JEE Main Online Exam 2026

Memory Based
Questions & Solution
24th January 2026 | Morning

PHYSICS

1. Electric potential at a point is $V = Ar^3 + B$. Find charge enclosed in a sphere of radius 1 m, centered at $r = 0$

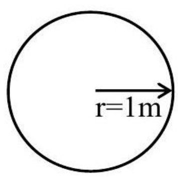
(1) $-4\varepsilon_0$ A (2) $-8\varepsilon_0$ A (3) $-12\varepsilon_0$ A (4) $-16\varepsilon_0 A$

Ans. **[3]**

Sol. $E = -\frac{dv}{dr}$

$E = -3Ar^2$

Charge enclosed in 1 m radius is



Applying guass law

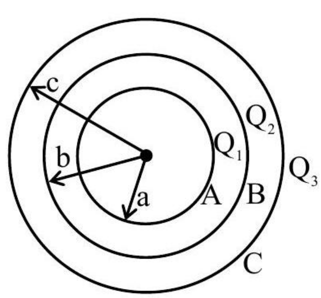
$\oint \varepsilon.ds = \frac{q_{in}}{\varepsilon_0}$

$E.S = \frac{q_{in}}{\varepsilon_0}$

$q_{in} = .\varepsilon_0 ES = -\varepsilon_0.(3Ar^2)(4\pi r^2)$

$q_{in})_{r=1\,m} = -12\varepsilon_0$ A

2. Three uniformly charged concentric shells are kept as shown in the diagram. Charges on individual shells are as shown. Find the final potential on each shell :



(1) $V_A = \frac{KQ_1}{a} + \frac{KQ_2}{b} + \frac{KQ_3}{c}$

$V_B = \frac{K(Q_1 + Q_2 + Q_3)}{c}$

$V_C = \frac{KQ_1}{b} + \frac{KQ_2}{b} + \frac{KQ_3}{c}$

(2) $V_A = \frac{KQ_1}{b} + \frac{KQ_2}{b} + \frac{KQ_3}{c}$

$V_B = \frac{KQ_1}{a} + \frac{KQ_2}{b} + \frac{KQ_3}{c}$

$V_C = \frac{K(Q_1 + Q_2 + Q_3)}{c}$

(3) $V_A = \frac{K(Q_1 + Q_2 + Q_3)}{c}$

$V_B = \frac{KQ_1}{b} + \frac{KQ_2}{b} + \frac{KQ_3}{c}$

$V_C = \frac{KQ_1}{a} + \frac{KQ_2}{b} + \frac{KQ_3}{c}$

(4) $V_A = \frac{KQ_1}{a} + \frac{KQ_2}{b} + \frac{KQ_3}{c}$

$V_B = \frac{KQ_1}{b} + \frac{KQ_2}{b} + \frac{KQ_3}{c}$

$V_C = \frac{K(Q_1 + Q_2 + Q_3)}{c}$

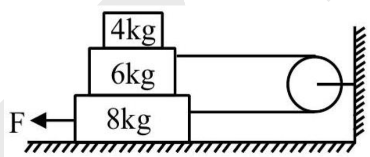
Ans. **[4]**

Sol. $V_A = \frac{KQ_1}{a} + \frac{KQ_2}{b} + \frac{KQ_3}{c}$

$V_B = \frac{KQ_1}{b} + \frac{KQ_2}{b} + \frac{KQ_3}{c}$

$V_C = \frac{KQ_1}{c} + \frac{KQ_2}{c} + \frac{KQ_3}{c} = \frac{K(Q_1 + Q_2 + Q_3)}{c}$

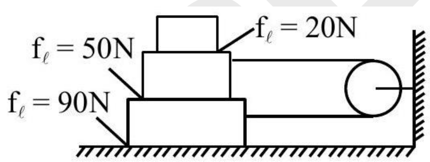
3. Figure shows three block with masses $8\text{ kg}, 6\text{ kg}$ and 4 kg. Friction coefficient between each surface is $\frac{1}{2}$. The maximum value of force 'F' such that 8 kg block moves with constant velocity will be :



(1) 210 N (2) 400 N (3) 110 N (4) 300 N

Ans. **[1]**

Sol. For 8 kg to move with constant velocity $F_{net} = 0$.



$\therefore F = 90 + T + 50$ (for 8 kg block)

$T = 20 + 50$ (for 6 kg block)

$\therefore F = 210\text{ N}$.

4. **Statement-I:** Greater is the mass of nucleus, more will be its binding energy.

Statement - II : Nucleus with less $\frac{BE}{A}$ (Binding energy/nucleon) breaks into nucleus with higher $\frac{BE}{A}$.

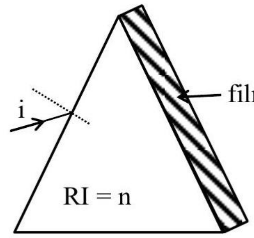
Choose the correct option :

(1) Statement I is true & statement II is false
(2) Statement I is false & statement II is true
(3) Both are true
(4) Both are false

Ans. **[3]**

Sol. On increasing number of nucleon, BE increase but stability of nucleus depends on BE / A.

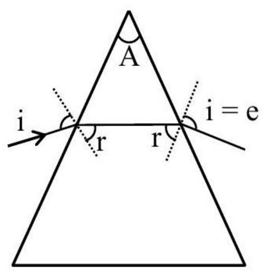
5. Light is incident at such an angle so that minimum deviation takes place. Now a film of refractive index ($RI = \frac{n}{2}$) is stick on other face such that total internal reflection takes place on second surface. Find angle of prism :



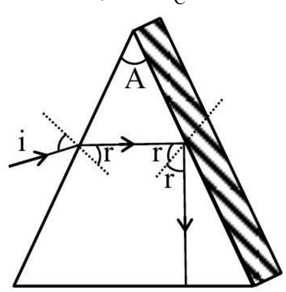
(1) 60° (2) 50° (3) 90° (4) 30°

Ans. **[1]**

Sol. $i = e$ & $r = A/2$ for minimum deviation



For TIR ; $r > \theta_C$



$$\text{Sinr} > \text{Sin}\theta_c$$

$$\text{Sinr} > \frac{n/2}{n}$$

$$\text{Sin } r > \frac{1}{2}$$

$$\text{Sin}\frac{A}{2} > \sin 30^\circ$$

$$\frac{A}{2} > 30^\circ$$

$$A > 60^\circ$$

6. There is a compound microscope of lenses having focal lengths 2 cm and 5 cm and tube length 10 cm . Find magnifying power in normal adjustment. If your answer is 5^α , find ' α ' :

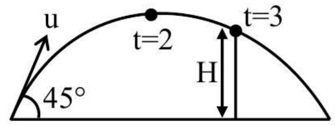
Ans. **[2]**

Sol. $f_0 = 2$ cm, fe = 5 cm

$\ell = 10$ cm

$$M = \frac{\ell}{f_0} \cdot \frac{D}{f_e} = 25$$

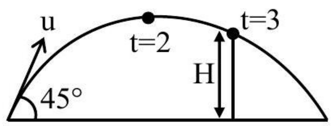
7. A projectile is projected with certain speed at an angle of 45° with horizontal as shown. At $t = 2$ s, projectile is at maximum height and at $t = 3$ s, it just touches a wall at a height H above horizontal. Find H in meters :



(1) 20 m (2) 10 m (3) 15 m (4) 25 m

Ans. **[3]**

Sol. $T = \dfrac{2u_y}{g} = 4$



$\Rightarrow u_y = \dfrac{40}{2} = 20 \text{ m/s}$

$u_x = 20 \text{ m/s}$

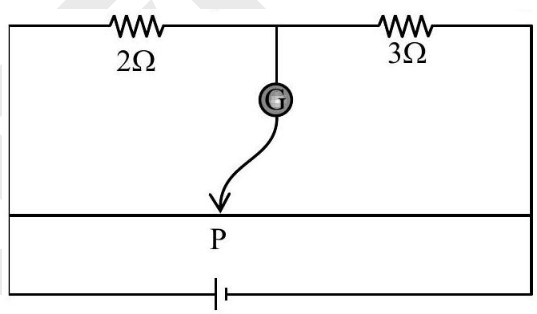
$\Delta y = u_y \Delta t - \dfrac{1}{2} g(\Delta t)^2$

$\Rightarrow H = 20 \times 3 - 5 \times 9$

$= 60 - 45$

$= 15 \text{ m}$

8. Figure shows a meter-bridge. Initially null point was achieved at point P as shown in the figure.



When an unknown resistance " R " is connected in parallel with 3Ω the null point was shifted by 22.5 cm. Then the value of unknown resistance is :

(1) 2Ω (2) 3Ω (3) 2.5Ω (4) 5Ω

Ans. **[1]**

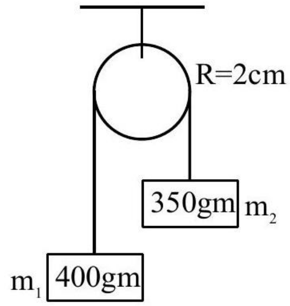
Sol. Initially, $\dfrac{2}{3} = \dfrac{40}{60}$

Now when ' R ' connected in parallel

$$\frac{2}{\frac{3R}{3+R}} = \frac{40+22.5}{60-22.5} = \frac{62.5}{37.5}$$

$\therefore R = 2\Omega$

9. After release, the blocks moves 81 cm in 9 seconds. Find moment of inertia of the pulley :



(1) $97 \times 10^{-4}\,\text{Kg} - \text{m}^2$ (2) $100 \times 10^{-4}\,\text{Kg} - \text{m}^2$ (3) $21 \times 10^{-4}\,\text{Kg} - \text{m}^2$ (4) $87 \times 10^{-4}\,\text{Kg} - \text{m}^2$

Ans. **[1]**

Sol.

$$a = \frac{(m_1 - m_2)}{m_1 + m_2 + \frac{I}{R^2}} \cdot g$$

$$S = ut + \frac{1}{2}at^2$$

$$\frac{81}{100} = \frac{1}{2}\left(\frac{m_1 - m_2}{m_1 + m_2 + \frac{I}{R^2}}\right) g \times (81)$$

$$500(m_1 - m_2) = (m_1 + m_2) + \frac{I}{R^2}$$

$$500\left(\frac{50}{1000}\right) = \left(\frac{750}{1000}\right) + \frac{I}{R^2}$$

$$I = 97 \times 10^{-4}\,\text{Kg} - \text{m}^2$$

10. Following are two lists, list-I contains the types of electromagnetic waves and list-II contains theirs source. Match the entries from list-I to appropriate entries from list-II.

	List-I		**List-II**
(a)	x-rays	(p)	Hot bodies and molecules
(b)	Infrared rays	(q)	Oscillatory current in antennas
(c)	Microwaves	(r)	Magnetron
(d)	Radio waves	(s)	Fast moving electrons striking a metal plate

(1) (a) → (r), (b) → (q), (c) → (s), (d) → (q)

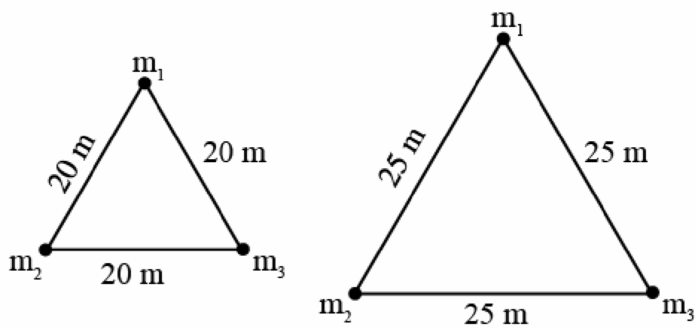
(2) (a) → (p), (b) → (s), (c) → (r), (d) → (q)

(3) (a) → (s), (b) → (p), (c) → (q), (d) → (s)

(4) (a) → (s), (b) → (p), (c) → (r), (d) → (q)

Ans. **[4]**

11. Three masses $m_1 = 200$ kg, $m_2 = 300$ kg and $m_3 =$ 400 kg are kept at the vertices of on equilateral triangle of side 20 m . If the masses are shifted to new configuration such that they are at the vertices of an equilateral triangle of 25 m now. Find the work done in this process :



(1) 1.735×10^{-7} J (2) 17.35×10^{-7} J (3) 173.5×10^{-7} J (4) 1735×10^{-7} J

Ans. **[1]**

Sol. Work done by external agent :

$w_{ext} = \Delta U$

$U_i = \frac{Gm_1\ m_2}{r_i} + \frac{Gm_2\ m_3}{r_i} + \frac{Gm_1\ m_3}{r_i} : r_i = 20\text{ m}$

$U_f = \frac{Gm_1\ m_2}{r_f} + \frac{Gm_2\ m_3}{r_f} + \frac{Gm_1\ m_3}{r_f} : r_f = 25\text{ m}$

$U_i = \frac{-6.67\times10^{-11}}{20}\left[200\times300+300\times400+200\times400\right]$

$= \frac{-6.67\times10^{-11}}{20}\times26\times10^4 = -86.71\times10^{-8}$ J

$U_f = \frac{-6.67\times10^{-11}}{0.25}\left[200\times300+300\times400+200\times400\right]$

$= \frac{-6.67\times10^{-11}}{0.25}\times26\times10^4 = -693.68\times10^{-9}$

$= -69.36\times10^{-8}$ J $W = +\Delta U = 17.35\times10^{-8}$

$= 1.735\times10^{-7}$ J

12. A cylindrical body of mass m and cross section A is floating in a liquid of density ρ_L such that its axis is vertical. If body is displaced by a small displacement ' x ' vertically, find the time period of oscillation of the body:

(1) $2\pi\sqrt{\frac{m}{\rho_L Ag}}$ (2) $3\pi\sqrt{\frac{m}{\rho_L Ag}}$ (3) $4\pi\sqrt{\frac{m}{\rho_L Ag}}$ (4) $5\pi\sqrt{\frac{m}{\rho_L Ag}}$

Ans. **[1]**

Sol. $\rho_L A\times hg = mg$

After displacing by x ,

$F = \rho_L A(h+x)g - mg$

$F = \rho_L Ahg + \rho_L Axg - mg$

$F = \rho_L Axg$

$$a = \left(\frac{\rho_L A g}{m}\right)x$$

comparing,

$$a = \omega^2 x$$

$$\omega = \sqrt{\frac{\rho_L A g}{m}}$$

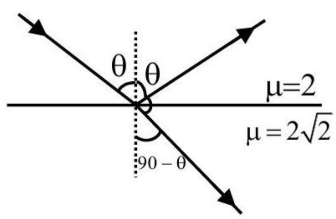
$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{\rho_L A g}}$$

13. Light wave are incident from a medium of refractive index 2 making an angle θ with normal on to a medium of refractive index $2\sqrt{3}$. What should be the value of θ for which reflected wave and refracted wave will be perpendicular to each other.

(1) 60° (2) 30° (3) 53° (4) 45°

Ans. **[1]**

Sol.



$$2\sin\theta = 2\sqrt{3}\sin(90-\theta)$$

$$\tan\theta = \sqrt{3}$$

$$\theta = 60^\circ$$

14. A brass rod is fixed rigidly at two ends at $27^\circ C$. If it is cooled to temperature $-43^\circ C$, tension in rod becomes T_0. Find temperature (in $^\circ C$) at which tension will be 1.4 T_0 :

Ans. -71°**C**

Sol. Thermal stress causes tension

$$T = \alpha y A \Delta T$$

$$-43^\circ C\ T_0 = \alpha y A(43+27) \quad \ldots \text{(i)}$$

$$-t^\circ C\ T_0 = \alpha y A(t+27) \quad \ldots \text{(ii)}$$

(ii)/(i)

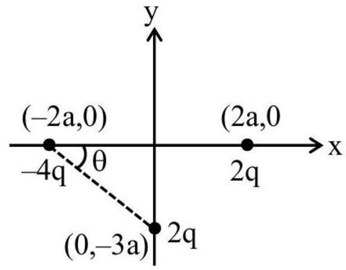
$$1.4 = \frac{t+27}{70}$$

$$t + 27 = 98$$

$$t = 71^\circ$$

$$\therefore \text{temp } (-71^\circ C)$$

15. In the following configuration of charges. Find the net dipole moment of the system :



(1) $\sqrt{180}qa$ (2) $\sqrt{150}qa$ (3) $\sqrt{200}qa$ (4) $\sqrt{140}qa$

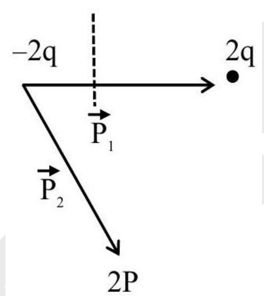
Ans. **[1]**

Sol. $\vec{P}_1 = (2q)(4a)\hat{i} = 8qa\hat{j}$

$\vec{P}_2 = (2q)\left(\sqrt{13}a\right)\left(\cos\theta\hat{i} - \sin\theta\hat{j}\right)$

$= (3q)\left(\sqrt{3}a\right)\left(\cos\theta\,\hat{i} - \sin\theta\,\hat{j}\right)$

$= (3q)\left(\sqrt{3}a\right)\left(\frac{2}{\sqrt{13}}\hat{i} - \frac{3}{\sqrt{3}}\hat{j}\right)$



$= 2qa\left(2\hat{i} - 3\hat{j}\right)$ $\cos\theta = \frac{2}{\sqrt{13}}$

$= 4qa\hat{i} - 6qa\hat{j}$ $\sin\theta = \frac{3}{\sqrt{13}}$

$\vec{P}_{-net} = \vec{p}_1 + \vec{p}_2 -$

$= 12qa\hat{i} - 6qa\,\hat{j}$

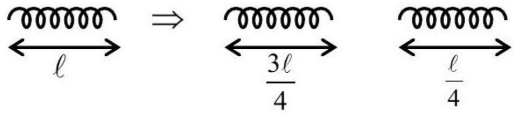
$\left|\vec{p}_{-net}\right| = \sqrt{180}qa$

16. A spring of spring constant $K = 15\ N/m$ is cut into two parts of ratio of length $3:1$. Find the spring constant of spring with smaller length (in N/m).

(1) 60 (2) 40 (3) 30 (4) 70

Ans. **[1]**

Sol.



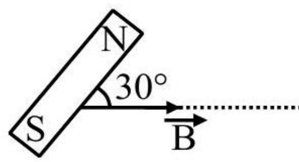
$K\ell =$ constant

$K\ell = K'\left(\frac{\ell}{4}\right)$

$K' = 4\ K$

$K' = 60\ N/m$

17. A bar magnet is kept such that it is making an angle of 30° with the magnetic field. The torque acting on the magnet is $0.016\ N-m$. Find the amount of work done by external agent in rotating the magnet from most stable position to most unstable position.



(1) 0.064 J (2) 0.020 J (3) 0.034 J (4) 0.055 J

Ans. **[1]**

Sol. $\tau = \mu B\sin\theta \Rightarrow 0.016 = \mu \times B \times \frac{1}{2}$

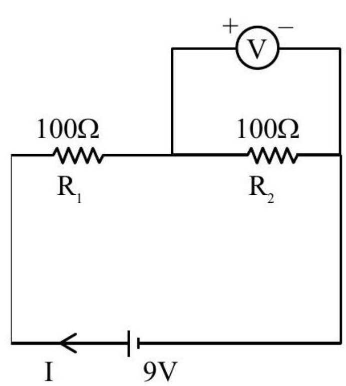
$\Rightarrow \mu = \frac{0.032}{B}$

$W_{ext} = U_f - U_i = \mu B - (\mu B) = 2\mu\ B$

$= 2 \times \frac{0.032}{B} \times B$

$= 0.064\ J$

18. Two resistors of resistances $R_1 = 100\Omega$ and $R_2 = 100\Omega$ are connected in series. A voltmeter of resistance 400Ω is connected in parallel to one of the resistance. Find the reading of voltmeter. The emf of battery is 9 V . :



(1) 3 V (2) 4 V (3) 2 V (4) 5 V

Ans. **[2]**

Sol. Current in circuit.

$$I = \frac{E}{\text{Req}}$$

$$\text{Req} = 100 + \frac{400 \times 100}{500} = 180\Omega$$

$$\therefore \text{I} = \frac{9}{180} = \frac{1}{20}\ \text{A}$$

Reading of voltmeter $= \text{V} = \text{I} \times 80 = \frac{1}{20} \times 80 = 4\ \text{V}$

19. An ideal gas in a closed rigid container is at 50°C and pressure 3.23 kPa. If temperature is doubled, find new pressure in Pa :

(1) 3730 Pa (2) 3230 Pa (3) 6460 Pa (4) 6430 Pa

Ans. **[1]**

Sol. Closed rigid container

V = constant

$\text{P} \propto \text{T}$

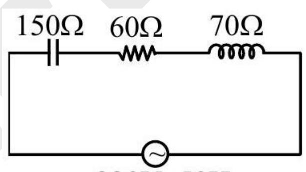
$\text{T}_\text{i} = 50^\circ\text{C} = 323\ \text{K}$

$\text{T}_\text{f} = 2 \times 50^\circ\text{C} = 100^\circ\text{C} = 373\ \text{K}$

$$\frac{\text{P}_1}{\text{P}_2} = \frac{\text{T}_1}{\text{T}_2} \Rightarrow \frac{3.23}{\text{P}_2} = \frac{323}{373}$$

$\therefore \text{P}_2 = 3730\ \text{Pa}$

20. Figure shows a circuit consisting capacitor, inductor and a resistor connected in series with an AC source. Find the power factor of the circuit.



(1) 0.2 (2) 0.4 (3) 0.6 (4) 0.8

Ans. **(3)**

Sol. Power factor $= \frac{\text{R}}{\text{Z}}$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$= \sqrt{60^2 + (150-70)^2} = 100\Omega$$

$\therefore$ Power factor $= \frac{60}{100} = 0.6$

21. In a H-like ion, ratio of speed of electron in two orbit is $3:2$, then ratio of energies in these orbits should be :

(1) $\frac{3}{5}$ (2) $\frac{9}{4}$ (3) $\frac{1}{4}$ (4) $\frac{3}{4}$

Ans. **[2]**

Sol. $v = v \cdot \frac{Z}{n}$

$\frac{v_1}{v_2} = \frac{z_1}{z_2} \cdot \frac{n_2}{n_1} = \frac{3}{2}$

$E = -E_0 \frac{z^2}{n^2}$

$\frac{E_1}{E_2} = \frac{\left(\frac{z_1}{n_1}\right)^2}{\left(\frac{z_2}{n_2}\right)^2} = \frac{9}{4}$

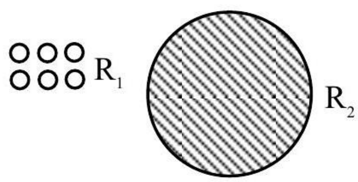
22. Terminal velocity of drop of radius 1 cm is 10 cm/sec. 64 such balls are combined to make a large drop. Find terminal velocity of this larger drop. :

(1) 160 cm / sec (2) 140 cm / sec (3) 180 cm / sec (4) 150 cm / sec

Ans. **[1]**

Sol. $V_T = \frac{2r^2 g}{9n}[\sigma - \rho]$

$V_T \propto r^2$



64 drop

$64\left(\frac{4}{3}\pi R_1^3\right) = \frac{4}{3}\pi R_2^3$

$R_2 = 4R_1$

$\frac{(V_T)_1}{(V_T)_2} = \left(\frac{R_1}{R_2}\right)^2 = \left(\frac{1}{4}\right)^2$

$\frac{10}{(V_T)_2} = \frac{1}{16}$

$(V_T)_2 = 160 \text{ cm/sec}$

23. Column-I gives physical quantities and Column-II represent their dimensions. Choose the option representing correct matching.

Column-I		Column-II	
(I)	Magnetic field intensity	(P)	$MLT^{-2}A^{-2}$
(II)	Magnetic flux	(Q)	$ML^2T^{-2}A^{-2}$
(III)	Magnetic permeability	(R)	$ML^2T^{-2}A^{-1}$
(IV)	Magnetic inductance	(S)	$MT^{-2}A^{-1}$

(1) I-S, II-R, III-P, IV-Q (2) I-Q, II-R, III-P, IV-S
(3) I-R, II-S, III-P, IV-Q (4) I-S, II-P, III-R, IV-Q

Ans. [1]

Sol. Magnetic field intensity, $B = \left[MT^{-2}\ A^{-1}\right] - S$

Magnetic Flux, $\phi = \left[ML^{2}\ T^{-2}\ A^{-1}\right] - R$

Magnetic Permeability, $\mu = \left[MLT^{-2}\ A^{-2}\right] - P$

Magnetic inductance, $L = \left[ML^{2}\ T^{-2}\ A^{-1}\right] - Q$

24. Density of water at $4^\circ C$ is $1000\ kg/m^3$ and at $20^\circ C$ it is $998\ kg/m^3$. If 4 kg of water is heated from $4^\circ C$ to $20^\circ C$, the change in internal energy of water is : (Given : specific heat capacity of water $= 4200 J/kg$).

(1) 268799.2 J (2) 268800.8 J (3) 268800.0 J (4) 267765.2 J

Ans. [1]

Sol. $Q = mS\Delta T = 4 \times 4200 \times 16\ J = 268800\ J$

$W = P\Delta V$

$$\Delta V = \left(\frac{m}{\rho_f} - \frac{m}{\rho_i}\right) = 4\left[\frac{1}{998} - \frac{1}{1000}\right]$$

$P = 10^5\ Pa$.

$$\therefore W = 10^5 \times 4 \times \left[\frac{1}{998} - \frac{1}{1000}\right] = \frac{8 \times 10^5}{10^3 \times 998} \approx 0.8\ J$$

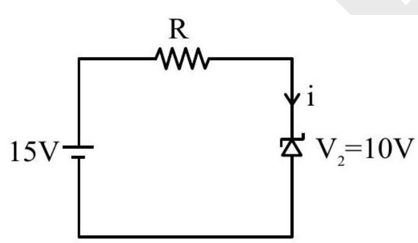
$\Delta U = Q - W = 268799.2\ J$

25. A zener diode of breakdown voltage 10 V is connected to an external voltage of 15 V and a resistance R in series. If power of zener diode is 0.4 W. Find value of unknown resistance R :

(1) 125Ω (2) 105Ω (3) 130Ω (4) 115Ω

Ans. [1]

Sol.



$P_D = 0.4w = 10i$

$i = 0.04\ A$

$$R = \frac{15-10}{0.04} = \frac{5}{0.04} = 125\Omega$$

JEE Main Online Exam 2026

Memory Based
Questions & Solution
24th January 2026 | Morning

CHEMISTRY

1. **Statement-I :** $K > Mg > Al > B$ metallic character order.

Statement-II : Ionic radius of any element is less than its atomic radius.

In the light of above statements, choose the most appropriate answer from the options given below :

(1) Both statements are true
(2) Statement I is false but statement II is true.
(3) Both statements are False.
(4) Statement I is true but statement II is false.

Ans. **[4]**

Sol. Statement-I : Correct

EN ↑ metallic character ↓

Metallic character : $K > Mg > Al > B$

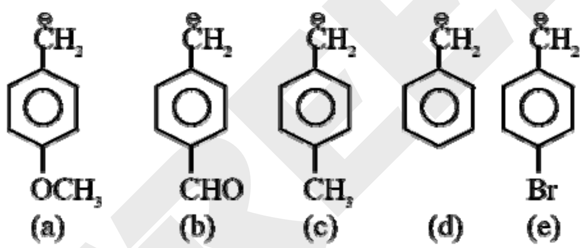
EN : $0.8 < 1.2 < 1.5 < 2.0$

Statement-II : Incorrect

Ionic size $M^+ < M < M^-$

Anionic radius > Atomic radius.

2. The correct order of stability of given carbanions is



(1) a > b > c > d > e (2) b > e > d > a > c (3) a > c > d > e > b (4) b > e > d > c > a

Ans. **[4]**

Sol. Electron withdrawing group increase the stability of carbanions.

3. **Statement-I :** $\left[Co(CO_3)_3\right]^{3-}$ has magnetic moment of 4.9 BM & hybridization is $sp^3\ d^2$

Statement-II : $[Ni(CN)_4]^{2-}$, $\left[Cr(H_2O)_6\right]^{2+}$ and $[MnF_6]^{4-}$ have square planar, octahedral and octahedral geometry respectively and $dsp^2, sp^3\ d^2$, d^2sp^3 hybridization respectively and $\mu = 0, 4.9BM$, 5.9 BM respectively.

(1) Both statements are correct
(2) Statement-I is correct & statement-II is incorrect
(3) Statement-I is incorrect & statement-II is correct
(4) Both statements are incorrect.

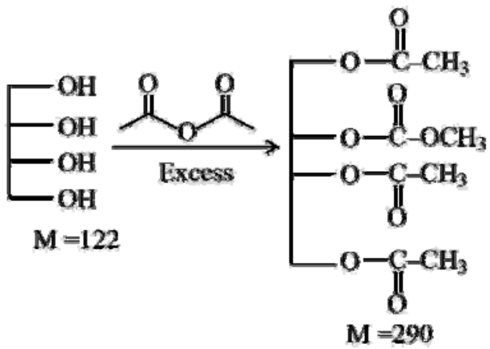
Ans. **[4]**

Sol. $\left[Co\left(CO_3\right)_3\right]^{3-}$ is d^2sp^3 hybridized $\left[MnF_6\right]^4$ is $sp^3\ d^2$ hybridized.

4. Hydroxy compound (A) with molecular mass = 122 react with excess of acetic anhydride and gives compound (X) with molecular mass = 290, then find the no. of hydroxy groups in given compound (A).

Ans. **[42]**

Sol.



No. of OH groups $= \dfrac{290-122}{4} = 42$

5. 4 kg of water is heated from $4^\circ C$ of $20^\circ C$ at constant pressure 10^5 Pa so that density changes from $1000\ kg/m^3$ to $998\ kg/m^3$. Then find ΔU (in Joules) given C_s of $H_2O = 4.2 Joule/gm.K$:

(1) 268799.2 Joule (2) 368900 Joule (3) 168400 Joule (4) 578876.8 Joule

Ans. **[1]**

Sol. $q = mc_s\Delta T$

$q = 4000 \times 4.2(20-4)$

$q = 268800$

$w = -P_{ext}\left(V_2 - V_1\right)$

$w = -10^5\left(\dfrac{4}{998} - \dfrac{4}{1000}\right)$

$w = -0.8$ Joule

$\Delta U = q + w$

$\Delta U = 268800 - 0.8$

$\Delta U = 268799.2$ Joule

6. For a reaction at 300 K , on addition of catalyst, activation energy of reaction lowered by 10 kJ . Then calculate the value of $\log \dfrac{K_{catalysed}}{K_{uncatalysed}}$

(1) 1.74 (2) 0.174 (3) 17.4 (4) 3.48

Ans. **[1]**

Sol. $\dfrac{K_{catalyst}}{K_{uncatalyst}} = e^{\frac{\Delta E_a}{RT}}$

$$\ln\frac{K_{catalyst}}{K_{uncatalyst}} = \frac{\Delta E_a}{RT}$$

$$\log\frac{K_{catalyst}}{K_{uncatalyst}} = \frac{\Delta E_a}{2.303RT}$$

$$= \frac{10\times1000}{2.303\times8.314\times300}$$

$$\log\frac{K_{catalyst}}{K_{uncatalyst}} = 1.74$$

7.

List-I (Isothermal Process)		List-I (work done) $(V_f > V_i)$	
P.	Reversible expansion	1.	$w = 0$
Q.	Free expansion	2.	$w = -nRT\ln\frac{V_f}{V_i}$
R.	Irreversible expansion	3.	$w = -P_{ext}(V_f - V_i)$
S.	Irreversible Compression	4.	$w = -P_{ext}(V_i - V_f)$

Select the correct match

	P	Q	R	S
(A)	4	3	2	1
(B)	2	1	3	4
(C)	1	2	3	4
(D)	3	4	1	2

Ans. **[2]**

Sol. Theoritical

8. W gm of non-volatile electrolyte solute is added in 100 ml pure water (P° = 640 mm Hg) showing vapour pressure of solution 600 mm Hg . This solution have b.p. of 375 K.

Given K_b of $H_2O = 0.52\frac{K-kg}{mol}$,

Molar mass of solute = M

Select the correct option about mole fraction of solute (X_{solute}).

(1) $\frac{1.3}{8}\left(\frac{W}{M}\right)$ (2) $\frac{8}{1.3}\left(\frac{W}{M}\right)$ (3) $\frac{2.6}{16}\left(\frac{M}{W}\right)$ (4) $\frac{1.3}{8}\left(\frac{M}{W}\right)$

Ans. **[1]**

Sol. $\Delta T_b = i\times K_b\times m$

$$2 = i\times0.52\times\frac{\frac{W}{M}}{\frac{100}{1000}}$$

$$i\times\frac{W}{M} = 2\times\frac{100}{1000}\times\frac{1}{.52}$$

$$i = \frac{1}{2.6} \times \frac{M}{W}$$

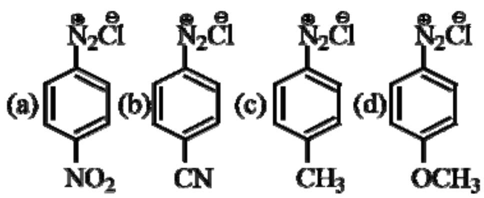
$$RLVP = \frac{P^\circ - P_S}{P^\circ} = i \times X_{solute}$$

$$\frac{640 - 600}{640} = i \times X_{solute}$$

$$\frac{1}{16} = \frac{1}{2.6} \times \frac{M}{W} \times X_{solute}$$

$$X_{solute} = \frac{1.3}{8} \times \frac{W}{M}$$

9. Correct order of stability is :

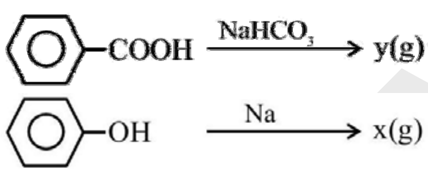


(1) a > b > c > d (2) d > c > b > a (3) b > a > c > d (4) d > b > c > a

Ans. **[2]**

Sol. +M group or +I group increases stability (i.e. $-OCH_3 - CH_3$)
– M decreases stability (i.e. $-NO_2$ and –CN)

10.



Sum of molar mass of gas (x) & (y) is

(1) 44 (2) 88 (3) 46 (4) 160

Ans. **[3]**

Sol. $x = H_2$ (gas), $y = CO_2$ (gas)
Sum of molar mass = 2 + 44 = 46

11. **Statement-I :** Among V_2O_5, $[TiF_6]^{3-}$, $[Fe(CN)_6]^{3-}$, $[CoF_6]^{3-}$ paramagnetic species are three in number.

Statement-II : Increasing number of unpaired electrons in the following.

$[Fe(CN)_6]^{4} < [Fe(CN)_6]^{3-} < [Fe(H_2O)_6]^{2+}$

(1) Both statements are correct
(2) Statement-I is correct ; statement-II is incorrect
(3) Statement-I is incorrect statement-II is correct
(4) Both statements are incorrect

Ans. **[1]**

Sol. $[TiF_6]^{3-} \rightarrow 1$ unpaired electron

$[Fe(CN)_6]^{3-} \rightarrow 1$ unpaired electron

$[CoF_6]^{3-} \rightarrow 4$ unpaired electron

$[Fe(H_2O)_6]^{2+} \rightarrow 4$ unpaired electron

$[Fe(CN)_6]^{3-} \rightarrow 1$ unpaired electron

$[Fe(CN)_6]^{4-} \rightarrow 0$ unpaired electron

12.

	List-I Species	**List-II Hybridization**	**List-III Shape**
(A)	IF_3	sp^3	T-shape
(B)	IF_7	$sp^3\ d^3$	P.B.P
(C)	IF_5	$sp^3\ d^2$	square pyramidal
(D)	ClO_4^-	$sp^2\ d$	square planar

Select the correct match

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

Ans. **[1]**

Sol. $ClO_4^- \rightarrow sp^3 \rightarrow$ tetrahedral, so (D) is incorrect, all others are correct.

13. Two solutes, 0.3 gm of $A(Mw = 60gm/mol)$ & 0.9 gm of $B(Mw = 180gm/mol)$ are dissolved in 100 ml solution. Find osmotic pressure of solution at 300 K (in atm)$(R = 0.082\ atm - L/mol - K)$

(1) 1.23 (2) 2.46 (3) 4.92 (4) 3.69

Ans. **[2]**

Sol. $\pi = (C_1 + C_2)$

$= \left(\frac{0.3\times1000}{60\times100} + \frac{0.9\times1000}{180\times100}\right)\times0.082\times300$

$= 2.46$ atm

14. Select correct statements(s)

(A) NF_3 has more dipole moment than NH_3

(B) O_2^{2-} and F_2 both have same bond order

(C) In O_3 central oxygen atom has -1 formal charge

(D) In NO_2 all the atoms follow octet rule, so it is stable.

(E) BeH_2 is planar

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

Ans. **[4]**

Sol. (1) dipole moment $NF_3 < NH_3$

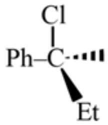
(2) O_2^{2-}, F_2 both have $B\cdot O = 1$

(3) In O_3 central oxygen atom has +1 formal charge

(4) In NO_2, octet of 'N' atom is not complete

(5) BeH_2 is linear, so planar

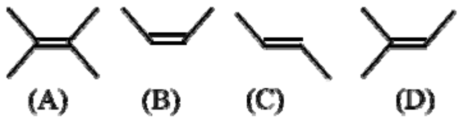
15. **Statement-1 :** $CH_2 = CH - Cl$ is having stronger C – Cl bond then $CH_2 - CH_2 - Cl$.

Statement-2 :  Me will rotate the plane polarised light after solvation.

(1) Both statements-I and II are correct
(2) Both statements-I and II are incorrect
(3) Statement-I is correct and statement-II is incorrect
(4) Statement-I is incorrect and statement-II is correct.

Ans. **[1]**
Sol. Theory based

16. Correct stability order of alkene :



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

Ans. **[1]**
Sol. Hyperconjugation (+H) and inductive group (+I) increases the stability of alkenes.

17. Electrolysis of aqueous solution of $CuSO_4$ is carried out, where 300 mg of copper is deposited (atomic mass of $Cu = 63.54$). After this 600 milli amp. current is further passed for 28 minutes. Calculate total volume of O_2 released (in ml).

(Given $Cu^{+2}\,(aq) + 2e^- \longrightarrow Cu(s)$
$2H_2O(l) \longrightarrow O_2(g) + 4H^+\,(aq) + 4e^-$

Ans. **[111]**
Sol. Eq of Cu = Eq of O_2

$$\frac{300\times10^{-3}\times2}{63.54} = n_{O_2}\times4$$

$$2.36\times10^{-3} = n_{O_2}$$

When current is further passed

$$n_{O_2}\times4 = \frac{600\times28\times60}{96500\times1000}$$

$$n_{O_2} = 2.611\times10^{-3}$$

Total O_2 released

$$= \left[10^{-3}\times(2.36+2.611)\right]\times22400\text{ml}$$

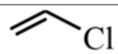
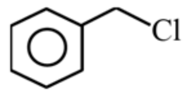
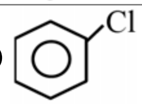
$$= 111.35\text{ml}$$

18. Salt (X) is soluble in water.
Salt (Y) is sparingly soluble in water.
Salt (Z) is soluble only in hot water.
X, Y, Z respectively are.

(1) $AgCl, Hg_2Cl_2, PbCl_2$
(2) $AlCl_3, AgCl, PbCl_2$
(3) $BaCl_2, PbCl_2, Hg_2Cl_2$
(4) $MgCl_2, Hg_2Cl_2, CaCl_2$

Ans. **[2]**
Sol. Theory based.

19. Match the List-I and List-II

(1) 	(I) Vinyl chloride
(2) 	(II) Allyl chloride
(3) 	(III) Aryl chloride
(4) 	(IV) Benzyl chloride

(1) $A \to I, B \to II, C \to III, D \to IV$
(2) $A \to I, B \to II, C \to IV, D \to III$
(3) $A \to III, B \to II, C \to I, D \to IV$
(4) $A \to III, B \to II, C \to IV, D \to II$

Ans. **[2]**

Sol. Common Names

20. Line corresponding to lyman series are $L_1, L_2, L_3, L_4 \ldots$, among these L_1 line corresponds to lowest energy. Similarly lines corresponding to balmer series are $B_1, B_2, B_3, B_4 \ldots\ldots$, among these B_1 line corresponds to lowest energy

$\Delta E_L =$ Energy of 1^{st} line of lyman series

$\Delta E_B =$ Energy of 1^{st} line of balmer series

If $\Delta E_L = x \cdot \Delta E_B$

Calculate $\left(x \times 10^{-1}\right)$

Ans. **[54]**

Sol.
$$\Delta E_L = 13.6 \times Z^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = 13.6Z^2 \times \frac{3}{4}$$

$$\Delta E_B = 13.6 \times Z^2 \times \left(\frac{1}{2^2} - \frac{1}{3^2}\right) = 13.6 \times Z^2 \times \frac{5}{4 \times 9}$$

$$\frac{\Delta E_L}{\Delta E_B} = \frac{3}{5} \times 9 = \frac{27}{5} = x$$

$$= \left(\frac{27}{5} \times 10\right) \times 10^{-1}$$

21. Select correct statements.

(I) Hybridisation of ClO_4^- is dsp^2

(II) $[Ni(CN)_4]^{2-}$ is tetrahedral

(III) $\left[Co\left(H_2O\right)_6\right]^{2+}$ has $sp^3\ d^2$ hybridisation

(IV) $[Mn(CN)_6]^4$ has $sp^3\ d^2$ hybridisation

(1) II and III and (2) III only (3) II, III and IV only (4) I, II, III and IV

Ans. **[2]**

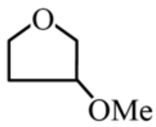
Sol. (I) $ClO_4^- \to sp^3$

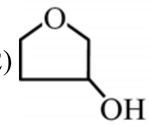
(II) $Ni^{2+} \to 3\ d^8 \to dsp^2$ (square planar)

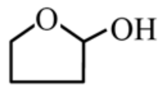
(III) $Co^{2+} \rightarrow 3\,d^7 \rightarrow t_{2\,g}^{2,2,1} eg^{1,1} \rightarrow sp^3\ d^2$

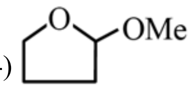
(IV) $Mn^{2+} 3\,d^5 \rightarrow t_{2\,g}^{2,2,1} eg^{0,0} \rightarrow\ d^2sp^3$

22. Which of the following gives positive tollen's test ?

(1) 

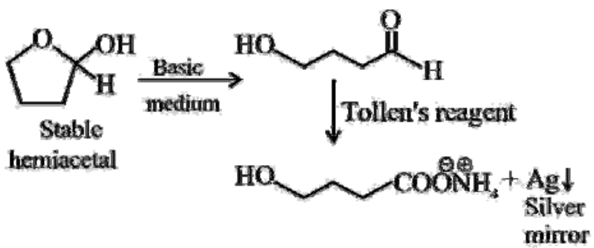
(2) 

(3) 

(4) 

Ans. **[3]**

Sol. In basic medium cyclic hemiacetal isomers to open hydroxyl aldehyde compound which easily gives positive tollen's test.



23. x & y are the number of moles of electrons involved respectively during oxidation of I^- to I_2 & S^{2-} to S by acidified $K_2Cr_2O_7$. The value of $x + y$ is?

Ans. **[12]**

Sol. $Cr_2O_7{}^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$

no. of moles e^- involved $= x = 6$

$Cr_2O_7{}^{2-} + 3\ S^{2-} + 14H^+ \rightarrow +S + 2Cr^{3+} + 7H_2O$

No. of moles e^- involved $= y = 6$

Sum of $x + y = 6 + 6 = 12$

24. For a chemical reaction :

$A \rightarrow D$

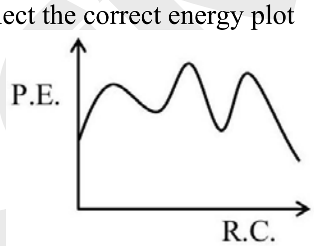
Mechanism is

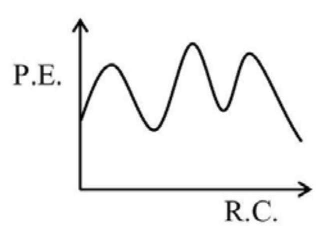
Step-1 : $A \rightarrow B$: $\Delta H = +ve$

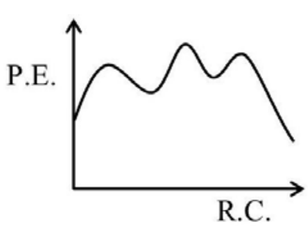
Step-2 : $B \rightarrow C : \Delta H = -ve$

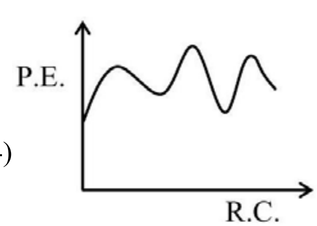
Step-3: $C \rightarrow D : \Delta H = -ve$

Select the correct energy plot

(1) 

(2) 

(3) 

(4) 

Ans. **[1]**

Sol. $\Delta H = E_{Product} - E_{Reactant}$

25. 0.5 gm of unknown organic compound undergo Duma's method for estimation of nitrogen. Percentage of nitrogen gas collected over water at P = 715 mm and 27°C has volume = 70 ml. Calculate % N in the unknown organic compound. (aq. Tension = 15 mm)

Ans. **[14.65]**

Sol. $P_{N_2} = (715 - 15)\,mm = \frac{700}{760}$ atm

$$V_{N_2} = 70\,ml = \frac{70}{1000} l$$

$$n_{N_2} = \frac{PV}{RT} = \frac{\left(\frac{700}{700}\right)\times\left(\frac{70}{1000}\right)}{0.821\times 300}$$

$$W_{N_2} = \frac{700}{700}\times\frac{\frac{70}{1000}}{0.821\times 300}\times 28$$

$$\%\,N = \frac{W_{N_2}}{0.5}\times 100 = \frac{700}{760}\times\frac{\frac{70/1000}{0.821\times 300}\times 28}{0.5}\times 100$$

= 14.65%

CAREER POINT

JEE Main Online Exam 2026

Memory Based
Questions & Solution

24th January 2026 | Morning

MATHEMATICS

1. If $A=\{1,2,3,4\}$. A relation from set A to $A(a,b)R(c,d)$ such that $2a+3b=3c+4d$, then find the number of element(s) in relation :

(1) 9 (2) 10 (3) 11 (4) 12

Ans. **[3]**

Sol.

(a, b)	(c, d)
$(1,1)$	x
$(1,2)$	x
$(1,3)$	$(1,2)$
$(1,4)$	$(2,2)$
$(2,1)$	$(1,1)$
$(2,2)$	$(2,1)$
$(2,3)$	$(3,1)$
$(2,4)$	$(4,1)$
$(3,1)$	x
$(3,2)$	x
$(3,3)$	$(1,3)$
$(3,4)$	$(2,3)$
$(4,1)$	$(1,2)$
$(4,2)$	$(2,2)$
$(4,3)$	x
$(4,4)$	$(4,2)$

2. If the domain of $f(x)=\log_{(10x^2-17x+7)}(18x^2-11x+1)$ is $(-\infty,a)\cup(b,c)\cup(d,\infty)-\{e\}$, then find 90 $(a+b+c+d+e)$:

(1) 316 (2) 320 (3) 163 (4) 631

Ans. **[1]**

Sol. $18x^2-11x+1>0$

$(9x-1)(2x-1)>0 \Rightarrow x>\frac{1}{2}$ or $x<\frac{1}{9}$ ...(1)

$10x^2-17x+7>0$

$(10x-7)(x-1)>0$

$x>1$ or $x<\frac{7}{10}$ ...(2)

$10x^2-17x+7>0$

$10x^2-17x+6\neq 0$

$(5x-6)(2x-1)\neq 0$

$x\neq \frac{6}{5},\frac{1}{2}$ ...(3)

Eq. (1) & (2) & (3)

$x\in\left(-\infty,\frac{1}{9}\right)\cup\left(\frac{1}{2},\frac{7}{10}\right)\cup(1,\infty)-\left\{\frac{6}{5}\right\}$

$a=\frac{1}{9},\ b=\frac{1}{2}, c=\frac{7}{10},\ d=e,1, e=\frac{6}{5}$

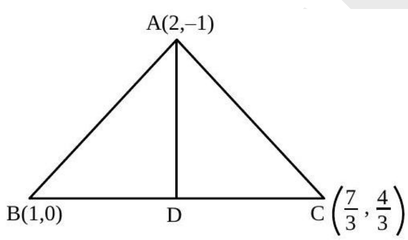
$90(9+b+c+d+e)$

$=316$

3. Let the vertices of the triangle are $(1,0),(2,-1),\left(\frac{7}{3},\frac{4}{3}\right)$. If the equation of internal angle bisector through $(2,-1)$ is $\alpha x+\beta y=5$ then value of ($\alpha^2+\beta^2$) is:

Ans. **[10]**

Sol.



$\frac{BD}{DC}=\frac{AB}{AC}=\frac{\sqrt{2}\times 3}{5\sqrt{2}}=\frac{3}{5}$

$D=\left(\frac{12}{8},\frac{4}{8}\right)=\left(\frac{3}{2},\frac{1}{2}\right)$

Slope of $AD=\frac{-3/2}{\frac{1}{2}}=-3$

$3x+y=5$

$\alpha=3,\beta=1;\alpha^2+\beta^2=10$

4. Let mean & variance of 10 numbers are $10 \& 2$ respectively. If one number α is replaced by another number β, then new mean & variance are 10.1 & 1.99. Find $(\alpha+\beta)$

(1) 20 (2) 19 (3) 18 (4) 17

Ans. **[1]**

Sol. Let first 10 numbers are $x_1, x_2, \ldots\ldots x_9, \alpha$

$$\Rightarrow \alpha + \sum_{i=1}^{9} x_i = 100 \Rightarrow \sum_{i=1}^{9} x_i = 100 - \alpha$$

$$\text{Variance} = \left(\frac{\sum x_i^2}{n}\right) - \left(\frac{\sum x_i}{n}\right)^2$$

$$\Rightarrow \frac{\sum x_i^2}{n} = 98$$

$$\Rightarrow x_1^2 + x_2^2 + \ldots\ldots x_9^2 + \alpha^2 = 1020 \Rightarrow \sum x_i^2 = 1020 - \alpha^2$$

In second case, let number are

$x_1, x_2, \ldots\ldots x_9, \beta$

$100 - \alpha + \beta = 101\alpha - \beta + 1 = 0$

$$\frac{\sum x_i^2 + \beta^2}{10} - (10.1)^2 = 1.99$$

$\beta^2 - \alpha^2 = 20$

$$\alpha = \frac{19}{2}$$

$$\beta = \frac{21}{2}$$

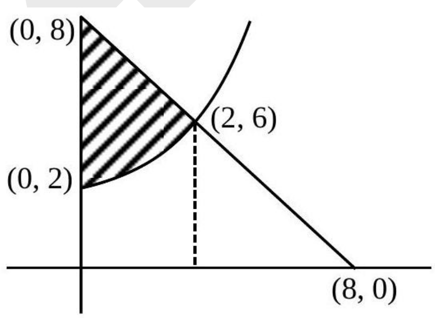
$$\alpha + \beta = \frac{19+21}{2} = 20$$

5. A_1 is the area bounded by $y = x^2 + 2, x + y = 8, y-$ axis in the I[st] quadrant and A_2 is the area bounded by $y = x^2 + 2, y^2 = x, x = 0$ and $x = 2$ in the 1[st] quadrant find $(A_1 - A_2)$:

(1) $\frac{2}{3} + \frac{4\sqrt{2}}{3}$ (2) $\frac{3}{2} + \frac{4\sqrt{2}}{3}$ (3) $\frac{3}{5} + \frac{4\sqrt{2}}{3}$ (4) None of these

Ans. **[1]**

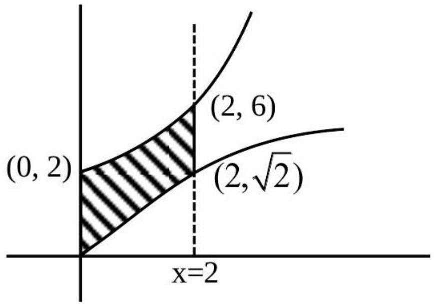
Sol.



$$A_1 = \int_0^2 \left((8-x) - (x^2+2)\right) dx$$

$= A_1 = \int_0^2 \left(6 - x - x^2\right) dx$

$A_1 \left(6x - \frac{x^2}{2} - \frac{x^3}{3}\right)_0^2 = 12 - 2 - \frac{8}{3} = 10 - \frac{8}{3} = \frac{22}{3}$



$A_2 = \int_0^2 \left(x^2 + 2\right) dx - \frac{2}{3}\left(2\sqrt{2}\right)$

$A_2 = \left(\frac{x^3}{3} + 2x\right)_0^2 - \frac{4\sqrt{2}}{3}$

$A_2 = \frac{8}{3} + 4 - \frac{4\sqrt{2}}{3} = \frac{20}{3} - \frac{4\sqrt{2}}{3}$

$A_1 - A_2 = \frac{2}{3} + \frac{4\sqrt{2}}{3}$

6. $\lim\limits_{x \to 0} \frac{e^x \left(e^{\tan x - x} - 1\right) + \ln\left(\sec x + \tan x\right) - x}{\left(\tan x - x\right)}$

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

Ans. **[1]**

Sol. $\lim\limits_{x \to 0} \frac{e^{\tan x} - e^x + \ln\left(\sec x + \tan x\right) - x}{\tan x - x}$

Applying L'hospital rule

$\Rightarrow \lim\limits_{x \to 0} \frac{e^{\tan x} \cdot \sec^2 x - e^x + \sec x - 1}{\sec^2 x - 1}$

$\lim\limits_{x \to 0} \frac{e^{\tan x}\left(\sec^2 x - 1\right) + \left(e^{\tan x} - e^x\right) + \sec x - 1}{\tan^2 x}$

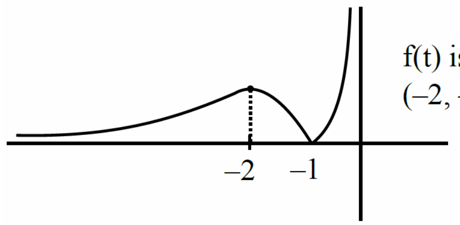
$\lim\limits_{x \to 0} \left(e^{\tan x} + \frac{e^x\left(e^{\tan x - x} - 1\right)}{\tan^2 x} + \frac{1}{\sec x + 1}\right)$

$\Rightarrow 1 + 0 + \frac{1}{2} = \frac{3}{2}$

7. Given $f(t)=\left|\frac{t+1}{t^2}\right|;(t<0)$ is strictly decreasing in the interval $(2\alpha,\alpha)$ then maximum value of $g(x)=2\log_e(x-2)+\alpha x^2+4x-\alpha$ is

Ans. **[4]**

Sol. Drawing graph of $f(t)$ for $t<0$

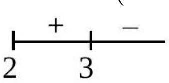


f(t) is decreasing in $(-2,-1)\Rightarrow \alpha=-1$

$g(x)=\log_e(x-2)-x^2+4x+1;\ x>2$

$g'(x)=\frac{2}{x-2}-(2(x-2);x>2$

$g'(x)=\frac{1-(x-2)^2}{(x-2)}=\frac{-(x-3)(x-1)}{(x-2)}$



as $x>2$

maxima occur at $x=3$

$g(3)=2\log_e 1-9+12+1=4$

8. If $\cot x=\frac{5}{12}$ for some $x\in\left(\pi,\frac{3\pi}{2}\right)$ then $\sin 7x\left(\cos\frac{13x}{2}+\sin\frac{13x}{2}\right)+\cos 7x\left(\cos\frac{13x}{2}-\sin\frac{13x}{2}\right)$ is equal to :

(1) $\frac{1}{\sqrt{13}}$ (2) $\frac{5}{\sqrt{13}}$ (3) $-\frac{1}{\sqrt{13}}$ (4) $\frac{8}{\sqrt{13}}$

Ans. **[1]**

Sol. $\cot x=\frac{5}{12}\Rightarrow \cos x=\frac{-5}{13}=2\cos^2\frac{x}{2}-1$

$\cos\left(\frac{x}{2}\right)=-\frac{2}{\sqrt{13}}$ or $\frac{2}{\sqrt{13}}$ (rejected)

$\left\{\because \frac{x}{2}\in\left(\frac{\pi}{2},\frac{3\pi}{4}\right)\right\}$

$\left(\sin 7x\frac{\sin 13x}{2}+\cos 7x\frac{\cos 13x}{2}\right)+\left(\sin 7x\frac{\cos 13x}{2}-\cos 7x\frac{\sin 13x}{2}\right)$

$\cos\left(7x-\frac{13x}{2}\right)+\sin\left(7x-\frac{13x}{2}\right)$

$\cos\frac{x}{2}+\sin\left(\frac{x}{2}\right)$

$\frac{3}{\sqrt{13}}-\frac{2}{\sqrt{13}}=\frac{1}{\sqrt{13}}$

9. Let $f(x)=\int \frac{1-\sin(\ell nt)}{1-\cos(\ell nt)}dt$ and $f\left(e^{\pi/2}\right)=-e^{\frac{\pi}{2}}$ then $f\left(e^{\frac{\pi}{4}}\right)$ is :

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

Ans. **[2]**

Sol. $f(t)=\int \frac{1-\sin(\ln t)}{1-\cos(\ln t)}dt$

Let $\ln t = x \Rightarrow t = e^x \Rightarrow dt = e^x dx$

$=\frac{1}{2}\int\left(\text{cosec}^2\frac{x}{2}-2\cot\frac{x}{2}\right)e^x dx - t\cot\left(\frac{\ln t}{2}\right)+C$

$\left(\because \int (f(x)+f'(x))e^x dx = f(x)\cdot e^x + c\right)$

Now $f\left(e^{\pi/2}\right)=-e^{\pi/2}\cot\left(\frac{\pi}{4}\right)+C=-e^{\frac{\pi}{2}}$ (given)

$C=0$

Now $f\left(e^{\pi/4}\right)=-e^{\pi/4}\cot\left(\frac{\pi}{8}\right)+C=-e^{\frac{\pi}{4}}\left(\sqrt{2}+1\right)$

10. Consider a geometric sequence $729, 81, 9, 1, \ldots\ldots$. If P_n denotes the product of $I^{st} n$ terms of G.P. such that $\sum_{n=1}^{40}(P_n)^{\frac{1}{n}}=\frac{3^\alpha-1}{2\times 3^\beta}$, then value of $(\alpha+\beta)$ is :

(1) 72 (2) 74 (3) 73 (4) 75

Ans. **[3]**

Sol. $P_n = 729.81.9\ldots\ldots.(\ n\ \text{terms})$

$=3^6.3^4.3^2\ldots\ldots..3^{-2n+8}$

$P_n = 3^{6+4+2+\ldots\ldots+(-2n+8)} = 3^{n(7-n)}$

$P_n^{1/n}=3^{7-n}$

$\Rightarrow \sum_{n=1}^{40}(P_n)^{\frac{1}{n}} = 3^6+3^5+\ldots..+(40\ \text{terms}\ )$

$=3^6\left[\frac{1-\left(\frac{1}{3}\right)^{40}}{1-\frac{1}{3}}\right]$

$=\frac{3^6\left[3^{40}-1\right]\times 3^1}{3^{40}\times 2}$

$\sum(P_n)^{\frac{1}{n}}=\frac{\left(3^{40}-1\right)}{2\times 3^{33}}$, $\alpha = 40$

$\beta = 33$

$\alpha+\beta=73$

11. If $\int_0^{36} f\left(\frac{tx}{36}\right)dt$ at $= 4\alpha\ f(x)$, $y = f(x)$ is standard parabola passing through $(2,1)$ and $(-4,\beta)$. Then value of β^{α} is :

Ans. **[64]**

Sol. $\int_0^{36} f\left(\frac{tx}{36}\right)dt = 4\alpha f(x)$, Put $\frac{tx}{36} = y$

$$\frac{dy}{dt} = \frac{x}{36}$$

$$\int_0^x \frac{f(y)36dy}{x} = 4\alpha f(x)$$

$$\int_0^x f(y)dy = \frac{\alpha f(x)x}{9}$$

$$f(x) = \frac{\alpha}{9}\left(f(x) + xf'(x)\right)$$

$$\left(1-\frac{\alpha}{9}\right)f(x) = \frac{\alpha x}{9}f'(x) \Rightarrow (9-\alpha)f(x) = \alpha x f'(x)$$

$$\frac{f'(x)}{f(x)} = \left(\frac{9}{\alpha}-1\right)\frac{1}{x}$$

$$\log_e f(x) = \left(\frac{9}{\alpha}-1\right)\log_e x + \log_e c$$

$f(x) = cx^{\left(\frac{9}{\alpha}-1\right)}$ for standard parabola

$$\frac{9}{\alpha}-1 = 2$$

$$\alpha = 3$$

$$f(x) = cx^2$$

passing through $(2,1)$

$$1 = 4c \Rightarrow c = 1/4$$

$y = \frac{x^2}{4}$ passing through $(-4,\beta)$

$$\beta = 4$$

$$\beta^x = 4^3 = 64$$

12. Let the lines $L_2 : \vec{r} = \left(\hat{i} + 2\hat{j} + 3\hat{k}\right) + \lambda\left(2\hat{i} + 3\hat{j} + 4\hat{k}\right)$, $\lambda \in R$ and $L_2 : \vec{r} = \left(4\hat{i} + \hat{j}\right) + \mu\left(5\hat{i} + 2\hat{j} + \hat{k}\right), \mu \in R$ intersect at the point R . Let P and Q be the points lying on the line L_1 & L_2 respectively. Such that $|PR| = \sqrt{29}$ and $|PQ| = \sqrt{\frac{47}{3}}$. If the point P lies is the first octant then $27(QR)^2$ is :

(1) 340 (2) 360 (3) 320 (4) 348

Ans. **[2]**

Sol. For POI

$2\lambda+1=5\mu+4; 3\lambda+2=2\mu+1; 4\lambda+3=\mu$

$\Rightarrow \lambda=\mu=-1$

$R(-1,-1,-1)\ P(2\lambda+1, 3\lambda+2, 4\lambda+3)$

$PR^2 = 29 \Rightarrow (2\lambda+2)^2+(3\lambda+3)^2+(4\lambda+4)^2=29$

$\Rightarrow \lambda=0$ or $\lambda=-2$ (Reject)

$\Rightarrow P(1,2,3)$

$Q(5\mu+4, 2\mu+1, \mu)$

$|PQ| = \sqrt{\frac{47}{3}} \Rightarrow PQ^2 = \frac{47}{3}$

$\Rightarrow (5\mu+3)^2+(2\mu-1)^2+(\mu-3)^2 = \frac{47}{3}$

$\Rightarrow \mu = -\frac{1}{3}$

$Q = \left(\frac{7}{3}, \frac{1}{3}, -\frac{1}{3}\right)$

$(QR)^2 = \left(\frac{7}{3}+1\right)^2 + \left(\frac{1}{3}+1\right)^2 + \left(-\frac{1}{3}+1\right)^2$

$= \frac{100+16+4}{9} = \frac{120}{9}$

$\Rightarrow 27\times(QR)^2 = 27\times\frac{120}{9} = 360$

13. The value of $\frac{\sqrt{3}\text{cosec}20^\circ - \sec 20^\circ}{\cos 20^\circ \cos 40^\circ \cos 60^\circ \cos 80^\circ}$ is :

(1) 64 (2) 48 (3) 46 (4) 40

Ans. **[1]**

Sol. $E = \frac{\frac{\sqrt{3}}{\sin 20^\circ} - \frac{1}{\cos 20^\circ}}{\frac{1}{2}\cdot\frac{1}{4}\cdot\cos 60^\circ}$

$= \frac{\left(\sqrt{3}\cos 20^\circ - \sin 20^\circ\right)}{\cos 20^\circ \cdot \sin 20^\circ} 16$

$= \frac{\left(\frac{\sqrt{3}}{2}\cos 20^\circ - \frac{1}{2}\sin 20^\circ\right) 32\times 2}{2\cos 20^\circ \cdot \sin 20^\circ}$

$= \frac{\sin 40^\circ}{\sin 40^\circ}\times 64 = 64$

14. z is a complex number satisfying $\left|\frac{z-6i}{z-2i}\right| = 1$ and $\left|\frac{z-8+2i}{z+2i}\right| = \frac{3}{5}$ then $\Sigma|z|^2$ is

(1) 225 (2) 321 (3) 284 (4) 385

Ans. **[4]**

Sol. Solving $\left|\frac{z-6i}{z-2i}\right| = 1 \Rightarrow y = 4$ ....(1)

(where $z = x + iy$)

Now solving $\left|\frac{z-8+2i}{z+2i}\right| = \frac{3}{5}$

$\Rightarrow x^2 + y^2 - 25x + 4y + 104 = 0$ ....(2)

Solving (1) & (2) $\Rightarrow$ $z = 17 + 4i \;\&\; 8 + 4i$

$\Rightarrow \Sigma |z|^2 = (17)^2 + (4)^2 + (8)^2 + (4)^2 = 385$

15. Let $5000 < N < 9000$ and N has digits from $\{0,1,2,5,9\}$ and digits can be repeated then find the number of N divisible by 3 .

Ans. **[84]**

Sol. **[84]**

$\underline{5}\ \underline{9}\ \underline{9}\ \ \underline{9}\ \underline{\times}$

$\underline{0}\,\underline{1} = 3! = 6$

$\underline{2}\,\underline{2} = \frac{3!}{2!} = 3$

$\underline{5}\,\underline{5} = \frac{3!}{2!} = 3$

$\underline{5}\,\underline{2} = 3! = 6$

$\underline{5}\ \underline{5}\ \underline{0}\ \ \underline{2} = 3! = 6$

$\underline{0}\,\underline{5} = \frac{3!}{2!} = 3$

$\underline{9}\,\underline{2} = 3! = 6$

$9\underline{5} = \frac{3!}{2!} = 3$

$\underline{5}\ \underline{2}\ \underline{0}\ \ \underline{2} = 3$

$\underline{0}\,\underline{5} = 6$

$\underline{9}\,\underline{2} = 3$

$\underline{9}\,\underline{5} = 6$

$\underline{5}\ \underline{1}\ \underline{0}\ \ \underline{0} = 3$

$\underline{2}\,\underline{1} = 3$

$\underline{5}\,\underline{1} = 3$

$\underline{9}\,\underline{0} = 6$

$\underline{5}\ \underline{0}\ \underline{0}\ \ \underline{1} = 3$

$\underline{2}\,\underline{2} = 3$

$\underline{5}\,\underline{2} = 3! = 6$

$\underline{5}\,\underline{5} = 3$

Total $= 8 \times 6 + 12 \times 3$

$= 48 + 36$

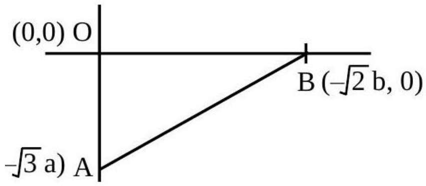
$= 84$

16. Given triangle OAB where O is the origin, $A=(0,-\sqrt{3}a)$ & $B(-\sqrt{2}\,b,0)$ let the circumradius of ΔOAB is 4 units. If the locus of the centroid of ΔOAB is a circle then its radius is :

(1) $\frac{8}{3}$ (2) $\frac{7}{3}$ (3) $\frac{11}{3}$ (4) $\frac{5}{3}$

Ans. **[1]**

Sol.



$4=\frac{\sqrt{2\,b^2+3a^2}}{2}$

$2b^2+3a^2=8^2$

$(h,k)=\left(\frac{-\sqrt{2}\,b}{3},\frac{-\sqrt{3}a}{3}\right)$

$b=\frac{3\,h}{-12},\ a=\frac{3k}{-\sqrt{3}}$

$2b^2+3a^2=64$

$9h^2+9k^2=64\Rightarrow x^2+y^2=\left(\frac{8}{3}\right)^2$

$r=\frac{8}{3}$

17. Given that $\vec{a}=2\hat{i}+\hat{j}-\hat{k},\ \vec{b}=\hat{i}+\hat{j},\ \vec{c}=\vec{a}\times\vec{b}\,|\vec{d}\times\vec{c}|=3$ & $\vec{d}\wedge\vec{c}=\frac{\pi}{4}$ & $|\vec{a}-\vec{d}|=\sqrt{11}$ find $\vec{a}.\vec{d}$

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

Ans. **[3]**

Sol. $\vec{c}=\vec{a}\times\vec{d}=\begin{vmatrix} i & j & k \\ 2 & 1 & -1 \\ 1 & 1 & 0\end{vmatrix}=i-j+k$ ....(1)

$|\vec{d}\times\vec{c}|=|\vec{d}||\vec{c}|\sin\theta=|\vec{d}|\sqrt{3}\cdot\frac{1}{\sqrt{2}}=3$ (given)

$\Rightarrow|\vec{d}|=\sqrt{6}$ ...(2)

Now

$|\vec{a}-\vec{d}|=\sqrt{11}\Rightarrow|\vec{a}|^2+|\vec{d}|^2-2\vec{a}\cdot\vec{d}=11$

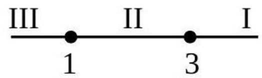
$\Rightarrow 6+6-2\vec{a}\cdot\vec{d}=11\Rightarrow\vec{a}\cdot\vec{d}=\frac{1}{2}$

18. Find the number of real solutions of $x|x-3|+|x-1|+3=0$:

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

Ans. **[1]**

Sol.



(I) if $x \geq 3$

$\therefore x^2-3x+x-1+3=0$

$\therefore x^2-2x+2=0$

No real solution

(ii) If $1<x<3$

$\therefore 3x-x^2+x-1+3=0$

$\Rightarrow x^2-4x-2=0$

$\rightarrow x=\frac{4\pm\sqrt{16+8}}{2}=\frac{4\pm\sqrt{24}}{2}=2\pm\sqrt{6}$

(III) If $x \leq 1$

$\therefore 3x-x^2+1-x+3=0$

$\Rightarrow x^2-2x-4=0 \rightarrow x=\frac{2\pm\sqrt{4+16}}{2}=1\pm\sqrt{5}$

So, total 1 real solution

19. Consider an ellipse $E_1:\frac{x^2}{a^2}+\frac{y^2}{b^2}=1(a>b)$ and $E_2:\frac{x^2}{A^2}+\frac{y^2}{B^2}=1(B>A)$ where $e=\frac{4}{5}$ for both the curves and ℓ_1 is the length of latus rectum of E_1 and ℓ_2 is the length of latus rectum of E_2. Let the distance between the focii of the first curve is 8 . Find the distance between the focii of the second curve $\left(\text{Given}\left(2\ell_1^2=9\ell_2\right)\right)$:

(1) $\frac{64}{5}$ (2) $\frac{8}{5}$ (3) $\frac{32}{5}$ (4) $\frac{16}{5}$

Ans. **[3]**

Sol. $2ae=8 \Rightarrow a=5$

$b^2=a^2\left(1-e^2\right)$

$b^2=a^2\times\frac{9}{25}\quad b^2=9$

$E_1:\frac{x^2}{25}+\frac{y^2}{9}=1$

$\ell_1:\frac{2\,b^2}{a}=\frac{2\times 9}{5}=\frac{18}{5}$

$A^2=B^2\left(1-e^2\right)\Rightarrow A^2=\frac{9}{25}B^2\Rightarrow A=\frac{3}{5}B$

$2\ell^2=9\ell_2\Rightarrow 2\left(\frac{18}{5}\right)^2=9\ell_2\Rightarrow \ell_2=\frac{4\times 18}{25}$

$$\frac{2\,A^2}{B} = \frac{72}{25} \Rightarrow A^2 \frac{36}{25} B$$

$$\frac{9}{25} B^2 = \frac{36\,B}{25} \Rightarrow B = 4\,,$$

Distance between focii $2Be = 2 \times \frac{4}{5} \times 4 = \frac{32}{5}$

20. Evaluate the series $\frac{1}{25!} + \frac{1}{3!23!} + \frac{1}{5!21!} + \ldots\ldots + $ upto 13 terms :

(1) $\frac{2^{26}}{26!}$ (2) $\frac{2^{25}}{26!}$ (3) $\frac{2^{26}}{25!}$ (4) $\frac{2^{25}}{25!}$

Ans. **[2]**

Sol. $\frac{1}{26!}\left(\frac{26!}{25!1!} + \frac{26!}{3!23!} + \frac{26!}{5!21!} + \ldots.. + 13 \text{ terms }\right)$

$\frac{1}{26!}\left({}^{26}C_1 + {}^{26}C_3 + {}^{26}C_5 + \ldots. + 13 \text{ terms }\right)$

$\frac{1}{26!}\left({}^{26}C_1 + {}^{26}C_5 + \ldots. + {}^{26}C_{25}\right)$

$\frac{1}{26!} \times 2^{25}$

21. Find number of matrices A whose order is 3×2 has elements from the set $\{\pm 2, \pm 1, 0\}$ if $Tr\left(A^T A\right) = 5$:

(1) 310 (2) 312 (3) 320 (4) 325

Ans. **[2]**

Sol. $\begin{pmatrix} a_1 & b_1 \\ a_2 & b_2 \\ a_3 & b_3 \end{pmatrix}_{3\times 2}$

$$A^T A = \begin{pmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{pmatrix}_{2\times 3} \begin{pmatrix} a_1 & b_1 \\ a_2 & b_2 \\ a_3 & b_3 \end{pmatrix}_{3\times 2}$$

$$= \begin{pmatrix} a_1^2 + a_2^2 + a_3^2 & \\ - & b_1^2 + b_2^2 + b_3^2 \end{pmatrix}$$

$$Tr\left(A^T A\right) = a_1^2 + a_2^2 + a_3^2 + b_1^2 + b_2^2 + b_3^2 = 5$$

$\{2, 1, 0, 0, 0, 0\}$

$\{2, -1, 0, 0, 0, 0\}$

$\{-2, 1, 0, 0, 0, 0\}$

$\{-2, -1, 0, 0, 0, 0\}$

$\{1, 1, 1, 1, 1, 0\}$

No. of ways $= \frac{6!}{4!} \times 4 + 2 \times \frac{6!}{5!} + 2 \times \frac{6!}{4!} + 2 \times \frac{6!}{3!2!}$

$= \frac{6!}{3!} + 2\times6 + 2\times15\times2\times\frac{6!}{3!}$

$= 120 + 120 + 12 + 60 = 312$

22. Consider an A.P. $a_1, a_2, \ldots\ldots. a_n; a_1 > 0$, $a_2 - a_1 = \frac{-3}{4}$, $a_n = \frac{a_1}{4}$, $\sum_{n=1}^{n} a_i = \frac{525}{2}$ then $\sum_{i=1}^{17} a_i$ is equal to:

(1) 231 (2) 234 (3) 236 (4) 238

Ans. **[4]**

Sol. $S_n = \frac{n}{2}[a_1 + a_n] = \frac{525}{2}$, $d = \frac{-3}{4}$

$\frac{n}{2}\left[a_1 + \frac{a_1}{4}\right] = \frac{525}{2}$

$\frac{5a_1 n}{4} = 525$

$a_1 n = 420$

$a_n = a_1 + (n-1)\left(\frac{-3}{4}\right)$

$\Rightarrow \frac{-3}{4}a_1 = \left(\frac{-3}{4}\right)(n-1) \Rightarrow a_1 = n - 1$

$n(n-1) = 420$

$n^2 - n - 420 = 0$

$(n-21)(n+20) = 0$

$n = 21, a_1 = 20$

$\sum_{i=1}^{17} a_i = \frac{17}{2}[2a_1 + 16\ d]$

$= \frac{17}{2}\left[40 + 16\left(\frac{-3}{4}\right)\right]$

$= \frac{17}{2}[40 - 12]$

$= 17\times14 = 238$

23. There are 10 defective & 90 non-defective balls in a bag. 8 balls are taken one by one with replacement then probability that at least 7 defective balls are selected.

(1) $\left(\frac{73}{10^8}\right)$ (2) $\left(\frac{37}{10^8}\right)$ (3) $\left(\frac{105}{10^8}\right)$ (4) $\left(\frac{11}{10^8}\right)$

Ans. **[1]**

Sol. 10 defective & 90 non-defective

Req. probability = (7 def 1 fair) or (8 defective)

Req. probability $= \frac{(10^7\times90)\times8 + 10^8}{100^8}$

$= \frac{72\times10^8 + 10^8}{100^8} = \frac{73}{10^8}$