MENIIT
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JEE MAINS-2015

IMPORTANT INSTRUCTIONS

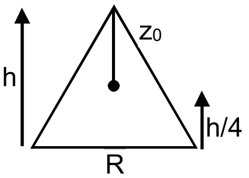
1. The test is of **3** hours duration.
2. The Test Booklet consists of **90** questions. The maximum marks are **360**.
3. There are **three** parts in the question paper A, B, C consisting of **Physics, Mathematics and Chemistry** having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for each correct response.
4. Candidates will be awarded marks as stated above in instruction No.3 for correct response of each question. 1/4 (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
5. There is only one correct response for each question. Filling up more than one response in each question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 4 above.

PART-A-PHYSICS

1. Distance of the centre of mass of a solid uniform cone from its vertex is z_0. If the radius of its base is R and its height is h then z_0 is equal to :

(A) $\frac{5h}{8}$ (B) $\frac{3h^2}{8R}$ (C) $\frac{h^2}{4R}$ (D*) $\frac{3h}{4}$

Sol.



$z_0 = \frac{3h}{4}$

2. A red LED emits light at 0.1 watt uniformly around it. The amplitude of the electric field of the light at a distance of 1 m from the diode is:

(A) 5.48 V/m (B) 7.75 V/m (C) 1.73 V/m (4*) 2.45 V/m

Sol. $I = \frac{1}{2}\varepsilon_0 E^2 C = \frac{P}{A}$

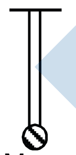
$$\frac{0.1}{4\pi(1)^2} = \frac{1}{2}\varepsilon_0 E^2 C$$

$$E = \sqrt{\frac{0.1\times 2}{4\pi 8.35\times 10^{-12}\times 3\times 10^8}} - 2.45 \text{ V/m}$$

3. A pendulum made of a uniform wire of cross sectional area A has time period T. When an additional mass M is added to its bob, the time period changes to T_M. If the Young's modulus of the material of the wire is Y then $\frac{1}{Y}$ is equal to : (g = gravitational acceleration)

(A) $\left[1-\left(\frac{T_M}{T}\right)^2\right]\frac{A}{Mg}$ (B) $\left[1-\left(\frac{T}{T_M}\right)^2\right]\frac{A}{Mg}$ (3*) $\left[\left(\frac{T_M}{T}\right)^2-1\right]\frac{A}{Mg}$ (D) $\left[\left(\frac{T_M}{T}\right)^2-1\right]\frac{Mg}{A}$

Sol.



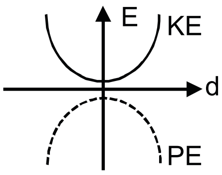
$T = 2\pi\sqrt{\frac{\ell}{g}}$ $\frac{Mg}{A} = \frac{Y\Delta\ell}{\ell}$

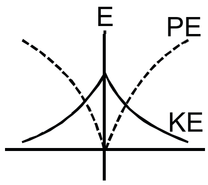
$$T_M = 2\pi\sqrt{\frac{\ell + \frac{Mg}{AY}\ell}{g}} \qquad \Delta\ell = \frac{Mg\ell}{AY}$$

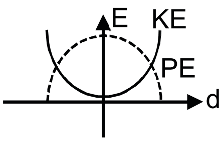
$$\frac{T_M}{T} = \sqrt{\left(\frac{Mg}{AY}+1\right)}$$

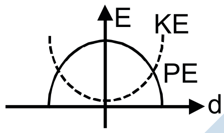
$$\left(\frac{T_M^2}{T^2}-1\right)\frac{A}{Mg} = \frac{1}{Y}$$

4. For a simple pendulum, a graph is plotted between its kinetic energy (KE) and potential energy (PE) against its displacement d. Which one of the following represents these correctly? (graphs are schematic and not drawn to scale)

(A)


(B)


(C)


(D*)


Sol. At mean position, K.E. is maximum where as P.E. is minimum

5. A train is moving on a straight track with speed 20 ms^{-1}. It is blowing its whistle at the frequency of 1000 Hz. The percentage change in the frequency heard by a person standing near the track as the train passes him is (speed of sound = 320 ms^{-1}) close to :

(A) 18% (B) 24% (C) 6% (D*) 12%

Sol. $f_1 = f_0\left(\frac{320}{320-20}\right) = f_0\frac{320}{300}$

$f_2 = f_0\left(\frac{320}{320+20}\right) = f_0\frac{320}{340}$

$\frac{f_1 - f_2}{f_0}\times 100 = \left(\frac{320}{300} - \frac{320}{340}\right)\times 100$

= (1.066 – 0.941) × 100 ≅ 12.4%

6. When 5V potential difference is applied across a wire of length 0.1 m, the drift speed of electron is 2.5 × 10^{-4} ms^{-1}. If the electron density in the wire is 8 × 10^{28} m^{-3}, the resistivity of the material is close to

(A) 1.6 × 10^{-6} Ωm (B*) 1.6 × 10^{-5} Ωm (C) 1.6 × 10^{-8} Ωm (D) 1.6 × 10^{-7} Ωm

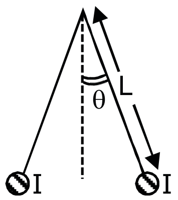
Sol. $V = neAv_d\,\rho\frac{\ell}{A}$

$\rho = \frac{V}{nev_d\ell}$

$= \frac{5}{8\times10^{28}\times1.6\times10^{-19}\times2.5\times10^{-4}\times0.1}$

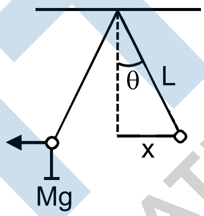
$= \frac{5}{32}\times10^{-4}$ = 0.156 × 10^{-4} = 1.6 × 10^{-5}

7. Two long current carrying thin wires, both with current I, are held by insulating threads of length L and are in equilibrium as shown in the figure, with threads making an angle 'θ' with the vertical. If wires have mass λ per unit length then the value of I is : (g = gravitational acceleration)



(A) $2\sqrt{\frac{\pi g L}{\mu_0}\tan\theta}$ (B) $2\sqrt{\frac{\pi g L}{\mu_0}\tan\theta}$ (C) $\sin\theta\sqrt{\frac{\pi\lambda g L}{\mu_0\cos\theta}}$ (D*) $2\sin\theta\sqrt{\frac{\pi\lambda g L}{\mu_0\cos\theta}}$

Sol. $\frac{x}{L}=\sin\theta$ $x = L\tan\theta$



$d = 2L\sin\theta$

$$\frac{dF}{d\ell}=\frac{\mu_0 i_1 i_2}{2\pi d}$$

$$\tan\theta=\frac{\mu_0 i^2}{2\pi 2L\sin\theta\lambda g}$$

$$\sqrt{\frac{4\pi L\sin\theta\lambda g\tan\theta}{\mu_0}}=i$$

$$i = 2\sin^2\theta\sqrt{\frac{\pi L\lambda g}{\mu_0\cos\theta}}$$

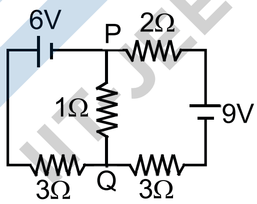
8. In the circuit shown, the current in the 1Ω resistor is :

(1*) 0.13 A, from Q to P

(B) 0.13 A, from P to Q

(C) 1.3 A, from P to Q

(D) 0 A



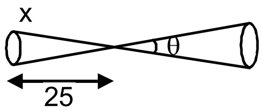
Sol. $$E_{eq}=\frac{\frac{6}{3}-\frac{9}{5}}{\frac{1}{2}+\frac{1}{5}}$$

$$Req = \frac{15}{8}+1$$

$$i=\frac{\frac{3}{8}}{\frac{23}{8}}=\frac{3}{23}$$

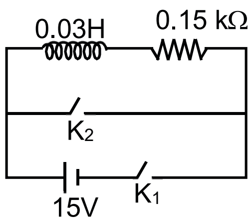
9. Assuming human pupil to have a radius of 0.25 cm and a comfortable viewing distance of 25 cm, the minimum separation between two objects that human eye can resolve at 500 nm wavelength is

(A) 100 μm (B) 300 μm (C) 1 μm (D*) 30 μm

Sol. 

$$1.22\frac{\lambda}{D}=\frac{x}{25}$$

10. An inductor (L = 0.03 H) and a resistor (R = 0.15 kΩ) are connected in series to a battery of 15V EMF in a circuit shown below. The key K_1 has been kept closed for a long time. Then at t = 0, K_1 is opened and key K_2 is closed simultaneously. At t = 1 ms, the current in the circuit will be : ($e^5 \cong 150$)]



(A) 6.7 mA (B*) 0.67 mA (C) 100 mA (D) 67 mA

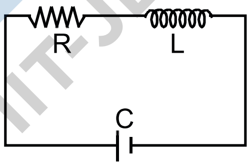
Sol. $i_0 = \frac{15}{0.15\times 10^3} = 0.1\text{A}$

$i = i_0 e^{-\frac{tR}{L}}$

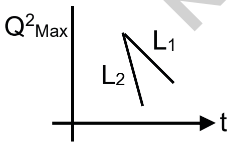
$= 0.1\, e^{\frac{-1\times 10^{-3}\times 150\times 100}{.03}}$

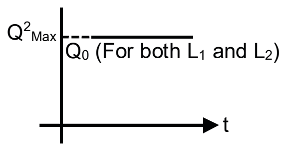
$= 0.1\, e^{-5} = \frac{0.1}{e^5} = \frac{0.1}{150}$

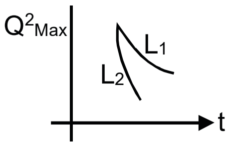
11. An LCR circuit is equivalent to a damped pendulum. In an LCR circuit the capacitor is charged to Q_0 and then connected to the L and R as shown below :

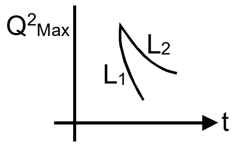


If a student plots graphs of the square of maximum charge (Q^2_{Max}) on the capacitor with time (t) for two different values L_1 and L_2($L_1 > L_2$) of L then which of the following represents this graph correctly? (plots are schematic and not drawn to scale) :

(A) 

(B) 

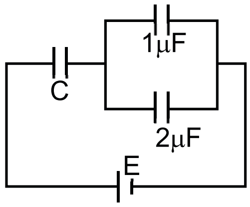
(C*) 

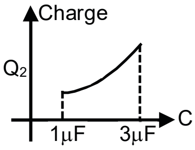
(D) 

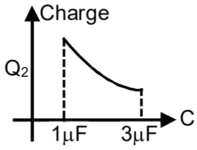
Sol. $Q = Q_0\, e^{-\frac{Rt}{2L}}$

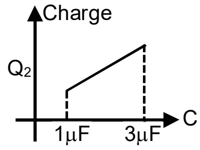
$Q^2 = Q_0^2\, e^{-\frac{Rt}{L}}$

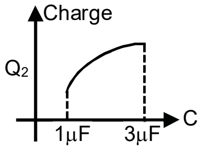
12. In the given circuit, charge Q_2 on the 2μF capacitor changes as C is varied from 1μF to 3μF. Q_2 as a function of 'C' is given properly by : (figures are drawn schematically and are not to scale.



(A) 

(B) 

(C) 

(D*) 

Sol. $\frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2}$ $\quad\quad$ Q = C V

$$C=\frac{3C}{3+C}$$

$$Q=\frac{3CE}{3+C} \qquad Q_2=\left(\frac{3CE}{3+C}\right)\frac{2}{3}=\frac{2CE}{3+C}$$

$$Q_2=\frac{2CE}{3+C}$$

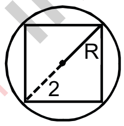
13. From a solid sphere of mass M and radius R a cube of maximum possible volume is cut. Moment of inertia of cube about an axis passing through its centre and perpendicular to one of its faces is

(A*) $\frac{4MR^2}{9\sqrt{3}\pi}$ (B) $\frac{4MR^2}{3\sqrt{3}\pi}$ (C) $\frac{MR^2}{32\sqrt{2}\pi}$ (D) $\frac{MR^2}{16\sqrt{2}\pi}$

Sol. $2R=\sqrt{3}\,\ell$

$$\ell=\frac{2R}{\sqrt{3}}$$

$$\frac{M}{\frac{4}{3}\pi R^3}=\frac{M_1}{\ell^3}=\frac{M_1}{\frac{8}{3\sqrt{3}}R^3}$$



$$M_1=\frac{2M}{\sqrt{3}\pi}$$

$$I=\frac{1}{6}M_1\left(2\ell^2\right)=\frac{1}{3}\times\frac{2M}{\sqrt{3}\pi}\times\frac{4R^2}{3}=\frac{4MR^2}{9\sqrt{3}\pi}$$

14. The period of oscillation of a simple pendulum is $T=2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 20.0 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 90s using a wrist watch of 1s resolution. The accuracy in the determination of g is :

(A) 1% (B) 5% (C) 2% (D*) 3%

Sol. $\frac{\Delta g}{g}=\frac{\Delta\ell}{\ell}+\frac{2\Delta T}{T}$

$$= \frac{1\times100}{200} + \frac{2\times1}{90}\times100$$

$$= \frac{1}{2} + \frac{20}{9} = \frac{9+40}{18} = \frac{49}{18} = 3\%$$

15. On a hot summer night, the refractive index of air is smallest near the ground and increases with height from the ground. When a light beam is directed horizontally, the Huygens' principle leads us to conclude that as it travels, the light beam :

(A) bends downwards

(B*) bends upwards

(C) becomes narrower

(D) goes horizontally without any deflection

Sol. According to Huygens' principle, each point on wave front behaves as a point source of light.

16. A signal of 5 kHz frequency is amplitude modulated on a carrier wave of frequency 2 MHz. The frequencies of the resultant signal is/are :

(A*) 2005 kHz, 2000 kHz and 1995 kHz

(B) 2000 kHz and 1995 kHz

(C) 2 MHz only

(D) 2005 kHz, and 1995 kHz

Sol. $f_R = f_C + f_m$ = 2000 kHz + 5kHz = 2005 kHz

$f_R = f_C - f_m$ = 2000 kHz - 5kHz = 1995 kHz

So, frequency content of resultant wave will have frequencies 1995 kHz, 2000 kHz and 2005 kHz

17. A solid body of constant heat capacity 1 J/ºC is being heated by keeping it in contact with reservoirs in two ways :

(i) Sequentially keeping in contact with 2 reservoirs such that each reservoir supplies same amount of heat.

(ii) Sequentially keeping in contact with 8 reservoirs such that each reservoir supplies same amount of heat.

In both the cases body is brought from initial temperature 100°C to final temperature 200ºC. Entropy change of the body in the two cases respectively is :

(A) $\ell n2, 2\ell n2$ (B) $2\ell n2, 8\ell n2$ (C) $\ell n2, 4\ell n2$ (D*) $\ell n2, \ell n2$

Sol. $\Delta S = \frac{\Delta Q}{T} = \frac{1\Delta T}{T}$

$$\Delta S = \int_{100}^{150} \frac{dT}{T} = \ell n\frac{150}{100} + \ell n\frac{200}{150} = \ell n\,2$$

18. Consider a spherical shell of radius R at temperature T. The black body radiation inside it can be considered as an ideal gas of photons with internal energy per unit volume $u = \frac{U}{V} \propto T^4$ and pressure $P = \frac{1}{3}\left(\frac{U}{V}\right)$. If the shell now undergoes an adiabatic expansion the relation between T and R is :

(A*) $T \propto \frac{1}{R}$ (B) $T \propto \frac{1}{R^3}$ (C) $T \propto e^{-R}$ (D) $T \propto e^{-3R}$

Sol. $dU + dW = 0$

$dU + PdV = 0$

$dU + \frac{U}{3V}dV = 0$

$\frac{dU}{U} + \frac{dV}{3V} = 0$

$UV^{1/3}$ = constant

$V^{4/3}T^4$ = constant

$V^{1/3}\,T$ = constant

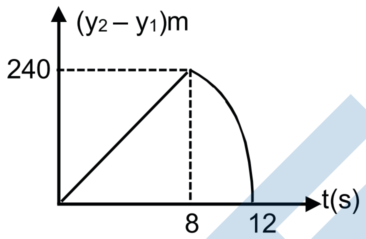
$\Rightarrow$ TR = constant

19. Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speed of 10 m/s and 40 m/s respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first?

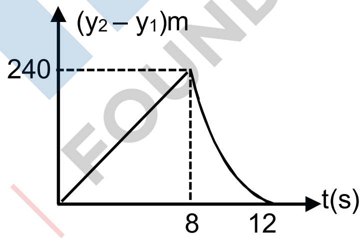
(Assume stones do not rebound after hitting the ground and neglect air resistance, take g = 10 m/s^2)

(The figures are schematic and not drawn to scale)

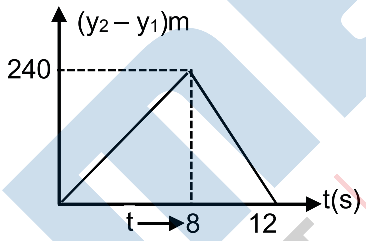
(A*)



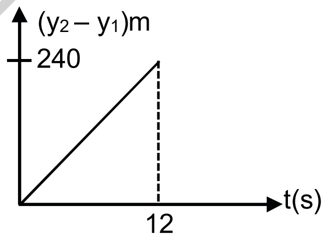
(B)



(C)



(D)



Sol. v_{rel} = constant initially

finally $V_{relative} = gt$

20. A uniformly charged solid sphere of radius R has potential V_0 (measured with respect to ∞) on its surface. For this sphere the equipotential surfaces with potentials $\frac{3V_0}{2}, \frac{5V_0}{4}, \frac{3V_0}{4}$ and $\frac{V_0}{4}$ have radius R_1, R_2, R_3 and R_4 respectively. Then

(A*) $R_1 = 0$ and $R_2 < (R_4 - R_3)$ (B*) $2R < R_4$

(C) $R_1 = 0$ and $R_2 > (R_4 - R_3)$ (D) $R_1 \neq 0$ and $(R_2 - R_1) > (R_4 - R_3)$

Sol. $V_0 = \frac{kQ}{R}$

$V_{centre} = \frac{3kQ}{2R} = \frac{3V_0}{2}$

$\Rightarrow R_1 = 0$

$\frac{5kQ}{4R} = \frac{kQ}{2R^3}(3R^2 - x^2)$

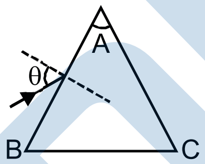
$R_2 = \frac{R}{\sqrt{2}}$

$R_3 = \frac{4R}{3}$

$R_4 = 4R$

$\frac{R}{\sqrt{2}} < \frac{8R}{3}$ & $2R < 4R$

21. Monochromatic light is incident on a glass prism of angle A. If the refractive index of the material of the prism is μ, a ray, incident at an angle θ, on the face AB would get transmitted through the face AC of the prism provided :



(A) $\theta > \cos^{-1}\left[\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(B) $\theta < \cos^{-1}\left[\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(C*) $\theta > \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(D) $\theta < \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

Sol. $1 \sin \theta = m \sin \phi$

$\mu \sin \phi < 1$

$A - \alpha = \phi < \sin^{-1}\left(\frac{1}{\mu}\right)$

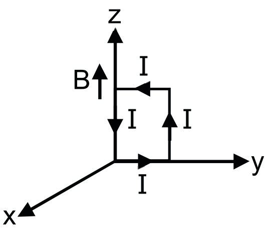
$A - \sin^{-1}\left(\frac{1}{\mu}\right) < \alpha$

$\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)$

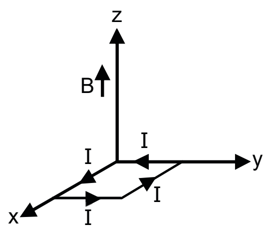
$< \mu \sin \alpha = \sin \theta$

22. A rectangular loop of sides 10 cm and 5 cm carrying a current I of 12 A is placed in different orientations as shown in the figures below :

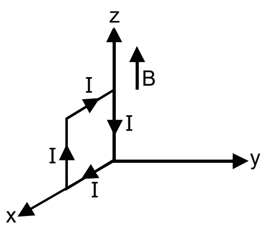
(a)



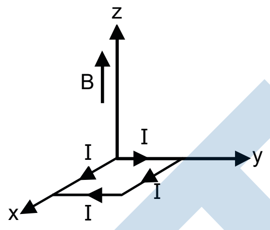
(b)



(c)



(d)



If there is a uniform magnetic field of 0.3 T in the positive z direction, in which orientations the loop would be in (i) stable equilibrium and (ii) unstable equilibrium?

(A*) (b) and (d), respectively (B) (b) and (c), respectively

(C) (a) and (b), respectively (D) (a) and (c), respectively

Sol. Since $\vec{B}$ is uniform, only torque acts on a current carrying loop. $\vec{\tau} = \left(I\vec{A}\right) \times \vec{B}$

$\vec{A} = \hat{A}$ for (b) $\vec{A} = -A\hat{k}$ for (d).

for (b) and A □ □Ak̂

$\therefore \quad \vec{\tau} = 0$ for both these cases.

The energy of the loop in the $\vec{B}$ field is: $U = -I\vec{A} \cdot \vec{B}$, which is minimum for (b).

23. Two coaxial solenoids of different radii carry current I in the same direction. Let $\vec{F}_1$ be the magnetic force on the inner solenoid due to the outer one and $\vec{F}_2$ be the magnetic force on the outer solenoid due to the inner one. Then:

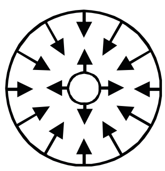
(A) $\vec{F}_1$ is radialy inwards and $\vec{F}_2$ = 0

(2*) $\vec{F}_1$ is radially outwards and $\vec{F}_2$ = 0

(C) $\vec{F}_1 = \vec{F}_2 = 0$

(D) $\vec{F}_1$ is radially inwards and $\vec{F}_2$ is radially outwards

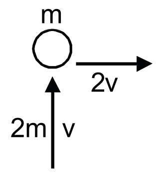
Sol.



24. A particle of mass m moving in the x direction with speed 2v is hit by another particle of mass 2m moving in the y direction with speed v. If the collision is perfectly inelastic, the percentage loss in the energy during the collision is close to:

(A*) 56%   (B) 62%   (C) 44%   (D) 50%

Sol. (1) $2mv\hat{i} + 2mv\hat{j} = 3m\vec{v}$



(2) $\vec{v} = \frac{2}{3}v\hat{i} + \frac{2}{3}v\hat{j}$

(3) $K_i = \frac{1}{2}m \times (2v)^2 + \frac{1}{2}2mv^2 = 3mv^2$

(4) $K_i = \frac{1}{2} \times 3m \times \frac{8}{9}v^2 = \frac{4}{3}mv^2$

25. Consider an ideal gas confined in an isolated closed chamber. As the gas undergoes an adiabatic expansion, the average time of collision between molecules increases as V^q, where V is the volume of the gas. The value of q is :

$\left(\gamma = \frac{C_p}{C_v}\right)$

(A*) $\frac{\gamma+1}{2}$ (B) $\frac{\gamma-1}{2}$ (C) $\frac{3\gamma+5}{6}$ (D) $\frac{3\gamma-5}{6}$

Sol. $\Delta t = \frac{\Delta \ell}{v}$

$TV^{\gamma-1} = C$

$T = CV^{-\gamma+1}$

$\Delta t \propto VT^{-1/2}$

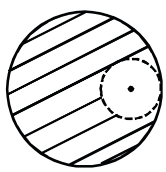
$= V \times CV^{\frac{\gamma-1}{2}}$

$= V^{1+\frac{\gamma-1}{2}}$

$= V^{\frac{\gamma+1}{2}}$

26. From a solid sphere of mass M and radius R, a spherical portion of radius $\frac{R}{2}$ is removed, as shown in the figure. Taking gravitational potential V = 0 at r = ∞, the potential at the centre of the cavity thus formed is :

(G = gravitational constant)

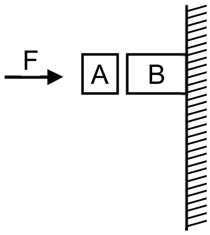


(A) $\frac{-2GM}{3R}$ (B) $\frac{-2GM}{R}$ (C) $\frac{-GM}{2R}$ (D*) $\frac{-GM}{R}$

Sol. $\frac{-GM}{2R^3}\left(3R^2 - \left(\frac{R}{2}\right)^2\right) + \frac{\frac{GM}{8}}{2\left(\frac{R}{2}\right)^3}\left(3\left(\frac{R}{2}\right)^2 - 0^2\right)$

$$= -\frac{GM}{2R^3}\left(\frac{11R^2}{4}\right) + \frac{GM}{8R^3} \times \frac{3R^2}{4} = -\frac{GM}{R}$$

27. Given in the figure are two blocks A and B of weight 20 N and 100 N, respectively. These are being pressed against a wall by a force F as shown. If the coefficient of friction between the blocks is 0.1 and between block B and the wall is 0.15, the friction force applied by the wall on block B is :

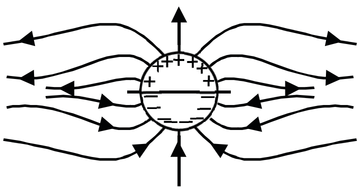


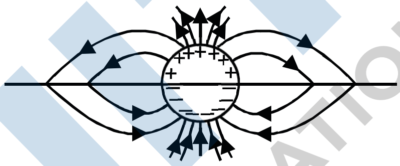
(A*) 120 N (B) 150 N (C) 100 N (D) 80 N

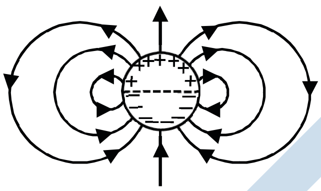
Sol. F = mg

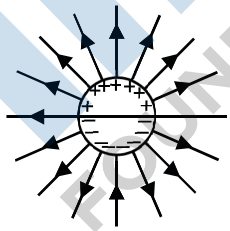
frictional force = 120 N

28. A long cylindrical shell carries positive surface charge σ in the upper half and negative surface charge –σ in the lower half. The electric field lines around the cylinder will look like figure given in : (figures are schematic and not drawn to scale)

(A) 

(B) 

(C*) 

(D) 

Sol. It originates from +Ve charge and terminates at – Ve charge. It can not form close loop.

29. As an electron makes a transition from an excited state to the ground state of a hydrogen - like atom / ion :

(A) kinetic energy decreases, potential energy increases but total energy remains same

(B) kinetic energy and total energy decrease but potential energy increases

(C*) its kinetic energy increase but potential energy and total energy decrease

(D) kinetic energy, potential energy and total energy decrease

Sol. As electron goes to ground state, total energy decreases.

TE = -KE

PE = 2TE

So, kinetic energy increases but potential energy and total energy decreases.

30. Match **List – I** (Fundamental Experiment) with **List – II** (its conclusion) and select the correct option from the choices given below the list :

List – I	**List – II**
(A) Franck-Hertz Experiment.	(i) Particle nature of light
(B) Photo-electric experiment.	(ii) Discrete energy levels of atom
© Davison-Germer Experiment	(iii) Wave nature of electron
	(iv) Structure of atom

(A*) (A) – (ii) ; (B) – (i) ; (C) – (iii)
(B) (A) – (iv) ; (B) – (iii) ; (C) – (ii)
(C) (A) – (i) ; (B) – (iv) ; (C) – (iii)
(D) (A) – (ii) ; (B) – (iv) ; (C) – (iii)

Sol. $J = ne\,V_d$

$$\frac{A\Delta V}{\rho\ell A} = nev_d$$

$$= \qquad \rho = \frac{\Delta v}{\ell n e v_d} = \frac{5}{0.1\times 8\times 10^{28}\times 1.6\times 10^{-19} 2.5\times 10^{-4}}$$

$=1.56 \times 10^{-5}$

$\approx 1.6 \times 10^{-5}\ \Omega m$

PART-B-MATHEMATICS

31. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three non-zero vectors such that no two of them are collinear and $(\vec{a}\times\vec{b})\times\vec{c} = \frac{1}{3}|\vec{b}||\vec{c}|\vec{a}$. If θ is the angle between vectors $\vec{b}$ and $\vec{c}$, then a value of $\sin\theta$ is

(A) $\frac{2}{3}$ (B) $\frac{-2\sqrt{3}}{3}$ (C*) $\frac{2\sqrt{2}}{3}$ (D) $\frac{-\sqrt{2}}{3}$

Sol. $(\vec{a}.\vec{c})\vec{b} - (\vec{b}.\vec{c})\vec{a} = \frac{1}{3}|\vec{b}||\vec{c}|\vec{a}$

$(\vec{a}.\vec{c})\,\vec{b} = \left(\vec{b}.\vec{c} + \frac{1}{3}|\vec{b}||\vec{c}|\right)\vec{a}$

$\vec{b}.\vec{c} + \frac{1}{3}|\vec{b}||\vec{c}| = 0 \quad \Rightarrow \cos\theta = -\frac{1}{3} \Rightarrow \sin\theta = \frac{2\sqrt{2}}{3}$

32. Let O be the vertex and Q be any point on the parabola, $x^2 = 8y$. If the point P divides the line segment OQ internally in the ratio 1 : 3, then the locus of P is

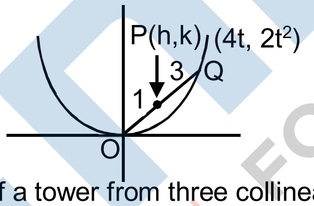
(A) $y^2 = 2x$ (B*) $x^2 = 2y$ (C) $x^2 = y$ (D) $y^2 = x$

Sol. $h = t$

$2k = t^2$

$\therefore \quad h^2 = 2k$

$\Rightarrow \quad x^2 = 2y$



33. If the angles of elevation of the top of a tower from three collinear points A, B and C, on a line leading to the foot of the tower, are 30°, 45° and 60° respectively, then the ratio, AB : BC is

(A) $1:\sqrt{3}$ (B) 2 : 3 (C*) $\sqrt{3}:1$ (D) $\sqrt{3}:\sqrt{2}$

Sol. $h = \sqrt{3}\,CD$

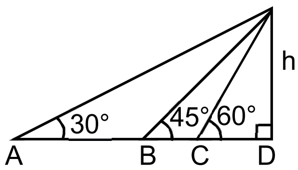
$h = BC + CD$

$h = \frac{(AB + BC + CD)}{\sqrt{3}}$

$BC = \left(\frac{\sqrt{3}-1}{\sqrt{3}}\right)h$

$AB = \left(\sqrt{3}-1\right)h$

$\Rightarrow AB : BC = \sqrt{3}:1$



34. The number of points, having both co-ordinates as integers, that lie in the interior of the triangle with vertices (0, 0), (0, 41) and (41, 0), is

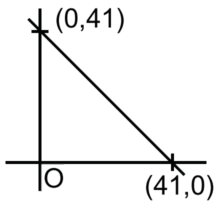
(A) 820 (B*) 780 (C) 901 (D) 86

Sol. $x + y < 41, \quad x, y > 0$

$x + y \le 40, \quad x, y \ge 1$

$x + y + z \le 38, \quad x, y, z \ge 0$

Required number of points = ${}^{40}C_2 = 780$



35. The equation of the plane containing the line $2x - 5y + z = 3$; $x + y + 4z = 5$, and parallel to the plane, $x + 3y + 6z = 1$, is

(A*) $x + 3y + 6z = 7$ (B) $2x + 6y + 12z = -13$

(C) $2x + 6y + 12z = 13$ (D) $x + 3y + 6z = -7$

Sol. Putting $z = 0$, get $x = 4, y = 1$

$\therefore$ (4, 1, 0)

Required plane is

$1\cdot(x - 4) + 3(y - 1) + 6(z - 0) = 0$

$x + 3y + 6z = 7$

36. Let A and B be two sets containing four and two elements respectively. Then the number of subsets of the set A × B, each having at least three elements is

(A) 275 (B) 510 (C*) 219 (D) 256

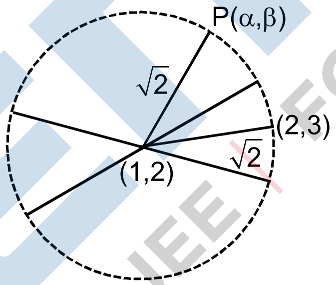
Sol. $2^8 - ({}^8C_0 + {}^8C_1 + {}^8C_2) = 256 - (1 + 8 + 28) = 219$

37. Locus of the image of the point (2, 3) in the line $(2x - 3y + 4) + k(x - 2y + 3) = 0$, $k \in R$, is a

(A*) circle of radius $\sqrt{2}$. (B) circle of radius $\sqrt{3}$.

(C) straight line parallel to x-axis. (D) straight line parallel to y-axis.

Sol. Required locus will be a circle whose centre is (1, 2), and radius is $\sqrt{2}$.



38. $\lim_{x\to 0} \frac{(1-\cos 2x)(3+\cos x)}{x\tan 4x}$ is equal to

(A*) 2 (B) $\frac{1}{2}$ (C) 4 (D) 3

Sol. $\lim_{x\to 0} \frac{(1-\cos 2x)(3+\cos x)}{4x\cdot\frac{x\tan 4x}{4x}} = \frac{1}{2}\times 4 = 2$

39. The distance of the point (1, 0, 2) from the point of intersection of the line $\frac{x-2}{3} = \frac{y+1}{4} = \frac{z-2}{12}$ and the plane $x - y + z = 16$, is

(A) $3\sqrt{21}$ (B*) 13 (C) $2\sqrt{14}$ (D) 8

Sol. General point on the line is $(3r + 2, 4r - 1, 12r + 2)$ which satisfies the plane $x - y + z = 16$.

$3r + 2 - 4r + 1 + 12r + 2 = 16 \Rightarrow r = 1$

Required distance between points (5, 3, 14) and (1, 0, 2) is13.

40. The sum of coefficients of integral powers of x in the binomial expansion of $\left(1-2\sqrt{x}\right)^{50}$ is

(A) $\frac{1}{2}\left(3^{50}-1\right)$ (B) $\frac{1}{2}\left(2^{50}+1\right)$ (C*) $\frac{1}{2}\left(3^{50}+1\right)$ (D) $\frac{1}{2}\left(3^{50}\right)$

Sol. ${}^{50}C_0 + {}^{50}C_2 \cdot 2^2 + {}^{50}C_4 \cdot 2^4 + \ldots\ldots + {}^{50}C_{50} \cdot 2^{50} = \frac{1}{2}(3^{50} + 1)$

41. The sum of first 9 terms of the series $\frac{1^3}{1}+\frac{1^3+2^3}{1+3}+\frac{1^3+2^3+3^3}{1+3+5}+\ldots\ldots$ is

(A) 142 (B) 192 (C) 71 (D*) 96

Sol. $T_n = \frac{(n+1)^2}{4}$

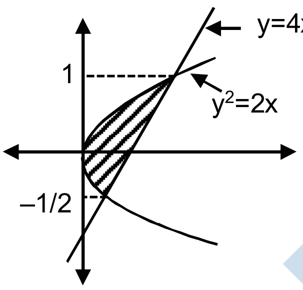
$S_n = \frac{1}{4}\left(\frac{n(n+1)(2n+1)}{6}+2\frac{n(n+1)}{2}+n\right)$

$\therefore \quad S_9 = 96.$

42. The area (in sq. units) of the region described by $\{(x, y) : y^2 \le 2x \text{ and } y \ge 4x - 1\}$ is

(A) $\frac{15}{64}$ (B*) $\frac{9}{32}$ (C) $\frac{7}{32}$ (D) $\frac{5}{64}$

Sol.



Required area= $\int_{-\frac{1}{2}}^{1}\left(\frac{y+1}{4}-\frac{y^2}{2}\right)dy = \frac{9}{32}.$

43. The set of all values of λ for which the system of linear equations

$2x_1 - 2x_2 + x_3 = \lambda x_1$

$2x_1 - 3x_2 + 2x_3 = \lambda x_2$

$-x_1 + 2x_2 = \lambda x_3$

has a non-trivial solution,

(A*) contains two elements (B) contains more than two elements

(C) is an empty set (D) is a singleton

Sol. $\begin{vmatrix} 2-\lambda & -2 & 1 \\ 2 & -(3+\lambda) & 2 \\ -1 & 2 & -\lambda \end{vmatrix} = 0 \Rightarrow \lambda = 1, -3.$

44. A complex number z is said to be unimodular if |z| = 1. Suppose z_1 and z_2 are complex numbers such that $\frac{z_1 - 2z_2}{2 - z_1\bar{z}_2}$ is unimodular and z_2 is not unimodular. Then the point z_1 lies on a

(A*) circle of radius 2
(B) circle of radius $\sqrt{2}$
(C) straight line parallel to x-axis
(D) straight line parallel to y-axis

Sol. $\left|\frac{z_1 - 2z_2}{2 - z_1\bar{z}_2}\right| = 1$

$\Rightarrow |z_1 - 2z_2| = |2 - z_1\bar{z}_2|$

$|z_1|^2 - 2z_1\bar{z}_2 - 2z_2\bar{z}_1 + 4|z_1|^2 = 4 - 2\bar{z}_1\bar{z}_2 - 2z_1\bar{z}_2 + |z_1|^2|z_2|^2$

$(|z_2|^2 - 1)(|z_1|^2 - 4) = 0 \Rightarrow |z_1| = 2.$

45. The number of common tangents to the circles

$x^2 + y^2 - 4x - 6y - 12 = 0$ and $x^2 + y^2 + 6x + 18y + 26 = 0$, is

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

Sol. $C_1C_2 = r_1 + r_2$

$\therefore$ circles touches each other externally, hence they have exactly 3 common tangents.

46. The number of integers greater than 6,000 that can be formed, using the digits 3, 5, 6, 7 and 8 without repetition, is

(A) 120 (B) 72 (C) 216 (D*) 192

Sol. N > 6000

[• | • | • | •] $= {}^3C_1 \times {}^4C_3 \times 3! = 72$

4 digit number

[• | • | • | • | •] $= 5! = 120$

5 digit number

$\therefore$ Total = 72 + 120 = 192

47. Let y(x) be the solution of the differential equation $(x \log x)\frac{dy}{dx} + y = 2x \log x$, $(x \geq 1)$. Then y(e) is equal to

(A*) 2 (B) 2e (C) e (D) 0

Sol. Integrating factor = $\ell n\, x$

$\therefore$ General solution is

$y(\ln x) = 2(x\, \ell n\, x - x) + c$

Put x = 1, we get c = 2

$\therefore y(e) = 2$

48. If $A' = \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ a & 2 & b \end{bmatrix}$ is a matrix satisfying the equation $AA^T = 9I$, where I is 3 × 3 identity matrix, then the ordered pair (a, b) is equal to

(A) (2, 1) (B*) (–2, –1) (C) (2, –1) (D) (–2, 1)

Sol. $AA^T = 9\,I$

$$= \begin{bmatrix} 9 & 0 & a+4+2b \\ 0 & 9 & 0 \\ a+4+2b & 2a+2-2b & a^2+4+b^2 \end{bmatrix}$$

$$\begin{bmatrix} 9 & 0 & 0 \\ 0 & 9 & 0 \\ 0 & 0 & 9 \end{bmatrix}$$

∴ On solving, a + 2b = –4 2a – 2b = –2

We get (a = –2, b = –1)

49. If m is the A.M. of two distinct real numbers ℓ and n (ℓ, n > 1) and G_1, G_2 and G_3 are three geometric means between ℓ and n, then $G_1^4 + 2G_2^4 + G_3^4$ equals.

(A) $4\,\ell mn^2$ (B) $4\,\ell^2m^2n^2$ (C) $4\,\ell^2mn$ (D*) $4\,\ell m^2n$

Sol. $m = \dfrac{\ell + n}{2}$ ……(A)

$G_1^4 = n\,\ell^3$ ……(B)

$G_2^4 = n^2\,\ell^2$ ……(C)

$G_3^4 = \ell n^3$ ……(D)

∴ $\left(G_1^4 + 2G_2^4 + G_3^4\right) = n\,\ell\,(\ell + n)^2 = 4n\,\ell m^2$.

50. The negation of $\sim s \vee (\sim r \wedge s)$ is equivalent to

(A) $s \vee (r \vee \sim s$ (B*) $s \wedge r$ (C) $s \wedge \sim r$ (D) $s \wedge (r \wedge \sim s)$

Sol.

r	s	~ r	~ s	(~ r ∧ s)	~ s(~ r ∧ s)	s ∧ r
T	F	F	T	F	T	F
F	T	T	F	T	T	F
F	F	T	T	F	T	F
T	T	F	F	F	F	T

∴ Negation of statement $\sim s \vee (\sim r \wedge s)$ is equivalent to $(s \wedge r)$

51. The integral $\int \dfrac{dx}{x^2(x^4+1)^{\frac{3}{4}}}$ equals

(A) $-(x^4+1)^{\frac{1}{4}} + c$ (B*) $-\left(\dfrac{x^4+1}{x^4}\right)^{\frac{1}{4}} + c$ (C) $\left(\dfrac{x^4+1}{x^4}\right)^{\frac{1}{4}} + c$ (D) $(x^4+1)^{\frac{1}{4}} + c$

Sol. $I = \int \frac{dx}{x^5\left(1+\frac{1}{x^4}\right)^{\frac{3}{4}}}$

Put $\left(1+\frac{1}{x^4}\right) = t \Rightarrow \frac{-4}{x^5}dx = dt$

$\therefore \quad I = \frac{-1}{4}\int t^{\frac{-3}{4}}\,dt = -\left(\frac{x^4+1}{x^4}\right)^{\frac{1}{4}} + c$

52. The normal to the curve, $x^2 + 2xy - 3y^2 = 0$, at (1, 1)

(A) meets the curve again in the third quadrant. (B*) meets the curve again in the fourth quadrant.

(C) does not meet the curve again. (D) meets the curve again in the second quadrant.

Sol. Slope of normal at (1, 1) on the curve = – 1

$\therefore$ Equation of normal is $x + y = 2$ ......(A)

Put $y = (2 - x)$ in the curve $x^2 + 2xy - 3y^2 = 0$, we get (1, 1) and (3, – 1)

53. Let $\tan^{-1}y = \tan^{-1}x + \tan^{-1}\left(\frac{2x}{1-x^2}\right)$, where $|x| < \frac{1}{\sqrt{3}}$. Then a value of y is

(A) $\frac{3x-x^3}{1+3x^2}$ (B) $\frac{3x+x^3}{1+3x^2}$ (C*) $\frac{3x-x^3}{1-3x^2}$ (D) $\frac{3x+x^3}{1-3x^2}$

Sol. $\tan^{-1} y = 3\tan^{-1}x = \tan^{-1}\left(\frac{3x-x^3}{1-3x^2}\right)$, $|x| < \frac{1}{\sqrt{3}}$

$\Rightarrow \quad y = \left(\frac{3x-x^3}{1-3x^2}\right)$

54. If the function $g(x) = \begin{cases} k\sqrt{x+1}, & 0 \le x \le 3 \\ mx+2, & 3 < x \le 5 \end{cases}$ is differentiable, then the value of k + m is

(A) $\frac{10}{3}$ (B) 4 (C*) 2 (D) $\frac{16}{5}$

Sol. By continuity of functions, we get $2k = 3m + 2$ ....(A)

By differentiability of function, we get $k = 4m$ ....(B)

$\therefore$ On solving (A) and (B), we get $m = \frac{2}{5}$, $k = \frac{8}{5}$

55. The mean of the data set comprising of 16 observations is 16. If one of the observation valued 16 is deleted and three new observations valued 3, 4 and 5 are added to the data, then the mean of the resultant data, is

(A) 15.8 (B*) 14.0 (C) 16.8 (D) 16.0

Sol. Let Observations be

$x_1, x_2, x_3, \ldots\ldots\ldots., x_{16}$

$\therefore \quad n = 16, \ \bar{x} = 16$

$\Rightarrow \quad 16 = \frac{x_1 + x_2 + \ldots\ldots + x_{16}}{16}$

$\Rightarrow \quad x_1 + x_2 + \ldots\ldots\ldots + x_{16} = 256$

Let $x_1 = 16$ (deleted)

$\Rightarrow \quad (x_2 + x_3 + \ldots\ldots\ldots\ldots + x_{16}) = 256 - 16 = 240$

$\therefore$ New mean

$$\frac{12 + (x_2 + x_3 + \ldots\ldots + x_{16})}{18} = \frac{12 + 240}{18} = \frac{252}{18} = 14$$

56. The integral $\int_2^4 \frac{\log x^2}{\log x^2 + \log(36 - 12x + x^2)} dx$ is equal to

(A*) 1 (B) 6 (C) 2 (D) 4

Sol. Let $I = \int_2^4 \frac{\ell og\, x^2}{\ell og\, x^2 + \ell og(x-6)^2} dx$ .....(A)

Also, $I = \int_2^4 \frac{\log(x-6)^2}{\log(x-6)^2 + \log x^2} dx$ ......(B) (using king property)

$\therefore$ (A) + (B) $\Rightarrow 2I = \int_2^4 1\, dx \Rightarrow I = \frac{2}{2} = 1.$

57. Let α and β be the roots of equation $x^2 - 6x - 2 = 0$. If $a_n = \alpha^n - \beta^n$, for $n \geq 1$, then the value of $\frac{a_{10} - 2a_8}{2a_9}$ is equal to

(A*) 3 (B) –3 (C) 6 (D) –6

Sol. $\frac{a_{10} - 2a_8}{2a_9} = \frac{\alpha^8(\alpha^2 - 2) - \beta^8(\beta^2 - 2)}{2(\alpha^9 - \beta^9)} = \frac{6(\alpha^9 - \beta^9)}{2(\alpha^9 - \beta^9)} = 3$

58. Let f(x) be a polynomial of degree four having extreme values at x = 1 and x = 2. If $\lim_{x \to 0}\left[1 + \frac{f(x)}{x^2}\right] = 3$, then f(B) is equal to

(A*) 0 (B) 4 (C) –8 (D) –4

Sol. We have $\lim_{x \to 0} \frac{f(x)}{x^2} = 2$

$\therefore \quad f(x) = (ax^4 + bx^3 + 2x^2)$

Now, $f'(A) = 0 \quad \Rightarrow \quad 4a + 3b = -4$

and $f'(B) = 0 \quad \Rightarrow \quad 8a + 3b = -2$

$\therefore$ we get, $a = \frac{1}{2}$, $b = -2$

So, f (B) = 0

59. The area (in sq. units) of the quadrilateral formed by the tangents at the end points of the latera recta to the ellipse $\frac{x^2}{9}+\frac{y^2}{5}=1$ is

(A) $\frac{27}{2}$ (B*) 27 (C) $\frac{27}{4}$ (D) 18

Sol. Area = $\frac{2a^2}{e}=\frac{2\times 9}{\frac{2}{3}}=27$

60. If 12 identical balls are to be placed in 3 identical boxes, then the probability that one of the boxes contains exactly 3 balls is

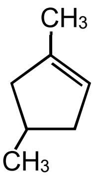
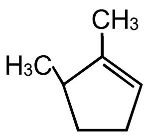
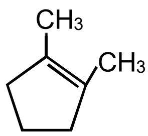
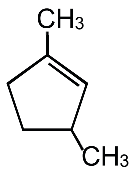
(A) $220\left(\frac{1}{3}\right)^{12}$ (B) $22\left(\frac{1}{3}\right)^{11}$ (C*) $\frac{55}{3}\left(\frac{2}{3}\right)^{11}$ (D) $55\left(\frac{2}{3}\right)^{10}$

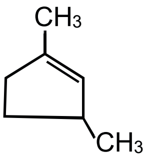
Sol. Consider 12 different balls and 3 different boxes

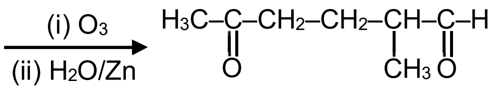
$\therefore$ Probability = $\frac{{}^{12}C_3\,(2)^9}{3^{12}}=\left(\frac{12\times 11\times 10}{6}\right)\times\frac{(2)^9}{(3^{12})}=\frac{55}{3}\left(\frac{2}{3}\right)^{11}$

PART-C-CHEMISTRY

61. Which compound would give 5 – keto – 2 – methyl hexanal upon ozonolysis?

(A) 
(B) 
(C) 
(D*) 

Sol. (D) 



62. Which of the vitamins given below is water soluble?

(A) Vitamin E (B) Vitamin K (C*) Vitamin C (D) Vitamin D

Sol. (C) Vitamin C is water soluble, Vitamin A, D, E are fat soluble.

63. Which one of the following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy?

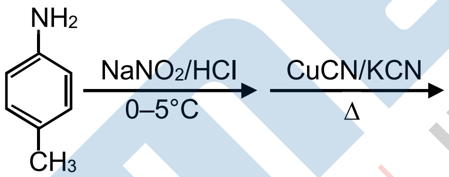
(A) $BaSO_4$ (B) $SrSO_4$ (C) $CaSO_4$ (D*) $BeSO_4$

Sol. (D) Solubility order of sulphates in water $BeSO_4 > CaSO_4 > SrSO_4 > BaSO_4$

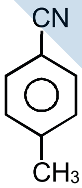
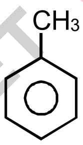
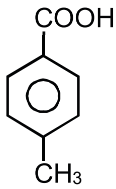
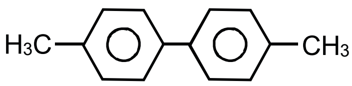
$BeSO_4$ has greater hydration enthalpy than its lattice enthalpy

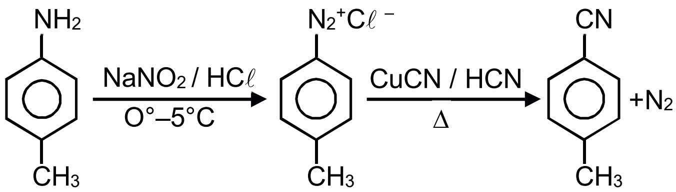
Because Be^{2+} ion has maximum charge density.

64. In the reaction :



E + N_2 the product E is :

(A*) 
(B) 
(C) 
(D) 

Sol. (A) 

65. Sodium metal crystallizes in a body centred cubic lattice with a unit cell edge of 4.29 Å. The radius of sodium atom is approximately :

(A) 5.72 Å (B) 0.93 Å (C*) 1.86 Å (D) 3.22 Å

Sol. (C) $\sqrt{3}a = 4r$

$r = \frac{\sqrt{3} \times 4.29}{4} \cong 1.86\,Å$

66. Which of the following compounds is not colored yellow?

(A) $(NH_4)_3[As(Mo_3O_{10})_4]$ (B) $BaCrO_4$

(C*) $Zn_2[Fe(CN)_6]$ (D) $K_3[Co(NO_2)_6]$

Sol. (C) $Zn_2[Fe(CN)_6]$ = Bluish white coloured

67. Which of the following is the energy of a possible excited state of hydrogen?

(A*) – 3.4 eV (B) + 6.8 eV (C) + 13.6 eV (D) – 6.8 eV

Sol. (A) $E_n = -13.6 \times \frac{z^2}{n^2}$

z = 1 and n = 2

$E_2 = -3.4$ eV

68. Which of the following compounds is not an antacid?

(A*) Phenelzine (B) Ranitidine

(C) Aluminium hydroxide (D) Cimetidine

Sol. (A) Ranitidine, $Al(OH)_3$, Cimetidine are antacids. Phenelzine is anti depresent.

69. The ionic radii (in Å) of N^{3-}, O^{2-} and F^- are respectively?

(A*) 1.71, 1.40 and 1.36 (B) 1.71, 1.36 and 1.40

(C) 1.36, 1.40 and 1.71 (D) 1.36, 1.71 and 1.40

Sol. (A) Ionic radii order

N^{3-} > O^{2-} > F^- [All are isoelectronic species]

1.71 1.40 1.36

70. In the context of the Hall-Heroult process for the extraction of Al, which of the following statements is false?

(A) Al^{3+} is reduced at the cathode to form Al

(B*) Na_3AlF_6 serves as the electrolyte

(C) CO and CO_2 are produced in this process

(D) Al_2O_3 is mixed with CaF_2 which lowers the melting point of the mixture and brings conductivity

Sol. (B) In Hall Heroult process alumina (Al_2O_3) is used as electrolyte.

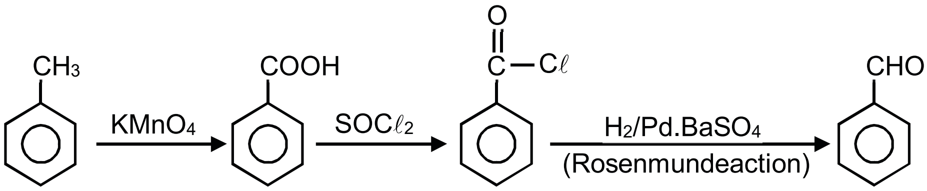
Cryolite (Na_3AlF_6) and Fluospar (CaF_2) are used to lowers the melting point of the mixture and brings conductivity

71. In the following sequence of reactions :

Toluene $\xrightarrow{KMnO_4}$ A $\xrightarrow{SOC\ell_2}$ B $\xrightarrow[BaSO_4]{H_2/Pd}$ C the product C is :

(A) $C_6H_5CH_2OH$ (B*) C_6H_5CHO (C) C_6H_5COOH (D) $C_6H_5CH_3$

Sol. (B)



72. Higher order (>3) reactions are rare due to :

(A) shifting of equilibrium towards reactants due to elastic collisions

(B) loss of active species on collision

(C*) low probability of simultaneous collision of all the reacting species

(D) increase in entropy and activation energy as more molecules are involved.

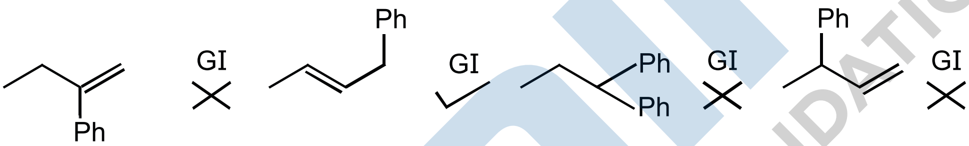
Sol. Higher order (>3) reactions are less probable due to low probability of simultaneous collision of all the reacting species.

73. Which of the following compounds will exhibit geometrical isomerism?

(A) 2 -Phenyl -1 -butene | (B) 1, 1 -Diphenyl -1 -propane

(C*) 1 -Phenyl -2 -butene | (D) 3 -Phenyl -1 -butene

Sol. (C)



74. Match the catalysts to the correct processes:

Catalyst	**Process**
(A) $TiC\ell_3$	(i) Wacker process
(B) $PdC\ell_2$.	(ii) Ziegler -Natta Polymerization
(C) $CuC\ell_2$	(iii) Contact process
(D) V_2O_5	(iv) Deacon's process

(A) (A) -(ii), (B) -(iii), (C) -(iv), (D) -(i) | (B) (A) -(iii), (B) -(i), (C) -(ii), (D) -(iv)

(C) (A) -(iii), (B) -(ii), (C) -(iv), (D) -(i) | (D*) (A) -(ii), (B) -(i), (C) -(iv), (D) -(iii)

Sol. $TiCl_4 + (C_2H_5)_3Al \rightarrow$ Ziegler Natta catalyst, used for coordination polymerization.

$$CH_2 = CH_2 \xrightarrow[H_2O+PdCl_2]{\text{Waker procerss}} CH_3 - CHO + 2HCl$$

$CuCl_2 \rightarrow$ used as catalyst in Deacon's process of production of Cl_2.
$V_2O_5 \rightarrow$ used as catalyst in Contact Process of manufacturing of H_2SO_4.

75. The intermolecular interaction that is dependent on the inverse cube of distance between the molecules is :

(A) London force | (B*) Hydrogen bond

(C) Ion -ion interaction | (D) Ion -dipole interaction

Sol. By considering intermolecular interaction as force.

(A) London force $\alpha \frac{1}{r^6}$ | (B) Hydrogen bond $\alpha \frac{1}{r^4}$

(C) Ion -ion interaction $\alpha \frac{1}{r^2}$ | (D) Ion -dipole interaction $\alpha \frac{1}{r^3}$

76. The molecular formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3Na$ (Mol. wt. 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin?

(A) $\frac{2}{309}$ (B*) $\frac{1}{412}$ (C) $\frac{1}{103}$ (D) $\frac{1}{206}$

Sol. (B) $2C_8H_7SO_3Na + Ca^{2+} \longrightarrow (C_8H_7SO_3)_2Ca + 2Na^+$ $\frac{1}{206}$ mole 0 $\frac{1}{2}\times\frac{1}{206}$ mole $= \frac{1}{412}$ mole $\frac{1}{412}$

mole of Ca^{2+} per gram of resin.

77. Two Faraday of electricity is passed through a solution of $CuSO_4$. The mass of copper deposited at the cathode is : (at. mass of Cu =63.5 amu)

(A) 2 g (B) 127 g (C) 0 g (D*) 63.5 g

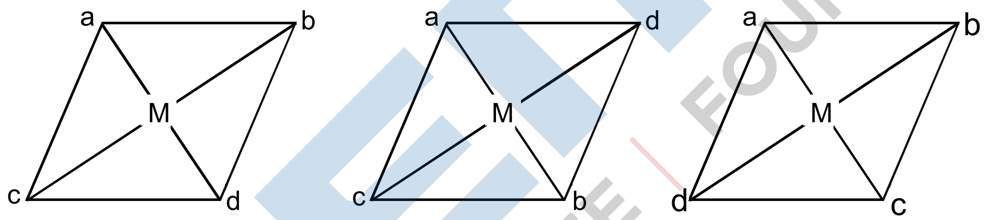
Sol. (D) $Cu^{2+} + 2e^- \longrightarrow Cu(s)$

2 equivalents of $Cu^{2+} = 2 \times \frac{63.5}{2} = 63.5$ gm

78. The number of geometric isomers that can exist for square planar $[Pt\ (Cl)\ (py)\ (NH_3)\ (NH_2OH)]^+$ is (py = pyridine) :

(A) 4 (B) 6 (C) 2 (D*) 3

Sol. (D) $[Pt(C\ell)(py)(NH_3)(NH_2OH)]^+$ has three geometric isomers = [Mabcd]



79. In Carius method of estimation of halogens, 250 mg of an organic compound gave 141 mg of AgBr. The percentage of bromine in the compound is : (at. mass Ag =108; Br =80)

(A) 48 (B) 60 (C*) 24 (D) 36

Sol. (C) Sample $\longrightarrow$ AgBr % of Ag = $\dfrac{\frac{141}{188}\times 80}{250}\times 100 \cong 24$

80. The color of $KMnO_4$ is due to :

(A*) L $\rightarrow$ M charge transfer transition (B) $\sigma-\sigma^*$ transition

(C) M $\rightarrow$ L charge transfer transition (D) d – d transition

Sol. (A) The colour of $KMnO_4$ is due to ligands (L) $\rightarrow$ metal charge transfer transition.

due to high value of positive charge on Mn

81. The synthesis of alkyl fluorides is best accomplished by :

(A) Finkelstein reaction (B*) Swarts reaction

(C) Free radical fluorination (D) Sandmeyer's reaction

Sol. (B) $R–Cl + AgF \xrightarrow[\text{Or DMF}]{\text{DMSO}} R–F + AgCl$

82. 3 g of activated charcoal was added to 50 mL of acetic acid solution (0.06N) in a flask. After an hour it was filtered and the strength of the filtrate was found to be 0.042 N. The amount of acetic acid adsorbed (per gram of charcoal) is :

(A) 42 mg (B) 54 mg (C*) 18 mg (D) 36 mg

Sol. For acetic acid molarity = Normality

Initial millimoles of CH_3COOH = 50 × 0.06 = 3

Final millimoles of CH_3COOH = 50 × 0.042 = 2.1

Millimoles of CH_3COOH adsorbed = 3 – 2.1 = 0.9

Mass of CH_3COOH adsorbed = $\frac{0.9}{1000} \times 60 = 54 \times 10^{-3}$ g = 54 mg

Mass of CH_3COOH adsorbed per gram charcoal = $\frac{54}{3}$mg = 18 mg

83. The vapour pressure of acetone at 20°C is 185 torr. When 1.2 g of a non-volatile substance was dissolved in 100 g of acetone at 20°C, its vapour pressure was 183 torr. The molar mass (g mol^{-1}) of the substance is :

(A) 128 (B) 488 (C) 32 (D*) 64

Sol. (D) $\frac{P_A^o - P_S}{P_S} = \frac{n_B}{n_A}$

$\frac{185 - 183}{183} = \frac{1.2 \times 58}{M \times 100}$

M = 64

84. Which among the following is the most reactive?

(A) I_2 (B*) $IC\ell$ (C) $C1_2$ (D) Br_2

Sol. (B) In general interhalogen compounds are more reactive than halogens (except fluorine). $IC\ell$ is interhalogen compounds.

85. The standard Gibbs energy change at 300 K for the reaction 2A ⇌ B + C is 2494.2 J. At a given time, the composition of the reaction mixture is [A] = $\frac{1}{2}$, [B] = 2 and [C] = $\frac{1}{2}$. The reaction proceeds in the: [R = 8.314 J/K/mol, e = 2.718]

(A) forward direction because $Q < K_C$ (B) reverse direction because $Q < K_C$

(C) forward direction because $Q > K_C$ (D*) reverse direction because $Q > K_C$

Sol. (D) $\Delta G° = – RT\ \ell n\ K$

$2494.2 = – 8.314 \times 300\ \ell n\ K$

$\ell n\ K = – 1 = \ell n\ \frac{1}{e}$

$K = \frac{1}{e}$

$$\theta = \frac{[B]_t[C]_t}{[A]_t^2} = \frac{2 \times \frac{1}{2}}{\left(\frac{1}{2}\right)^2} = 4$$

$\theta > K \Rightarrow$ (4)

86. **Assertion:** Nitrogen and Oxygen are the main components in the atmosphere but these do not react to form oxides of nitrogen.

Reason: The reaction between nitrogen and oxygen requires high temperature.

(A) The assertion is incorrect, but the reason is correct

(B) Both the assertion and reason are incorrect

(C*) Both assertion and reason are correct, and the reason is the correct explanation for the assertion

(D) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion

Sol. (C) Nitrogen is not react in normal condition because N_2 has triple bond which provide inert nature to N_2

$$N_2 + O_2 \xrightarrow{2000°C-3000°C} 2NO$$

87. Which one has the highest boiling point?

(A) Kr (B*) Xe (C) He (D) Ne

Sol. (B) Highest boiling point is Xe

He < Ne < Kr < Xe

(i) Induced dipole – Induced dipole interaction increases as size of atom increases.

(ii) B.P.↑

88. Which polymer is used in the manufacture of paints and lacquers?

(A) Polypropene (B) Poly vinyl chloride (C) Bakelite (D*) Glyptal

Sol. (D) Glyptal is used in the manufacturing of paints & lacquers.

89. The following reaction is performed at 298 K.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$$

The standard free energy of formation of NO(g) is 86.6 kJ/mol at 298 K. What is the standard free energy of formation of $NO_2(g)$ at 298 K? ($K_p = 1.6\times10^{12}$)

(A) $86600 - \dfrac{\ell n(1.6\times10^{12})}{R(298)}$

(B*) $0.5[2 \times 86,600 - R(298)\ \ell n(1.6 \times 10^{12})]$

(C) $R(298)\ \ell n(1.6 \times 10^{12}) - 86600$

(D) $86600 + R(298)\ \ell n(1.6 \times 10^{12})$

Sol. (B) $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

$$\Delta G° = 2\Delta_f G° (NO_2) - \Delta_f G° (O_2) - 2\Delta_f G° (NO)$$

$$= -RT\ \ell n\ K$$

$$\Delta_f G° (NO_2) = \frac{1}{2}\left(2\times86600 - R\times298\ \ell n(1.6\times10^{12})\right)$$

90. From the following statements regarding H_2O_2, choose the incorrect statement:

(A) It has to be stored in plastic or wax lined glass bottles in dark

(B) It has to be kept away from dust

(C*) It can act only as an oxidizing agent

(D) It decomposes on exposure to light

Sol. (C) H_2O_2 act as both as oxidizing agent or reducing agent.