 18\frac{4}{5} + \ldots$ upto n^{th} term is 488

and the n^{th} term is negative, then :

(1) n^{th} term is $-4\frac{2}{5}$ (2) n = 41

(3) n^{th} term is –4 (4) n = 60

15. Let x_i $(1 \le i \le 10)$ be ten observations of a random variable X. If $\sum_{i=1}^{10}(x_i - p) = 3$ and $\sum_{i=1}^{10}(x_i - p)^2 = 9$ where $0 \ne p \in R$, then the standard deviation of these observations is :

(1) $\sqrt{\frac{3}{5}}$ (2) $\frac{7}{10}$ (3) $\frac{9}{10}$ (4) $\frac{4}{5}$

16. If $x^3dy + xy\,dx = x^2\,dy + 2y\,dx$; y(2) = e and x > 1, then y(4) is equal to :

(1) $\frac{3}{2} + \sqrt{e}$ (2) $\frac{3}{2}\sqrt{e}$

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

17. Let e_1 and e_2 be the eccentricities of the ellipse, $\frac{x^2}{25} + \frac{y^2}{b^2} = 1 (b < 5)$ and the hyperbola, $\frac{x^2}{16} - \frac{y^2}{b^2} = 1$ respectively satisfying $e_1e_2 = 1$. If α and β are the distances between the foci of the ellipse and the foci of the hyperbola respectively, then the ordered pair (α, β) is equal to :

(1) (8, 10) (2) (8, 12)

(3) $\left(\frac{20}{3}, 12\right)$ (4) $\left(\frac{24}{5}, 10\right)$

18. The set of all real values of λ for which the quadratic equations,

$(\lambda^2 + 1)x^2 - 4\lambda x + 2 = 0$ always have exactly one root in the interval (0, 1) is :

(1) (–3, –1) (2) (1, 3]

(3) (0, 2) (4) (2, 4]

19. If the term independent of x in the expansion of $\left(\frac{3}{2}x^2 - \frac{1}{3x}\right)^9$ is k, then 18 k is equal to :

(1) 9 (2) 11

(3) 5 (4) 7

20. Let p, q, r be three statements such that the truth value of $(p \wedge q) \rightarrow (\sim q \vee r)$ is F. Then the truth values of p, q, r are respectively :

(1) T, F, T (2) F, T, F

(3) T, T, F (4) T, T, T

21. If m arithmetic means (A.Ms) and three geometric means (G.Ms) are inserted between 3 and 243 such that 4^{th} A.M. is equal to 2^{nd} G.M., then m is equal to _____.

22. If the tangent of the curve, $y = e^x$ at a point (c, e^c) and the normal to the parabola, $y^2 = 4x$ at the point (1, 2) intersect at the same point on the x-axis, then the value of c is _____.

23. Let a plane P contain two lines

$\vec{r} = \hat{i} + \lambda(\hat{i} + \hat{j})$, $\lambda \in R$ and

$\vec{r} = -\hat{j} + \mu(\hat{j} - \hat{k})$, $\mu \in R$

If $Q(\alpha, \beta, \gamma)$ is the foot of the perpendicular drawn from the point M(1, 0, 1) to P, then $3(\alpha + \beta + \gamma)$ equals _____.

24. Let S be the set of all integer solutions, (x, y, z), of the system of equations

$x - 2y + 5z = 0$

$-2x + 4y + z = 0$

$-7x + 14y + 9z = 0$

such that $15 \le x^2 + y^2 + z^2 \le 150$. Then, the number of elements in the set S is equal to _____.

25. The total number of 3-digit numbers, whose sum of digits is 10, is _____.

SET # 05

PHYSICS

1. A beam of plane polarised light of large cross sectional area and uniform intensity of 3.3 Wm^{-2} falls normally on a polariser (cross sectional area 3×10^{-4} m^2) which rotates about its axis with an angular speed of 31.4 rad/s. The energy of light passing through the polariser per revolution, is close to :

(1) 1.0×10^{-5} J (2) 5.0×10^{-4} J
(3) 1.0×10^{-4} J (4) 1.5×10^{-4} J

2. Match the C_P/C_V ratio for ideal gases with different type of molecules :

Molecular type	$\mathbf{C_P/C_V}$
(A) Monoatomic	(I) 7/5
(B) Diatomic rigid molecules	(II) 9/7
(C) Diatomic non-rigid molecules	(III) 4/3
(D) Triatomic rigid molecules	(IV) 5/3

(1) A-IV, B-I, C-II, D-III
(2) A-IV, B-II, C-I, D-III
(3) A-III, B-IV, C-II, D-I
(4) A-II, B-III, C-I, D-IV

3. Choose the correct option relating wavelengths of differnet parts of electromagnetic wave spectrum :

(1) $\lambda_{\text{x-rays}} < \lambda_{\text{micro waves}} < \lambda_{\text{radio waves}} < \lambda_{\text{visible}}$
(2) $\lambda_{\text{visible}} > \lambda_{\text{x-rays}} > \lambda_{\text{radio waves}} > \lambda_{\text{micro waves}}$
(3) $\lambda_{\text{radio waves}} > \lambda_{\text{micro waves}} > \lambda_{\text{visible}} > \lambda_{\text{x-rays}}$
(4) $\lambda_{\text{visible}} < \lambda_{\text{micro waves}} < \lambda_{\text{radio waves}} < \lambda_{\text{x-rays}}$

4. A air bubble of radius 1 cm in water has an upward acceleration 9.8 cm s^{-2}. The density of water is 1 gm cm^{-3} and water offers negligible drag force on the bubble. The mass of the bubble is (g = 980 cm/s^2)

(1) 3.15 gm (2) 4.51 gm
(3) 4.15 gm (4) 1.52 gm

5. Dimensional formula for thermal conductivity is (here K denotes the temperature)

(1) $MLT^{-3}K$ (2) $MLT^{-2}K$
(3) $MLT^{-2}K^{-2}$ (4) $MLT^{-3}K^{-1}$

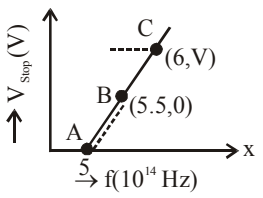
6. On the x-axis and a dsitance x from the origin, the gravitational field due to a mass distribution is given by $\frac{Ax}{(x^2+a^2)^{3/2}}$ in the x-direction. The magnitude of gravitational potential on the x-axis at a distance x, taking its value to be zero at infinity, is :

(1) $\frac{A}{(x^2+a^2)^{1/2}}$ (2) $\frac{A}{(x^2+a^2)^{3/2}}$
(3) $A(x^2 + a^2)^{3/2}$ (4) $A(x^2 + a^2)^{1/2}$

7. Starting from the origin at time t = 0, with initial velocity $5\hat{j}\ ms^{-1}$, a particle moves in the x-y plane with a constant acceleration of $(10\hat{i}+4\hat{j})\,ms^{-2}$. At time t, its coordinates are (20 m, y_0 m). The values of t and y_0, are respectively :

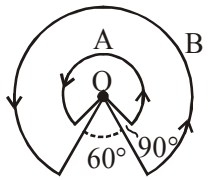
(1) 4s and 52 m (2) 2s and 24 m
(3) 2s and 18 m (4) 5s and 25 m

8. Given figure shows few data points in a photo electric effect experiment for a certain metal. The minimum energy for ejection of electron from its surffface is : (Plancks constant $h = 6.62 \times 10^{-34}$ J.s)



(1) 2.27 eV (2) 2.59 eV
(3) 1.93 eV (4) 2.10 eV

9. A wire A, bent in the shape of an arc of a circle, carrying a current of 2A and having radius 2 cm and another wire B, also bent in the shape of arc of a circle, carrying a current of 3A and having radius of 4 cm, are placed as shown in the figure. The ratio of the magnetic fields due to the wires A and B at the common centre O is :



(1) 4 : 6 (2) 6 : 4
(3) 6 :5 (4) 2 : 5

10. For a transverse wave travelling along a straight line, the distance between two peaks (crests) is 5 m, while the distance between one crest and one trough is 1.5 m. The possible wavelengths (in m) of the waves are :

(1) 1, 2, 3, ... (2) $\frac{1}{2},\frac{1}{4},\frac{1}{6},\ldots$

(3) 1, 3, 5, ... (4) $\frac{1}{1},\frac{1}{3},\frac{1}{5},\ldots$

11. A small bar magnet placed with its axis at 30° with an external field of 0.06 T experiences a torque of 0.018 Nm. The minimum work required to rotate it from its stable to unstable equilibrium position is :

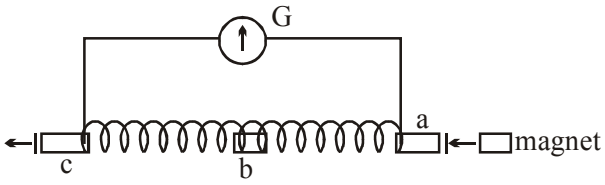
(1) 9.2×10^{-3} J (2) 6.4×10^{-2} J
(3) 11.7×10^{-3} J (4) 7.2×10^{-2} J

12. Particle A of mass $m_A = \frac{m}{2}$ moving along the x-axis with velocity v_0 collides elastically with another particle B at rest having mass $m_B = \frac{m}{3}$. If both particles move along the x-axis after the collision, the change $\Delta\lambda$ in de-Broglie wavelength of particle A, in terms of its de-Broglie wavelength (λ_0) before collision is :

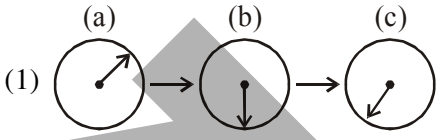
(1) $\Delta\lambda = 4\lambda_0$ (2) $\Delta\lambda = \frac{5}{2}\lambda_0$

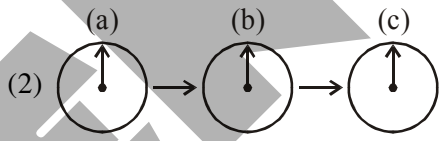
(3) $\Delta\lambda = 2\lambda_0$ (4) $\Delta\lambda = \frac{3}{2}\lambda_0$

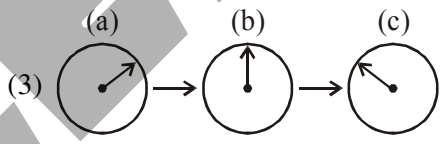
13. A small bar magnet is moved through a coil at constant speed from one end to the other. Which of the following series of observations wil be seen on the galvanometer G attached across the coil ?

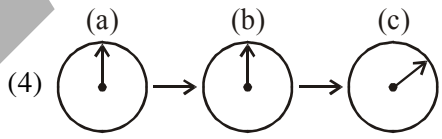


Three positions shown describe : (a) the magnet's entry (b) magnet is completely inside and (c) magnet's exit.

(1) 

(2) 

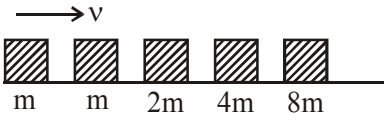
(3) 

(4) 

14. A battery of 3.0 V is connected to a resistor dissipating 0.5 W of power. If the terminal voltage of the battery is 2.5 V, the power dissipated within the internal resistance is :

(1) 0.50 W (2) 0.125 W
(3) 0.072 W (4) 0.10 W

15. Blocks of masses m, 2m, 4m and 8m are arranged in a line on a frictionless floor. Another block of mass m, moving with speed v along the same line (see figure) collides with mass m in perfectly inelastic manner. All the subsequent collisions are also perfectly inelastic. By the time the last block of mass 8m starts moving the total energy loss is p% of the original energy. Value of 'p' is close to :



(1) 77 (2) 37 (3) 87 (4) 94

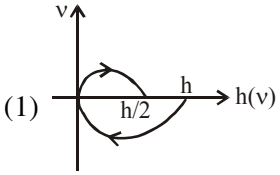
16. The specific heat of water = 4200 J kg^{-1} K^{-1} and the latent heat of ice = 3.4×10^5 J kg^{-1}. 100 grams of ice at 0°C is placed in 200 g of water at 25°C. The amount of ice that will melt as the temperature of water reaches 0°C is close to (in grams) :

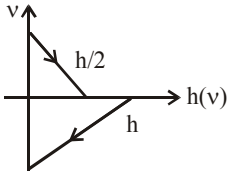
(1) 61.7 (2) 63.8

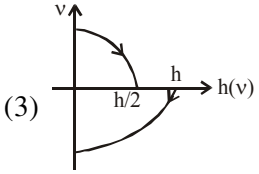
(3) 69.3 (4) 64.6

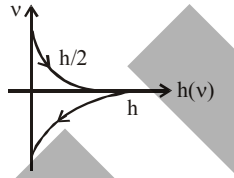
17. A Tennis ball is released from a height h and after freely falling on a wooden floor it rebounds and reaches height $\frac{h}{2}$. The velocity versus height of the ball during its motion may be represented graphically by :

(graph are drawn schematically and on not to scale)

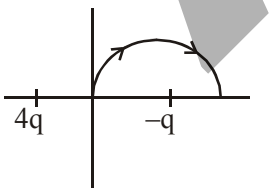
(1) 

(2) 

(3) 

(4) 

18. A two point charges 4q and –q are fixed on the x-axis at $x = -\frac{d}{2}$ and $x = \frac{d}{2}$, respectively. If a third point charge 'q' is taken from the origin to x = d along the semicircle as shown in the figure, the energy of the charge will :



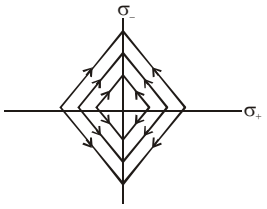
(1) increase by $\frac{2q^2}{3\pi\varepsilon_0 d}$

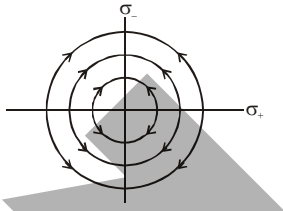
(2) increase by $\frac{3q^2}{4\pi\varepsilon_0 d}$

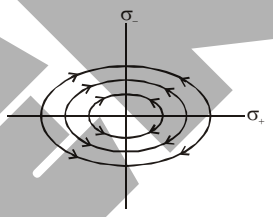
(3) decrease by $\frac{4q^2}{3\pi\varepsilon_0 d}$

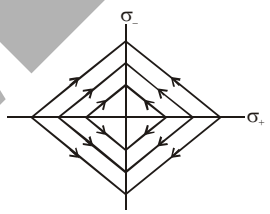
(4) decrease by $\frac{q^2}{4\pi\varepsilon_0 d}$

19. Two charged thin infinite plane sheets of uniform surface charge density σ_+ and σ_- where $|\sigma_+| > |\sigma_-|$ intersect at right angle. Which of the following best represents the electric field lines for this system :

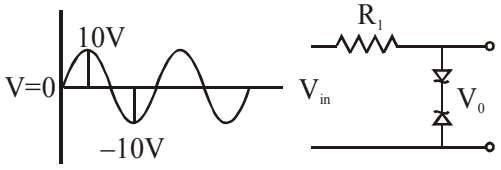
(1) 

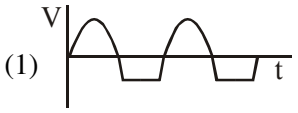
(2) 

(3) 

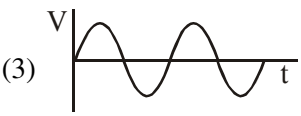
(4) 

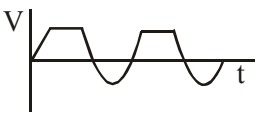
20. Take the breakdown voltage of the zener diode used in the given circuit as 6V. For the input voltage shown in figure below, the time variation of the output voltage is : (Graphs drawn are schematic and not to scale)



(1) 

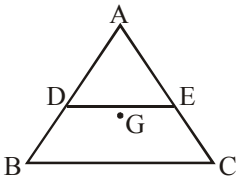
(2) 

(3) 

(4) 

21. In a compound microscope, the magnified virtual image is formed at a distance of 25 cm from the eye-piece. The focal length of its objective lens is 1 cm. If the magnification is 100 and the tube length of the microscope is 20 cm, then the focal length of the eye-piece lens (in cm) is _____.

22. ABC is a plane lamina of the shape of an equilateral triagnle. D, E are mid points of AB, AC and G is the centroid of the lamina. Moment of inertia of the lamina about an axis passing through G and perpendicular to the plane ABC is I_0. If part ADE is removed, the moment of inertia of the remaining part about the same axis is $\frac{NI_0}{16}$ where N is an integer. Value of N is _____.



23. A circular disc of mass M and radius R is rotating about its axis with angular speed ω_1. If another stationary disc having radius $\frac{R}{2}$ and same mass M is dropped co-axially on to the rotating disc. Gradually both discs attain constant angular speed ω_2. The energy lost in the process is p% of the initial energy. Value of p is _____.

24. A closed vessel contains 0.1 mole of a monoatomic ideal gas at 200 K. If 0.05 mole of the same gas at 400 K is added to it, the final equilibrium temperature (in K) of the gas in the vessel will be closed to _____.

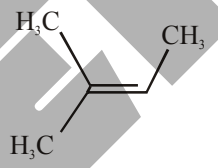
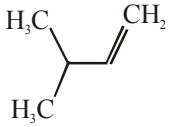
25. In the line spectra of hydrogen atom, difference between the largest and the shortest wavelengths of the Lyman series is 304 Å. The corresponding difference for the Paschan series in Å is : _____.

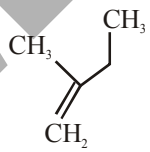
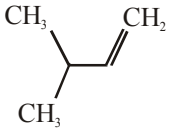
CHEMISTRY

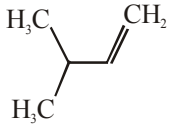
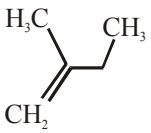
1. On heating, lead(II) nitrate gives a brown gas (A). The gas (A) on cooling changes to a colourless solid/liquid (B). (B) on heating with NO changes to a blue solid (C). The oxidation number of nitrogen in solid (C) is :
(1) +5 (2) +2
(3) +4 (4) +3

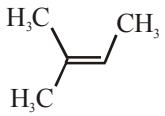
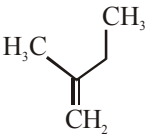
2. Which of the following will react with $CHCl_3$ + alc. KOH ?
(1) Adenine and lysine
(2) Adenine and thymine
(3) Adenine and proline
(4) Thymine and proline

3. When neopentyl alcohol is heated with an acid, it slowly converted into an 85 : 15 mixture of alkenes A and B, respectively. What are these alkenes ?

(1)  and 

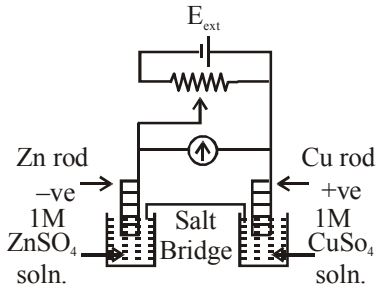
(2)  and 

(3)  and 

(4)  and 

4. Among statements (a) -(d), the correct ones are :
(a) Lime stone is decomposed to CaO during the extraction of iron from its oxides.
(b) In the extraction of silver, silver is extracted as an anionic complex.
(c) Nickel is purified by Mond's process.
(d) Zr and Ti are purified by Van Arkel method.
(1) (c) and (d) only
(2) (a), (c) and (d) only
(3) (b), (c) and (d) only
(4) (a), (b), (c) and (d)

5.



$E^{o}_{Cu^{2+}|Cu} = +0.34V$

$E^{o}_{Zn^{2+}|Zn} = -0.76V$

Identify the incorrect statement from the options below for the above cell :

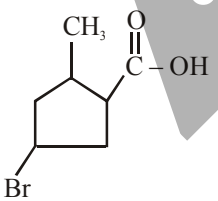
(1) If E_{ext} > 1.1 V, Zn dissolves at Zn electrode and Cu deposits at Cu electrode

(2) If E_{ext} > 1.1 V, e^- flows from Cu to Zn

(3) If E_{ext} = 1.1 V, no flow of e^- or current occurs

(4) If E_{ext} < 1.1 V, Zn dissolves at anode and Cu deposits at cathode

6. The IUPAC name of the following compound is :



(1) 4-Bromo-2-methylcyclopentane carboxylic acid

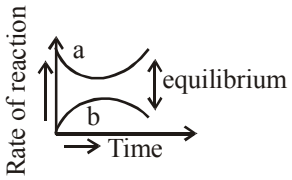
(2) 5-Bromo-3-methylcyclopentanoic acid

(3) 3-Bromo-5-methylcyclopentane carboxylic acid

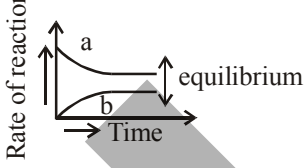
(4) 3-Bromo-5-methylcyclopentanoic acid

7. For the equilibrium $A \rightleftharpoons B$, the variation of the rate of the forward (a) and reverse (b) reaction with time is given by

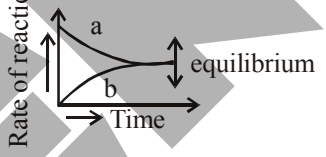
(1)



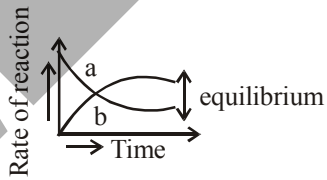
(2)



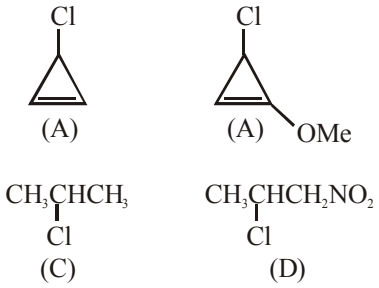
(3)



(4)



8. The decreasing order of reactivity of the following organic molecules towards $AgNO_3$ solution is :



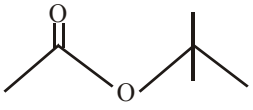
(1) (A) > (B) > (D) > (C)

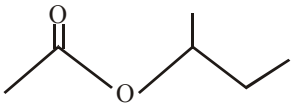
(2) (A) > (B) > (C) > (D)

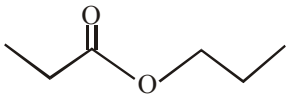
(3) (C) > (D) > (A) > (B)

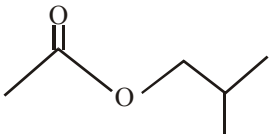
(4) (B) > (A) > (C) > (D)

9. An organic compound (A) (molecular formula $C_6H_{12}O_2$) was hydrolysed with dil. H_2SO_4 to give a carboxylic acid (B) and an alcohol (C). 'C' give white turbidity immediately when treated with anhydrous $ZnCl_2$ and conc. HCl. The organic compound (A) is :

(1) 

(2) 

(3) 

(4) 

10. Match the following :

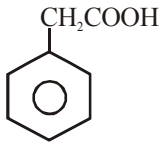
(i) Foam	(a) smoke
(ii) Gel	(b) cell fluid
(iii) Aerosol	(c) jellies
(iv) Emulsion	(d) rubber
	(e) froth
	(f) milk

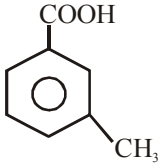
(1) (i)-(b), (ii)-(c), (iii)-(e), (iv)-(d)
(2) (i)-(d), (ii)-(b), (iii)-(e), (iv)-(f)
(3) (i)-(e), (ii)-(c), (iii)-(a), (iv)-(f)
(4) (i)-(d), (ii)-(b), (iii)-(a), (iv)-(e)

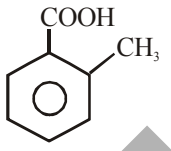
11. The elements with atomic numbers 101 and 104 belong to, respectively :
(1) Group 11 and Group 4
(2) Actinoids and Group 4
(3) Actinoids and Group 6
(4) Group 6 and Actinoids

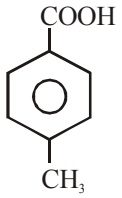
12. On combustion Li, Na and K in excess of air, the major oxides formed, respectively, are :
(1) Li_2O, Na_2O and K_2O_2
(2) Li_2O, Na_2O_2 and K_2O
(3) Li_2O, Na_2O_2 and KO_2
(4) Li_2O_2, Na_2O_2 and K_2O_2

13. [P] on treatment with $Br_2/FeBr_3$ in CCl_4 produced a single isomer $C_8H_7O_2Br$ while heating [P] with sodalime gave toluene.
The compound [P] is :

(1) 

(2) 

(3) 

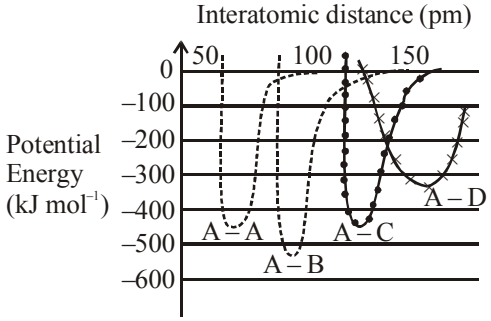
(4) 

14. The number of isomers possible for $[Pt(en)(NO_2)_2]$ is :
(1) 3 (2) 2
(3) 1 (4) 4

15. The ionic radii of O_2^-, F^-, Na^+ and Mg^{2+} are in the order :
(1) $F^- > O^{2-} > Na^+ > Mg^{2+}$
(2) $Mg^{2+} > Na^+ > F^- > O^{2-}$
(3) $O^{2-} > F^- > Mg^{2+} > Na^+$
(4) $O^{2-} > F^- > Na^+ > Mg^{2+}$

16. The region in the electromagnetic spectrum where the Balmer series lines appear is
(1) Visible (2) Microwave
(3) Ultraviolet (4) Infrared

17. The intermolecular potential energy for the molecules A, B, C and D given below suggests that :



(1) D is more electronegative than other atoms
(2) A-D has the shortest bond length
(3) A-B has the stiffest bone
(4) A–A has the largest bond enthalpy

18. What are the functional groups present in the structure of maltose ?

(1) One ketal and one hemiketal

(2) One acetal and one hemiacetal

(3) Two acetals

(4) One acetal and one ketal

19. For one mole of an ideal gas, which of these statements must be true ?

(a) U and H each depends only on temperature

(b) Compressibility factor z is not equal to 1

(c) $C_{P,m} - C_{V,m} = R$

(d) $dU = C_V dT$ for any process

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

(3) (c) and (d) (4) (a) and (c)

20. The pair in which both the species have the same magnetic moment (spin only) is :

(1) $[Mn(H_2O)_6]^{2+}$ and $[Cr(H_2O)]^{2+}$

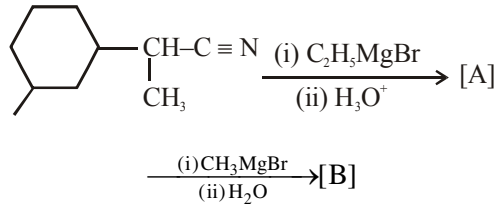
(2) $[Cr(H_2O)_6]^{2+}$ and $[CoCl_4]^{2-}$

(3) $[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$

(4) $[Co(OH)_4]^{2-}$ and $[Fe(NH_3)_6]^{2+}$

21. The mass of ammonia in grams produced when 2.8 kg of dinitrogen quantitatively reacts with 1 kg of dihydrogen is _____.

22. The number of chiral centres present in [B] is _____.



23. A 20.0 mL solution containing 0.2 g impure H_2O_2 reacts completely with 0.316 g of $KMnO_4$ in acid solution. The purity of H_2O_2 (in %) is _____ (mol. wt. of H_2O_2 = 34; mol. wt. of $KMnO_4$ = 158)

24. If 75% of a first order reaction was completed in 90 minutes, 60% of the same reaction would be completed in approximately (in minutes) _____.

(Take : log 2 = 0.30; log 2.5 = 0.40)

25. At 300 K, the vapour pressure of a solution containing 1 mole of n-hexane and 3 moles of n-heptane is 550 mm of Hg. At the same temperature, if one more mole of n-heptane is added to this solution, the vapour pressure of the solution increases by 10 mm of Hg. What is the vapour pressure in mm Hg of n-heptane in its pure state _____ ?

MATHEMATICS

1. If $A = \begin{bmatrix} \cos\theta & i\sin\theta \\ i\sin\theta & \cos\theta \end{bmatrix}$, $\left(\theta = \frac{\pi}{24}\right)$ and $A^5 = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, where $i = \sqrt{-1}$, then which one of the following is not true?

(1) $0 \le a^2 + b^2 \le 1$ (2) $a^2 - d^2 = 0$

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

2. Let [t] denote the greatest integer ≤ t. Then the equation in x, $[x]^2 + 2[x + 2] - 7 = 0$ has :

(1) no integral solution

(2) exactly four integral solutions

(3) exactly two solutions

(4) infinitely many solutions

3. Let α and β be the roots of $x^2 - 3x + p = 0$ and γ and δ be the roots of $x^2 - 6x + q = 0$. If α, β, γ, δ form a geometric progression. Then ratio (2q + p) : (2q – p) is :

(1) 3 : 1 (2) 33 : 31

(3) 9 : 7 (4) 5 : 3

4. Let $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ (a > b) be a given ellipse, length of whose latus rectum is 10. If its eccentricity is the maximum value of the function, $\phi(t)=\frac{5}{12}+t-t^2$, then a^2+b^2 is equal to :

(1) 126 (2) 135 (3) 145 (4) 116

5. A triangle ABC lying in the first quadrant has two vertices as A(1, 2) and B(3, 1). If $\angle BAC = 90°$, and ar(ΔABC) = $5\sqrt{5}$ sq. units, then the abscissa of the vertex C is :

(1) $2+\sqrt{5}$ (2) $1+\sqrt{5}$

(3) $1+2\sqrt{5}$ (4) $2\sqrt{5}-1$

6. Let f(x) = |x – 2| and g(x) = f(f(x)), $x \in [0, 4]$. Then $\int_0^3 \big(g(x)-f(x)\big)dx$ is equal to :

(1) $\frac{3}{2}$ (2) 0 (3) $\frac{1}{2}$ (4) 1

7. Given the following two statements :

(S_1) : $(q \vee p) \rightarrow (p \leftrightarrow \sim q)$ is a tautology.

(S_2) : $\sim q \wedge (\sim p \leftrightarrow q)$ is a fallacy.

Then :

(1) only (S_1) is correct.

(2) both (S_1) and (S_2) are correct.

(3) both (S_1) and (S_2) are not correct.

(4) only (S_2) is correct.

8. Let P(3, 3) be a point on the hyperbola, $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$. If the normal to it at P intesects the x-axis at (9, 0) and e is its eccentricity, then the ordered pair (a^2, e^2) is equal to :

(1) $\left(\frac{9}{2}, 3\right)$ (2) $\left(\frac{9}{2}, 2\right)$

(3) $\left(\frac{3}{2}, 2\right)$ (4) (9, 3)

9. Let $f(x)=\int\frac{\sqrt{x}}{(1+x)^2}dx$ $(x \geq 0)$. Then f(3) – f(1) is equal to :

(1) $-\frac{\pi}{6}+\frac{1}{2}+\frac{\sqrt{3}}{4}$ (2) $\frac{\pi}{6}+\frac{1}{2}-\frac{\sqrt{3}}{4}$

(3) $-\frac{\pi}{12}+\frac{1}{2}+\frac{\sqrt{3}}{4}$ (4) $\frac{\pi}{12}+\frac{1}{2}-\frac{\sqrt{3}}{4}$

10. A survey shows that 63% of the people in a city read newspaper A whereas 76% read newspaper B. If x% of the people read both the newspapers, then a possible value of x can be:

(1) 65 (2) 37 (3) 29 (4) 55

11. Let $u=\frac{2z+i}{z-ki}$, z = x + iy and k > 0. If the curve represented by Re(u) + Im(u) = 1 intersects the y-axis at the points P and Q where PQ = 5, then the value of k is :

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

12. Let x_0 be the point of local maxima of $f(x)=\vec{a}.(\vec{b}\times\vec{c})$, where $\vec{a}=x\hat{i}-2\hat{j}+3\hat{k}$, $\vec{b}=-2\hat{i}+x\hat{j}-\hat{k}$ and $\vec{c}=7\hat{i}-2\hat{j}+x\hat{k}$. Then the value of $\vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a}$ at $x = x_0$ is :

(1) –30 (2) 14

(3) –4 (4) –22

13. Two vertical poles AB = 15 m and CD = 10 m are standing apart on a horizontal ground with points A and C on the ground. If P is the point of intersection of BC and AD, then the height of P (in m) above the line AC is :

(1) 20/3 (2) 5 (3) 10/3 (4) 6

14. The mean and variance of 8 observations are 10 and 13.5, respectively. If 6 of these observations are 5, 7, 10, 12, 14, 15, then the absolute difference of the remaining two observations is :

(1) 7 (2) 3 (3) 5 (4) 9

15. The integral $\int\left(\frac{x}{x\sin x+\cos x}\right)^2 dx$ is equal to :

(where C is a constant of integration)

(1) $\sec x+\frac{x\tan x}{x\sin x+\cos x}+C$

(2) $\sec x-\frac{x\tan x}{x\sin x+\cos x}+C$

(3) $\tan x+\frac{x\sec x}{x\sin x+\cos x}+C$

(4) $\tan x-\frac{x\sec x}{x\sin x+\cos x}+C$

16. If

$1+(1-2^2.1)+(1-4^2.3)+(1-6^2.5)+.....+(1-20^2.19) = \alpha - 220\beta$, then an ordered pair (α, β) is equal to :

(1) (10, 97) (2) (11, 103)

(3) (10, 103) (4) (11, 97)

17. Let $y = y(x)$ be the solution of the differential equation, $xy' - y = x^2(x\cos x + \sin x)$, $x > 0$. If $y(\pi) = \pi$, then $y''\left(\frac{\pi}{2}\right)+y\left(\frac{\pi}{2}\right)$ is equal to :

(1) $2+\frac{\pi}{2}$ (2) $1+\frac{\pi}{2}$

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

18. The value of $\sum_{r=0}^{20} {}^{50-r}C_6$ is equal to :

(1) ${}^{51}C_7 + {}^{30}C_7$ (2) ${}^{51}C_7 - {}^{30}C_7$

(3) ${}^{50}C_7 - {}^{30}C_7$ (4) ${}^{50}C_6 - {}^{30}C_6$

19. Let f be a twice differentiable function on (1, 6). If $f(2) = 8$, $f'(2) = 5$, $f'(x) \geq 1$ and $f''(x) \geq 4$, for all $x \in (1, 6)$, then :

(1) $f(5) \leq 10$ (2) $f'(5) + f''(5) \leq 20$

(3) $f(5) + f'(5) \geq 28$ (4) $f(5) + f'(5) \leq 26$

20. If $\left(a+\sqrt{2}\,b\cos x\right)\left(a-\sqrt{2}\,b\cos y\right)=a^2-b^2$, where $a > b > 0$, then $\frac{dx}{dy}$ at $\left(\frac{\pi}{4}, \frac{\pi}{4}\right)$ is :

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

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

21. If the system of equations

$x - 2y + 3z = 9$

$2x + y + z = b$

$x - 7y + az = 24$,

has infinitely many solutions, then $a - b$ is equal to _____ .

22. The probability of a man hitting a target is $\frac{1}{10}$. The least number of shots required, so that the probability of his hitting the target at least once is greater than $\frac{1}{4}$, is _____.

23. Suppose a differentiable function $f(x)$ satisfies the identity $f(x + y) = f(x) + f(y) + xy^2 + x^2y$, for all real x and y. If $\lim_{x\to 0}\frac{f(x)}{x}=1$, then $f'(3)$ is equal to _____.

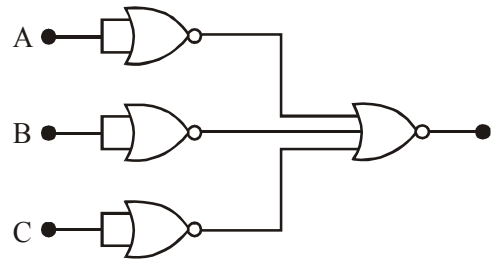
24. Let $(2x^2 + 3x + 4)^{10} = \sum_{r=0}^{20} a_r x^r$. Then $\frac{a_7}{a_{13}}$ is equal to _____.

25. If the equation of a plane P, passing through the intesection of the planes, $x + 4y - z + 7 = 0$ and $3x + y + 5z = 8$ is $ax + by + 6z = 15$ for some $a, b \in R$, then the distance of the point (3, 2, –1) from the plane P is _____.

SET # 06

PHYSICS

1. Identify the operation performed by the circuit given below :



(1) AND (2) NAND

(3) OR (4) NOT

2. Consider two uniform discs of the same thickness and different radii $R_1 = R$ and $R_2 = \alpha R$ made of the same material. If the ratio of their moments of inertia I_1 and I_2, respectively, about their axes is $I_1 : I_2 = 1 : 16$ then the value of α is :

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

3. A capacitor C is fully charged with voltage V_0. After disconnecting the voltage source, it is connected in parallel with another uncharged capacitor of capacitance $\frac{C}{2}$. The energy loss in the process after the charge is distributed between the two capacitors is :

(1) $\frac{1}{6}CV_0^2$ (2) $\frac{1}{2}CV_0^2$

(3) $\frac{1}{3}CV_0^2$ (4) $\frac{1}{4}CV_0^2$

4. A person pushes a box on a rough horizontal platform surface. He applies a force of 200 N over a distance of 15 m. Thereafter, he gets progressively tired and his applied force reduces linearly with distance of 100 N. The total distance through which the box has been moved is 30 m. What is the work done by the person during the total movement of the box ?

(1) 5690 J (2) 5250 J

(3) 3280 J (4) 2780 J

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

$\vec{E} = E_0(\hat{x} + \hat{y})\sin(kz - \omega t)$

Its magnetic field will be given by :

(1) $\frac{E_0}{c}(\hat{x} - \hat{y})\cos(kz - \omega t)$

(2) $\frac{E_0}{c}(-\hat{x} + \hat{y})\sin(kz - \omega t)$

(3) $\frac{E_0}{c}(\hat{x} - \hat{y})\sin(kz - \omega t)$

(4) $\frac{E_0}{c}(\hat{x} + \hat{y})\sin(kz - \omega t)$

6. Find the binding energy per nucleon for $^{120}_{50}Sn$. Mass of proton $m_P = 1.00783$ U, mass of neutron $m_n = 1.00867$ U and mass of tin nucleus $m_{Sn} = 119.902199$ U. (take 1U = 931 MeV)

(1) 8.5 MeV (2) 7.5 MeV

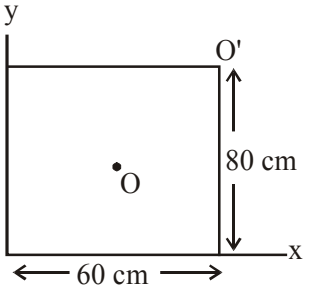
(3) 8.0 MeV (4) 9.0 MeV

7. A small ball of mass is thrown upward with velocity u from the ground. The ball experiences a resistive force mkv^2 where v is its speed. The maximum height attained by the ball is :

(1) $\frac{1}{2k}\tan^{-1}\frac{ku^2}{g}$ (2) $\frac{1}{2k}\ln\left(1+\frac{ku^2}{g}\right)$

(3) $\frac{1}{k}\tan^{-1}\frac{ku^2}{2g}$ (4) $\frac{1}{k}\ln\left(1+\frac{ku^2}{2g}\right)$

8.



For a uniform rectangular sheet shown in the figure, the ratio of moments of inertia about the axes perpendicular to the sheet and passing through O (the centre of mass) and O' (corner point) is :

(1) 1/2 (2) 2/3 (3) 1/8 (4) 1/4

9. Match the thermodynamic processes taking place in a system with the correct conditions. In the table : ΔQ is the heat supplied, ΔW is the work done and ΔU is change in internal energy of the system :

Process	Condition
(I) Adiabatic	(A) $\Delta W = 0$
(II) Isothermal	(B) $\Delta Q = 0$
(III) Isochoric	(C) $\Delta U \neq 0$, $\Delta W \neq 0$, $\Delta Q \neq 0$
(IV) Isobaric	(D) $\Delta U = 0$

(1) I-B, II-D, III-A, IV-C
(2) I-B, II-A, III-D, IV-C
(3) I-A, II-A, III-B, IV-C
(4) I-A, II-B, III-D, IV-D

10. A paramagnetic sample shows a net magnetisation of 6 A/m when it is placed in an external magnetic field of 0.4 T at a temperature of 4 K. When the sample is placed in an external magnetic field of 0.3 T at a temperature of 24 K, then the magnetisation will be :
(1) 4 A/m (2) 0.75 A/m
(3) 2.25 A/m (4) 1 A/m

11. A series L-R circuit is connected to a battery of emf V. If the circuit is switched on at t = 0, then the time at which the energy stored in the inductor reaches $\left(\frac{1}{n}\right)$ times of its maximum value, is :

(1) $\frac{L}{R}\ln\left(\frac{\sqrt{n}-1}{\sqrt{n}}\right)$ (2) $\frac{L}{R}\ln\left(\frac{\sqrt{n}}{\sqrt{n}+1}\right)$

(3) $\frac{L}{R}\ln\left(\frac{\sqrt{n}}{\sqrt{n}-1}\right)$ (4) $\frac{L}{R}\ln\left(\frac{\sqrt{n}+1}{\sqrt{n}-1}\right)$

12. The driver of a bus approaching a big wall notices that the frequency of his bus's horn changes from 420 Hz to 490 Hz, when he hears it after it gets reflected from the wall. Find the speed of the bus if speed of the sound is 330 ms^{-1}.
(1) 91 kmh^{-1} (2) 71 kmh^{-1}
(3) 81 kmh^{-1} (4) 61 kmh^{-1}

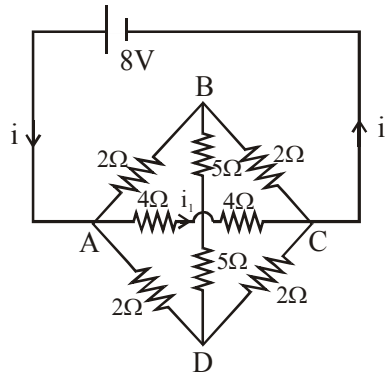
13. Two identical cylindrical vessels are kept on the ground and each contain the same liquid of density d. The area of the base of both vessels is S but the height of liquid in one vessel is x_1 and in the other, x_2. When both cylinders are connected through a pipe of negligible volume very close to the bottom, the liquid flows from one vessel to the other until it comes to equilibrium at a new height. The change in energy of the system in the process is :
(1) $gdS\ (x_2 + x_1)^2$
(2) $\frac{3}{4}gdS(x_2 - x_1)^2$
(3) $\frac{1}{4}gdS(x_2 - x_1)^2$
(4) $gdS(x_2^2 + x_1^2)$

14. A circular coil has moment of inertia 0.8 kg m^2 around any diameter and is carrying current to produce a magnetic moment of 20 Am^2. The coil is kept initially in a vertical position and it can rotate freely around a horizontal diameter. When a uniform magnetic field of 4T is applied along the vertical, it starts rotating around its horizontal diameter. The angular speed the coil acquires after rotating by 60° will be:
(1) 10 rad s^{-1} (2) 20 π rad s^{-1}
(3) 10 π rad s^{-1} (4) 20 rad s^{-1}

15. A particle of charge q and mass m is subjected to an electric field $E = E_0 (1 - ax^2)$ in the x-direction, where a and E_0 are constants. Initially the particle was at rest at x = 0. Other than the initial position the kinetic energy of the particle becomes zero when the distance of the particle from the origin is :
(1) $\sqrt{\frac{2}{a}}$ (2) $\sqrt{\frac{1}{a}}$ (3) a (4) $\sqrt{\frac{3}{a}}$

16. A cube of metal is subjected to a hydrostatic pressure of 4 GPa. The percentage change in the length of the side of the cube is close to :
(Given bulk modulus of metal, $B = 8 \times 10^{10}$ Pa)
(1) 0.6 (2) 1.67 (3) 5 (4) 20

17. The value of current i_1 flowing from A to C in the circuit diagram is :



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

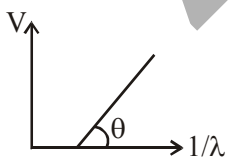
18. A body is moving in a low circular orbit about a planet of mass M and radius R. The radius of the orbit can be taken to be R itself. Then the ratio of the speed of this body in the orbit to the escape velocity from the planet is :

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

19. A quantity x is given by (IFv^2/WL^4) in terms of moment of inertia I, force F, velocity v, work W and Length L. The dimensional formula for x is same as that of :

(1) Planck's constant
(2) Force constant
(3) Energy density
(4) Coefficient of viscosity

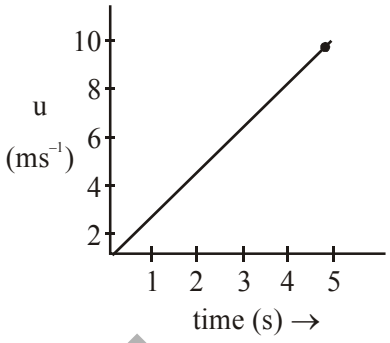
20. In a photoelectric effect experiment, the graph of stopping potential V versus reciprocal of wavelength obtained is shown in the figure. As the intensity of incident radiation is increased :



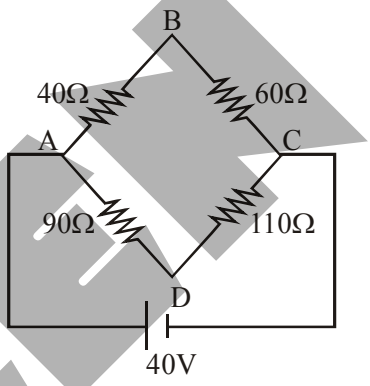
(1) Slope of the straight line get more steep
(2) Straight line shifts to left
(3) Graph does not change
(4) Straight line shifts to right

21. Orange light of wavelength 6000×10^{-10} m in illuminates a single slit of width 0.6×10^{-4} m. The maximum possible number of diffraction minima produced on both sides of the central maximum is _____.

22. The speed verses time graph for a particle is shown in the figure. The distance travelled (in m) by the particle during the time interval t = 0 to t = 5s will be _____ :



23.



Four resistances 40Ω, 60Ω, 90Ω and 110Ω make the arms of a quadrilateral ABCD. Across AC is a battery of emf 40V and internal resistance negligible. The potential difference across BD is V is _____.

24. The distance between an object and a screen is 100 cm. A lens can produce real image of the object on the screen for two different positions between the screen and the object. The distance between these two positions is 40 cm. If the power of the lens is close to $\left(\frac{N}{100}\right)$D where N is an integer, the value of N is _____.

25. The change in the magnitude of the volume of an ideal gas when a small additional pressure ΔP is applied at a constant temperature, is the same as the change when the temperature is reduced by a small quantity ΔT at constant pressure. The initial temperature and pressure of the gas were 300 K and 2 atm respectively. If $|\Delta T| = C|\Delta P|$ then value of C in (K/atm) is _____:

CHEMISTRY

1. If the equilibrium constant for $A \rightleftharpoons B+C$ is $K_{eq}^{(1)}$ and that of $B+C \rightleftharpoons P$ is $K_{eq}^{(2)}$, the equilibrium constant for A $\rightleftharpoons$ P is :-

(1) $K_{eq}^{(2)} - K_{eq}^{(1)}$ (2) $K_{eq}^{(1)} K_{eq}^{(2)}$

(3) $K_{eq}^{(1)} / K_{eq}^{(2)}$ (4) $K_{eq}^{(1)} + K_{eq}^{(2)}$

2. Five moles of an ideal gas at 1 bar and 298 K is expanded into vacuum to double the volume. The work done is :-

(1) $C_V(T_2 - T_1)$ (2) –RT ln V_2/V_1

(3) $-RT(V_2 - V_1)$ (4) zero

3. The process that is NOT endothermic in nature is :-

(1) $Ar_{(g)} + e^- \rightarrow Ar_{(g)}^-$ (2) $H_{(g)} + e^- \rightarrow H_{(g)}^-$

(3) $Na_{(g)} \rightarrow Na_{(g)}^+ + e^-$ (4) $O_{(g)}^- + e^- \rightarrow O_{(g)}^{2-}$

4. The crystal Field stabilization Energy (CFSE) of $[CoF_3(H_2O)_3](\Delta_0 < P)$ is :-

(1) –0.8 Δ_0 (2) –0.4 Δ_0 + P

(3) –0.8 Δ_0 + 2P (4) –0.4 Δ_0

5. The mechanism of action of "Terfenadine" (Seldane) is :-

(1) Activates the histamine receptor

(2) Inhibits the secretion of histamine

(3) Inhibits the action of histamine receptor

(4) Helps in the secretion of histamine

6. An alkaline earth metal 'M' readily forms water soluble sulphate and water insoluble hydroxide. Its oxide MO is very stable to heat and does not have rock-salt structure. M is :-

(1) Ca (2) Be (3) Mg (4) Sr

7. The reaction in which the hybridisation of the underlined atom is affected is :-

(1) $\underline{N}H_3 \xrightarrow{H^+}$

(2) $\underline{Xe}F_4 + SbF_5 \rightarrow$

(3) $H_2\underline{S}O_4 + NaCl \xrightarrow{420\ K}$

(4) $H_3\underline{P}O_2 \xrightarrow{\text{Disproportionation}}$

8. The one that can exhibit highest paramagnetic behaviour among the following is :-

gly = glycinato; bpy = 2, 2'-bipyridine

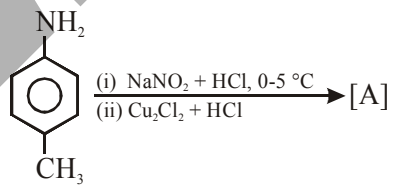
(1) $[Pd(gly)_2]$

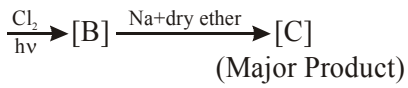
(2) $[Ti(NH_3)_6]^{3+}$

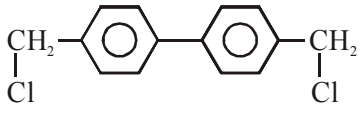
(3) $[Co(OX)_2(OH)_2]^-$ (Δ_0 > P)

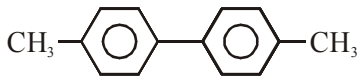
(4) $[Fe(en)(bpy)(NH_3)_2]^{2+}$

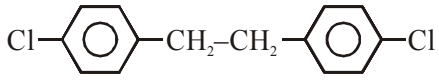
9. In the following reaction sequence, [C] is :-

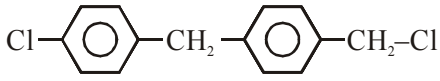




(1) 

(2) 

(3) 

(4) 

10. A sample of red ink (a colloidal suspension) is prepared by mixing eosin dye, egg white, HCHO and water. The component which ensures stability of the ink sample is :-

(1) HCHO (2) Eosin dye

(3) Egg white (4) Water

11. The processes of calcination and roasting in metallurgical industries, respectively, can lead to :-

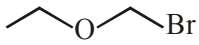
(1) Global warming and acid rain

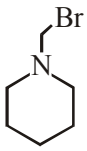
(2) Photochemical smog and ozone layer depletion

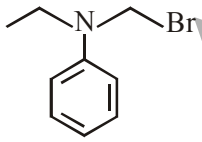
(3) Global warming and photochemical smog

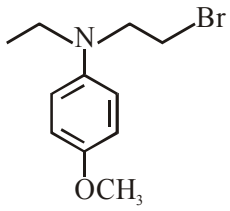
(4) Photochemical smog and global warming

12. Which of the following compounds will form the precipitate with aq. $AgNO_3$ solution most readily ?

(1) 

(2) 

(3) 

(4) 

13. The molecule in which hybrid MOs involve only one d-orbital of the central atom is :-

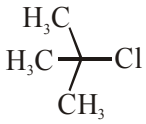
(1) $[Ni(CN)_4]^{2-}$

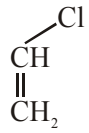
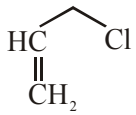
(2) $[CrF_6]^{3-}$

(3) BrF_5

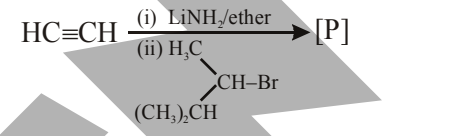
(4) XeF_4

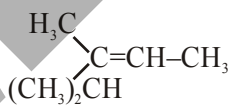
14. Among the following compounds, which one has the shortest C—Cl bond ?

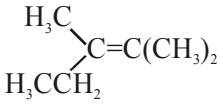
(1) $H_3C–Cl$ (2) 

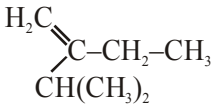
(3)  (4) 

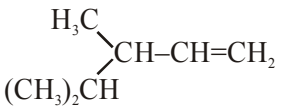
15. The major product [R] in the following sequence of reactions is :-



(1) 

(2) 

(3) 

(4) 

16. The incorrect statement(s) among (a) - (c) is (are) :-

(a) W(VI) is more stable than Cr(VI).

(b) in the presence of HCl, permanganate titrations provide satisfactory results.

(c) some lanthanoid oxides can be used as phosphors.

(1) (a) and (b) only (2) (a) only

(3) (b) and (c) only (4) (b) only

17. 250 mL of a waste solution obtained from the workshop of a goldsmith contains 0.1 M $AgNO_3$ and 0.1 M AuCl. The solution was electrolyzed at 2 V by passing a current of 1 A for 15 minutes. The metal/metals electrodeposited will be :-

$\left(E^0_{Ag^+/Ag} = 0.80V,\ E^0_{Au^+/Au} = 1.69V\right)$

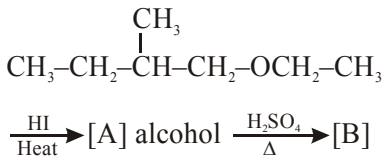
(1) only silver

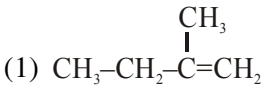
(2) only gold

(3) silver and gold in equal mass proportion

(4) silver and gold in proportion to their atomic weights

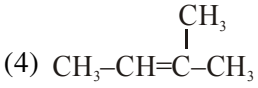
18. The major product [B] in the following reactions is :-



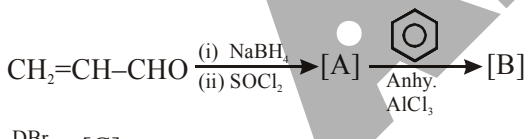
(1) 

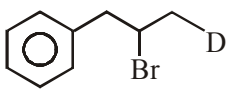
(2) $CH_3–CH_2–CH=CH–CH_3$

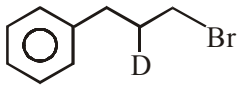
(3) $CH_2=CH_2$

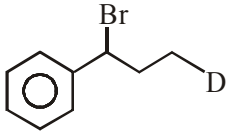
(4) 

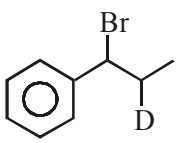
19. The major product [C] of the following reaction sequence will be :-



(1) 

(2) 

(3) 

(4) 

20. The shortest wavelength of H atom in the Lyman series is λ_1. The longest wavelength in the Balmer series of He^+ is :-

(1) $\frac{5\lambda_1}{9}$ (2) $\frac{27\lambda_1}{5}$

(3) $\frac{9\lambda_1}{5}$ (4) $\frac{36\lambda_1}{5}$

21. A 100 mL solution was made by adding 1.43 g of $Na_2CO_3 \cdot xH_2O$. The normality of the solution is 0.1 N. The value of x is _____.

(The atomic mass of Na is 23g/mol) :-

22. The osmotic pressure of a solution of NaCl is 0.10 atm and that of a glucose solution is 0.20 atm. The osmotic pressure of a solution formed by mixing 1 L of the sodium chloride solution with 2 L of the glucose solution is $x \times 10^{-3}$ atm. x is _____. (nearest integer) :-

23. The number of chiral centres present in threonine is _____.

24. Consider the following equations :

$2\ Fe^{2+} + H_2O_2 \rightarrow x\ A + y\ B$

(in basic medium)

$2MnO_4^- + 6H^+ + 5H_2O_2 \rightarrow x'\ C + y'\ D + z'\ E$

(in acidic medium)

The sum of the stoichiometric coefficients x, y, x', y' and z' for products A, B, C, D and E, respectively, is _____.

25. The number of molecules with energy greater than the threshold energy for a reaction increases five fold by a rise of temperature from 27 °C to 42 °C. Its energy of activation in J/mol is _____. (Take ln 5 = 1.6094; R = 8.314 J $mol^{-1}K^{-1}$)

MATHEMATICS

1. The function $f(x) = \begin{cases} \frac{\pi}{4} + \tan^{-1} x, & |x| \le 1 \\ \frac{1}{2}(|x|-1), & |x| > 1 \end{cases}$ is :

(1) continuous on R–{1} and differentiable on R – {–1, 1}.

(2) both continuous and differentiable on R – {–1}.

(3) continuous on R – {–1} and differentiable on R – {–1, 1}.

(4) both continuous and differentiable on R –{1}

2. Let $\bigcup_{i=1}^{50} X_i = \bigcup_{i=1}^{n} Y_i = T$, where each X_i contains 10 elements and each Y_i contains 5 elements. If each element of the set T is an element of exactly 20 of sets X_i's and exactly 6 of sets Y_i's, then n is equal to :

(1) 45 (2) 15

(3) 50 (4) 30

3. Let $\lambda \neq 0$ be in R. If α and β are the roots of the equation, $x^2 - x + 2\lambda = 0$ and α and γ are the roots of the equation, $3x^2 - 10x + 27\lambda = 0$, then $\frac{\beta\gamma}{\lambda}$ is equal to :

(1) 36 (2) 27

(3) 9 (4) 18

4. The solution of the differential equation $\frac{dy}{dx} - \frac{y+3x}{\log_e(y+3x)} + 3 = 0$ is :-

(where C is a constant of integration.)

(1) $x - 2\log_e(y+3x) = C$

(2) $x - \log_e(y+3x) = C$

(3) $x - \frac{1}{2}(\log_e(y+3x))^2 = C$

(4) $y + 3x - \frac{1}{2}(\log_e x)^2 = C$

5. Let $a_1, a_2 ..., a_n$ be a given A.P. whose common difference is an integer and $S_n = a_1 + a_2 + ..+ a_n$. If $a_1 = 1$, $a_n = 300$ and $15 \le n \le 50$, then the ordered pair (S_{n-4}, a_{n-4}) is equal to :

(1) (2480, 249) (2) (2490, 249)

(3) (2490, 248) (4) (2480, 248)

6. The distance of the point (1, – 2, 3) from the plane x–y+z = 5 measured parallel to the line $\frac{x}{2} = \frac{y}{3} = \frac{z}{-6}$ is :

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

7. Let $f : (0, \infty) \to (0, \infty)$ be a differentiable function such that f(1) = e and

$$\lim_{t \to x} \frac{t^2 f^2(x) - x^2 f^2(t)}{t - x} = 0$$

If f(x) = 1, then x is equal to :

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

8. If the system of equations

$x + y + z = 2$

$2x + 4y - z = 6$

$3x + 2y + \lambda z = \mu$

has infinitely many solutions, then :

(1) $\lambda - 2\mu = -5$ (2) $2\lambda - \mu = 5$

(3) $2\lambda + \mu = 14$ (4) $\lambda + 2\mu = 14$

9. The minimum value of $2^{\sin x} + 2^{\cos x}$ is :-

(1) $2^{1-\frac{1}{\sqrt{2}}}$ (2) $2^{-1+\sqrt{2}}$

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

10. $\int_{\pi/6}^{\pi/3} \tan^3 x \cdot \sin^2 3x (2\sec^2 x \cdot \sin^2 3x + 3\tan x \cdot \sin 6x) dx$

is equal to :

(1) $\frac{9}{2}$ (2) $-\frac{1}{9}$

(3) $-\frac{1}{18}$ (4) $\frac{7}{18}$

11. The circle passing through the intersection of the circles, $x^2 + y^2 - 6x = 0$ and $x^2 + y^2 - 4y = 0$, having its centre on the line, $2x - 3y + 12 = 0$, also passes through the point :

(1) (1, –3)

(2) (–1, 3)

(3) (–3, 1)

(4) (–3, 6)

12. The angle of elevation of a cloud C from a point P, 200 m above a still lake is 30º. If the angle of depression of the image of C in the lake from the point P is 60º, then PC (in m) is equal to :

(1) 400 (2) $400\sqrt{3}$

(3) 100 (4) $200\sqrt{3}$

13. If a and b are real numbers such that $(2 + \alpha)^4 = a + b\alpha$, where $\alpha = \frac{-1+i\sqrt{3}}{2}$, then $a + b$ is equal to :

(1) 57 (2) 33

(3) 24 (4) 9

14. In a game two players A and B take turns in throwing a pair of fair dice starting with player A and total of scores on the two dice, in each throw is noted. A wins the game if he throws a total of 6 before B throws a total of 7 and B wins the game if he throws a total of 7 before A throws a total of six The game stops as soon as either of the players wins. The probability of A winning the game is :

(1) $\frac{31}{61}$ (2) $\frac{5}{6}$

(3) $\frac{5}{31}$ (4) $\frac{30}{61}$

15. Let x = 4 be a directrix to an ellipse whose centre is at the origin and its eccentricity is $\frac{1}{2}$.

If P $(1, \beta)$, $\beta > 0$ is a point on this ellipse, then the equation of the normal to it at P is :-

(1) $7x - 4y = 1$ (2) $4x - 2y = 1$

(3) $4x - 3y = 2$ (4) $8x - 2y = 5$

16. Contrapositive of the statement:

'If a function f is differentiable at a, then it is also continuous at a', is :-

(1) If a function f is continuous at a, then it is not differentiable at a.

(2) If a function f is not continuous at a, then it is differentiable at a.

(3) If a function f is not continuous at a, then it is not differentiable at a.

(4) If a function f is continuous at a, then it is differentiable at a.

17. The area (in sq. units) of the largest rectangle ABCD whose vertices A and B lie on the x-axis and vertices C and D lie on the parabola, $y = x^2 - 1$ below the x-axis, is :

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

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

18. If for some positive integer n, the coefficients of three consecutive terms in the binomial expansion of $(1+x)^{n+5}$ are in the ratio 5 : 10 : 14, then the largest coefficient in this expansion is :-

(1) 792 (2) 252

(3) 462 (4) 330

19. If the perpendicular bisector of the line segment joining the points P (1, 4) and Q (k, 3) has y-intercept equal to –4, then a value of k is :-

(1) $\sqrt{15}$ (2) –2

(3) $\sqrt{14}$ (4) –4

20. Suppose the vectors x_1, x_2 and x_3 are the solutions of the system of linear equations, Ax = b when the vector b on the right side is equal to b_1, b_2 and b_3 respectively. If

$$x = \begin{bmatrix}1\\1\\1\end{bmatrix}, x_2 = \begin{bmatrix}0\\2\\1\end{bmatrix}, x_3 = \begin{bmatrix}0\\0\\1\end{bmatrix}, b_1 = \begin{bmatrix}1\\0\\0\end{bmatrix}$$

$b_2 = \begin{bmatrix}0\\2\\0\end{bmatrix}$ and $b_3 = \begin{bmatrix}0\\0\\2\end{bmatrix}$, then the determinant of A is equal to :-

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

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

21. A test consists of 6 multiple choice questions, each having 4 alternative answers of which only one is correct. The number of ways, in which a candidate answers all six questions such that exactly four of the answers are correct, is ____

22. Let PQ be a diameter of the circle $x^2+y^2=9$. If α and β are the lengths of the perpendiculars from P and Q on the straight line, x + y = 2 respectively, then the maximum value of $\alpha\beta$ is ____

23. Let {x} and [x] denote the fractional part of x and the greatest integer $\le$ x respectively of a real number x. If $\int_0^n \{x\}dx, \int_0^n [x]dx$ and $10(n^2 - n)$, ($n \in N$, $n > 1$) are three consecutive terms of a G.P., then n is equal to____

24. If $\vec{a} = 2\hat{i} + \hat{j} + 2\hat{k}$, then the value of $\left|\hat{i}\times(\vec{a}\times\hat{i})\right|^2 + \left|\hat{j}\times(\vec{a}\times\hat{j})\right|^2 + \left|\hat{k}\times(\vec{a}\times\hat{k})\right|^2$ is equal to ____

25. If the variance of the following frequency distribution :

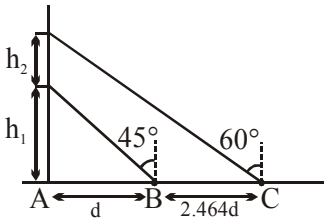
Class	: 10–20	20–30	30–40
Frequency :	2	x	2

is 50, then x is equal to ____

SET # 07

PHYSICS

1. A balloon is moving up in air vertically above a point A on the ground. When it is at a height h_1, a girl standing at a distance d (point B) from A (see figure) sees it at an angle 45° with respect to the vertical. When the balloon climbs up a further height h_2, it is seen at an angle 60° with respect to the vertical if the girl moves further by a distance 2.464 d (point C). Then the height h_2 is (given tan 30° = 0.5774) :



(1) d (2) 0.732d

(3) 1.464d (4) 0.464d

2. In a resonance tube experiment when the tube is filled with water up to height of 17.0 cm from bottom, it resonates with a given tuning fork. When the water level is raised the next resonance with the same tuning fork occurs at a height of 24.5 cm. If the velocity of sound in air is 330 m/s, the tuning fork frequency is:

(1) 1100 Hz (2) 3300 Hz

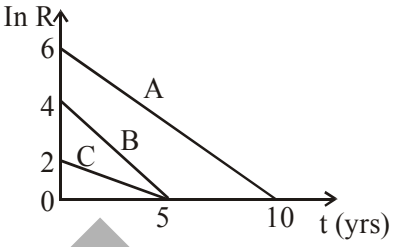
(3) 2200 Hz (4) 550 Hz

3. A helicopter reises from rest on the ground vertically upwards with a constant acceleration g. A food packet is dropped from the helicopter when it is a height h. The time taken by the packet to reach the ground is close to [g is the acceleration due to gravity] :

(1) $t = \sqrt{\frac{2h}{3g}}$ (2) $t = 1.8\sqrt{\frac{h}{g}}$

(3) $t = 3.4\sqrt{\left(\frac{h}{g}\right)}$ (4) $t = \frac{2}{3}\sqrt{\left(\frac{h}{g}\right)}$

4. Activities of three radioactive substances A, B and C are represented by the curves A, B and C, in the figure. Then their half-lives $T_{\frac{1}{2}}(A) : T_{\frac{1}{2}}(B) : T_{\frac{1}{2}}(C)$ are in the ratio :



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

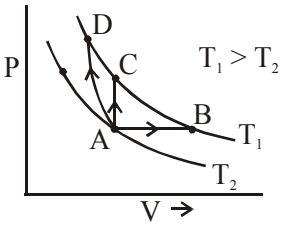
(3) 2 : 1 : 3 (4) 2 : 1 : 1

5. A hollow spherical shell at outer radius R floats just submerged under the water surface. The inner radius of the shell is r. If the specific gravity of the shell material is $\frac{27}{8}$ w.r.t. water, the value of r is :

(1) $\frac{4}{9}R$ (2) $\frac{8}{9}R$ (3) $\frac{1}{3}R$ (4) $\frac{2}{3}R$

6. Three different processes that can occur in an ideal monoatomic gas are shown in the P vs V diagram. The paths are labelled as A → B, A → C and A → D. The change in internal energies during these process are taken as E_{AB}, E_{AC} and E_{AD} and the workdone as W_{AB}, W_{AC} and W_{AD}.

The correct relation between these parameters are :



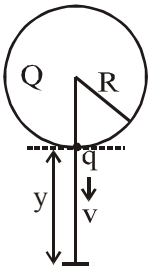
(1) $E_{AB} = E_{AC} = E_{AD}$, $W_{AB} > 0$, $W_{AC} = 0$, $W_{AD} > 0$

(2) $E_{AB} < E_{AC} < E_{AD}$, $W_{AB} > 0$, $W_{AC} > W_{AD}$

(3) $E_{AB} = E_{AC} < E_{AD}$, $W_{AB} > 0$, $W_{AC} = 0$, $W_{AD} < 0$

(4) $E_{AB} > E_{AC} > E_{AD}$, $W_{AB} < W_{AC} < W_{AD}$

7. A solid sphere of radius R carries a charge (Q + q) distributed uniformly over its volume. A very small point like piece of it of mass m gets detached from the bottom of the sphere and falls down vertically under gravity. This piece carries charge q. If it acquires a speed v when it has fallen through a vertical height y (see figure), then : (assume the remaining portion to be spherical).



(1) $v^2 = 2y\left[\frac{qQ}{4\pi\in_0 R(R+y)m} + g\right]$

(2) $v^2 = y\left[\frac{qQ}{4\pi\in_0 R^2 ym} + g\right]$

(3) $v^2 = 2y\left[\frac{qQR}{4\pi\in_0 (R+y)^3 m} + g\right]$

(4) $v^2 = y\left[\frac{qQ}{4\pi\in_0 R(R+y)m} + g\right]$

8. With increasing biasing voltage of a photodiode, the photocurrent magnitude :

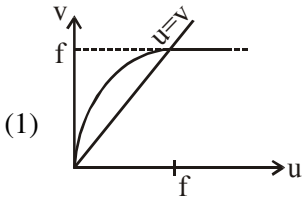
(1) increases initially and saturates finally

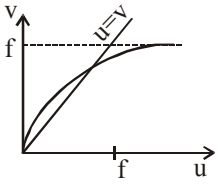
(2) increases initially and after attaining certain value, it decreases

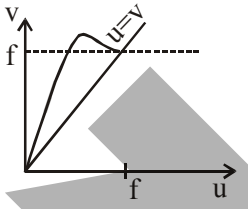
(3) increases linearly

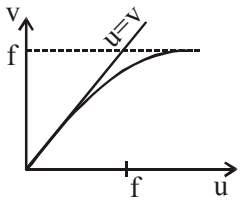
(4) remains constant

9. For a concave lens of focal length f, the relation between object and image distance u and v, respectively, from its pole can best be represented by (u = v is the reference line):

(1) 

(2) 

(3) 

(4) 

10. An electrical power line, having a total resistance of 2Ω, delivers 1 kW at 220 V. The efficiency of the transmission line is approximately:

(1) 72% (2) 96% (3) 91% (4) 85%

11. Assume that the displacement(s) of air is proportional to the pressure difference (Δp) created by a sound wave. Displacement(s) further depends on the speed of sound (v), density of air (ρ) and the frequency (f). If Δp~10Pa, v~300 m/s, p~1 kg/m^3 and f~1000Hz, then s will be the order of (take multiplicative constant to be 1)

(1) 10 mm (2) $\frac{3}{100}$ mm

(3) 1 mm (4) $\frac{1}{10}$ mm

12. A bullet of mass 5g, travelling with a speed of 210 m/s, strikes a fixed wooden target. One half of its kinetic energy is converted into heat in the bullet while the other half is converted into heat in the wood. The rise of temperature of the bullet if the specific heat of its material is 0.030 cal/(g–°C) (1 cal = 4.2 × 10^7 ergs) close to :

(1) 83.3°C (2) 87.5°C

(3) 119.2°C (4) 38.4°C

13. Number of molecules in a volume of 4 cm^3 of a perfect monoatomic gas at some temperature T and at a pressure of 2 cm of mercury is close to ? (Given, mean kinetic energy of a molecule (at T) is 4×10^{-14} erg, g = 980 cm/s^2, density of mercury = 13.6 g/cm^3)

(1) 5.8×10^{18} (2) 5.8×10^{16}

(3) 4.0×10^{18} (4) 4.0×10^{16}

14. A square loop of side 2a, and carrying current I, is kept in XZ plane with its centre at origin. A long wire carrying the same current I is placed parallel to the z-axis and passing through the point (0, b, 0), (b > > a). The magnitude of the torque on the loop about z-axis is given by:

(1) $\frac{2\mu_0 I^2 a^2}{\pi b}$ (2) $\frac{\mu_0 I^2 a^3}{2\pi b^2}$

(3) $\frac{\mu_0 I^2 a^2}{2\pi b}$ (4) $\frac{2\mu_0 I^2 a^3}{\pi b^2}$

15. A physical quantity z depends on four observables a, b, c and d, as $z = \frac{a^2 b^{\frac{2}{3}}}{\sqrt{c}\, d^3}$. The percentage of error in the measurement of a, b, c and d 2%, 1.5%, 4% and 2.5% respectively. The percentage of error in z is:

(1) 12.25% (2) 14.5%

(3) 16.5% (4) 13.5%

16. A galvanometer of resistance G is converted into a voltmeter of range 0 – 1V by connecting a resistance R_1 in series with it. The additional resistance that should be connected in series with R_1 to increase the range of the voltmeter to 0 – 2V will be :

(1) R_1 (2) R_1+G (3) R_1–G (4) G

17. A wheel is rotaing freely with an angular speed ω on a shaft. The moment of inertia of the wheel is I and the moment of inertia of the shaft is negligible. Another wheel of momet of inertia 3I initially at rest is suddenly coupled to the same shaft. The resultant fractional loss in the kinetic energy of the system is :

(1) 0 (2) $\frac{1}{4}$ (3) $\frac{3}{4}$ (4) $\frac{5}{6}$

18. The value of the acceleration due to gravity is g_1 at a height $h = \frac{R}{2}$ (R = radius of the earth) from the surface of the earth. It is again equal to g_1 at a depth d below the surface of the earth. The ratio $\left(\frac{d}{R}\right)$ equals :

(1) $\frac{7}{9}$ (2) $\frac{4}{9}$ (3) $\frac{1}{3}$ (4) $\frac{5}{9}$

19. An electron is constrained to move along the y-axis with a speed of 0.1 c (c is the speed of light) in the presence of electromagnetic wave, whose electric field is

$\vec{E} = 30\hat{j}\ \sin(1.5\times10^7 t - 5\times10^{-2} x) V/m$.

The maximum magnetic force experienced by the electron will be :

(given c = 3×10^8 ms^{-1} and electron charge = 1.6×10^{-19} C)

(1) 1.6×10^{-19} N (2) 4.8×10^{-19} N

(3) 3.2×10^{-18} N (4) 2.4×10^{-18} N

20. Two capacitors of capacitances C and 2C are charged to potential differences V and 2V, respectively. These are then connected in parallel in such a manner that the positive terminal of one is connected to the negative terminal of the other. The final energy of this configuration is:

(1) $\frac{9}{2}CV^2$ (2) $\frac{25}{6}CV^2$

(3) zero (4) $\frac{3}{2}CV^2$

21. Two concentric circular coils, C_1 and C_2, are placed in the XY plane. C_1 has 500 turns, and a radius of 1 cm. C_2 has 200 turns and radius of 20 cm. C_2 carries a time dependent current $I(t) = (5t^2 - 2t + 3)$ A where t is in s. The emf induced in C_1 (in mV), at the instant t = 1s is $\frac{4}{x}$. The value of x is ____.

22. A force $\vec{F}=\left(\hat{i}+2\hat{j}+3\hat{k}\right)N$ acts at a point $\left(4\hat{i}+3\hat{j}-\hat{k}\right)m$. Then the magnitude of torque about the point $\left(\hat{i}+2\hat{j}+\hat{k}\right)m$ will be $\sqrt{x}$ N-m. The value of x is _____.

23. A beam of electrons of energy E scatters from a target having atomic spacing of 1Å. The first maximum intensity occurs at θ = 60°. Then E (in eV) is _____.

(Planck constant h = 6.64 × 10^{-34} Js, 1eV = 1.6 × 10^{-19} J, electron mass m = 9.1 × 10^{-31} kg)

24. A particle of mass 200 MeV/c^2 collides with a hydrogen atom at rest. Soon after the collision the particle comes to rest, and the atom recoils and goes to its first excited state. The initial kinetic energy of the particle (in eV) is $\frac{N}{4}$. The value of N is :

(Given the mass of the hydrogen atom to be 1 GeV/c^2) _____.

25. A compound microscope consists of an objective lens of focal length 1cm and an eye piece of focal length 5 cm with a separation of 10 cm.

The distance between an object and the objective lens, at which the strain on the eye is minimum is $\frac{n}{40}$ cm. The value of n is ____.

CHEMISTRY

1. The equation that represents the water-gas shift reaction is :

(1) $CO(g) + H_2O(g) \xrightarrow[\text{Catalyst}]{673K} CO_2(g) + H_2(g)$

(2) $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270K} CO(g) + 3\,H_2(g)$

(3) $C(s) + H_2O(g) \xrightarrow{1270K} CO(g) + H_2(g)$

(4) $2C(s)+O_2(g)+4N_2(g) \xrightarrow{1273K} 2CO(g)+4N_2(g)$

2. Consider the following reaction

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$; ΔH^0 = +58 kJ

For each of the following cases (a, b), the direction in which the equilibrium shifts is:

(a) Temperature is decreased

(b) Pressure is increased by adding N_2 at constant T

(1) (a) towards reactant, (b) no change

(2) (a) towards product, (b) towards reactant

(3) (a) towards product, (b) no change

(4) (a) towards reactant, (b) towards product

3. The values of the crystal field stabilization energies for a high spin d^6 metal ion in octahedral and tetrahedral fields, respectively, are :

(1) –0.4 Δ_0 and –0.27 Δ_t

(2) –1.6 Δ_0 and –0.4 Δ_t

(3) –0.4 Δ_0 and –0.6 Δ_t

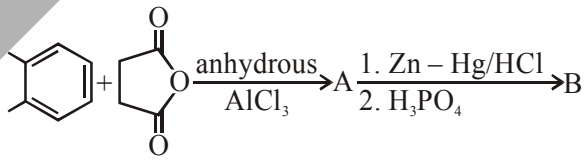
(4) –2.4 Δ_0 and –0.6 Δ_t

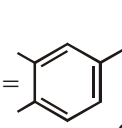
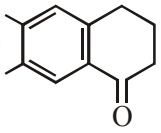
4. Which of the following is not an essential amino acid :

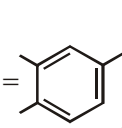
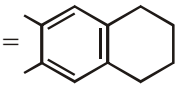
(1) Valine (2) Leucine

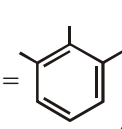
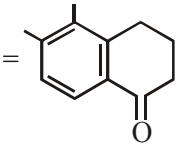
(3) Lysine (4) Tyrosine

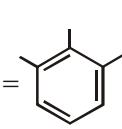
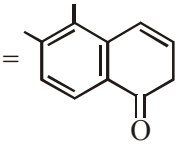
5. In the following reaction sequence the major products A and B are :



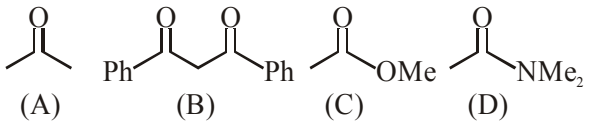
(1) A =  ; B = 

(2) A =  ; B = 

(3) A =  ; B = 

(4) A =  ; B = 

6. The increasing order of the acidity of the α-hydrogen of the following compounds is :



(A) (B) (C) (D)

(1) (C) < (A) < (B) < (D)

(2) (B) < (C) < (A) < (D)

(3) (A) < (C) < (D) < (B)

(4) (D) < (C) < (A) < (B)

7. An Ellingham diagram provides information about :

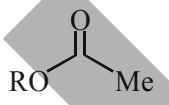
(1) the pressure dependence of the standard electrode potentials of reduction reactions involved in the extraction of metals.

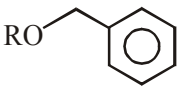
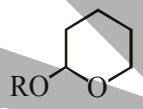
(2) the kinetics of the reduction process.

(3) the temperature dependence of the standard Gibbs energies of formation of some metal oxides.

(4) the conditions of pH and potential under which a species is thermodynamically stable.

8. Which of the following derivatives of alcohols is unstable in an aqueous base ?

(1) $RO - CMe_3$ (2) 

(3)  (4) 

9. The structure of PCl_5 in the solid state is

(1) square pyramidal

(2) tetrahedral $[PCl_4]^+$ and octahedral $[PCl_6]^-$

(3) square planar $[PCl_4]^+$ and octahedral $[PCl_6]^-$

(4) trigonal bipyramidal

10. The most appropriate reagent for conversion of C_2H_5CN into $CH_3CH_2CH_2NH_2$ is :

(1) $Na(CN)BH_3$ (2) $LiAlH_4$

(3) $NaBH_4$ (4) CaH_2

11. The difference between the radii of 3rd and 4th orbits of Li^{2+} is ΔR_1. The difference between the radii of 3rd and 4th orbits of He^+ is ΔR_2. Ratio $\Delta R_1 : \Delta R_2$ is :

(1) 8 : 3 (2) 3 : 2

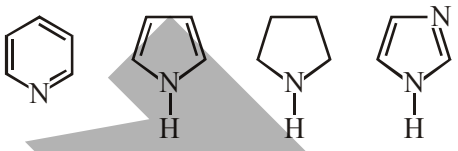
(3) 3 : 8 (4) 2 : 3

12. A flask contains a mixture of compounds A and B. Both compounds decompose by first-order kinetics. The half-lives for A and B are 300 s and 180 s, respectively. If the concentrations of A and B are equal initially, the time required for the concentration of A to be four times that of B(in s) : (Use ln 2 = 0.693)

(1) 180 (2) 120

(3) 300 (4) 900

13. The increasing order of basicity of the following compounds is



(A) (B) (C) (D)

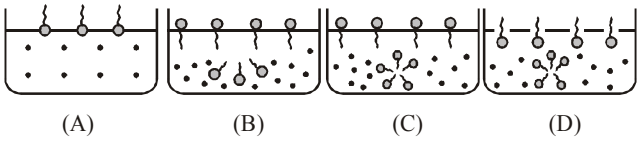
(1) (A) < (B) < (C) < (D)

(2) (B) < (A) < (C) < (D)

(3) (D) < (A) < (B) < (C)

(4) (B) < (A) < (D) < (C)

14. Identify the correct molecular picture showing that happens at the critical micellar concentration (CMC) of an aqueous solution of a surfactant (○ polar head; ∽ non-polar tail; • water).



(A) (B) (C) (D)

(1) (B) (2) (A) (3) (D) (4) (C)

15. If a person is suffering from the deficiency of nor-adrenaline, what kind of drug can be suggested ?

(1) Anti-inflammatory (2) Analgesic

(3) Antihistamine (4) Antidepressant

16. The correct electronic configuration and spin-only magnetic moment (BM) of Gd^{3+} (Z = 64), respectively, are

(1) $[Xe]5f^7$ and 8.9 (2) $[Xe]4f^7$ and 7.9

(3) $[Xe]5f^7$ and 7.9 (4) $[Xe]4f^7$ and 8.9

17. The condition that indicates a polluted environment is

(1) BOD value of 5 ppm

(2) eutrophication

(3) 0.03% of CO_2 in the atmosphere

(4) pH of rain water to be 5.6

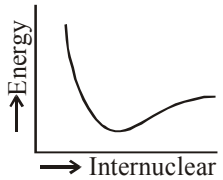
18. In the sixth period, the orbitals that are filled are

(1) 6s, 5f, 6d, 6p (2) 6s, 6p, 6d, 6f

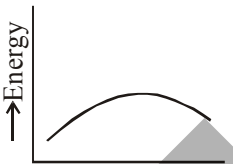
(3) 6s, 5d, 5f, 6p (4) 6s, 4f, 5d, 6p

19. The potential energy curve for the H_2 molecule as a function of internuclear distance is :

(1) 

(2) 

(3)

(4) 

20. A diatomic molecule X_2 has a body-centred cubic (bcc) structure with a cell edge of 300 pm. The density of the molecule is 6.17 g cm^{-3}. The number of molecules present in 200 g of X_2 is (Avogadro constant (N_A) = 6×10^{23} mol^{-1})

(1) 8 N_A (2) 40 N_A

(3) 4 N_A (4) 2 N_A

21. an oxidation-reduction reaction in which 3 electrons are transferred has a ΔG^o of 17.37 kJ mol^{-1} at 25°C. The value of E^o_{cell} (in V) is _____ $\times 10^{-2}$

(1 F = 96,500 C mol^{-1})

22. The minimum number of moles of O_2 required for complete combustion of 1 mole of propane and 2 moles of butane is _____.

23. The total number of coordination sites in ethylenediaminetetraacetate ($EDTA^{4-}$) is _____.

24. The number of chiral carbon(s) present in peptide, Ile-Arg-Pro, is _____.

25. A soft drink was bottled with a partial pressure of CO_2 of 3 bar over the liquid at room temperature. The partial pressure of CO_2 over the solution approaches a value of 30 bar when 44 g of CO_2 is dissolved in 1 kg of water at room temperature. The approximate pH of the soft drink is _____ $\times 10^{-1}$.

(First dissociation constant of $H_2CO_3 = 4.0 \times 10^{-7}$; log 2 = 0.3; density of the soft drink = 1 g mL^{-1})

MATHEMATICS

1. If $3^{2\sin 2\alpha - 1}$, 14 and $3^{4 - 2\sin 2\alpha}$ are the first three terms of an A.P. for some α, then the sixth term of this A.P. is :

(1) 66 (2) 65

(3) 81 (4) 78

2. If the function $f(x) = \begin{cases} k_1(x-\pi)^2 - 1, & x \le \pi \\ k_2 \cos x, & x > \pi \end{cases}$

is twice differentiable, then the ordered pair (k_1, k_2) is equal to :

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

(3) $\left(\frac{1}{2}, -1\right)$ (4) (1, 0)

3. If the common tangent to the parabolas, $y^2 = 4x$ and $x^2 = 4y$ also touches the circle, $x^2 + y^2 = c^2$, then c is equal to :

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

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

4. The negation of the Boolean expression $x \leftrightarrow \sim y$ is equivalent to :

(1) $(\sim x \wedge y) \vee (\sim x \wedge \sim y)$

(2) $(x \wedge \sim y) \vee (\sim x \wedge y)$

(3) $(x \wedge y) \vee (\sim x \wedge \sim y)$

(4) $(x \wedge y) \wedge (\sim x \vee \sim y)$

5. If the volume of a parallelopiped, whose coterminus edges are given by the vectors $\vec{a} = \hat{i} + \hat{j} + n\hat{k}$, $\vec{b} = 2\hat{i} + 4\hat{j} - n\hat{k}$ and $\vec{c} = \hat{i} + n\hat{j} + 3\hat{k}$ $(n \geq 0)$, is 158 cu. units, then :

(1) $\vec{a} \cdot \vec{c} = 17$ (2) $\vec{b} \cdot \vec{c} = 10$

(3) n = 7 (4) n = 9

6. If y = y(x) is the solution of the differential equation $\frac{5+e^x}{2+y} \cdot \frac{dy}{dx} + e^x = 0$ satisfying y(0) = 1, then a value of $y(\log_e 13)$ is :

(1) 1 (2) –1

(3) 2 (4) 0

7. A survey shows that 73% of the persons working in an office like coffee, whereas 65% like tea. If x denotes the percentage of them, who like both coffee and tea, then x cannot be:

(1) 63 (2) 38

(3) 54 (4) 36

8. The product of the roots of the equation $9x^2 - 18|x| + 5 = 0$, is

(1) $\frac{25}{9}$ (2) $\frac{25}{81}$

(3) $\frac{5}{27}$ (4) $\frac{5}{9}$

9. If $\int (e^{2x} + 2e^x - e^{-x} - 1)e^{(e^x + e^{-x})}dx$

$= g(x)e^{(e^x + e^{-x})} + c$, where c is a constant of integration, then g(0) is equal to :

(1) 2 (2) e^2

(3) e (4) 1

10. If the minimum and the maximum values of the function $f : \left[\frac{\pi}{4}, \frac{\pi}{2}\right] \to R$, defined by :

$$f(\theta) = \begin{vmatrix} -\sin^2\theta & -1-\sin^2\theta & 1 \\ -\cos^2\theta & -1-\cos^2\theta & 1 \\ 12 & 10 & -2 \end{vmatrix}$$

are m and M respectively, then the ordered pair (m, M) is equal to :

(1) (0, 4) (2) (–4, 4)

(3) $(0, 2\sqrt{2})$ (4) (–4, 0)

11. Let $\lambda \in R$. The system of linear equations

$2x_1 - 4x_2 + \lambda x_3 = 1$

$x_1 - 6x_2 + x_3 = 2$

$\lambda x_1 - 10x_2 + 4x_3 = 3$

is inconsistent for :

(1) exactly one negative value of λ.

(2) exactly one positive value of λ.

(3) every value of λ.

(4) exactly two values of λ.

12. If S is the sum of the first 10 terms of the series

$$\tan^{-1}\left(\frac{1}{3}\right) + \tan^{-1}\left(\frac{1}{7}\right) + \tan^{-1}\left(\frac{1}{13}\right) + \tan^{-1}\left(\frac{1}{21}\right) + \ldots,$$

then tan(S) is equal to :

(1) $\frac{5}{11}$ (2) $-\frac{6}{5}$

(3) $\frac{10}{11}$ (4) $\frac{5}{6}$

13. If the four complex numbers z, $\overline{z}$, $\overline{z} - 2\text{Re}(\overline{z})$ and $z - 2\text{Re}(z)$ represent the vertices of a square of side 4 units in the Argand plane, then |z| is equal to :

(1) 4 (2) 2

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

14. If the point P on the curve, $4x^2 + 5y^2 = 20$ is farthest from the point Q(0, –4), then PQ^2 is equal to :

(1) 21 (2) 36

(3) 48 (4) 29

15. The mean and variance of 7 observations are 8 and 16, respectively. If five observations are 2, 4, 10, 12, 14, then the absolute difference of the remaining two observations is :

(1) 2 (2) 4

(3) 3 (4) 1

16. If (a, b, c) is the image of the point (1, 2, –3) in the line, $\frac{x+1}{2} = \frac{y-3}{-2} = \frac{z}{-1}$, then $a + b + c$ is equal to

(1) –1 (2) 2

(3) 3 (4) 1

17. The value of $\int_{-\pi/2}^{\pi/2} \frac{1}{1+e^{\sin x}}\,dx$ is

(1) π (2) $\frac{3\pi}{2}$

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

18. If $2^{10} + 2^9 \cdot 3^1 + 2^8 \cdot 3^2 + \ldots + 2 \cdot 3^9 + 3^{10} = S - 2^{11}$, then S is equal to :

(1) $\frac{3^{11}}{2} + 2^{10}$ (2) $3^{11} - 2^{12}$

(3) 3^{11} (4) $2 \cdot 3^{11}$

19. If the co-ordinates of two points A and B are $(\sqrt{7}, 0)$ and $(-\sqrt{7}, 0)$ respectively and P is any point on the conic, $9x^2 + 16y^2 = 144$, then PA + PB is equal to :

(1) 8 (2) 6

(3) 16 (4) 9

20. If α is the positive root of the equation, $p(x) = x^2 - x - 2 = 0$, then $\lim\limits_{x \to \alpha^+} \frac{\sqrt{1-\cos(p(x))}}{x+\alpha-4}$ is equal to

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

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

21. Four fair dice are thrown independently 27 times. Then the expected number of times, at least two dice show up a three or a five, is ____.

22. If the line, $2x - y + 3 = 0$ is at a distance $\frac{1}{\sqrt{5}}$ and $\frac{2}{\sqrt{5}}$ from the lines $4x - 2y + \alpha = 0$ and $6x - 3y + \beta = 0$, respectively, then the sum of all possible values of α and β is _____

23. The natural number m, for which the coefficient of x in the binomial expansion of $\left(x^m + \frac{1}{x^2}\right)^{22}$ is 1540, is _____.

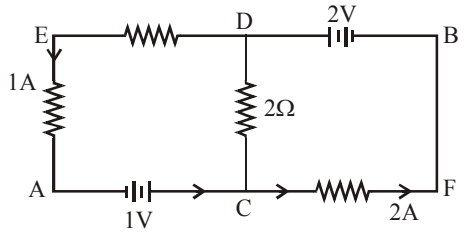
24. The number of words, with or without meaning, that can be formed by taking 4 letters at a time from the letters of the word 'SYLLABUS' such that two letters are distinct and two letters are alike, is _____.

25. Let $f(x) = x \cdot \left[\frac{x}{2}\right]$, for $-10 < x < 10$, where [t] denotes the greatest integer function. Then the number of points of discontinuity of f is equal to _____.

SET # 08

PHYSICS

1. In the circuit, given in the figure currents in different branches and value of one resistor are shown. Then potential at point B with respect to the point A is :



(1) +1V (2) – 1V (3) – 2V (4) +2V

2. A parallel plate capacitor has plate of length '*l*', width 'w' and separation of plates is 'd'. It is connected to a battery of emf V. A dielectric slab of the same thickness 'd' and of dielectric constant k = 4 is being inserted between the plates of the capacitor. At what length of the slab inside plates, will be energy stored in the capacitor be two times the initial energy stored?

(1) l / 4 (2) l / 2 (3) l / 3 (4) 2l / 3

3. Ten charges are placed on the circumference of a circle of radius R with constant angular separation between successive charges. Alternate charges 1, 3, 5, 7, 9 have charge (+q) each, while 2, 4, 6, 8, 10 have charge (–q) each. The potential V and the electric field E at the centre of the circle are respectively:

(Take V = 0 at infinity)

(1) $V = \frac{10q}{4\pi\in_0 R}; E = \frac{10q}{4\pi\in_0 R^2}$

(2) $V = 0, E = \frac{10q}{4\pi\in_0 R^2}$

(3) V = 0, E = 0

(4) $V = \frac{10q}{4\pi\in_0 R}; E = 0$

4. An iron rod of volume 10^{-3} m^3 and relative permeability 1000 is placed as core in a solenoid with 10 turns/cm. If a current of 0.5 A is passed through the solenoid, then the magnetic moment of the rod will be :

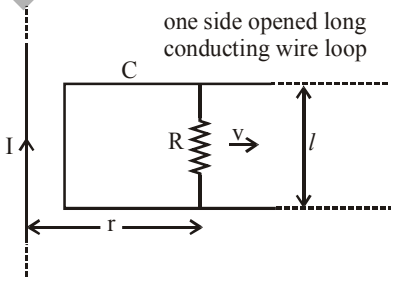
(1) 0.5×10^2 Am^2

(2) 50×10^2 Am^2

(3) 500×10^2 Am^2

(4) 5×10^2 Am^2

5. An infinitely long straight wire carrying current I, one side opened rectangular loop and a conductor C with a sliding connector are located in the same plane, as shown in the figure. The connector has length l and resistance R. It slides to the right with a velocity v. The resistance of the conductor and the self inductance of the loop are negligible. The induced current in the loop, as a function of separation r, between the connector and the straight wire is :



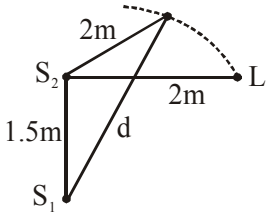
(1) $\frac{\mu_0}{\pi}\frac{Iv l}{Rr}$ (2) $\frac{\mu_0}{2\pi}\frac{Iv l}{Rr}$

(3) $\frac{2\mu_0}{\pi}\frac{Iv l}{Rr}$ (4) $\frac{\mu_0}{4\pi}\frac{Iv l}{Rr}$

6. The acceleration due to gravity on the earth's surface at the poles is g and angular velocity of the earth about the axis passing through the pole is ω. An object is weighed at the equator and at a height h above the poles by using a spring balance. If the weights are found to be same, then h is : (h<<R, where R is the radius of the earth)

(1) $\frac{R^2\omega^2}{8g}$ (2) $\frac{R^2\omega^2}{4g}$ (3) $\frac{R^2\omega^2}{g}$ (4) $\frac{R^2\omega^2}{2g}$

7. Two coherent sources of sound, S_1 and S_2, produce sound waves of the same wavelength, λ = 1 m, in phase. S_1 and S_2 are placed 1.5 m apart (see fig.) A listener, located at L, directly in front of S_2 finds that the intensity is at a minimum when he is 2m away from S_2. The listener moves away from S_1, keeping his distance from S_2 fixed. The adjacent maximum of intensity is observed when the listener is at a distance d from S_1. Then, d is :



(1) 12m (2) 3m (3) 5m (4) 2m

8. A driver in a car, approaching a vertical wall notices that the frequency of his car horn, has changed from 440 Hz to 480 Hz, when it gets reflected from the wall. If the speed of sound in air is 345 m/s, then the speed of the car is

(1) 36 km/hr (2) 24 km/hr

(3) 18 km/hr (4) 54 km/hr

9. In an adiabatic process, the density of a diatomic gas becomes 32 times its initial value. The final pressure of the gas is found to be n times the initial pressure. The value of n is:

(1) 326 (2) $\frac{1}{32}$ (3) 32 (4) 128

10. A radioactive nucleus decays by two different processes. The half life for the first process is 10 s and that for the second is 100s. the effective half life of the nucleus is close to:

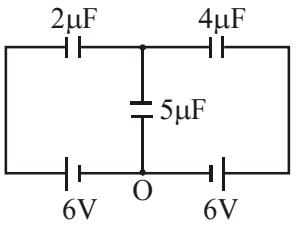
(1) 9 sec (2) 55 sec

(3) 6 sec (4) 12 sec

11. A ring is hung on a nail. It can oscillate, without slipping or sliding (i) in its plane with a time period T_1 and, (ii) back and forth in a direction perpendicular to its plane, with a period T_2. the ratio $\frac{T_1}{T_2}$ will be :

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

12. In the circuit shown, charge on the 5 μF capacitor is :



(1) 5.45 μC (2) 16.36 μC

(3) 10.90 μC (4) 18.00 μC

13. In an experiment to verify Stokes law, a small spherical ball of radius r and density ρ falls under gravity through a distance h in air before entering a tank of water. If the terminal velocity of the ball inside water is same as its velocity just before entering the water surface, then the value of h is proportional to :
(ignore viscosity of air)

(1) r (2) r^4 (3) r^3 (4) r^2

14. Two different wires having lengths L_1 and L_2, and respective temperature coefficient of linear expansion α_1 and α_2, are joined end-to-end. Then the effective temperature coefficient of linear expansion is :

(1) $4\frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}\frac{L_2L_1}{(L_2+L_1)^2}$ (2) $2\sqrt{\alpha_1\alpha_2}$

(3) $\frac{\alpha_1+\alpha_2}{2}$ (4) $\frac{\alpha_1L_1+\alpha_2L_2}{L_1+L_2}$

15. The quantities $x=\frac{1}{\sqrt{\mu_0 \in_0}}$, $y=\frac{E}{B}$ and $z=\frac{1}{CR}$ are defined where C-capacitance, R-Resistance, *l*-length, E-Electric field, B-magnetic field and $\in_0$, μ_0,-free space permittivity and permeability respectively. Then :

(1) Only x and y have the same dimension

(2) x, y and z have the same dimension

(3) Only x and z have the same dimension

(4) Only y and z have the same dimension

16. A galvanometer is used in laboratory for detecting the null point in electrical experiments. If, on passing a current of 6mA it produces a deflection of 2°, its figure of merit is close to :

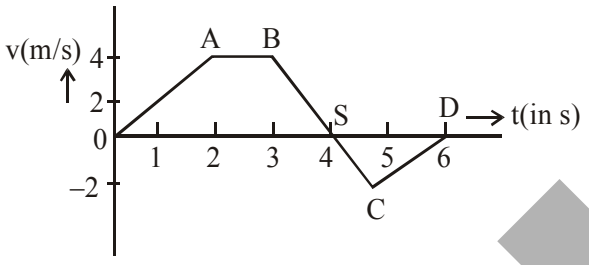
(1) 3×10^{-3} A/div.

(2) 333° A/div.

(3) 6×10^{-3} A/div.

(4) 666° A/div.

17. The velocity (v) and time (t) graph of a body in a straight line motion is shown in the figure. The point S is at 4.333 seconds. The total distance covered by the body in 6s is :



(1) 12m (2) $\frac{49}{4}$ m

(3) 11 m (4) $\frac{37}{3}$ m

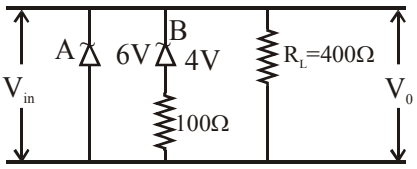
18. A spaceship in space sweeps stationary interplanetary dust. As a result, its mass increases at a rate $\frac{dM(t)}{dt} = bv^2(t)$, where v(t) is its instantaneous velocity. The instantaneous acceleration of the satellite is:

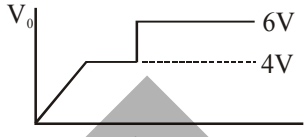
(1) $-\frac{2bv^3}{M(t)}$ (2) $-\frac{bv^3}{2M(t)}$

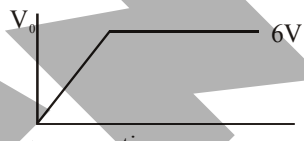
(3) $-bv^3(t)$ (4) $-\frac{bv^3}{M(t)}$

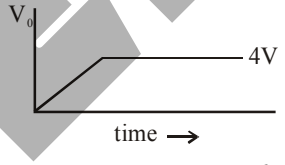
19. Two Zener diodes (A and B) having breakdown voltages of 6V and 4V respectively, are connected as shown in athe circuit below. The output voltage V_0 variation with input voltage linearly increasing with time, is given by :

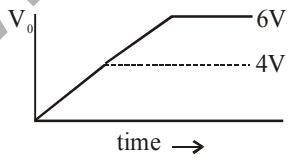
(V_{input} = 0V at t = 0) (figures are qualitative)



(1)


(2)


(3)


(4)


20. The correct match between the entries in column I and column II are :

I	II
Radiation	**Wavelength**
(a) Microwave	(i) 100m
(b) Gamma rays	(ii) 10^{-15} m
(c) A.M. radio waves	(iii) 10^{-10} m
(d) X-rays	(iv) 10^{-3} m

(1) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

(2) (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)

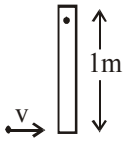
(3) (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)

(4) (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)

21. The surface of a metal is illuminated alternately with photons of energies E_1 = 4eV and E_2 = 2.5 eV respectively. The ratio of maximum speeds of the photoelectrons emitted in the two cases is 2. The work function of the metal in (eV) is _____.

22. Nitrogen gas is at 300°C temperature. The temperature (in K) at which the rms speed of a H_2 molecule would be equal to the rms speed of a nitrogen molecule, is _____.
(Molar mass of N_2 gas 28 g)

23. A thin rod of mass 0.9 kg and length 1m is suspended, at rest, from one end so that it can freely oscillate in the vertical plane. A particle of move 0.1 kg moving in a straight line with velocity 80 m/s hits the rod at its bottom most point and sticks to it (see figure). The angular speed (in rad/s) of the rod immediately after the collision will be _____.

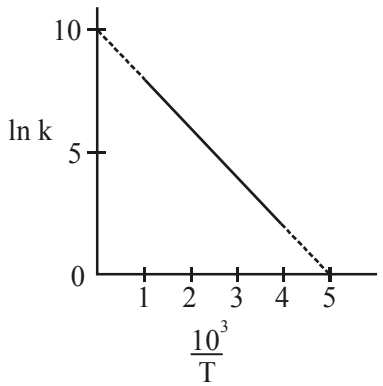


24. A body of mass 2kg is driven by an engine delivering a constant power 1J/s. The body starts from rest and moves in a straight line. After 9 seconds, the body has moved a distance (in m) _____.

25. A prism of angle A = 1° has a refractive index μ = 1.5. A good estimate for the minimum angle of deviation (in degrees) is close to N/10. Value of N is _____.

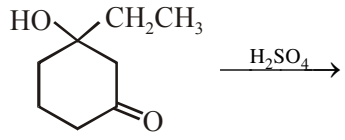
CHEMISTRY

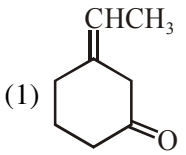
1. The rate constant (k) of a reaction is measured at different temperatures (T), and the data are plotted in the given figure. The activation energy of the reaction in kJ mol^{-1} is :
(R is gas constant)

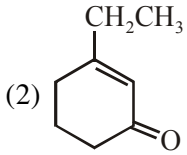


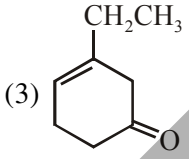
(1) 2R (2) R
(3) 1/R (4) 2/R

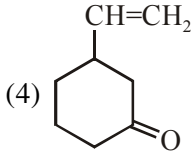
2. The major product of the following reaction is:



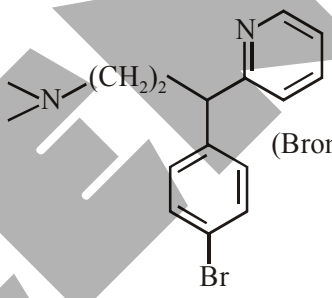
(1) 

(2) 

(3) 

(4) 

3. The following molecule acts as an :



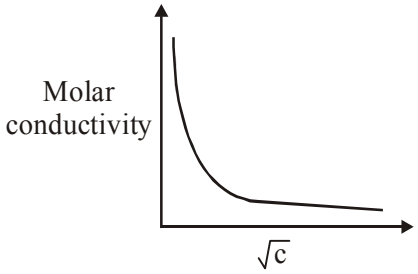
(Brompheniramine)

(1) Antiseptic (2) Anti-bacterial
(3) Anti-histamine (4) Anti-depressant

4. An element crystallises in a face-centred cubic (fcc) unit cell with cell edge a. The distance between the centres of two nearest octahedral voids in the crystal lattice is

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

5. The variation of molar conductivity with concentration of an electrolyte (X) in aqueous solution is shown in the given figure.



The electrolyte X is :

(1) CH_3COOH (2) KNO_3
(3) HCl (4) NaCl

6. The one that is NOT suitable for the removal of permanent hardness of water is :

(1) Treatment with sodium carbonate

(2) Calgon's method

(3) Clark's method

(4) Ion-exchange method

7. The correct statement about probability density (except at infinite distance from nucleus) is :

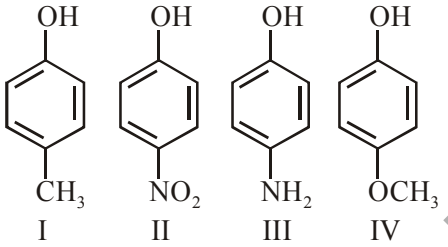
(1) It cn be negative for 2p orbital

(2) It can be zero for 3p orbital

(3) It can be zero for 1s orbital

(4) It can never be zero for 2s orbital

8. The increasing order of boiling points of the following compounds is :



(1) I < IV < III < II

(2) IV < I < II < III

(3) I < III < IV < II

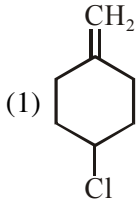
(4) III < I < II < IV

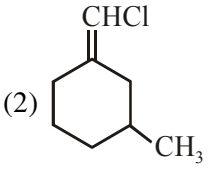
9. The compound that has the largest H–M–H bond angle (M=N, O, S, C), is :

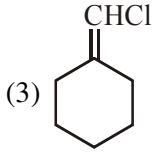
(1) H_2O (2) CH_4

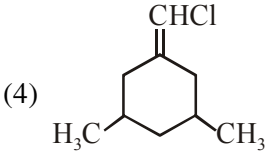
(3) NH_3 (4) H_2S

10. Among the following compounds, geometrical isomerism is exhibited by :

(1) 

(2) 

(3) 

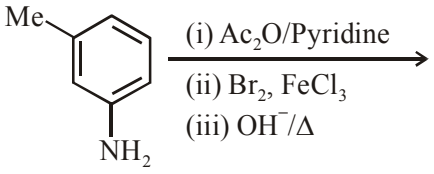
(4) 

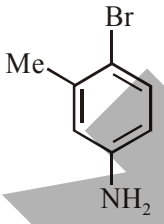
11. Which one of the following polymers is not obtained by condensation polymerisation?

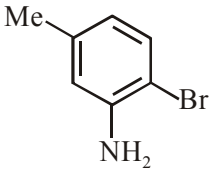
(1) Buna - N (2) Bakelite

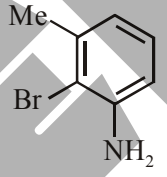
(3) Nylon 6 (4) Nylon 6, 6

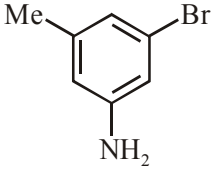
12. The final major product of the following reaction is :



(1) 

(2) 

(3) 

(4) 

13. Hydrogen peroxide, in the pure state, is :

(1) non-planar and almost colorless

(2) linear and almost colorless

(3) planar and blue in color

(4) linear and blue in color

14. Boron and silicon of very high purity can be obtained through :

(1) vapour phase refining

(2) electrolytic refining

(3) liquation

(4) zone refining

15. Lattice enthalpy and enthalpy of solution of NaCl are 788 kJ mol^{-1} and 4 kJ mol^{-1}, respectively. The hydration enthalpy of NaCl is :

(1) –780 kJ mol^{-1} (2) –784 kJ mol^{-1}

(3) 780 kJ mol^{-1} (4) 784 kJ mol^{-1}

16. Reaction of ammonia with excess Cl_2 gives :

(1) NH_4Cl and N_2

(2) NCl_3 and NH_4Cl

(3) NH_4Cl and HCl

(4) NCl_3 and HCl

17. The correct order of the ionic radii of O^{2-}, N^{3-}, F^-, Mg^{2+}, Na^+ and Al^{3+} is :

(1) $Al^{3+} < Na^+ < Mg^{2+} < O^{2-} < F^- < N^{3-}$

(2) $N^{3-} < O^{2-} < F^- < Na^+ < Mg^{2+} < Al^{3+}$

(3) $Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$

(4) $N^{3-} < F^- < O^{2-} < Mg^{2+} < Na^+ < Al^{3+}$

18. Consider the complex ions,

trans-$[Co(en)_2Cl_2]^+$ (A) and

cis-$[Co(en)_2Cl_2]^+$ (B). The correct statement regarding them is :

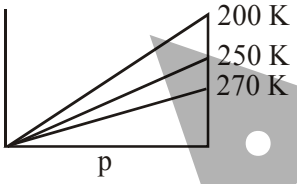
(1) both (A) and (B) can be optically active

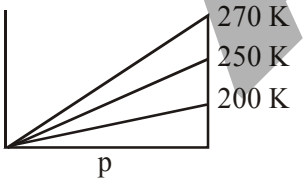
(2) both (A) and (B) cannot be optically active

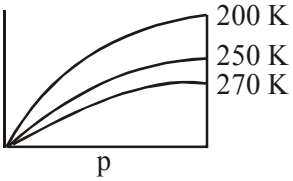
(3) (A) can be optically active, but (B) cannot be optically active

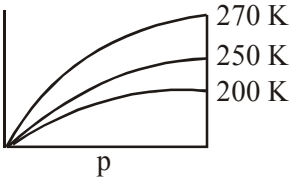
(4) (A) cannot be optically active, but (B) can be optically active

19. Adsorption of a gas follows Freundlich adsorption isotherm. If x is the mass of the gas adsorbed on mass m of the adsorbent, the correct plot of $\frac{x}{m}$ versus p is :

(1)


(2)


(3)


(4)


20. The major product formed in the following reaction is :

$CH_3CH = CHCH(CH_3)_2 \xrightarrow{HBr}$

(1) $CH_3\,CH_2\,CH_2\,C(Br)\,(CH_3)_2$

(2) $Br(CH_2)_3\,CH(CH_3)_2$

(3) $CH_3\,CH_2\,CH(Br)\,CH(CH_3)_2$

(4) $CH_3\,CH(Br)\,CH_2\,CH(CH_3)_2$

21. The number of chiral carbons present in sucrose is_____ .

22. For a dimerization reaction,

$2\,A(g) \rightarrow A_2(g)$

at 298 K, $\Delta U^\ominus$, = – 20kJ mol^{-1}, $\Delta S^\ominus$ = –30 J K^{-1} mol^{-1}, then the $\Delta G^\ominus$ will be _____J.

23. For a reaction $X + Y \rightleftharpoons 2Z$, 1.0 mol of X, 1.5 mol of Y and 0.5 mol of Z were taken in a 1 L vessel and allowed to react. At equilibrium, the concentration of Z was 1.0 mol L^{-1}. The equilibrium constant of the reaction is _____$\frac{x}{15}$. The value of x is _____ .

24. The volume, in mL, of 0.02 M $K_2Cr_2O_7$ solution required to react with 0.288 g of ferrous oxalate in acidic medium is_____.

(Molar mass of Fe = 56 g mol^{-1})

25. Considering that $\Delta_0 > P$, the magnetic moment (in BM) of $[Ru(H_2O)_6]^{2+}$ would be_____ .

MATHEMATICS

1. If the system of linear equations

$x + y + 3z = 0$

$x + 3y + k^2z = 0$

$3x + y + 3z = 0$

has a non-zero solution (x, y, z) for some $k \in R$, then $x + \left(\frac{y}{z}\right)$ is equal to :

(1) 9 (2) –3

(3) –9 (4) 4

2. If α and β are the roots of the equation, $7x^2 - 3x - 2 = 0$, then the value of $\frac{\alpha}{1-\alpha^2} + \frac{\beta}{1-\beta^2}$ is equal to :

(1) $\frac{27}{16}$ (2) $\frac{1}{24}$ (3) $\frac{27}{32}$ (4) $\frac{3}{8}$

3. If the sum of the first 20 terms of the series $\log_{(7^{1/2})} x + \log_{(7^{1/3})} x + \log_{(7^{1/4})} x + \ldots$ is 460, then x is equal to :

(1) $7^{46/21}$ (2) $7^{1/2}$ (3) e^2 (4) 7^2

4. $\lim\limits_{x\to 0} \dfrac{x\left(e^{\left(\sqrt{1+x^2+x^4}-1\right)/x}-1\right)}{\sqrt{1+x^2+x^4}-1}$

(1) does not exist. (2) is equal to $\sqrt{e}$.

(3) is equal to 0. (4) is equal to 1.

5. If the sum of the second, third and fourth terms of a positive term G.P. is 3 and the sum of its sixth, seventh and eighth terms is 243, then the sum of the first 50 terms of this G.P. is :

(1) $\dfrac{2}{13}(3^{50}-1)$ (2) $\dfrac{1}{26}(3^{50}-1)$

(3) $\dfrac{1}{13}(3^{50}-1)$ (4) $\dfrac{1}{26}(3^{49}-1)$

6. The value of $\left(\dfrac{-1+i\sqrt{3}}{1-i}\right)^{30}$ is :

(1) 2^{15} i (2) -2^{15} (3) -2^{15} i (4) 6^5

7. The derivative of $\tan^{-1}\left(\dfrac{\sqrt{1+x^2}-1}{x}\right)$ with respect to $\tan^{-1}\left(\dfrac{2x\sqrt{1-x^2}}{1-2x^2}\right)$ at $x = \dfrac{1}{2}$ is :

(1) $\dfrac{\sqrt{3}}{12}$ (2) $\dfrac{\sqrt{3}}{10}$

(3) $\dfrac{2\sqrt{3}}{5}$ (4) $\dfrac{2\sqrt{3}}{3}$

8. The area (in sq. units) of the region $A = \{(x, y) : (x-1)[x] \le y \le 2\sqrt{x}, 0 \le x \le 2\}$, where [t] denotes the greatest integer function, is :

(1) $\dfrac{8}{3}\sqrt{2}-\dfrac{1}{2}$ (2) $\dfrac{8}{3}\sqrt{2}-1$

(3) $\dfrac{4}{3}\sqrt{2}-\dfrac{1}{2}$ (4) $\dfrac{4}{3}\sqrt{2}+1$

9. If the length of the chord of the circle, $x^2 + y^2 = r^2$ ($r > 0$) along the line, $y - 2x = 3$ is r, then r^2 is equal to :

(1) $\dfrac{9}{5}$ (2) $\dfrac{12}{5}$ (3) 12 (4) $\dfrac{24}{5}$

10. If $x = 1$ is a critical point of the function $f(x) = (3x^2 + ax - 2 - a)e^x$, then :

(1) $x = 1$ is a local minima and $x = -\dfrac{2}{3}$ is a local maxima of f.

(2) $x = 1$ is a local maxima and $x = -\dfrac{2}{3}$ is a local minima of f.

(3) $x = 1$ and $x = -\dfrac{2}{3}$ are local minima of f.

(4) $x = 1$ and $x = -\dfrac{2}{3}$ are local maxima of f.

11. If the mean and the standard deviation of the data 3, 5, 7, a, b are 5 and 2 respectively, then a and b are the roots of the equation :

(1) $2x^2 - 20x + 19 = 0$

(2) $x^2 - 10x + 19 = 0$

(3) $x^2 - 10x + 18 = 0$

(4) $x^2 - 20x + 18 = 0$

12. If $a + x = b + y = c + z + 1$, where a, b, c, x, y, z are non-zero distinct real numbers, then $\begin{vmatrix} x & a+y & x+a \\ y & b+y & y+b \\ z & c+y & z+c \end{vmatrix}$ is equal to :

(1) 0 (2) $y(a - b)$

(3) $y(b - a)$ (4) $y(a - c)$

13. If $\int \dfrac{\cos\theta}{5+7\sin\theta-2\cos^2\theta}\, d\theta = A \log_e |B(\theta)| + C$, where C is a constant of integration, then $\dfrac{B(\theta)}{A}$ can be :

(1) $\dfrac{2\sin\theta+1}{5(\sin\theta+3)}$ (2) $\dfrac{2\sin\theta+1}{\sin\theta+3}$

(3) $\dfrac{5(\sin\theta+3)}{2\sin\theta+1}$ (4) $\dfrac{5(2\sin\theta+1)}{\sin\theta+3}$

14. If the line y = mx + c is a common tangent to the hyperbola $\frac{x^2}{100}-\frac{y^2}{64}=1$ and the circle $x^2 + y^2 = 36$, then which one of the following is true?

(1) 5m = 4 (2) $4c^2 = 369$

(3) $c^2 = 369$ (4) 8m + 5 = 0

15. There are 3 sections in a question paper and each section contains 5 questions. A candidate has to answer a total of 5 questions, choosing at least one question from each section. Then the number of ways, in which the candidate can choose the questions, is :

(1) 1500 (2) 2255

(3) 3000 (4) 2250

16. If for some $\alpha \in R$, the lines

$L_1 : \frac{x+1}{2}=\frac{y-2}{-1}=\frac{z-1}{1}$ and

$L_2 : \frac{x+2}{\alpha}=\frac{y+1}{5-\alpha}=\frac{z+1}{1}$ are coplanar, then the line L_2 passes through the point :

(1) (–2, 10, 2) (2) (10, 2, 2)

(3) (10, –2, –2) (4) (2, –10, –2)

17. Let y = y(x) be the solution of the differential equation $\cos x\frac{dy}{dx} + 2y \sin x = \sin 2x$, $x \in \left(0, \frac{\pi}{2}\right)$. If $y(\pi/3) = 0$, then $y(\pi/4)$ is equal to :

(1) $\sqrt{2}-2$ (2) $\frac{1}{\sqrt{2}} - 1$

(3) $2 - \sqrt{2}$ (4) $2 + \sqrt{2}$

18. Which of the following points lies on the tangent to the curve $x^4e^y + 2\sqrt{y+1} = 3$ at the point (1, 0) ?

(1) (2, 2) (2) (–2, 6)

(3) (–2, 4) (4) (2, 6)

19. The statement $(p \to (q \to p)) \to (p \to (p \vee q))$ is:

(1) a contradiction

(2) equivalent to $(p \wedge q) \vee (\sim q)$

(3) a tautology

(4) equivalent to $(p \vee q) \wedge (\sim p)$

20. If $L = \sin^2\left(\frac{\pi}{16}\right) - \sin^2\left(\frac{\pi}{8}\right)$ and

$M = \cos^2\left(\frac{\pi}{16}\right) - \sin^2\left(\frac{\pi}{8}\right)$, then :

(1) $M=\frac{1}{2\sqrt{2}}+\frac{1}{2}\cos\frac{\pi}{8}$

(2) $L=\frac{1}{4\sqrt{2}}-\frac{1}{4}\cos\frac{\pi}{8}$

(3) $M=\frac{1}{4\sqrt{2}}+\frac{1}{4}\cos\frac{\pi}{8}$

(4) $L=-\frac{1}{2\sqrt{2}}+\frac{1}{2}\cos\frac{\pi}{8}$

21. In a bombing attack, there is 50% chance that a bomb will hit the target. At least two independent hits are required to destroy the target completely. Then the minimum number of bombs, that must be dropped to ensure that there is at least 99% chance of completely destroying the target, is _____.

22. Let A = {a, b, c} and B = {1, 2, 3, 4}. Then the number of elements in the set $C = \{f : A \to B | 2 \in f(A)$ and f is not one-one$\}$ is _____.

23. The coefficient of x^4 in the expansion of $(1 + x + x^2 + x^3)^6$ in powers of x, is _____.

24. If the lines x + y = a and x – y = b touch the curve $y = x^2 - 3x + 2$ at the points where the curve intersects the x-axis, then $\frac{a}{b}$ is equal to_____.

25. Let the vectors $\vec{a}, \vec{b}, \vec{c}$ be such that $|\vec{a}| = 2, |\vec{b}| = 4$ and $|\vec{c}| = 4$. If the projection of $\vec{b}$ on $\vec{a}$ is equal to the projection of $\vec{c}$ on $\vec{a}$ and $\vec{b}$ is perpendicular to $\vec{c}$, then the value of $|\vec{a} + \vec{b} - \vec{c}|$ is _____.

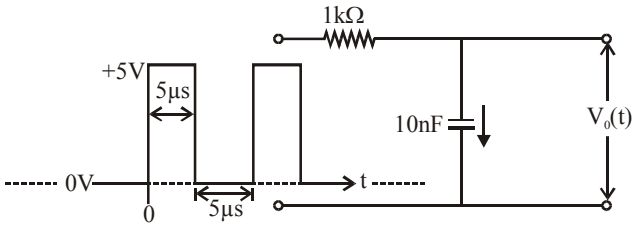
SET # 09

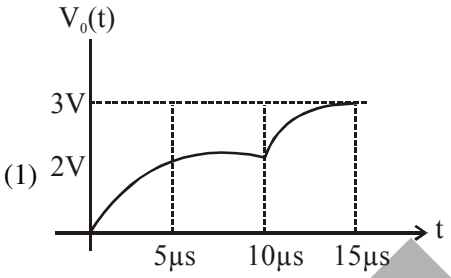
PHYSICS

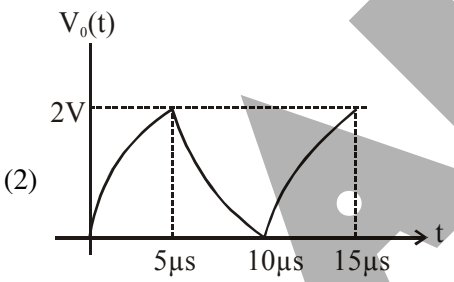
1. A satellite is in an elliptical orbit around a planet P. It is observed that the velocity of the satellite when it is farthest from the planet is 6 times less than that when it is closest to the planet. The ratio of distances between the satellite and the planet at closest and farthest points is :

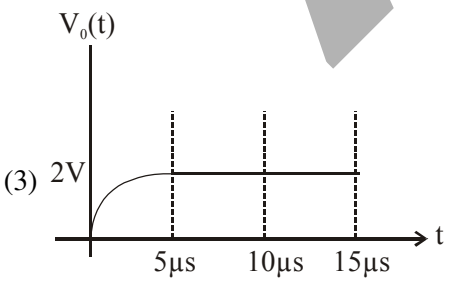
(1) 1 : 6 (2) 3 : 4 (3) 1 : 3 (4) 1 : 2

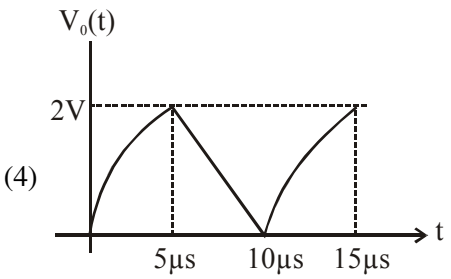
2. For the given input voltage waveform $V_{in}(t)$, the output voltage waveform $V_D(t)$, across the capacitor is correctly depicted by:



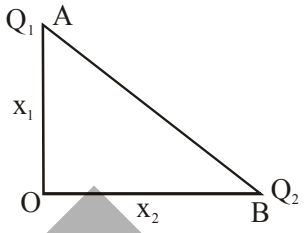
(1)


(2)


(3)


(4)


3. Charges Q_1 and Q_2 arc at points A and B of a right angle triangle OAB (see figure). The resultant electric field at point O is perpendicular to the hypotenuse, then Q_1/Q_2 is proportional to :



(1) $\frac{x_2^2}{x_1^2}$ (2) $\frac{x_1^3}{x_2^3}$ (3) $\frac{x_1}{x_2}$ (4) $\frac{x_2}{x_1}$

4. A screw gauge has 50 divisions on its circular scale. The circular scale is 4 units ahead of the pitch scale marking, prior to use. Upon one complete rotation of the circular scale, a displacement of 0.5 mm is noticed on the pitch scale. The nature of zero error involved, and the least count of the screw gauge, are respectively :

(1) Negative, 2 μm

(2) Positive, 10 μm

(3) Positive, 0.1 μm

(4) Positive, 0.1 mm

5. An object of mass m is suspended at the end of a massless wire of length L and area of cross-section, A. Young modulus of the material of the wire is Y. If the mass is pulled down slightly its frequency of oscillation along the vertical direction is:

(1) $f = \frac{1}{2\pi}\sqrt{\frac{YA}{mL}}$ (2) $f = \frac{1}{2\pi}\sqrt{\frac{YL}{mA}}$

(3) $f = \frac{1}{2\pi}\sqrt{\frac{mA}{YL}}$ (4) $f = \frac{1}{2\pi}\sqrt{\frac{mL}{YA}}$

6. A particle of charge q and mass m is moving with a velocity $-\upsilon\hat{i}(\upsilon \neq 0)$ towards a large screen placed in the Y-Z plane at a distance d. If there is a magnetic field $\vec{B} = B_0\hat{k}$, the minimum value of υ for which the particle will not hit the screen is:

(1) $\frac{qdB_0}{2m}$ (2) $\frac{qdB_0}{m}$

(3) $\frac{2qdB_0}{m}$ (4) $\frac{qdB_0}{3m}$

7. An insect is at the bottom of a hemispherical ditch of radius 1 m. It crawls up the ditch but starts slipping after it is at height h from the bottom. If the coefficient of friction between the ground and the insect is 0.75, then h is :
($g = 10ms^{-2}$)

(1) 0.80 m (2) 0.60 m

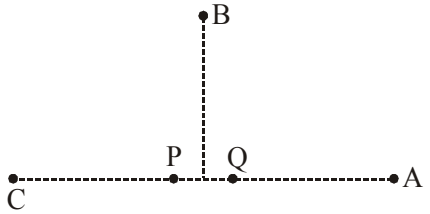
(3) 0.45 m (4) 0.20 m

8. A clock has a continuously moving second's hand of 0.1 m length. The average acceleration of the tip of the hand (in units of ms^{-2}) is of the order of:

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

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

9. In the figure below, P and Q are two equally intense coherent sources emitting radiation of wavelength 20 m. The separation between P and Q is 5 m and the phase of P is ahead of that of Q by 90°. A, B and C are three distinct points of observation, each equidistant from the midpoint of PQ. The intensities of radiation at A, B, C will be in the ratio:



(1) 0 : 1 : 2 (2) 4 : 1 : 0

(3) 0 : 1 : 4 (4) 2 : 1 : 0

10. An electron, a doubly ionized helium ion (He^{++}) and a proton are having the same kinetic energy. The relation between their respective de-Broglie wavelengths λ_e, $\lambda_{He^{++}}$ and λ_P is:

(1) $\lambda_e < \lambda_P < \lambda_{He^{++}}$ (2) $\lambda_e < \lambda_{He^{++}} = \lambda_P$

(3) $\lambda_e > \lambda_{He^{++}} > \lambda_P$ (4) $\lambda_e > \lambda_P > \lambda_{He^{++}}$

11. An electron is moving along + x direction with a velocity of 6×10^6 ms^{-1}. It enters a region of uniform electric field of 300 V/cm pointing along + y direction. The magnitude and direction of the magnetic field set up in this region such that the electron keeps moving along the x direction will be:

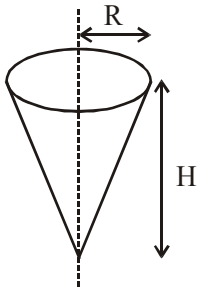
(1) 5×10^{-3} T, along +z direction

(2) 3×10^{-4} T, along –z direction

(3) 3×10^{-4} T, along +z direction

(4) 5×10^{-3} T, along –z direction

12. Shown in the figure is a hollow icecream cone (it is open at the top). If its mass is M, radius of its top, R and height, H, then its moment of inertia about its axis is:



(1) $\frac{MR^2}{2}$ (2) $\frac{MH^2}{3}$

(3) $\frac{MR^2}{3}$ (4) $\frac{M(R^2+H^2)}{4}$

13. An AC circuit has R = 100 Ω, C = 2 μF and L = 80 mH, connected in series. The quality factor of the circuit is :

(1) 0.5 (2) 2

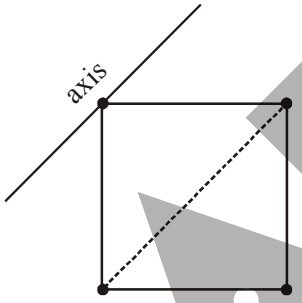
(3) 20 (4) 400

14. If the potential energy between two molecules is given by $U=\frac{A}{r^6}+\frac{B}{r^{12}}$, then at equilibrium, separation between molecules, and the potential energy are :

(1) $\left(\frac{B}{A}\right)^{1/6}, 0$ (2) $\left(\frac{B}{2A}\right)^{1/6}, -\frac{A^2}{2B}$

(3) $\left(\frac{2B}{A}\right)^{1/6}, -\frac{A^2}{4B}$ (4) $\left(\frac{2B}{A}\right)^{1/6}, -\frac{A^2}{2B}$

15. Four point masses, each of mass m, are fixed at the corners of a square of side ℓ. The square is rotating with angular frequency ω, about an axis passing through oneof the corners of the square and parallel to its diagonal, as shown in the figure. The angular momentum of the square about this axis is:



(1) $2m\ell^2\omega$ (2) $3m\ell^2\omega$

(3) $m\ell^2\omega$ (4) $4m\ell^2\omega$

16. You are given that Mass of $^{7}_{3}Li$ = 7.0160 u,

Mass of $^{4}_{2}He$ = 4.0026 u

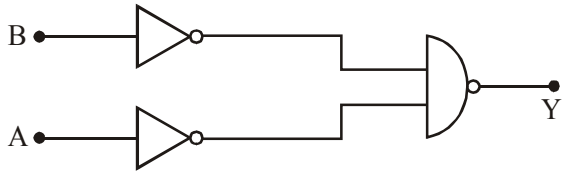
and Mass of $^{1}_{1}H$ = 1.0079 u.

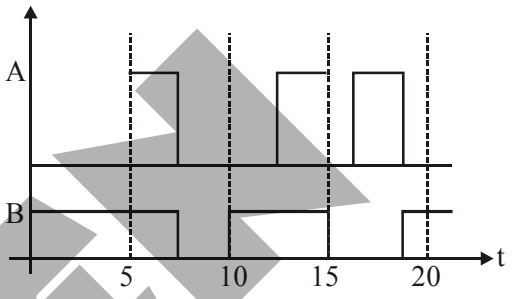
When 20 g of $^{7}_{3}Li$ is converted into $^{4}_{2}He$ by proton capture, the energy liberated, (in kWh), is: [Mass of nudeon = 1 GeV/c^2]

(1) 8×10^6 (2) 1.33×10^6

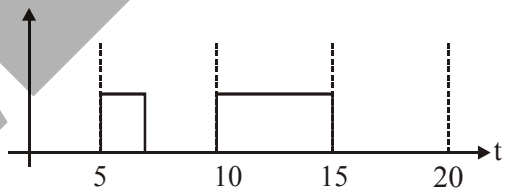
(3) 6.82×10^5 (4) 4.5×10^5

17. Identify the correct output signal Y in the given combination of gates (as shown) for the given inputs A and B.

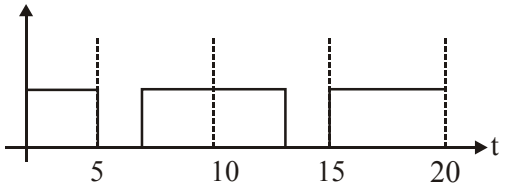




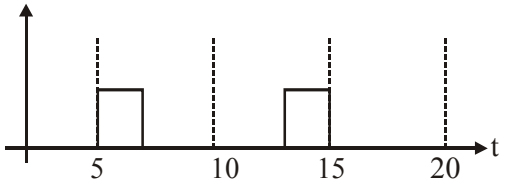
(1)



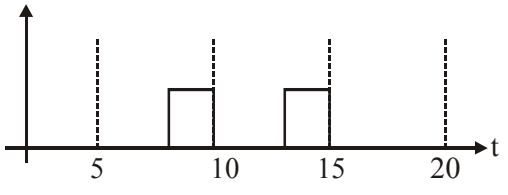
(2)



(3)



(4)



18. Molecules of an ideal gas are known to have three translational degrees of freedom and two rotational degrees of freedom. The gas is maintained at a temperature of T. The total internal energy, U of a mole of this gas, and the value of $\gamma\left(=\frac{C_P}{C_v}\right)$ given, respectively, by:

(1) $U=\frac{5}{2}RT$ and $\gamma=\frac{6}{5}$ (2) $U = 5RT$ and $\gamma=\frac{7}{5}$

(3) $U = 5RT$ and $\gamma=\frac{6}{5}$ (4) $U=\frac{5}{2}RT$ and $\gamma=\frac{7}{5}$

19. A point like object is placed at a distance of 1m in front of a convex lens of focal length 0.5 m. A plane mirror is placed at a distance of 2 m behind the lens. The position and nature of the final image formed by the system is :

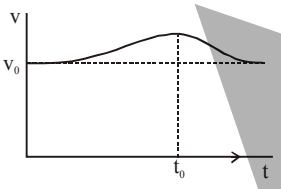
(1) 1 m from the mirror, virtual

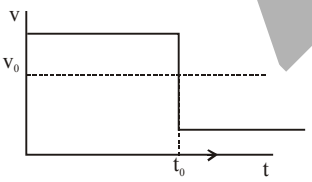
(2) 1 m from the mirror, real

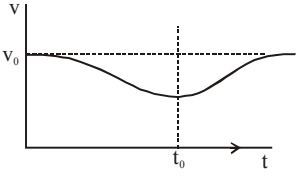
(3) 2.6 m from the mirror, real

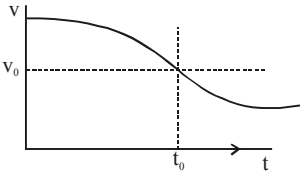
(4) 2.6 m from the mirror, virtual

20. A sound source S is moving along a straight track with speed v, and is emitting sound of frequency v_0 (see figure). An observer is standing at a finite distance, at the point O, from the track. The time variation of frequency heard by the observer is best represented by :
(t_0 represents the instant when the distance between the source and observer is minimum)

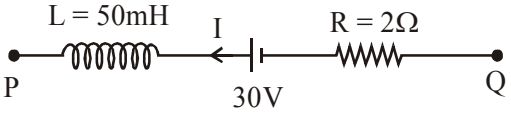
(1)


(2)


(3)


(4)


21. A part of a complete circuit is shown in the figure. At some instant, the value of current I is 1 A and it is decreasing at a rate of 10^2A s^{-1}. The value of the potential difference $V_P - V_Q$, (in volts) at that instant, is.



22. Two bodies of the same mass are moving with the same speed, but in different directions in a plane. They have a completely inelastic collision and move together thereafter with a final speed which is half of their initial speed. The angle between the initial velocities of the two bodies (in degree) is.

23. Suppose that intensity of a laser is $\left(\frac{315}{\pi}\right)W/m^2$. The rms electric field, in units of V/m associated with this source is close to the nearest integer is

($\in_0 = 8.86 \times 10^{-12}$ C^2 Nm^{-2}; $c = 3 \times 10^8$ ms^{-1})

24. The density of a solid metal sphere is determined by measuring its mass and its diameter. The maximum error in the density of the sphere is $\left(\frac{x}{100}\right)\%$. If the relative errors in measuring the mass and the diameter are 6.0% and 1.5% respectively, the value of x is .

25. Initially a gas of diatomic molecules is contained in a cylinder of volume V_1 at a pressure P_1 and temperature 250 K. Assuming that 25% of the molecules get dissociated causing a change in number of moles. The pressure of the resulting gas at temperature 2000 K, when contained in a volume $2V_1$ is given by P_2. The ratio P_2/P_1 is.

CHEMISTRY

1. The set that contains atomic number of only transition element is -

(1) 21, 32, 53, 64 (2) 21, 25, 42, 72

(3) 9, 17, 34, 38 (4) 37, 42, 50, 64

2. The lanthanoid that does NOT show +4 oxidation state is

(1) Dy (2) Eu (3) Ce (4) Tb

3. The INCORRECT statement is :

(1) bronze is an alloy of copper and tin.

(2) brass is an alloy of copper and nickel

(3) cast iron is used to manufacture wrought iron.

(4) german silver is an alloy of zinc, copper and nickel

4. The correct statement with respect to dinitrogen is :

(1) liquid dinitrogen is not used in cryosurgery.

(2) it can be used as an inert diluent for reactive chemicals.

(3) it can combine with dioxygen at 25°C

(4) N_2 is paramagnetic in nature.

5. A solution of two components containing n_1 moles of the 1st component and n_2 moles of the 2nd component is prepared. M_1 and M_2 are the molecular weights of component 1 and 2 respectively. If d is the density of the solution in g mL^{-1}, C_2 is the molarity and x_2 is the mole fraction of the 2nd component, then C_2 can be expressed as :

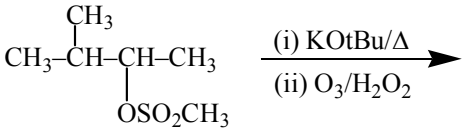
(1) $C_2 = \dfrac{1000x_2}{M_1 + x_2(M_2 - M_1)}$

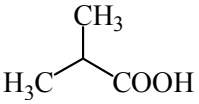
(2) $C_2 = \dfrac{dx_2}{M_2 + x_2(M_2 - M_1)}$

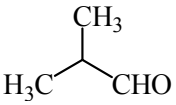
(3) $C_2 = \dfrac{dx_1}{M_2 + x_2(M_2 - M_1)}$

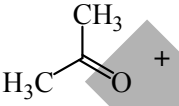
(4) $C_2 = \dfrac{1000dx_2}{M_1 + x_2(M_2 - M_1)}$

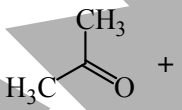
6. The major products of the following reaction are :



(1)  + HCOOH

(2)  + HCHO

(3)  + CH_3CHO

(4)  + CH_3COOH

7. Kraft temperature is the temperature

(1) below which the formation of micelles takes place.

(2) below which the aqueous solution of detergents starts freezing.

(3) above which the formation of micelles takes place.

(4) above which the aqueous solution of detergents starts boiling.

8. Consider the Assertion and Reason given below.

Assertion (A) : Ethene polymerized in the presence of Ziegler Natta Catalyst at high temperature and pressure is used to make buckets and dustbins.

Reason (R): High density polymers are closely packed and are chemically inert. Choose the correct answer from the following :

(1) (A) is correct but (R) is wrong.

(2) (A) and (R) both are wrong.

(3) Both (A) and (R) are correct and (R) is the correct explanation of (A).

(4) Both (A) and (R) are correct but (R) is not the correct explanation of (A).

9. The species that has a spin only magnetic moment of 5.9 BM, is -

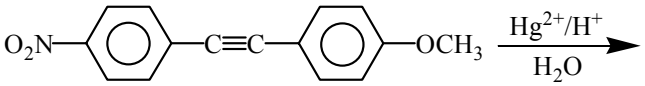
(1) $Ni(CO)_4(T_d)$

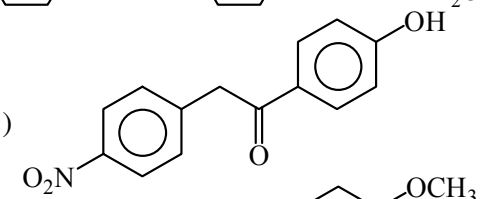
(2) $[MnBr_4]^{2-}(T_d)$

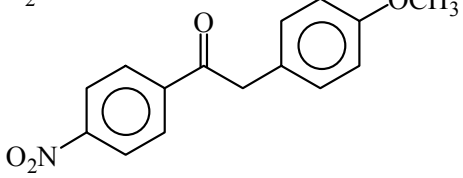
(3) $[NiCl_4]^{2-}(T_d)$

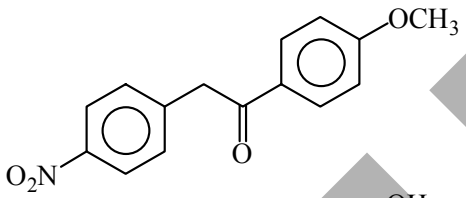
(4) $[Ni(CN)_4]^{2-}$ (square planar)

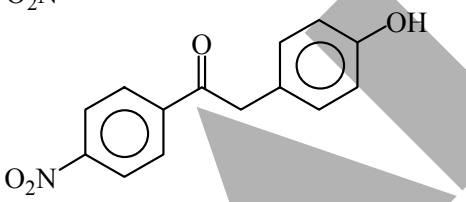
10. The major product obtained from the following reaction is -



(1) 

(2) 

(3) 

(4) 

11. For the reaction :

$$Fe_2N(s) + \frac{3}{2}H_2(g) \rightleftharpoons 2Fe(s) + NH_3(g)$$

(1) $K_C = K_P(RT)$ (2) $K_C = K_P(RT)^{-1/2}$

(3) $K_C = K_P(RT)^{-3/2}$ (4) $K_C = K_P(RT)^{1/2}$

12. Arrange the following solutions is the decreasing order of pOH :

(A) 0.01 M HC1

(B) 0.01 M NaOH

(C) 0.01 M CH_3COONa

(D) 0.01 M NaCl

(1) (B) > (C) > (D) > (A)

(2) (A) > (C) > (D) > (B)

(3) (B) > (D) > (C) > (A)

(4) (A) > (D) > (C) > (B)

13. The presence of soluble fluoride ion upto 1 ppm concentration in drinking water, is :

(1) harmful to bones

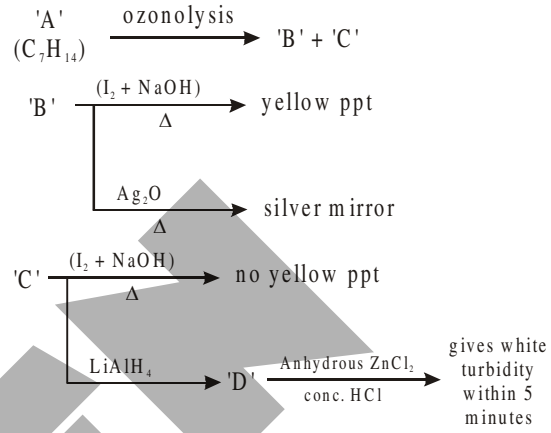
(2) harmful for teeth

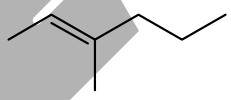
(3) safe for teeth

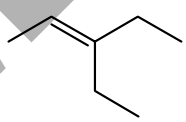
(4) harmful to skin

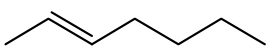
14. Consider the following reactions :

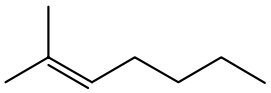
'A' is -



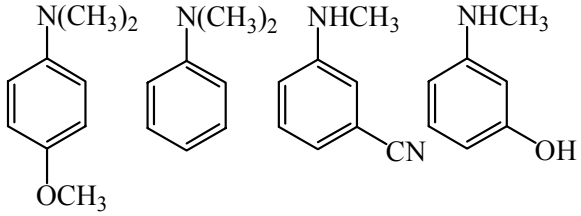
(1) 

(2) 

(3) 

(4) 

15. The increasing order of pK_b values of the following compounds is -



I II III IV

(1) I < II < IV < III (2) II < IV < III < I

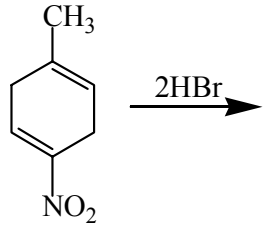
(3) II < I < III < IV (4) I < II < III < IV

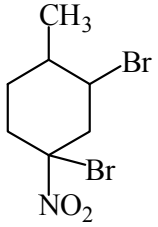
16. Among the sulphates of alkaline earth metals, the solubilities of $BeSO_4$ and $MgSO_4$ in water, respectively, are:

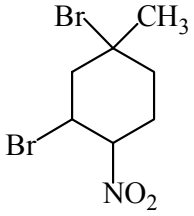
(1) high and high (2) poor and poor

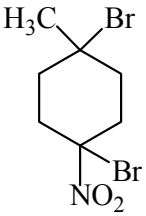
(3) high and poor (4) poor and high

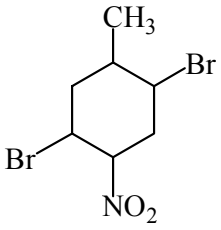
17. The major product of the following reaction is



(1) 

(2) 

(3) 

(4) 

18. The variation of equilibrium constant with temperature is given below :

Temperature	**Equilibrium constant**
T_1 = 25ºC	K_1 = 100
T_2 = 100ºC	K_2 = 100

The values of ΔH^o, ΔG^o at T_1 and ΔG^o at T_2 (in kJ mol^{-1}) respectively, are close to

[Use R = 8.314 $JK^{-1}mol^{-1}$]

(1) 0.64, –5.71 and –14.29

(2) 28.4, –7.14 and –5.71

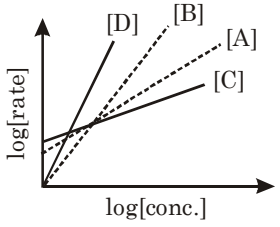
(3) 28.4, –5.71 and –14.29

(4) 0.64, –7.14 and –5.71

19. Consider the following reactions :

$A \rightarrow P1$; $B \rightarrow P2$; $C \rightarrow P3$; $D \rightarrow P4$

The order of the above reactions are a, b, c, and d, respectively. The following graph is obtained when log [rate] vs. log[conc] are plotted:



Among the following , the correct sequence for the order of the reactions is:

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

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

20. Which of the following compound shows geometrical isomerism

(1) 2-methylpent-2-ene

(2) 4-methylpent-l-ene

(3) 4-methylpent-2-ene

(4) 2-methylpent-l-ene

21. In an estimation of bromine by Carius method, 1.6 g of an organic compound gave 1.88 g of AgBr. The mass percentage of bromine in the compound is _____

(Atomic mass, Ag=108, Br = 80 g mol^{-1})

22. The elevation of boiling point of 0.10 m aqueous $CrCl_3.xNH_3$ solution is two times that of 0.05m aqueous $CaCl_2$ solution. The value of x is____.

[Assume 100% ionisation of the complex and $CaCl_2$, coordination number of Cr as 6, and that all NH_3 molecules are present inside the coordination sphere]

23. A spherical balloon of radius 3 cm containing helium gas has a pressure of 48×10^{-3} bar. At the same temperature, the pressure, of a spherical balloon of radius 12 cm containing the same amount of gas will be_____$\times 10^{-6}$ bar.

24. The number of CI = O bonds in perchloric acid is, "_____"

25. Potassium chlorate is prepared by the electrolysis of KCl in basic solution

$6OH^- + Cl^- \rightarrow ClO_3^- + 3H_2O + 6e^-$

If only 60% of the current is utilized in the reaction, the time (rounded to the nearest hour) required to produce 10 g of $KClO_3$ using a current of 2 A is_____.

(Given : F = 96,500 C mol^{-1} molar mass of $KClO_3$=122 $gmol^{-1}$)

MATHEMATICS

1. Which of the following points lies on the locus of the foot of perpendicular drawn upon any tangent to the ellipse, $\frac{x^2}{4}+\frac{y^2}{2}=1$ from any of its foci ?

(1) $\left(-1,\sqrt{3}\right)$ (2) $\left(-1,\sqrt{2}\right)$

(3) $\left(-2,\sqrt{3}\right)$ (4) (1,2)

2. Two families with three members each and one family with four members are to be seated in a row. In how many ways can they be seated so that the same family members are not separated ?

(1) 2!3!4! (2) $(3!)^3.(4!)$

(3) $(3!)^2.(4!)$ (4) $3!(4!)^3$

3. $\lim\limits_{x\to 1}\left(\frac{\int_0^{(x-1)^2} t\cos\left(t^2\right)dt}{(x-1)\sin(x-1)}\right)$

(1) does not exist (2) is equal to $\frac{1}{2}$

(3) is equal to 1 (4) is equal to $-\frac{1}{2}$

4. If {p} denotes the fractional part of the number p, then $\left\{\frac{3^{200}}{8}\right\}$, is equal to

(1) $\frac{1}{8}$ (2) $\frac{5}{8}$ (3) $\frac{3}{8}$ (4) $\frac{7}{8}$

5. The values of λ and μ for which the system of linear equations

$x + y + z = 2$; $x + 2y + 3z = 5$;

$x + 3y + \lambda z = \mu$

has infinitely many solutions are, respectively

(1) 5 and 7 (2) 6 and 8

(3) 4 and 9 (4) 5 and 8

6. The area (in sq. units) of the region $A = \{(x,y) : |x| + |y| \le 1, 2y^2 \ge |x|\}$ is :

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

7. Out of 11 consecutive natural numbers if three numbers are selected at random (without repetition), then the probability that they are in A.P. with positive common difference, is :

(1) $\frac{15}{101}$ (2) $\frac{5}{101}$ (3) $\frac{5}{33}$ (4) $\frac{10}{99}$

8. If $\sum_{i=1}^{n}\left(x_i-a\right)=n$ and $\sum_{i=1}^{n}\left(x_i-a\right)^2=na$, $(n,a>1)$ then the standard deviation of n observations $x_1,x_2,....,x_n$ is

(1) $n\sqrt{a-1}$ (2) $\sqrt{a-1}$

(3) a – 1 (4) $\sqrt{n(a-1)}$

9. Let L_1 be a tangent to the parabola $y^2 = 4(x + 1)$ and L_2 be a tangent to the parabola $y^2 = 8(x + 2)$ such that L_1 and L_2 intersect at right angles. Then L_1 and L_2 meet on the straight line:-

(1) x + 3 = 0 (2) x + 2y = 0

(3) 2x + 1 = 0 (4) x + 2 = 0

10. The negation of the Boolean expression $p\vee(\sim p\wedge q)$ is equivalent to :

(1) $\sim p\vee\sim q$ (2) $\sim p\vee q$

(3) $\sim p\wedge\sim q$ (4) $p\wedge\sim q$

11. If $f(x + y) = f(x)\, f(y)$ and $\sum_{x=1}^{\infty} f(x)=2, x, y\in N$, where N is the set of all natural numbers, then the value of $\frac{f(4)}{f(2)}$ is

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

12. The general solution of the differential equation $\sqrt{1+x^2+y^2+x^2y^2}+xy\frac{dy}{dx}=0$ is :

(where C is a constant of integration)

(1) $\sqrt{1+y^2}+\sqrt{1+x^2}=\frac{1}{2}\log_e\left(\frac{\sqrt{1+x^2}+1}{\sqrt{1+x^2}-1}\right)+C$

(2) $\sqrt{1+y^2}-\sqrt{1+x^2}=\frac{1}{2}\log_e\left(\frac{\sqrt{1+x^2}+1}{\sqrt{1+x^2}-1}\right)+C$

(3) $\sqrt{1+y^2}+\sqrt{1+x^2}=\frac{1}{2}\log_e\left(\frac{\sqrt{1+x^2}-1}{\sqrt{1+x^2}+1}\right)+C$

(4) $\sqrt{1+y^2}-\sqrt{1+x^2}=\frac{1}{2}\log_e\left(\frac{\sqrt{1+x^2}-1}{\sqrt{1+x^2}+1}\right)+C$

13. A ray of light coming from the point $\left(2,2\sqrt{3}\right)$ is incident at an angle 30° on the line x=l at the point A. The ray gets reflected on the line x = 1 and meets x-axis at the point B. Then, the line AB passes through the point:

(1) $\left(3,-\frac{1}{\sqrt{3}}\right)$ (2) $\left(3,-\sqrt{3}\right)$

(3) $\left(4,-\frac{\sqrt{3}}{2}\right)$ (4) $\left(4,-\sqrt{3}\right)$

14. Let a,b,c,d and p be any non zero distinct real numbers such that $(a^2 + b^2 + c^2)p^2 - 2(ab + bc + cd)p + (b^2 + c^2 + d^2) = 0$. Then :

(1) a,c,p are in G.P. (2) a,c,p are in A.P.

(3) a,b,c,d are in G.P. (4) a,b,c,d are in A.P.

15. If $I_1 = \int_0^1 \left(1-x^{50}\right)^{100} dx$ and $I_2 = \int_0^1 \left(1-x^{50}\right)^{101} dx$ such that $I_2 = \alpha I_1$ then α equals to

(1) $\frac{5050}{5051}$ (2) $\frac{5050}{5049}$ (3) $\frac{5049}{5050}$ (4) $\frac{5051}{5050}$

16. The position of a moving car at time t is given by $f(t) = at^2 + bt + c$, $t > 0$, where a, b and c are real numbers greater than 1. Then the average speed of the car over the time interval $[t_1,t_2]$ is attained at the point :

(1) $a(t_2 - t_1) + b$ (2) $(t_2 - t_1)/2$

(3) $2a(t_1 + t_2) + b$ (4) $(t_1 + t_2)/2$

17. The region represented by $\{z = x + iy \in C : |z| - Re(z) \le 1\}$ is also given by the inequality :

(1) $y^2 \ge x + 1$ (2) $y^2 \ge 2(x + 1)$

(3) $y^2 \le x + \frac{1}{2}$ (4) $y^2 \le 2\left(x+\frac{1}{2}\right)$

18. If α and β be two roots of the equation $x^2 - 64x + 256 = 0$.

Then the value of $\left(\frac{\alpha^3}{\beta^5}\right)^{\frac{1}{8}} + \left(\frac{\beta^3}{\alpha^5}\right)^{\frac{1}{8}}$ is

(1) 1 (2) 3r

(3) 4 (4) 2

19. The shortest distance between the lines $\frac{x-1}{0} = \frac{y+1}{-1} = \frac{z}{1}$ and $x + y + z + 1 = 0$, $2x - y + z + 3 = 0$ is :

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

20. Let m and M be respectively the minimum and maximum values of

$$\begin{vmatrix} \cos^2 x & 1+\sin^2 x & \sin 2x \\ 1+\cos^2 x & \sin^2 x & \sin 2x \\ \cos^2 x & \sin^2 x & 1+\sin 2x \end{vmatrix}.$$ Then the ordered pair (m,M) is equal to

(1) (–3,–1) (2) (–4,–1)

(3) (1,3) (4) (–3,3)

21. Let AD and BC be two vertical poles at A and B respectively on a horizontal ground. If AD = 8 m, BC = 11 m and AB = 10 m; then the distance (in meters) of a point M on AB from the point A such that $MD^2 + MC^2$ is minimum is_.

22. The angle of elevation of the top of a hill from a point on the horizontal plane passing through the foot of the hill is found to be 45°. After walking a distance of 80 meters towards the top, up a slope inclined at an angle of 30° to the horizontal plane, the angle of elevation of the top of the hill becomes 75°. Then the height of the hill (in meters) is_.

23. Set A has m elements and Set B has n elements. If the total number of subsets of A is 112 more than the total number of subsets of B, then the value of m.n is _.

24. If $\vec{a}$ and $\vec{b}$ are unit vectors, then the greatest value of $\sqrt{3}\left|\vec{a}+\vec{b}\right| + \left|\vec{a}-\vec{b}\right|$ is _.

25. Let $f : R \to R$ be defined as

$$f(x) = \begin{cases} x^5 \sin\left(\frac{1}{x}\right) + 5x^2 & , \quad x < 0 \\ 0 & , \quad x = 0 \\ x^5 \cos\left(\frac{1}{x}\right) + \lambda x^2 & , \quad x > 0 \end{cases}$$. The value of λ for which $f''(0)$ exists, is _.

SET # 10

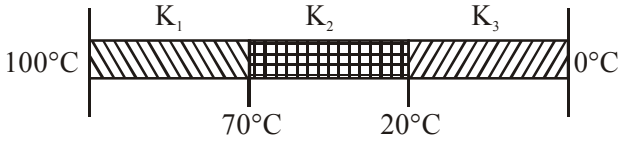
PHYSICS

1. Two planets have masses M and 16 M and their radii are a and 2a, respectively. The separation between the centres of the planets is 10a. A body of mass m is fired from the surface of the larger planet towards the smaller planet along the line joining their centres. For the body to be able to reach at the surface of smaller planet, the minimum firing speed needed is :

(1) $\sqrt{\frac{GM^2}{ma}}$ (2) $\frac{3}{2}\sqrt{\frac{5GM}{a}}$

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

2. Three rods of identical cross-section and lengths are made of three different materials of thermal conductivity K_1, K_2, and K_3, respectively. They are joined together at their ends to make a long rod (see figure). One end of the long rod is maintained at 100°C and the other at 0°C (see figure). If the joints of the rod are at 70°C and 20°C in steady state and there is no loss of energy from the surface of the rod, the correct relationship between K_1, K_2 and K_3 is :



(1) $K_1 : K_3 = 2 : 3$; $K_2 : K_3 = 2 : 5$

(2) $K_1 < K_2 < K_3$

(3) $K_1 : K_2 = 5 : 2$; $K_1 : K_3 = 3 : 5$

(4) $K_1 > K_2 > K_3$

3. For a plane electromagnetic wave, the magnetic field at a point x and time t is

$$\vec{B}(x,t) = \left[1.2\times10^{-7}\sin(0.5\times10^3 x + 1.5\times10^{11}t)\hat{k}\right]T$$

The instantaneous electric field $\vec{E}$ corresponding to $\vec{B}$ is :

(speed of light c = 3 × 10^8 ms^{-1})

(1) $\vec{E}(x,t) = \left[36\sin(0.5\times10^3 x + 1.5\times10^{11}t)\hat{k}\right]\frac{V}{m}$

(2) $\vec{E}(x,t) = \left[-36\sin(0.5\times10^3 x + 1.5\times10^{11}t)\hat{j}\right]\frac{V}{m}$

(3) $\vec{E}(x,t) = \left[36\sin(1\times10^3 x + 0.5\times10^{11}t)\hat{j}\right]\frac{V}{m}$

(4) $\vec{E}(x,t) = \left[36\sin(1\times10^3 x + 1.5\times10^{11}t)\hat{j}\right]\frac{V}{m}$

4. A double convex lens has power P and same radii of curvature R of both the surfaces. The radius of curvature of a surface of a plano-convex lens made of the same material with power 1.5 P is:

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

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

5. A circuit to verify Ohm's law uses ammeter and voltmeter in series or parallel connected correctly to the resistor. In the circuit :

(1) ammeter is always connected series and voltmeter in parallel.

(2) Both, ammeter and voltmeter mast be connected in series.

(3) Both ammeter and voltmeter must be connected in parallel.

(4) ammeter is always used in parallel and voltmeter is series.

6. A particle moving in the xy plane experiences a velocity dependent force $\vec{F} = k(v_y\hat{i} + v_x\hat{j})$, where v_x and v_y are the x and y components of its velocity $\vec{v}$. If $\vec{a}$ Ls the acceleration of the particle, then which of the following statements is true for the particle ?

(1) quantity $\vec{v}\cdot\vec{a}$ is constant in time.

(2) kinetic energy of particle is constant in time.

(3) quantity $\vec{v}\times\vec{a}$ is constant in lime.

(4) $\vec{F}$ arises due to a magnetic field.

7. Consider the force F on a charge 'q' due to a uniformly charged spherical shell of radius R carrying charge Q distributed uniformly over it. Which one of the following statements is true for F, if 'q' is placed at distance r from the centre of the shell ?

(1) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for r > R

(2) $\frac{1}{4\pi\varepsilon_0}\frac{qQ}{R^2} > F > 0$ for r < R

(3) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for all r

(4) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{R^2}$ for r < R

8. Given the masses of various atomic particles m_p = 1.0072u, m_n = 1.0087u, m_e = 0.000548u, $m_{\bar{\nu}}$ = 0, m_d = 2.0141u, where p ≡ proton, n ≡ neutron, e ≡ electron, $\bar{\nu}$ ≡ antineutrino and d ≡ deuteron. Which of the following process is allowed by momentum and energy conservation ?

(1) $n + p \rightarrow d + \gamma$

(2) $e^+ + e^- \rightarrow \gamma$

(3) $n + n \rightarrow$ deuterium atom
(electron bound to the nucleus)

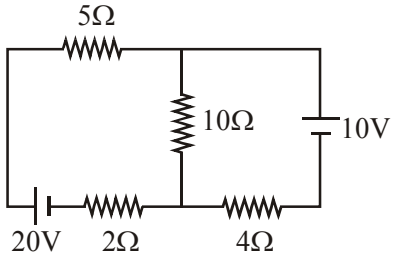
(4) $p \rightarrow n + e^+ + \bar{\nu}$

9. Two identical electric point dipoles have dipole moments $\vec{p}_1 = p\hat{i}$ and $\vec{p}_2 = -p\hat{i}$ and are held on the x axis at distance 'a' from each other. When released, they move along the x-axis with the direction of their dipole moments remaining unchanged. If the mass of each dipole is'm', their speed when they arc infinitely far apart is:

(1) $\frac{p}{a}\sqrt{\frac{1}{\pi\varepsilon_0 ma}}$ (2) $\frac{p}{a}\sqrt{\frac{3}{2\pi\varepsilon_0 ma}}$

(3) $\frac{p}{a}\sqrt{\frac{1}{2\pi\varepsilon_0 ma}}$ (4) $\frac{p}{a}\sqrt{\frac{2}{\pi\varepsilon_0 ma}}$

10. In the figure shown, the current in the 10 V battery is close to :



(1) 0.36 A from negative to positive terminal.

(2) 0.71 A from positive to negative terminal.

(3) 0.21 A from positive to negative terminal.

(4) 0.42 A from positive to negative terminal.

11. The linear mass density of a thin rod AB of length L varies from A to B as $\lambda(x) = \lambda_0\left(1 + \frac{x}{L}\right)$, where x is the distance from A. If M is the mass of the rod then its moment of inertia about an axis passing through A and perpendicular to the rod is:

(1) $\frac{5}{12}ML^2$ (2) $\frac{3}{7}ML^2$

(3) $\frac{2}{5}ML^2$ (4) $\frac{7}{18}ML^2$

12. A student measuring the diameter of a pencil of circular cross-section with the help of a vernier scale records the following four readings 5.50 mm, 5.55 mm, 5.45 mm; 5.65 mm. The average of these four readings is 5.5375 mm and the standard deviation of the data is 0.07395 mm. The average diameter of the pencil should therefore be recorded as :

(1) (5.5375 ± 0.0739) mm

(2) (5.538 ± 0.074) mm

(3) (5.54 ± 0.07) mm

(4) (5.5375 ± 0.0740) mm

13. When a particle of mass m is attached to a vertical spring of spring constant k and released, its motion is described by $y(t) = y_0\sin^2\omega t$, where 'y' is measured from the lower end of unstretched spring. Then ω is :

(1) $\sqrt{\frac{g}{y_0}}$ (2) $\sqrt{\frac{g}{2y_0}}$ (3) $\frac{1}{2}\sqrt{\frac{g}{y_0}}$ (4) $\sqrt{\frac{2g}{y_0}}$

14. In a dilute gas at pressure P and temperature T, the mean time between successive collisions of a molecule varies with T as :

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

15. A fluid is flowing through a horizontal pipe of varying cross-section, with speed v ms^{-1} at a point where the pressure is P Pascal. P At another point where pressure is $\frac{P}{2}$ Pascal its speed is V ms^{-1}. If the density of the fluid is ρ kg m^{-3} and the flow is streamline, then V is equal to :

(1) $\sqrt{\frac{P}{2\rho}+v^2}$ (2) $\sqrt{\frac{P}{\rho}+v^2}$

(3) $\sqrt{\frac{2P}{\rho}+v^2}$ (4) $\sqrt{\frac{P}{\rho}+v}$

16. Assuming the nitrogen molecule is moving with r.m.s. velocity at 400 K, the de-Broglie wavelength of nitrogen molecule is close to : (Given : nitrogen molecule weight : 4.64×10^{-26}kg, Boltzman constant : 1.38×10^{-23} J/K, Planck constant: 6.63×10^{-34} J.s)

(1) 0.34 Å (2) 0.24 Å

(3) 0.20 Å (4) 0.44 Å

17. Particle A of mass m_1 moving with velocity $(\sqrt{3}\hat{i}+\hat{j})ms^{-1}$ collides with another particle B of mass m_2 which is at rest initially. Let $\vec{V}_1$ and $\vec{V}_2$ be the velocities of particles A and B after collision respectively. If $m_1 = 2m_2$ and after collision $\vec{V}_1 = (\hat{i}+\sqrt{3}\hat{j})ms^{-1}$, the angle between $\vec{V}_1$ and $\vec{V}_2$ is :

(1) 60° (2) 15° (3) –45° (4) 105°

18. A charged particle going around in a circle can be considered to be a current loop. A particle of mass m carrying charge q is moving in a plane with speed v under the influence of magnetic field $\vec{B}$. The magnetic moment of this moving particle :

(1) $-\frac{mv^2\vec{B}}{B^2}$ (2) $-\frac{mv^2\vec{B}}{2\pi B^2}$

(3) $\frac{mv^2\vec{B}}{2B^2}$ (4) $-\frac{mv^2\vec{B}}{2B^2}$

19. A square loop of side 2a and carrying current I is kept in xz plane with its centre at origin. A long wire carrying the same current I is placed parallel to z-axis and passing through point (0, b, 0), (b >> a). The magnitude of torque on the loop about z-ax is will be :

(1) $\frac{2\mu_0 I^2a^2b}{\pi(a^2+b^2)}$ (2) $\frac{\mu_0 I^2a^2b}{2\pi(a^2+b^2)}$

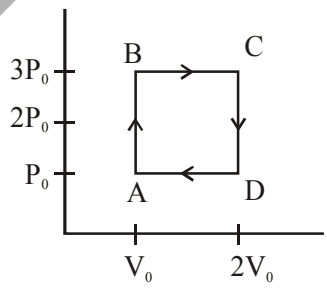
(3) $\frac{\mu_0 I^2a^2}{2\pi b}$ (4) $\frac{2\mu_0 I^2a^2}{\pi b}$

20. When a car is at rest, its driver sees rain drops falling on it vertically. When driving the car with speed v, he sees that rain drops are coming at an angle 60° from the horizontal. On further increasing the speed of the car to (1 + β)v, this angle changes to 45°. The value of β is close to:

(1) 0.41 (2) 0.50

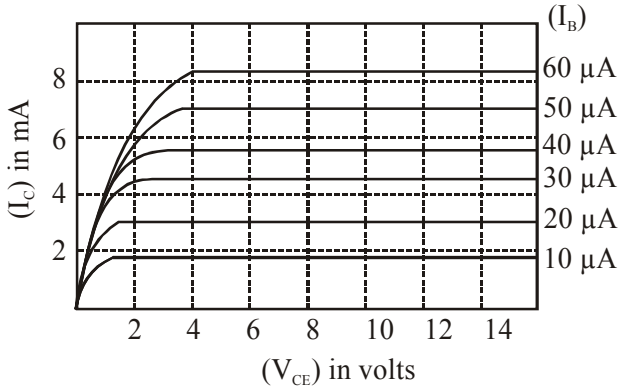
(3) 0.37 (4) 0.73

21. An engine operates by taking a monatomic ideal gas through the cycle shown in the figure. The percentage efficiency of the engine is close to _____ .



22. The centre of mass of a solid hemisphere of radius 8 cm is X cm from the centre of the flat surface. Then value of x is _____ .

23. The output characteristics of a transistor is shown in the figure. When V_{CE} is 10 V and 1_C = 4.0 mA, then value of β_{ac} is _____ .



24. In a scries LR circuit, power of 400 W is dissipated from a source of 250 V, 50 Hz. The power factor of the circuit is 0.8. In order to bring the power factor to unity, a capacitor of value C is added in series to the L and R. Taking the value of C as $\left(\frac{n}{3\pi}\right)\mu F$, then value of n is _____ .

25. A Young's doublc-slit experiment is performed using monochromatic light of wavelength λ. The intensity of light at a point on the screen, where the path difference is λ, is K units. The intensity of light at a point where the path difference is A $\frac{\lambda}{6}$ is given by $\frac{nK}{12}$, where n is an integer. The value of n is _____ .

CHEMISTRY

1. The value of K_C is 64 at 800 K for the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

The value of K_C for the following reaction is :

$NH_3(g) \rightleftharpoons \frac{1}{2}N_2(g) + \frac{3}{2}H_2(g)$

(1) $\frac{1}{4}$ (2) $\frac{1}{8}$ (3) 8 (4) $\frac{1}{64}$

2. The element that can be refined by distillation is :

(1) nickel (2) zinc

(3) gallium (4) tin

3. The correct match between **Item-I** and **Item-II** :

Item-I	**Item-II**
(a) Natural rubber	(I) 1, 3-butadiene + styrene
(b) Neoprene	(II) 1, 3-butadiene + acrylonitrile
(c) Buna-N	(III) Chloroprene
(d) Buna-S	(IV) Isoprene

(1) (a) - (III), (b) - (IV), (c) - (I), (d) - (II)

(2) (a) - (IV), (b) - (III), (c) - (II), (d) - (I)

(3) (a) - (IV), (b) - (III), (c) - (I), (d) - (II)

(4) (a) - (III), (b) - (IV), (c) - (II), (d) - (I)

4. Mischmetal is an alloy consisting mainly of:

(1) lanthanoid metals

(2) actinoid metals

(3) actinoid and transition metals

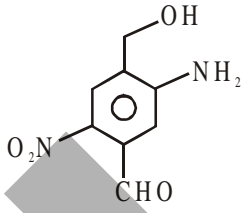
(4) lanthanoid and actinoid metals

5. Reaction of an inorganic sulphite X with dilute H_2SO_4 generates compound Y. Reaction of Y with NaOH gives X. Further, the reaction of X with Y and water affords compound Z. Y and Z, respectively, are:

(1) S and Na_2SO_3 (2) SO_2 and $NaHSO_3$

(3) SO_3 and $NaHSO_3$ (4) SO_2 and Na_2SO_3

6. The IUPAC name of the following compound is :



(1) 3-amino-4-hydroxymethyl-5-nitrobenzaldehyde

(2) 2-nitro-4-hydroxymethyl-5-aminobenzaldehyde

(3) 4-amino-2-formyl-5-hydroxymethylnitrobenzene

(4) 5-amino-4-hydroxymethyl-2-nitrobenzaldehyde

7. Dihydrogen of high purity (> 99.95%) is obtained through:

(1) the electrolysis of warm $Ba(OH)_2$ solution using Ni electrodes.

(2) the reaction of Zn with dilute HCl

(3) the electrolysis of brine solution.

(4) the electrolysis of acidified water using Pt electrodes.

8. Match the following :

Test/Method	**Reagent**
(i) Lucas Test	(a) $C_6H_5SO_2Cl$/aq. KOH
(ii) Dumas method	(b) $HNO_3/AgNO_3$
(iii) Kjeldahl's method	(c) CuO/CO_2
(iv) Hinsberg Test	(d) Conc. HCl and $ZnCl_2$
	(e) H_2SO_4

(1) (i)-(d), (ii)-(c), (iii)-(e), (iv)-(a)

(2) (i)-(b), (ii)-(d), (iii)-(e), (iv)-(a)

(3) (i)-(d), (ii)-(c), (iii)-(b), (iv)-(e)

(4) (i)-(b), (ii)-(a), (iii)-(c), (iv)-(d)

9. The reaction of NO with N_2O_4 at 250 K gives :

(1) N_2O_5 (2) NO_2

(3) N_2O (4) N_2O_3

10. For the given cell ;
$Cu(s)|Cu^{2+}(C_1M)||Cu^{2+}(C_2M)|Cu(s)$ change in Gibbs energy (ΔG) is negative, if :

(1) $C_1 = 2C_2$ (2) $C_2 = C_1/\sqrt{2}$

(3) $C_1 = C_2$ (4) $C_2 = \sqrt{2}C_1$

11. A crystal is made up of metal ions 'M_1' ana 'M_2' and oxide ions. Oxide ions form a ccp lattice structure. The cation 'M_1' occupies 50% of octahedral voids and the cation 'M_2' occupies 12.5% of tetrahedral voids of oxide lattice. The oxidation numbers of 'M_1' and 'M_2' are, respectively :

(1) +2, +4 (2) +3, +1

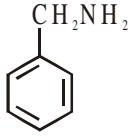
(3) +1, +3 (4) +4, +2

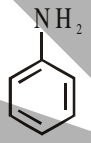
12. For a d^4 metal ion in an octahedral field, the correct electronic configuration is :

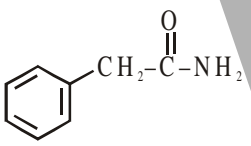
(1) $t_{2g}^4e_g^0$ when $\Delta_O < P$ (2) $e_g^2t_{2g}^2$ when $\Delta_O < P$

(3) $t_{2g}^3e_g^1$ when $\Delta_O < P$ (4) $t_{2g}^3e_g^1$ when $\Delta_O > P$

13. Which of the following compounds can be prepared in good yield by Gabriel phthalimide synthesis?

(1) 

(2) 

(3) 

(4) $CH_3–CH_2–NHCH_3$

14. The correct match between **Item-I** (starting material) and **Item-II** (reagent) for the preparation of benzaldehyde is :

Item-I	Item-II
(I) Benzene	(P) HCl and $SnCl_2, H_3O^+$
(II) Benzonitrile	(Q) H_2, Pd-$BaSO_4$, S and quinoline
(III) Benzoyl Chloride	(R) CO, HCl and $AlCl_3$

(1) (I)-(Q), (II)-(R) and (III)-(P)

(2) (I)-(R), (II)-(Q) and (III)-(P)

(3) (I)-(R), (II)-(P) and (III)-(Q)

(4) (I)-(P), (II)-(Q) and (III)-(R)

15. The average molar mass of chlorine is 35.5 g mol^{-1}. The ratio of ^{35}Cl to ^{37}Cl in naturally occurring chlorine is close to :

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

16. Which one of the following statements not true ?

(1) Lactose contains α-glycosidic linkage between C_1 of galactose and C_4 of glucose.

(2) Lactose ($C_{11}H_{22}O_{11}$) is a disaccharide and it contains 8 hydroxyl groups.

(3) On acid hydrolysis, lactose gives one molecule of D(+)-glucose and one molecule of D(+)-galactose.

(4) Lactose is a reducing sugar and it gives Fehling's test.

17. A set of solutions is prepared using 180 g of water as a solvent and 10 g of different non-volatile solutes A, B and C. The relative lowering of vapour pressure in the presence of these solutes are in the order [Given, molar mass of A = 100 g mol^{-1}; B = 200 g mol^{-1}; C = 10,000 g mol^{-1}]

(1) A > B > C (2) A > C > B

(3) C > B > A (4) B > C > A

18. For a reaction,
$4M(s) + nO_2(g) \rightarrow 2M_2O_n(s)$,
the free energy change is plotted as a function of temperature. The temperature below which the oxide is stable could be inferred from the plot as the point at which :

(1) the slope changes from positive to zero

(2) the free energy change shows a change from negative to positive value

(3) the slope changes from negative to positive

(4) the slope changes from positive to negative

19. Match the following compounds (Column-I) with their uses (Column-II) :

S.No.	Column – I	S.No.	Column – II
(I)	$Ca(OH)_2$	(A)	casts of statues
(II)	NaCl	(B)	white wash
(III)	$CaSO_4.\frac{1}{2}H_2O$	(C)	antacid
(IV)	$CaCO_3$	(D)	washing soda preparation

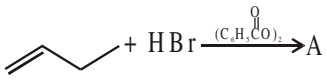
(1) (I)-(D), (II)-(A), (III)-(C), (IV)-(B)

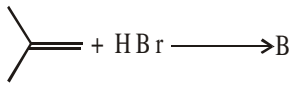
(2) (I)-(B), (II)-(C), (III)-(D), (IV)-(A)

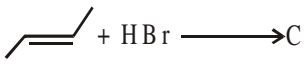
(3) (I)-(C), (II)-(D), (III)-(B), (IV)-(A)

(4) (I)-(B), (II)-(D), (III)-(A), (IV)-(C)

20. The increasing order of the boiling points of the major products A, B and C of the following reactions will be :

(a) 

(b) 

(c) 

(1) C < A < B (2) B < C < A

(3) A < B < C (4) A < C < B

21. For Freundlich adsorption isotherm, a plot of log (x/m) (y-axis) and log p (x-axis) gives a straight line. The intercept and slope for the line is 0.4771 and 2, respectively. The mass of gas, adsorbed per gram of adsorbent if the initial pressure is 0.04 atm, is_ _ _ _ _ _ × 10^{-4}g.

(log 3 = 0.4771)

22. A solution of phenol in chloroform when treated with aqueous NaOH gives compound P as a major product. The mass percentage of carbon in P is_____. (to the nearest integer)

(Atomic mass : C = 12; H = 1; O = 16)

23. If the solubility product of AB_2 is 3.20 × 10^{-11} M^3, then the solubility of AB_2 in pure water is_ _ _ _ _ × 10^{-4} mol L^{-1}. [Assuming that neither kind of ion reacts with water]

24. The rate of a reaction decreased by 3.555 times when the temperature was changed from 40°C to 30°C. The activation energy (in kJ mol^{-1}) of the reaction is_ _ _ _ _ _.

Take; R=8.314 J mol^{-1} K^{-1} In 3.555 = 1.268

25. The atomic number of Unnilunium is _____.

MATHEMATICS

1. The set of all real values of λ for which the function $f(x) = (1 - \cos^2 x).(\lambda + \sin x)$, $x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$, has exactly one maxima and exactly one minima, is :

(1) $\left(-\frac{1}{2}, \frac{1}{2}\right) - \{0\}$ (2) $\left(-\frac{1}{2}, \frac{1}{2}\right)$

(3) $\left(-\frac{3}{2}, \frac{3}{2}\right)$ (4) $\left(-\frac{3}{2}, \frac{3}{2}\right) - \{0\}$

2. For all twice differentiable functions $f : R \to R$, with $f(0) = f(1) = f'(0) = 0$

(1) $f''(x) = 0$, for some $x \in (0, 1)$

(2) $f''(0) = 0$

(3) $f''(x) \neq 0$ at every point $x \in (0, 1)$

(4) $f''(x) = 0$ at every point $x \in (0, 1)$

3. If the tangent to the curve, $y = f(x) = x\log_e x$, $(x > 0)$ at a point $(c, f(c))$ is parallel to the line - segement joining the points (1, 0) and (e, e), then c is equal to :

(1) $\frac{1}{e-1}$ (2) $e^{\left(\frac{1}{1-e}\right)}$

(3) $e^{\left(\frac{1}{e-1}\right)}$ (4) $\frac{e-1}{e}$

4. Consider the statement : "For an integer n, if $n^3 - 1$ is even, then n is odd." The contrapositive statement of this statement is :

(1) For an integer n, if $n^3 - 1$ is not even, then n is not odd.

(2) For an integer n, if n is even, then $n^3 - 1$ is odd.

(3) For an integer n, if n is odd, then $n^3 - 1$ is even.

(4) For an integer n, if n is even, then $n^3 - 1$ is even.

5. If the normal at an end of a latus rectum of an ellipse passes through an extremity of the minor axis, then the eccentricity e of the ellipse satisfies :

(1) $e^2 + 2e - 1 = 0$ (2) $e^2 + e - 1 = 0$

(3) $e^4 + 2e^2 - 1 = 0$ (4) $e^4 + e^2 - 1 = 0$

6. A plane P meets the coordinate axes at A, B and C respectively. The centroid of ΔABC is given to be (1, 1, 2). Then the equation of the line through this centroid and perpendicular to the plane P is :

(1) $\frac{x-1}{1}=\frac{y-1}{2}=\frac{z-2}{2}$

(2) $\frac{x-1}{2}=\frac{y-1}{2}=\frac{z-2}{1}$

(3) $\frac{x-1}{2}=\frac{y-1}{1}=\frac{z-2}{1}$

(4) $\frac{x-1}{1}=\frac{y-1}{1}=\frac{z-2}{2}$

7. If α and β are the roots of the equation $2x(2x + 1) = 1$, then β is equal to :

(1) $2\alpha^2$ (2) $2\alpha(\alpha + 1)$

(3) $-2\alpha(\alpha + 1)$ (4) $2\alpha(\alpha - 1)$

8. Let $z = x + iy$ be a non-zero complex number such that $z^2 = i|z|^2$, where $i=\sqrt{-1}$, then z lies on the :

(1) imaginary axis (2) real axis

(3) line, $y = x$ (4) line, $y = -x$

9. The common difference of the A.P. $b_1, b_2, ..., b_m$ is 2 more than the common difference of A.P. $a_1, a_2, ..., a_n$. If $a_{40} = -159$, $a_{100} = -399$ and $b_{100} = a_{70}$, then b_1 is equal to :

(1) –127 (2) –81

(3) 81 (4) 127

10. The angle of elevation of the summit of a mountain from a point on the ground is 45°. After climding up one km towards the summit at an inclination of 30° from the ground, the angle of elevation of the summit is found to be 60°. Then the height (in km) of the summit from the ground is :

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

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

11. Let $\theta=\frac{\pi}{5}$ and $A=\begin{bmatrix}\cos\theta & \sin\theta\\ -\sin\theta & \cos\theta\end{bmatrix}$. If $B = A + A^4$, then det(B) :

(1) is one (2) lies in (1, 2)

(3) is zero (4) lies in (2, 3)

12. For a suitably chosen real constant a, let a function, $f : R - \{-a\} \to R$ be defined by $f(x)=\frac{a-x}{a+x}$. Further suppose that for any real number $x \neq -a$ and $f(x) \neq -a$, $(fof)(x) = x$. Then $f\left(-\frac{1}{2}\right)$ is equal to :

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

13. Let $f : R \to R$ be a function defined by $f(x) = \max\{x, x^2\}$. Let S denote the set of all points in R, where f is not differentiable. Then :

(1) {0, 1} (2) {0}

(3) ϕ(an empty set) (4) {1}

14. The area (in sq. units) of the region enclosed by the curves $y = x^2 - 1$ and $y = 1 - x^2$ is equal to :

(1) $\frac{4}{3}$ (2) $\frac{8}{3}$ (3) $\frac{16}{3}$ (4) $\frac{7}{2}$

15. The probabilities of three events A, B and C are given by P(A) = 0.6, P(B) = 0.4 and P(C) = 0.5. If $P(A \cup B) = 0.8$, $P(A \cap C) = 0.3$, $P(A \cap B \cap C) = 0.2$, $P(B \cap C) = \beta$ and $P(A \cup B \cup C) = \alpha$, where $0.85 \le \alpha \le 0.95$, then β lies in the interval:

(1) [0.36, 0.40] (2) [0.35, 0.36]

(3) [0.25, 0.35] (4) [0.20, 0.25]

16. if the constant term in the binomial expansion of $\left(\sqrt{x}-\frac{k}{x^2}\right)^{10}$ is 405, then |k| equals :

(1) 2 (2) 1 (3) 3 (4) 9

17. The integral $\int_1^2 e^x.x^x\left(2+\log_e x\right)dx$ equal :

(1) e(4e + 1)

(2) e(2e – 1)

(3) $4e^2 - 1$

(4) e(4e – 1)

18. Let L denote the line in the xy-plane with x and y intercepts as 3 and 1 respectively. Then the image of the point (–1, –4) in this line is :

(1) $\left(\frac{8}{5},\frac{29}{5}\right)$

(2) $\left(\frac{29}{5},\frac{11}{5}\right)$

(3) $\left(\frac{11}{5},\frac{28}{5}\right)$

(4) $\left(\frac{29}{5},\frac{8}{5}\right)$

19. If $y=\left(\frac{2}{\pi}x-1\right)\text{cosec}x$ is the solution of the differential equation,

$\frac{dy}{dx}+p(x)y=\frac{2}{\pi}\text{cosec}x$, $0 < x < \frac{\pi}{2}$, then the function p(x) is equal to

(1) cotx

(2) tanx

(3) cosecx

(4) secx

20. The centre of the circle passing through the point (0, 1) and touching the parabola $y = x^2$ at the point (2, 4) is :

(1) $\left(\frac{3}{10},\frac{16}{5}\right)$

(2) $\left(\frac{-16}{5},\frac{53}{10}\right)$

(3) $\left(\frac{6}{5},\frac{53}{10}\right)$

(4) $\left(\frac{-53}{10},\frac{16}{5}\right)$

21. The sum of distinct values of λ for which the system of equations

$(\lambda - 1)x + (3\lambda + 1)y + 2\lambda z = 0$

$(\lambda - 1)x + (4\lambda - 2)y + (\lambda + 3)z = 0$

$2x + (3\lambda + 1)y + 3(\lambda - 1)z = 0,$

has non-zero solutions, is _____.

22. Suppose that a function $f : R \to R$ satisfies $f(x + y) = f(x)f(y)$ for all $x, y \in R$ and $f(1) = 3$. If $\sum_{i=1}^{n} f(i) = 363$, then n is equal to _____.

23. The number of words (with or without meaning) that can be formed from all the letters of the word "LETTER" in which vowels never come together is _____.

24. Consider the data on x taking the values 0, 2, 4, 8, ..., 2^n with frequencies ${}^nC_0, {}^nC_1, {}^nC_2, ..., {}^nC_n$ respectively. If the mean of this data is $\frac{728}{2^n}$, then n is equal to _____.

25. If $\vec{x}$ and $\vec{y}$ be two non-zero vectors such that $|\vec{x}+\vec{y}| = |\vec{x}|$ and $2\vec{x}+\lambda\vec{y}$ is perpendicular to $\vec{y}$, then the value of λ is _____.

JEE (MAIN) PAPER
JANUARY

ANSWER KEY

SET-1

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	3	1	3	2	1	3	2	1	2	1	1	3	4	1
Q.No.	16	17	18	19	20	21	22		23		24	25			
Ans.	2	2	2	1	2	10.00	600.00		11.00		60.00	175.00			

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	4	3	3	3	3	1	1	4	4	1	2	3	1	2
Q.No.	16	17	18	19	20	21			22			23	24	25	
Ans.	1	4	1	4	3	–2.70 to –2.71			23 to 23.03			2.00	10.60	1.66 to 1.67	

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	2	3	1	1	3	3	3	2	3	4	1	1	*4/ Bonus	*1 / 1or3
Q.No.	16	17	18	19	20	21	22	23	24		25		* NTA Ans / ALLEN Ans		
Ans.	2	4	2	3	3	36.00	18.00	30.00	5.00		3.00				

SET-2

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	3	4	1	3	3	2	1	4	*1/2	2	2	1	3	4
Q.No.	16	17	18	19	20	21	22	23	24	25	* NTA Ans / ALLEN Ans				
Ans.	3	4	1	4	2	6.00	75.00	12.00	90.00	40.00					

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	1	4	1	1	2	1	1	1	3	2	2	4	3	3
Q.No.	16	17	18	19	20	21	22		23			24			25
Ans.	2	1	3	4	4	18.00	5.22 to 5.24		–192.50 or –85.00			0.36 to 0.38			9.00

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	4	1	1	4	4	3	4	1	2	2	3	2	4	3
Q.No.	16	17	18	19	20	21	22	23	24	25					
Ans.	3	3	2	3	4	13.00	5.00	54.00	4.00	29.00					

SET-3

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	3	4	4	4	2	Bonus	4	4	4	4	4	3	2	4
Q.No.	16	17	18	19	20	21	22	23	24	25					
Ans.	1	3	4	3	3	10.00	60.00	1.00	580.00	106.00 to 107.20					

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	1	4	1	3	4	3	3	3	3	4	2	3	4	4
Q.No.	16	17	18	19	20	21	22	23			24			25	
Ans.	1	2	2	2	4	3.00	48.00	26.60 to 27.00			–0.93 to –0.94			4.95 to 4.97	

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	2	1	4	*1/ Bonus	4	3	1	*2/ Bonus	4	1	4	2	2	4
Q.No.	16	17	18	19	20	21	22	23	24	25			* NTA Ans / ALLEN Ans		
Ans.	3	3	1	2	1	672.00	8.00	4.00	1540.00	*490.00/490.00 or 13.00					

SET-4

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	4	2	1	3	3	1	2	4	4	3	4	3	2	3
Q.No.	16	17	18	19	20	21	22		23	24	25				
Ans.	1	4	1	2	2	50.00	8 or 2888		486.00	16.00	30.00				

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	1	3	1	4	1	1	1	1	2	3	2	4	4	3
Q.No.	16	17	18	19	20	21		22	23		24	25			
Ans.	2	2	3	4	1	2.13 to 2.17		6.25	2120 to 2140		13	20			

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	4	2	1	2	*2/ Bonus	1	2	4	4	3	1	2	1	3
Q.No.	16	17	18	19	20	21	22	23	24		25		* NTA Ans / ALLEN Ans		
Ans.	4	4	4	1	1	1.00	3.00	0.50	504.00		2454.00				

SET-5

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	3	1	3	4	1	2	3	2	2	2	3	2	4	2
Q.No.	16	17	18	19	20	21	22	23	24	25					
Ans.	2	1	3	1	3	10.00	15.00	3.00	4.00	12.00					

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	4	1	1	1	2	2	2	1	4	3	1	4	2	3
Q.No.	16	17	18	19	20	21	22	23			24			25	
Ans.	3	1	4	1	2	100	14.00	5.66 to 5.68			37.80 to 38.20			1.74 to 1.76 or 0.03	

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	1	3	1	4	3	3	4	2	4	1	3	4	3	1
Q.No.	16	17	18	19	20	21	22	23	24	25					
Ans.	1	2	4	3	3	615.00	8.00	3.00	1.00	8.00					

SET-6

PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	2	4	1	3	2	2	4	1	1	*1/3	3	3	4	1
Q.No.	16	17	18	19	20	21			22	23		24	25	*NTA Ans / ALLEN Ans	
Ans.	2	1	4	Bonus	1	1816.00 to 1820.00			40	*12.00/40.00		750.00	–48.00		

CHEMISTRY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	1	1	3	4	4	3	3	1	4	*1/1 or Bonus	3	1	4	2
Q.No.	16	17	18	19	20	21	22	23			24	25		*NTA Ans / ALLEN Ans	
Ans.	4	2	4	4	1	2.17 to 2.23	10.00	3.98 to 4.00 or –3.98 to –4.00			*12.00/ 18.00	66.65 to 66.70			

MATHEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	1	Bonus	2	2	2	2	3	1	2	*3/ Bonus	3	4	1	4
Q.No.	16	17	18	19	20	21	22	23	24	25	* NTA Ans / ALLEN Ans				
Ans.	2	3	4	4	3	14.00	30.00	3.00	51.00	36.00					

JEE (MAIN) PAPER
SEPTEMBER

ANSWER KEY

ALLEN CAREER INSTITUTE
KOTA (RAJASTHAN)
path to success

SET-1

PHYSICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	4	2	4	4	4	3	1	4	2	2	2	1	4	2
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	1	1	1, 3	2	3	36.00	46.00	3.00	15.00	9.00					

CHEMISTRY

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	1	4	1	2	4	4	4	3	2	1	2	1, 3	1	1
Q. No.	16	17	18	19	20	21		22	23	24	25				
Ans.	3	4	4	3	3	96500.00		48.00	5.00	6.00	189000.00 to 190000.00				

MATHEMATICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	2	4	1	2	3	4	3	4	1	3	4	2	1	2
Q. No.	16	17	18	19	20	21	22	23	24		25				
Ans.	4	2	1	2	4	1.50	2.00	40.00	309.00		9.00				

SET-2

PHYSICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	4	1	1	3	1	2	3	2	3	1	4	3	1	4
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	4	2	2	1	4	8.00	90.00	10.00	23.00	35.00					

CHEMISTRY

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	3	1	2	3	1	4	3	4	2	1	1	2	3	2
Q. No.	16	17	18	19	20	21		22		23	24	25			
Ans.	2	2	2	3	1	–326400.00		144.00		19.00	5.00	222.00			

MATHEMATICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	3	4	3	1	4	1	2	1	4	2	2	1	2	1
Q. No.	16	17	18	19	20	21	22	23	24		25				
Ans.	2	4	2	3	4	3.00	91.00	0.8	118.00		1.00				

SET-3

PHYSICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	4	1	3	2	3	3	1	2	1	2	1	1	1	2
Q. No.	16	17	18	19	20	21	22		23		24	25			
Ans.	2	4	3	4	1	20.00	150.00		101.00		9.00	158.00			

CHEMISTRY

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	3	2	4	4	2	2	3	3	4	3	2	2	4	3
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	4	4	3	Bonus	1	100	47	58.00	143	8					

MATHEMATICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	3	4	2	3	4	3	4	1	1	1	2	3	3	1
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	2	3	2	3	1	10	8	3	4	4					

SET-4

PHYSICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	3	1	4	2	3	3	3	4	1	1	3	1	1	4
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	1	2	1	2	2	1	20	8791	346	25					

CHEMISTRY

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	2	1	2	3	2	2	3	3	2	2	4	1	3	3
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	3	2	3	4	3	60	25	10	177	5					

MATHEMATICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	1	4	1	3	3	3	4	1	1	3	3	1	3	3
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	2	1	2	4	3	39	4	5	8	54					

SET-5

PHYSICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	1	3	3	4	1	3	1	3	4	4	1	3	4	4
Q. No.	16	17	18	19	20	21	22	23	24			25			
Ans.	1	3	3	1	2	6.25	11	20	266.00 to 267.00			10553 to 10554			

CHEMISTRY

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	1	4	4	1	1	3	4	1	3	2	3	4	1	4
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	1	3	2	1	3	3400	4	85	60	600					

MATHEMATICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	4	3	1	3	4	3	1	4	4	3	4	4	1	4
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	2	1	2	3	2	5	3	10	8	3					

SET-6

PHYSICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	2	1	2	2	1	2	4	1	2	3	1	3	1	4
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	2	4	3	3	3	200	20	2	5	150					

CHEMISTRY

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	4	2	4	3	2	2	3	3	3	1	2	1	3	2
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	4	4	4	3	3	10	167	2	19	84290.00 to 84300.00					

MATHEMATICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	4	4	3	3	2	4	3	1	3	4	1	4	4	2
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	3	1	3	4	4	135	7	21	18	4					

SET-7

PHYSICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	3	3	3	2	1	1	1	4	2	2	2	3	1	2
Q. No.	16	17	18	19	20	21	22	23		24	25				
Ans.	2	3	4	2	4	5	195	50 to 51		51	50				

CHEMISTRY

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	1	3	4	1	4	3	2	2	2	4	4	4	3	4
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	2	2	4	2	3	6	18	6	4	37					

MATHEMATICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	1	3	3	2	2	4	2	1	4	1	4	4	2	1
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	2	4	3	1	1	11	30	13	240	8					

SET-8

PHYSICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	3	3	4	2	4	2	4	4	1	1	2	2	4	2
Q. No.	16	17	18	19	20	21	22		23	24	25				
Ans.	1	4	4	4	4	2	40 to 41		20	18	5				

CHEMISTRY

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	2	3	3	1	3	2	1	2	2	1	1	1	4	2
Q. No.	16	17	18	19	20	21	22				23	24	25		
Ans.	4	3	4	3	1	9	–13540.00 to –13537.00				16	50	0.00		

MATHEMATICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	1	4	4	2	3	2	1	2	1	2	2	4	2	4
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	4	1	2	3	1	11	19	120	0.50	6.00					

SET-9

PHYSICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	1	3	2	1	2	4	1	4	4	1	1	2	3	2
Q. No.	16	17	18	19	20	21	22	23			24	25			
Ans.	2	3	4	1, 4	4	33	120	NTA-275/Allen-194			1050	5			

CHEMISTRY

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	2	2	2	4	1	3	3	2	3	4	4	3	2	1
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	1	2	3	3	3	50	5	750	3	11					

MATHEMATICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	2	Bonus	1	4	4	3	2	1	3	2	1	2	3	1
Q. No.	16	17	18	19	20	21	22	23	24	25					
Ans.	4	4	4	4	1	5	80	28	4	5					

SET-10

PHYSICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	1	2	4	1	3	1	1	3	3	4	3	2	3	2
Q. No.	16	17	18	19	20	21		22	23	24	25				
Ans.	2	4	4	1	4	19.00 to 19.10		3	150	400	9				

CHEMISTRY

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	2	2	1	2	4	1	1	4	4	1	3	1	3	4
Q. No.	16	17	18	19	20	21	22	23	24			25			
Ans.	1	1	2	4	2	48	69.00	2	99.90 to 100.10			101.00			

MATHEMATICS

Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	1	3	2	4	2	3	3	2	1	2	2	1	2	3
Q. No.	16	17	18	19	20	21	22	23		24	25				
Ans.	3	4	3	1	2	3.00	5.00	120.00		6.00	1.00				