JEE Main Online Exam 2026

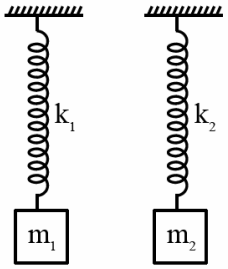
Memory Based

Questions & Solution

23rd January 2026 | Morning

PHYSICS

1. There are two spring-block system as shown. They are in equilibrium. If $\frac{m_1}{m_2}=\alpha$ and $\frac{k_1}{k_2}=\beta$. Then the ratio of the energies of springs $\left(\frac{E_1}{E_2}\right)$ is :-



(1) $\frac{E_1}{E_2}=\frac{\alpha^2}{\beta}$ (2) $\frac{E_1}{E_2}=\frac{\alpha}{\beta}$ (3) $\frac{E_1}{E_2}=\frac{\alpha}{\beta^2}$ (4) $\frac{E_1}{E_2}=\frac{\alpha^2}{\beta^2}$

Ans. **[1]**

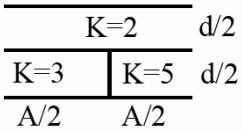
Sol. $x_1=\frac{m_1 g}{k_1}$ and $x_2=\frac{m_2 g}{k_2}$

$$\frac{E_1}{E_2}=\frac{\frac{1}{2}k_1x_1^2}{\frac{1}{2}k_2x_2^2}=\frac{\frac{1}{2}k_1\left(\frac{m_1 g}{k_1}\right)^2}{\frac{1}{2}k_2\left(\frac{m_2 g}{k_2}\right)^2}=\frac{\frac{m_1^2}{k_1}}{\frac{m_2^2}{k_2}}$$

$$\frac{E_1}{E_2}=\left(\frac{m_1}{m_2}\right)^2\times\frac{k_2}{k_1}=\frac{\alpha^2}{\beta}$$

$$\frac{E_1}{E_2}=\frac{\alpha^2}{\beta}$$

2. When there is no dielectric then value of capacitance of a capacitor is C . Now some dielectrics inserted in this capacitor as shown in the diagram if capacitance become $\frac{nC}{3}$ then find value of ' n ' to the nearest integer.



Ans. **[8]**

Sol. $C_1 = \frac{5\epsilon_0 \, A/2}{d/2} = \frac{5\epsilon_0 \, A}{d} = 5C$

$C_2 = \frac{2\epsilon_0 \, A/2}{d/2} = \frac{2\epsilon_0 \, A}{d} = 2C$

C_1 & C_2 in series.

$C' = \frac{C_1C_2}{C_1 + C_2} = \frac{(5C)(2C)}{7C} = \frac{10}{7}C$

$C_3 = \frac{3\epsilon_0 \, A/2}{d/2} = 3C$

$C_4 = \frac{2\epsilon_0 \, A/2}{d/2} = 2C$

C_4 & C_3 in series; $C'' = \frac{(2C)(3C)}{5C} = \frac{6}{5}C$

C' & C'' in parallel;

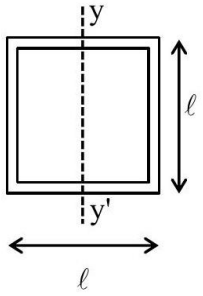
So, $C_{eq} = C\left(\frac{6}{5} + \frac{10}{7}\right) = C\left(\frac{42+50}{35}\right) = \left(\frac{92}{35}\right)C$

$\frac{92}{35}C = \frac{nC}{3}$

$n = \frac{92 \times 3}{35} = 7.9$

$n \simeq 8$

3. All are cylindrical rods having radius of cross-section ' R ' and mass of each rod is $\frac{M}{4}$. Find moment of inertia about yy' axis. :



(1) $I = \frac{1}{16}MR^2 + \frac{1}{6}M\ell^2$

(2) $I = \frac{5}{16}MR^2 + M\ell^2$

(3) $I = \frac{16}{5}MR^2 + \frac{1}{6}M\ell^2$

(4) $I = \frac{3}{8}MR^2 + \frac{M\ell^2}{6}$

Ans. **[4]**

Sol. $I = I_1 + I_2 + I_3 + I_4$

$= 2\left(\frac{M'R^2}{4} + \frac{M'\ell^2}{12}\right) + 2\left(\frac{M'R^2}{2} + M'\left(\frac{\ell}{2}\right)^2\right)$

$= \frac{M'R^2}{2} + \frac{M'R^2}{6} + M'R^2 + \frac{M'\ell^2}{2}$

$= \frac{3M'R^2}{2} + \frac{2M'\ell^2}{3}$

Given masses $M' = \frac{M}{4}$

So, $I = \frac{3(M/4)R^2}{2} + 2\frac{(M/4)\ell^2}{3}$

$I = \frac{3}{8}MR^2 + \frac{M\ell^2}{6}$

4. If electric field component is $E = 377\sin(\omega t + kx)V/m$ of a electromagnetic wave and $\sqrt{\frac{\mu_0}{\varepsilon_0}} = 377$. Then find average intensity of the wave. (in W/m^2)

(1) 188.5 (2) 200 (3) 100 (4) 300

Ans. **[1]**

Sol. $I_{avg} = \left(\frac{1}{2}\varepsilon_0 E^2\right)\cdot C$

$= \frac{1}{2}\varepsilon_0 E^2 \frac{1}{\sqrt{\mu_0\varepsilon_0}}$

$= \frac{1}{2}\sqrt{\frac{\varepsilon_0}{\mu_0}}\cdot E_0^2$

$= \frac{1}{2}\times\frac{1}{377}\times(377)^2$

$= \frac{377}{2} = 188.5\ W/m^2$

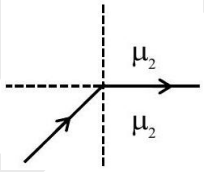
5. Two media of refractive indices n_1 and n_2 have a plane interface. In the first medium, speed of light is $2.4\times10^8\ m/s$ and in the second medium, it is $2.8\times10^8\ m/s$. Find the critical angle when light travels from 1^{st} medium to 2^{nd} medium :

(1) $\sin^{-1}\left(\frac{5}{7}\right)$ (2) $\sin^{-1}\left(\frac{1}{3}\right)$ (3) $\sin^{-1}\left(\frac{6}{7}\right)$ (4) $\sin^{-1}\left(\frac{1}{4}\right)$

Ans. **[3]**

Sol. $\mu_1 = \frac{C}{v_1} = \frac{3}{2.4} = \frac{5}{4}$

$\mu_2 = \frac{C}{v_2} = \frac{3}{2.8} = \frac{15}{14}$



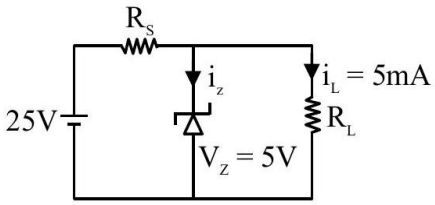
For critical angle :

$\mu_1\times\sin\theta_C = \mu_2\times\sin90^\circ$

$\Rightarrow \sin\theta_C = \frac{\mu_1}{\mu_2} = \frac{15}{14}\times\frac{4}{5} = \frac{6}{7}$

$\theta_C = \sin^{-1}\left(\frac{6}{7}\right)$

6.



In the given diagram if $i_z = 4i_L$. Find R_s(in Ω)

Ans. **[800]**

Sol. Zener diode is conducting

means $V_Z = V_{R_L} = 5$ V

$i_L = 5$ mA

$\therefore V_{RS} = 20$ V

$i_{RS} = i_Z + i_L = 5i_L = 25$ mA

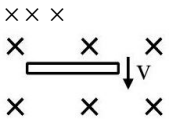
$$R_S = \frac{V_{RS}}{i_{RS}} = \frac{20}{25\times10^{-3}} = \frac{20\times1000}{25} = 800\Omega$$

7. A rod of mass ' m ' and length ' ℓ ' falls from rest in a region of uniform horizontal magnetic field B . Find emf induced in the rod after falling through a distance ' x ' :

(1) $B\ell\sqrt{gx}$ (2) $B\ell\sqrt{5gx}$ (3) $B\ell\sqrt{2gx}$ (4) $B\ell\sqrt{3gx}$

Ans. **[3]**

Sol. Free fall distance ' x '



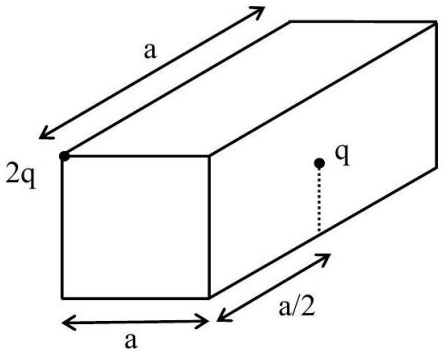
$v = \sqrt{2gx}$

induced emf

$e = Bv\ell$

$= B\ell\sqrt{2gx}$

8. There are two point charges, one at vertex and other at face centre as shown on the cube. Find electric flux through the cube :



(1) $3q/\varepsilon_0$ (2) q/ε_0 (3) $3q/4\varepsilon_0$ (4) $5q/\varepsilon_0$

Ans. **[3]**

Sol. $\phi = \frac{(2q)}{8\varepsilon_0} + \frac{q}{2\varepsilon_0}$

$= \frac{q}{4\varepsilon_0} + \frac{2}{2\varepsilon_0} = \frac{3}{4}\frac{q}{\varepsilon_0}$

9. In young's double slit experiment with two different set-up fringe widths are equal. If ratio of slits-separation is 2 and wavelengths ratio is $\frac{1}{2}$. Find ratio of screen distances in both setup :

(1) $\frac{D_1}{D_2} = 3$ (2) $\frac{D_1}{D_2} = 2$ (3) $\frac{D_1}{D_2} = 8$ (4) $\frac{D_1}{D_2} = 4$

Ans. **[4]**

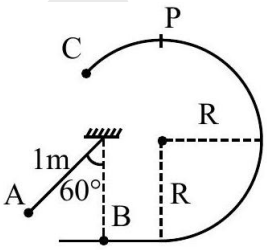
Sol. $\beta_1 = \beta_2$

$\frac{D_1\lambda_1}{d_1} = \frac{D_2\lambda_2}{d_2}$

$\frac{D_1}{D_2} = \frac{\lambda_2}{\lambda_1}\left(\frac{d_1}{d_2}\right) = 2\times 2$

$\frac{D_1}{D_2} = 4$

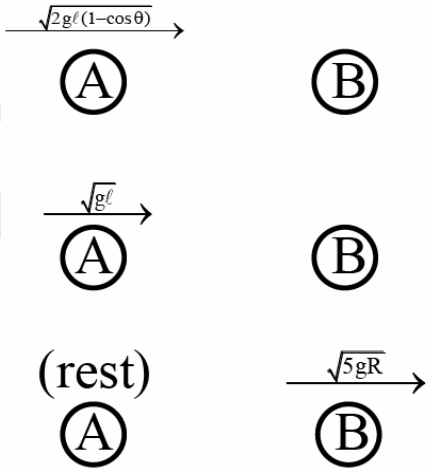
10. A and B are identical point masses. A is released as shown in diagram at angle 60° from vertical. Find 'R' if B is able to reach point ' C ' after elastic impact.



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

Ans. **[1]**

Sol. If ball reach at point ' p ' then it will pass through C surely.



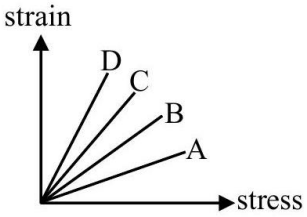
Before :

$\sqrt{g\ell} = \sqrt{5gR}$

$\ell = 5R$

$R = \frac{\ell}{5} = \frac{1}{5}$ m

11. Figure beside represent strain versus stress graph for four materials A,B,C and D. Which material has maximum Young's modulus.



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

Ans. **[1]**

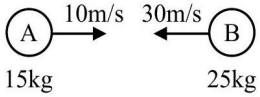
Sol. Young's modulus

$= \frac{\text{stress}}{\text{strain}}$

= inverse of slope given in graph.

Hence, A should have maximum Young's modulus.

12.



Two ball made of same material collides perfectly inelastically. Energy lost in the collision is completely utilized for raising temperature of each ball. Find rise in temperature of balls. [specific heat: $31\text{cal}/\text{kg}-^\circ\text{C}$] :

(1) 1.24°C (2) 2.44°C (3) 2.24°C (4) 1.44°C

Ans. **[4]**

Sol. $(\text{K.E})_{\text{lost}} = \frac{1}{2}\mu\, V_{\text{rel}}^2\left(1-e^2\right)$

$= \frac{1}{2}\left(\frac{m_1 m_2}{m_1+m_2}\right)(10+30)^2(1-0)$

$= \frac{1}{2}\left[\frac{(15)(25)}{40}\right][40]^2$

$= 7500$ J

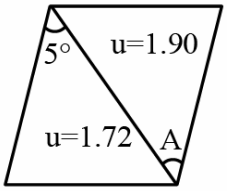
$(\text{K.E})_{\text{loss}} = (m_1+m_2)(S)(\Delta T)$

$\left[S = 31\times 4.2\ \text{J}/\text{kg}-^\circ\text{C}\right]$

$7500 = (40)(31)(\Delta T)$

$\Delta T = \frac{7500}{40\times 31\times 4.2} = 1.44^\circ$C

13. Find the angle A of second prism so that light ray suffers dispersion without deviation :



(1) 6° (2) 4° (3) 7° (4) 2°

Ans. **[2]**

Sol. For no deviation,

$$\left(\mu_{y_1}-1\right)A_1-\left(\mu_{y_2}-1\right)A_2=0$$

$$\Rightarrow (1.72-1)5-(1.90-1)\mathrm{A}=0$$

$$\therefore \mathrm{A}=4^\circ$$

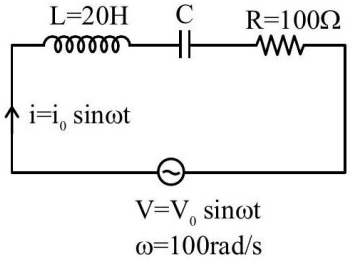
14. A screw gauge has a least count of 0.01 mm . Using this screw gauge a measurement was done. When nothing was present in the jaw, zero of circular scale was above reference line by 3 units. When a sphere was kept between the jaws, main scale reads 1 mm and 51^{st} division of circular scale coincides with reference line. The actual diameter of the ball is :

(1) 1.54 mm (2) 1.48 mm (3) 1.51 mm (4) 1.53 mm

Ans. **[1]**

Sol. Screw gauge has negative zero error.

15. Find capacitance ' C ' for the given circuit.



(1) 5×10^{-6} farad (2) 8×10^{-6} farad (3) 7×10^{-6} farad (4) 4×10^{-6} farad

Ans. **[1]**

Sol. Condition of resonance

$$\omega=\omega_0=\frac{1}{\sqrt{\mathrm{LC}}}$$

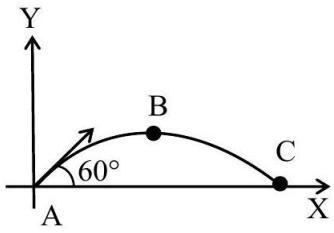
$$\mathrm{LC}=\frac{1}{\omega_0^2}$$

$$\mathrm{C}=\frac{1}{\mathrm{L}\omega_0^2}=\frac{1}{20\times(100)^2}$$

$$\mathrm{C}=\frac{1}{2}\times10^{-5}$$

$$\mathrm{C}=5\times10^{-6} \text{ farad}$$

16. A projectile is projected with speed v at an angle 60° with ground (horizontal). Find the ratio of difference of kinetic energies at point C (at ground) and point B (at highest point) with kinetic energy at point C as shown in the diagram:



(1) 3 : 4 (2) 1 : 3 (3) 1 : 2 (4) 1 : 12

Ans. **[1]**

Sol. $K_A = K_C = K = \frac{1}{2}mu^2$

$K_B = \frac{1}{2}\, m\left(u\cos 60^\circ\right)^2$

$\left(\frac{1}{2}mu^2\right)\frac{1}{4} = \frac{k}{4}$

$\frac{K_C - K_B}{K_C} = 1 - \frac{K_B}{K_C} = 1 - \frac{1}{4} = \frac{3}{4}$

17. Among the given options choose the correct energy of transition :

(1) $H_{2\to 1}\left(6.8ev\right)$ (2) $Li^{2+}_{2\to 1}\left(13.6ev\right)$ (3) $He^{+}_{2\to 1}\left(40.8ev\right)$ (4) $Be^{3+}_{2\to 1}\left(13.6ev\right)$

Ans. **[3]**

Sol. $Ex = -13.6\frac{z^2}{n^2}$

H-atom :

$E_1 = -13.6eV$

$E_2 = -3.4eV\ \Delta E = 10.2eV$

He^+ -ion :

$E_1 = -54.4eV$

$E_2 = -13.6eV$

$\Delta E = 40.8eV$

Li^{2+} -ion :

$E_1 = -122.4eV$

$E_2 = -30.6eV\ \Delta E = 91.8eV$

Be^{3+} ion :

$E_1 = -217.6eV$

$E_2 = -54.4eV$

18. Find de-Broglie wavelength of oxygen molecule at $27^\circ C$. Molar mass of oxygen molecule is 32 gm/mole.

(1) 0.257Å (2) 2.57Å (3) 25.7Å (4) 257Å

Ans. **[1]**

Sol. KE of O_2 molecule at $27^\circ C$

$$K = \frac{3}{2}kT$$

$$= \frac{3}{2} \times 1.38 \times 10^{-23} \times 300$$

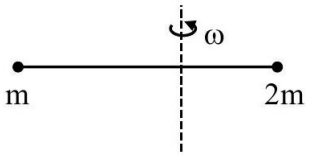
$$= 6.21 \times 10^{-21} \text{ J}$$

de-Broglie wavelength $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mk}}$

$$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times \frac{32 \times 10^{-3}}{6 \times 10^{23}} \times 6.21 \times 10^{-21}}} = 2.57 \times 10^{-11}$$

$$= 0.257 \text{Å}$$

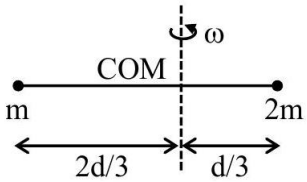
19. Masses ' m ' and ' 2 m ' are connected by a massless rod of length ' d '. If angular momentum about axis passing through centre of mass and perpendicular to length is ' L '. Then angular speed (ω) of the system is :



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

Ans. **[1]**

Sol.

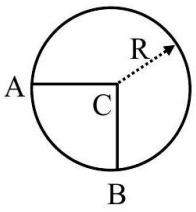


$$L = I\omega \text{ and } \omega = \frac{L}{I}$$

$$\omega = \frac{L}{m\left(\frac{2d}{3}\right)^2 + 2m\left(\frac{d}{3}\right)^2} = \frac{L}{\frac{4}{9}md^2 + \frac{2}{9}md^2} = \frac{L}{\frac{6md^2}{9}}$$

$$\omega = \frac{3L}{2md^2}$$

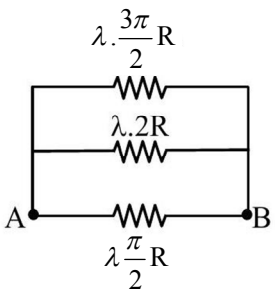
20. A circular ring and two wires AC and BC are joined as shown in the figure. If all wires have resistance $\lambda\Omega / m$. Find equivalent resistance across A and B :



(1) $\lambda R\left(\frac{6\pi}{16+3\pi}\right)$ (2) $\lambda R\left(\frac{6\pi}{16-3\pi}\right)$ (3) $\lambda R\left(\frac{\pi}{16-3\pi}\right)$ (4) $\lambda R\left(\frac{\pi}{6-3\pi}\right)$

Ans. **[1]**

Sol.



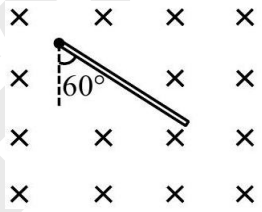
$$\frac{1}{R_{AB}}=\frac{2}{\lambda\pi R}+\frac{1}{\lambda.2R}+\frac{2}{\lambda.3\pi R}$$

$$=\frac{1}{\lambda R}\left[\frac{2}{\pi}+\frac{1}{2}+\frac{2}{3\pi}\right]$$

$$=\frac{1}{\lambda R}\left(\frac{12+3\pi+4}{6\pi}\right)=\frac{1}{\lambda R}\cdot\left(\frac{16+3\pi}{6\pi}\right)$$

$$R_{AB}=\lambda R\left(\frac{6\pi}{16+3\pi}\right)$$

21. A rod of mass m and length ℓ is released from the position shown with upper end hinged in uniform horizontal magnetic field ' B '. Find maximum induced emf in the rod:



(1) $B\ell\sqrt{\frac{3}{8}g\ell}$ (2) $B\ell\sqrt{\frac{1}{8}g\ell}$ (3) $B\ell\sqrt{\frac{7}{8}g\ell}$ (4) $B\ell\sqrt{\frac{5}{8}g\ell}$

Ans. **[1]**

Sol. Maximum emf of maximum ' ω '

$$e_{max}=\frac{B\omega\ell^2}{2}$$

W.E.T.

$$mg\frac{\ell}{2}(1-\cos60)=\frac{1}{2}\frac{m\ell^2}{3}\omega^2$$

$$\frac{mg\ell}{4}=\frac{m\ell^2}{6}\omega^2$$

$$\omega^2=\frac{3}{2}\frac{g}{\ell}$$

$$e_{max}=\frac{B\ell^2}{2}\sqrt{\frac{3}{2}\frac{g}{\ell}}=B\ell\sqrt{\frac{3}{8}g\ell}$$

22. A set of measurements of a certain parameter is : $20.00, 19.75, 18.25, 17.01$. Find relative error for the set of measurements.

(1) 0.12 (2) 0.06 (3) 0.09 (4) 0.17

Ans. **[2]**

Sol. Average value $= \frac{75.01}{4} = 18.75$

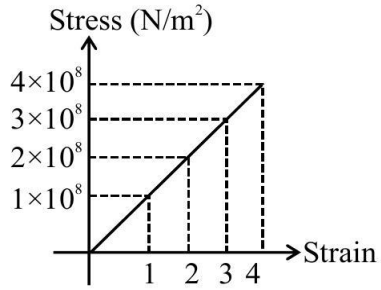
Absolute error of each measurement :

1.25, 1.00, 0.5, 1.74

Mean absolute error = 1.12

Relative error $= \frac{1.12}{18.75} = 0.06$

23. The stress v / s strain graph of a material is as shown. Find the Young's modulus of the material.



(1) 10^8 N / m^2 (2) 2×10^8 N / m^2 (3) 4×10^8 N / m^2 (4) 3×10^8 N / m^2

Ans. **[1]**

Sol. $Y = \frac{\text{Stress}}{\text{Strain}}$

$= \frac{4\times10^8}{4} = 10^8$ N / m^2

24. A simple pendulum of length 30 cm makes 20 oscillations in 10 sec on a certain planet. Another pendulum makes 40 oscillations in 10 sec on same planet. Find length of second pendulum:

(1) 10 cm (2) 14 cm (3) 7.5 cm (4) 25 cm

Ans. **[3]**

Sol. $T = 2\pi\sqrt{\frac{\ell}{g}} = \frac{\Delta t}{N}$

1st pendulum

$2\pi\sqrt{\frac{0.3}{g}} = \frac{10}{20}$ … (i)

2nd pendulum

$2\pi\sqrt{\frac{\ell}{g}} = \frac{10}{40}$ … (ii)

(ii)/(i) $\sqrt{\frac{\ell}{0.3}} = \frac{1}{2}$

$\ell = \frac{0.3}{4}$ m $= 7.5$ cm

CAREER POINT

JEE Main Online Exam 2026

Memory Based

Questions & Solution

23rd January 2026 | Morning

CHEMISTRY

1. For a given reaction at 400 K

($R = 0.082$ atm – L / mol – K)

$xA \rightleftharpoons yB$

Given (i) $K_P = 0.82,\ K_C = 25.7$

(ii) $K_P = 8.2,\ K_C = 0.25$

Then which will be correct combination of x & y for above set (i) & set (ii) data

	set (i) (x,y)	set (ii) (x,y)
(A)	(1, 2)	(2, 1)
(B)	(2, 1)	(1, 2)
(C)	(1, 1)	(2, 1)
(D)	(1,2)	(1, 1)

Ans. **[2]**

Sol. $\frac{K_P}{K_C} = (RT)^{\Delta n_g}$

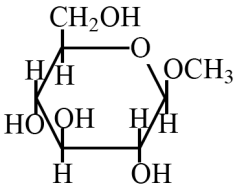
for $\Delta n_g = 1 (RT)^{\Delta n_g} = 32.8$

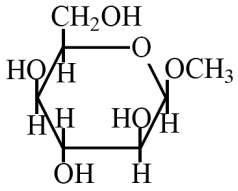
for $\Delta n_g = -1 (RT)^{\Delta n_g} = 0.03$

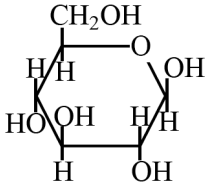
set (i) $\frac{K_P}{K_C} = \frac{0.82}{25.7} = 0.03 \Rightarrow \Delta n_g = -1$

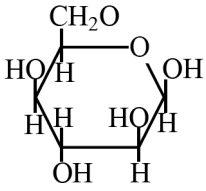
set (ii) $\frac{K_P}{K_C} = \frac{8.2}{0.25} = 32.8 \Rightarrow \Delta n_g = +1$

2. Which of the following are the compound(s) do not give Tollen's test?

(A) 

(B) 

(C) 

(D) 

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

Ans. **[1]**

Sol. Compound in option (A) and (B) are acetals (i.e. not having anomeric –OH). Hence they do not give Tollen's test.

3. **Statement-1 :** Sublimation is a purification technique that is used to separate those solid substance which changes from solid to vapour state without passing through liquid state.
Statement-2 : If external atmospheric pressure is reduced, then boiling point of substance decreased.
(1) Statement-1 and Statement-1 both are correct.
(2) Statement-1 and Statement-1 both are incorrect.
(3) Statement-1 is correct but Statement-2 is incorrect.
(4) Statement-1 is incorrect but Statement-2 is correct.

Ans. **[1]**

Sol. Statement-1 and Statement-1 both are correct.

4. Consider the following statements about group 13 elements of the periodic table.
(A) Electronegativity decreases down the group.
(B) Size increases down the group.
(C) Ionization energy decreases down the group.
(D) Boiling point of Boron is maximum.
(E) Melting point of Boron is maximum.
(1) A, B, C are correct
(2) A, D, E are correct
(3) D and E are correct
(4) A, B, C, D and E are correct

Ans. **[3]**

Sol. Atomic radii order → B < Ga < Al < In < Tℓ
Ionization enthalpies order → B > Tℓ > Ga > Al > In.
Electronegativity order → B > Tℓ > In > Ga > Al
M.P. → B > Al > Tl > In > Ga
B.P. → B > Al > Ga > In > Tl

5. Match the list-I and list-II name of reagent.

(1) Baeyer's reagent	(P) Violet colour
(2) Cerric Ammonium nitrate	(Q) Red
(3) Tollen's reagent	(R) Silver mirror
(4) Neutral $FeCl_3$	(S) Pink colour disappears

(1) 1-S, 2-Q, 3-R, 4-P
(2) 1-Q, 2-S, 3-R, 4-P
(3) 1-R, 2-P, 3-Q, 4-S
(4) 1-P, 2-R, 3-Q, 4-S

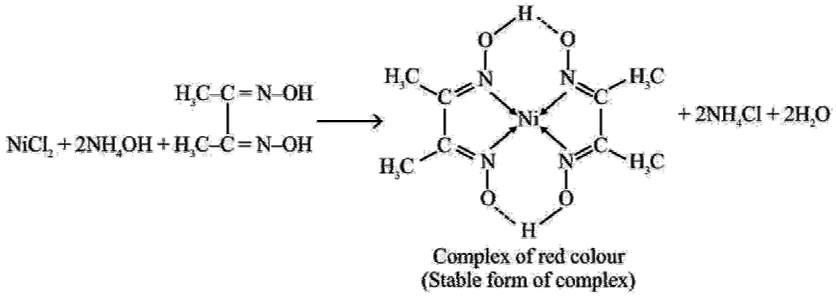
Ans. **[1]**

Sol.

6. Consider the following statements for $[Ni(dmg)_2]$
(A) It is a red colour compound.
(B) It is readily soluble in water at $pH = 9$.
(C) Central metal ion has two unpaired electrons.
(D) It has four, 5 membered metal containing rings.
(1) A and D are correct
(2) B, C and D are incorrect
(3) A,C and D are correct
(4) A, B, C, D are incorrect

Ans. **[2]**

Sol.



7. $25ml, 0.1M Ba(OH)_2$ react completely with HCl. Find weight of HCl (in milligram) required?

Ans. **[182]**

Sol. $Ba(OH)_{2(aq)} + 2HCl_{(aq)} \rightarrow BaCl_{2(aq)} + 2H_2O_{(\ell)}$

2.5 mmole 5 mmole

wt of $HCl = 5 \times 36.5$ (milligram)

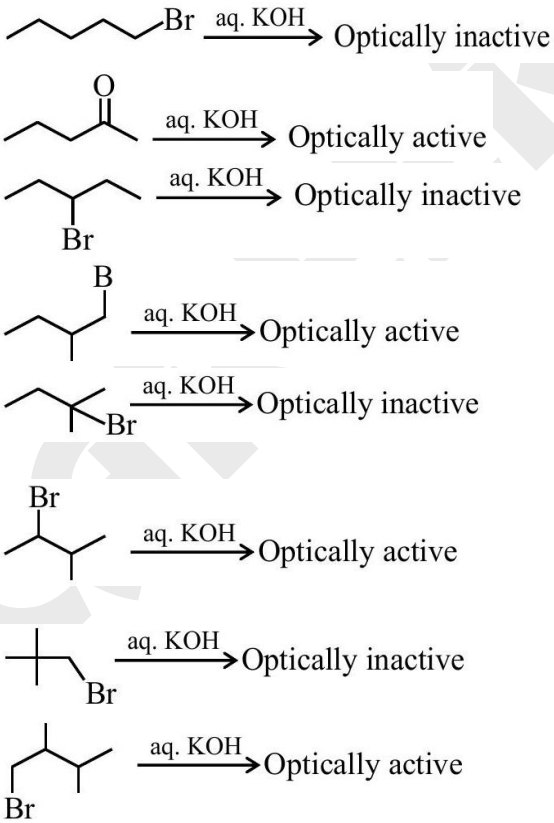
= 182.5 (milligram)

= 182

8. All possible isomers of $C_5H_{11}Br$ when reacted with aq. KOH. Find out total number of optically active product (without rearrangement).

Ans. **[6]**

Sol.



9. The correct order of ionization energy of Cl, S, P, Al, Si is. :
(1) Cl > P > S > Si > Al
(2) Cl < P < S < Si < Al
(3) P > Cl > S > Si > Al
(4) S > P > Cl > Si > Al

Ans. **[1]**

Sol. In general on moving from left to right in a period ionization energy increases.

10. For a given reaction, $K_P = 9$ atm

$$NH_{3(g)} \rightleftharpoons \frac{1}{2}N_{2(g)} + \frac{3}{2}H_{2(g)}$$

Total pressure at equilibrium is $\sqrt{3}$ atm .
Find the value of $7\alpha^2$, where α is degree of dissociation of $NH_{3(g)}$?

Ans. **[6]**

Sol.

$$NH_{3(g)} \rightleftharpoons \frac{1}{2}N_{2(g)} + \frac{3}{2}H_{2(g)}$$

$t = 0$	1 mole	–	–
$t = t_{eq}$	$1-\alpha$	$\alpha/2$	$3\alpha/2$

$$k_P = \frac{\left(\frac{\alpha}{2}\right)^{1/2}\left(\frac{3\alpha}{2}\right)^{3/2}}{(1-\alpha)}\left[\frac{P_T}{1+\alpha}\right]^1 \qquad [\because P_T = \sqrt{3} \text{ atm}]$$

$$9 = \frac{\left(\frac{\alpha}{2}\right)^{1/2}\left(\frac{3\alpha}{2}\right)^{3/2}}{(1-\alpha)} \times \frac{(3)^{1/2}}{1+\alpha}$$

$$9 = \frac{9\left(\frac{\alpha}{2}\right)^2}{1-\alpha^2}$$

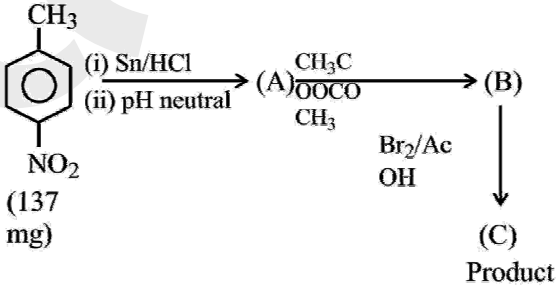
$$1-\alpha = \frac{\alpha^2}{4}$$

$$\frac{5\alpha^2}{4} = 1$$

$$\alpha^2 = 0.8$$

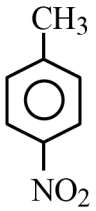
$$7\alpha^2 = 5.6$$

11. What is the mass (in mg) of final product (C) ?



Ans. **[228]**

Sol.

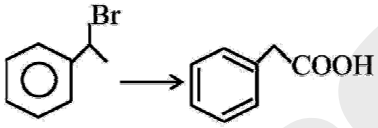


$(137mg)$

$$\text{Mole} = \frac{137\times10^{-3}}{137} = 0.001 \text{ mole}$$

Mole of product = 0.001 mole
Mass of product = 0.001 × 228 gm
= 0.228 gm = 228 mg

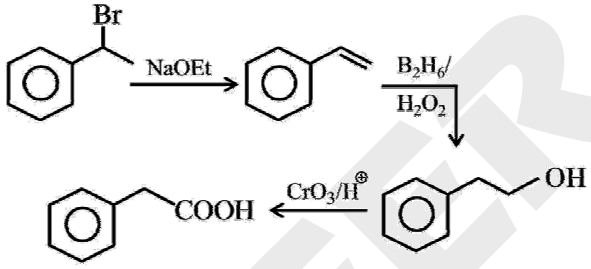
12. Correct sequence of reagent for the given the reaction



(1) NaOEt, B_2H_6/H_2O_2/Jone's reg
(2) B_2H_6/H_2O_2/Jone's reagent, NaOEt
(3) aq. KOH, B_2H_6/H_2O_2/Jone's reagent
(4) NaOEt, $Hg(OAc)_2/H_2O$/Jone's reagent.

Ans. **[1]**

Sol.



13. A cell representation is given

$Ag / AgCl \| FeCl_2, FeCl_3 / Pt$

Which of the following can increase the EMF of cell?

(i) By increasing concentration of Fe^{2+}
(ii) By increasing concentration of Fe^{3+}
(iii) By decreasing concentration of Fe^{2+}
(iv) By decreasing concentration of Fe^{3+}
(v) By increasing concentration of Cl^-

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

Ans. **[2]**

Sol. $Cl^-_{aq} + Ag_{(S)} + Fe^{+3}_{aq} \rightarrow Fe^{+2}_{aq} + AgCl_{(S)}$

$$E_{cell} = E^\circ_{cell} - \frac{0.059}{1}\log\frac{\left[Fe^{2+}\right]}{\left[Cl^-\right]\left[Fe^{3+}\right]}$$

14. Find the ratio of CFSE of $\left[Co(C_2O_4)_3\right]^{3-}$ and $\left[Cr(C_2O_4)_3\right]^{3-}$, for each complex assume $\Delta_0 > P$:

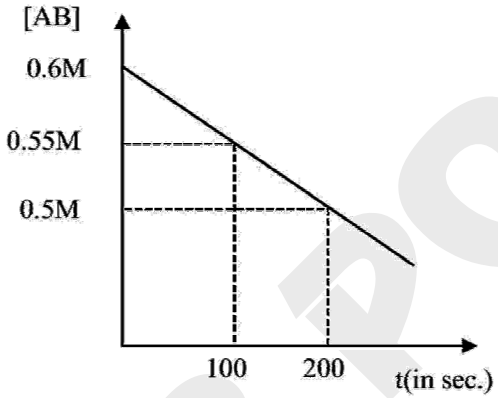
Ans. **[2]**

Sol. $Co^{3+} \rightarrow 3\,d^6 \rightarrow t_{2g}^{2,2,2}eg^{0,0} \rightarrow CFSE = 6\times\left(\frac{-2}{5}\right)\Delta_0$

$Cr^{3+} \rightarrow 3\,d^3 \rightarrow t_{2g}^{1,1,1}eg^{0,0} \rightarrow CFSE = 3\times\left(\frac{-2}{5}\right)\Delta_0$

Required ratio $= \frac{6}{3} = 2$

15. For given zero order reaction $AB_g \rightleftharpoons A_g + B_g$, the graph is given for decomposition of [AB]. Find half life ($t_{1/2}$) in minutes?



Ans. **[10]**

Sol. $[AB]_0 - [AB]_t = kt$

$0.60 - 0.55 = k(100)$

$k = 5\times10^{-4}$

Half life $\left(t_{1/2}\right) = \frac{[AB]_0}{2k}$

$= \frac{0.60}{2\times5\times10^{-4}}$

= 600 sec

= 10 min

16. $CH_3–C\equiv C–CH_3$ → (H_2/Pd-$CaCO_3$) → (X)

$CH_3–C\equiv C–CH_3$ → (Na/Liq. NH_3) → (Y)

Select correct statement.

(1) Boiling point of X < Y

(2) Dipole moment Y > X

(3) X and Y are stereoisomer of each other

(4) Melting point of X > Y

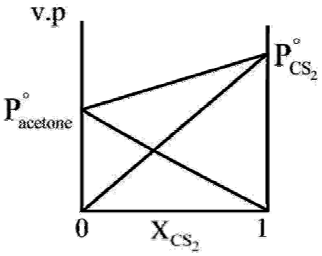
Ans. **[3]**

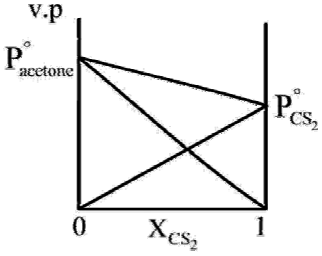
Sol. X is cis-1-butene

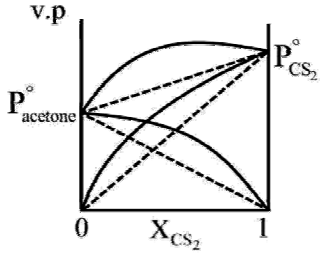
Y is trans-2-butene

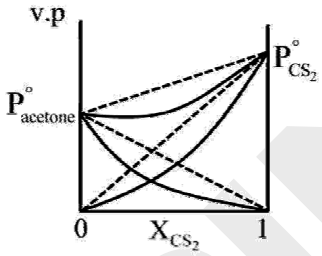
and both are geometrical isomers (i.e. stereoisomers).

17. Choose the correct graph for the mixture of the volatile liquid CS_2 and acetone

(1) 

(2) 

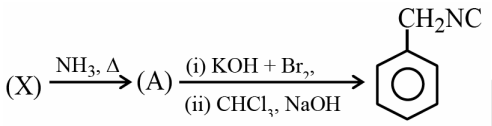
(3) 

(4) 

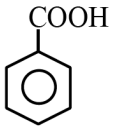
Ans. **[3]**

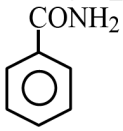
Sol. Mixture of CS_2 and $CH_3-\underset{\underset{O}{\|}}{C}-CH_3$ show positive deviation

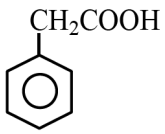
$P^\circ_{CS_2} > P^\circ_{Acetone}$

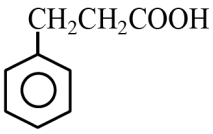
18. 

X will be :

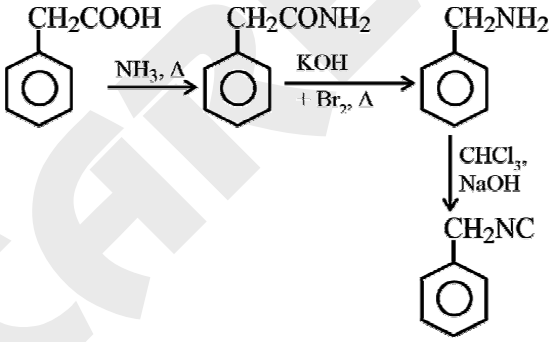
(1) 

(2) 

(3) 

(4) 

Ans. **[3]**

Sol. 

19. Which of the following is correct match for hydrogen like species for the total energy of e^-

	Energy (J/atom)
(1) 3rd orbit of Li^{2+} ion	-21.6×10^{-19}
(2) 2nd orbit of He^+ ion	-10.8×10^{-19}
(3) 2nd orbit of Li^{2+} ion	-9.6×10^{-19}
(4) 2nd orbit of H-atom	-86.4×10^{-19}

Ans. **[1]**

Sol. $E = -21.6\times10^{-19}\times\frac{Z^2}{n^2}J/\text{ atom}$

20. For the following change

$H_2O(\ell)\rightarrow H_2O(g)$

5°C 100°C

Select the correct answer

(1) q = +ve, w = +ve, ΔU = +ve

(2) q = –ve, w = –ve, ΔU = +ve

(3) q = +ve, w = –ve, ΔU= +ve

(4) q = –ve, w = –ve, ΔU= –ve

Ans. **[3]**

Sol. $\underset{5°C}{H_2O(\ell)}\longrightarrow\underset{100°C}{H_2O(\ell)}\rightleftarrows\underset{100°C}{H_2O(g)}$

due to expansion

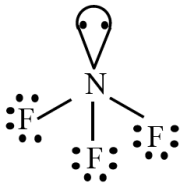
$w = -ve$

as heat is given to system so $q = +ve$ and internal energy of gas will be more than internal energy of liquid so $\Delta U = +ve$

21. The correct bond angle in the compound which has maximum number of lone pair of electrons among the following compounds H_2SO_4, HNO_3, O_3, NF_3 is :

(1) 102° (2) 107° (3) 112° (4) 126°

Ans. **[1]**

Sol. 

sp^3, Higher the electronegativity of surrounding atoms smaller is the bond angle.

22. Given below are two statements:

Statement-I : $[CoBr_4]^{2-}$ absorbs lesser energy than $[CoCl_4]^{2-}$

Statement-II : $[CoCl_4]^{2-}$ has higher crystal field splitting energy than $[CoBr_4]^{2-}$

(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. Cl^- is a stronger ligand than Br^-.

23. The maximum number of electrons in the following two given set of quantum numbers

(i) $n = 5,\ m_\ell = -1$ and

(ii) $n = 4, \ell = 2,\ m_\ell = 1,\ m_s = \frac{1}{2}$

respectively is :-

(1) 8,1 (2) 4, 1 (3) 26,2 (4) 10, 2

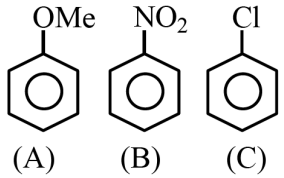
Ans. **[1]**

Sol. $n = 5, \ell = 0,1,2,3$ and 4 .

Only p,d,f and g subshells have one orbital each of $m_\ell = -1$ so total 4 orbitals and & 8 electrons.

$n = 4, \ell = 2,\ m_\ell = 1,\ m_s = \frac{1}{2} \Rightarrow$ All the four quantum members $\Rightarrow$ only one electron.

24. Compare rate of nitration is decreasing order :



(A) (B) (C)

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

Ans. **[2]**

Sol. In $Ph - OMe, -OMe$ is a electron donor group (+M).

$Ph - NO_2, -NO_2$ is a strong withdrawing group (–M).

$Ph - Cl, -Cl$ is a electron withdrawing group.

CAREER POINT

JEE Main Online Exam 2026

Memory Based

Questions & Solution

23rd January 2026 | Morning

MATHEMATICS

1. Number of 4 letter words with or without meaning formed from the letters of the word PQRSSSTTUVV is :

(1) 2214 (2) 1420 (3) 1422 (4) 1242

Ans. **[3]**

Sol. **Case I** 3 alike, 1 different

$${}^{1}C_{1} \times {}^{6}C_{1} \times \frac{4!}{3!} = 24$$

Case II 2 alike, 2 alike

$${}^{3}C_{2} \times \frac{4!}{2!2!} = 18$$

Case III 2 alike, 2 different

$${}^{3}C_{1} \times {}^{6}C_{2} \times \frac{4!}{2!} = 540$$

Case IV All 4 different

$${}^{7}C_{4} \times 4! = 840$$

Total words $= 1422$

2. If A is square matrix of order $3 \& |A| = 6$.

It $\left|\text{adj}\left(3\text{adj}\left(A^2\text{adj}(2A)\right)\right)\right| = 2^m \cdot 3^n$

(m , n are natural numbers) then find $m + n$

adj (X) denotes adjoint of matrix X

$\&|X|$ denotes determinant of matrix X.

Ans. **[62]**

Sol. $\text{adj}2A = 2^2 \text{adj}\, A \because \text{adjk}A = k^{n-1}(\text{adj}\, A)$

$= 4\text{adj}\, A$

Now $A^2(\text{adj}2A) = 4A(\text{adj}\, A)$

$= 4A|A|I_3$

$= 24A$

Now $3\,\text{adj}\left(A^2(\text{adj}2A)\right) = 3\text{adj}(2uA)$

$= 3.(2u)^2\ \text{adj}\, A$

Now $\left|\text{adj}\left(3\text{adj}\left(\text{A}^2\left(\text{adj}2\text{ A}\right)\right)\right)\right|$

$=\left|\text{adj}\left(3.(2u)^2\text{adj A}\right)\right|$

$=\left|\left(3.(2u)^2\right)^2\left(\text{adjadj A}\right)\right|$

$=\left|3^6.2^{12}\text{adjadj A}\right|$

$=\left(3^6.2^{12}\right)^3\left|\text{adjadj A}\right|$

$=3^{18}.2^{36}.(\text{A})^4$

$3^{22}.2^{40}$

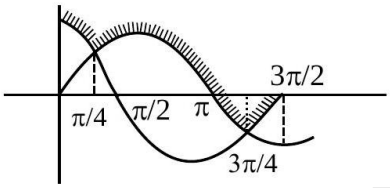
$\therefore$ m + n = 62

3. Find the area bounded by $y=\max\{\sin x,\cos x\}$ when $x\in\left[0,\frac{3\pi}{2}\right]$ with x -axis :

(1) 3 (2) 3π (3) 4π (4) 4

Ans. **[3]**

Sol.



$$\text{A}=\int_0^{\pi/4}\cos x\,dx+\int_{\pi/4}^{\pi}\sin x\,dx+\int_{\pi}^{5\pi/4}-\sin x\,dx+\int_{5\pi/4}^{3\pi/2}-\cos x\,dx$$

$$\text{A}=(\sin x)_0^{\pi/4}+(\cos x)_{\pi}^{\pi/4}+(\cos x)_{\pi}^{5\pi/4}+(\sin x)_{3\pi/2}^{5\pi/4}$$

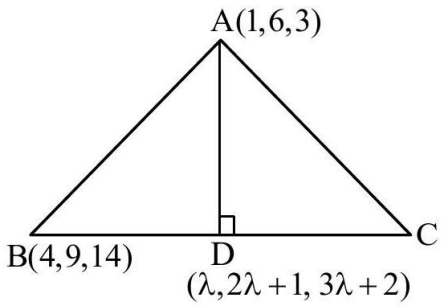
$$\text{A}=\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{2}}+1+1-\frac{1}{\sqrt{2}}+1-\frac{1}{\sqrt{2}}=3$$

4. Let $\text{A}(1,6,3)$ and point B and C lies on line $\frac{x}{1}=\frac{y-1}{2}=\frac{z-2}{3}$ where $\text{B}(4,9,\alpha)$ and point C is 10 unit from B . Find area of ΔABC :

(1) $6\sqrt{13}$ (2) $5\sqrt{13}$ (3) $7\sqrt{13}$ (4) $8\sqrt{13}$

Ans. **[2]**

Sol. $\frac{4}{1}=\frac{9-1}{2}=\frac{\alpha-2}{3}\Rightarrow\alpha=14$



$\overrightarrow{AD}.(\hat{i}+2\hat{j}+3\hat{k})=0$

$(\lambda-1)\hat{i}+(2\lambda-5)\hat{j}+(3\lambda-1)\hat{k}=\overrightarrow{AD}$

$\Rightarrow \lambda-1+4\lambda-10+9\lambda-3=0$

$\Rightarrow 14\lambda=14 \Rightarrow \lambda=1$

$D=(1,3,5)$

$AD=\sqrt{3^2+2^2}=\sqrt{13}$

$Ar(\Delta ABC)=\frac{1}{2}\times\sqrt{13}\times 10=5\sqrt{13}$

5. If $\int e^x\left(\frac{x^2-2}{\sqrt{1+x}(1-x)^{3/2}}\right)dx=f(x)+c$ & $f(0)=1$ find $f(1/2)$:

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

Ans. **[2]**

Sol. $F(x)=\int\frac{e^x(x^2-2)}{\sqrt{1+x}(1-x)^{3/2}}dx=\int e^x\left[\frac{(x^2-1)-1}{\sqrt{x+1}(1-x)^{3/2}}\right]dx$

$$F(x)=-\int e^x\left[\sqrt{\frac{1+x}{1-x}}+\frac{1}{\sqrt{1+x}(1-x)^{3/2}}\right]dx$$

$$=-e^x\cdot\sqrt{\frac{1+x}{1-x}}+\lambda=f(x)+c$$

according to given question

$\because f(0)=1$

$\Rightarrow f(x)=2-e^x\sqrt{\frac{1+x}{1-x}}$

& $f\left(\frac{1}{2}\right)=2-\sqrt{3e}$

6. If $x^4dy+(4x^3y+2\sin x)dx=0$ & $f\left(\frac{\pi}{2}\right)=0$ then the value of $\pi^4 f\left(\frac{\pi}{3}\right)$ (where $y=f(x)$) :

(1) 81 (2) 80 (3) 83 (4) 9

Ans. **[1]**

Sol. $(x^4dy+4x^3ydx)=-2\sin x dx$

$\Rightarrow \int d(x^4y)=\int -2\sin x dx$

$\Rightarrow x^4y=2\cos x+c$

$\Rightarrow x^4 f(x) = 2\cos x + c$

As $f\left(\frac{\pi}{2}\right) = 0$

So, $c = 0$

$\left(\frac{\pi}{3}\right)^4 f\left(\frac{\pi}{3}\right) = 2\cos\frac{\pi}{3}$

$\pi^4 f\left(\frac{\pi}{3}\right) = 81$

7. If in the expansion of $\left(1+x^2\right)^2 (1+x)^n$, the coefficient of x, x^2 & x^3 are in arithmetic progression, then sum of all possible values of n is (where $n \geq 3$) :

Ans. **[7]**

Sol. $\left(x^4 + 2x^2 + 1\right)\left({}^nC_0x^0 + {}^nC_1x^1 + {}^nC_2x^2 + {}^nC_3\right)$

Coefficient $x \Rightarrow {}^nC_1$, coeff. of $x^2 \Rightarrow 2 + {}^nC_2$

$$2 + \frac{n(n-1)}{2}$$

Coeff. of $x^3 = 2.{}^nC_1 + {}^nC_3 = 2n + \frac{n(n-1)(n-2)}{6}$

Now according to question

$$n + 2n + \frac{n(n-1)(n-2)}{6} = 2\left[2 + \frac{n(n-1)}{2}\right]$$

$$3n + \frac{n(n-1)(n-2)}{6} = 4 + n(n-1)$$

$\Rightarrow n^3 - 9n^2 + 26n - 24 = 0$

$\Rightarrow n = 2, 3, 4$ (n = 2 rejected)

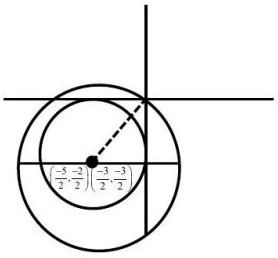
$\Rightarrow$ sum of values of $n = 3 + 4 = 7$

8. If $3 \leq \left|2Z + 3(1+i)\right| \leq 7$ and if maximum and minimum value of $\left|Z + \frac{1}{2}(5+3i)\right|$ is α and β respectively then $(\alpha + 2\beta)$ is :

(1) $\frac{3}{2}$ (2) $\frac{5}{2}$ (3) $\frac{9}{2}$ (4) $\frac{11}{2}$

Ans. **[4]**

Sol. $\frac{3}{2} \leq \left|Z + \frac{3}{2} + \frac{3}{2}i\right| \leq \frac{7}{2}$



$\left|Z+\frac{5}{2}+\frac{3}{2}i\right|$

Maximum $\alpha = 1+\frac{7}{2}=\frac{9}{2}$

Maximum $\beta = \frac{3}{2}-1=\frac{1}{2}$

$\alpha+2\beta=\frac{9}{2}+1=\frac{11}{2}$

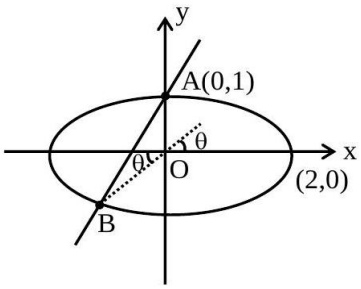
9. Let $\frac{x^2}{2}+\frac{y^2}{1}=1$ & $y=x+1$ intersects each other at A & B then $\angle AOB$ is (where O is centre of ellipse).

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

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

Ans. **[1]**

Sol.



By solving line & equation of ellipse we get $x=0$ & $x=-\frac{4}{3}$

$\therefore B\left(-\frac{4}{3},-\frac{1}{3}\right)$

$m_{OB}=\tan\theta=\frac{1}{4}$

$\because \angle AOB=\frac{\pi}{2}+\theta=\frac{\pi}{2}+\tan^{-1}\frac{1}{4}$

10. If $(f(x))^2=25+\int_0^x (f(x))^2+(f'(x))^2\,dx$. Find mean of $f(\ell n\,1)+f(\ell n\,2)+\ldots\ldots\ldots+f(\ell n\,625)$:

(1) 1561 (2) 1675 (3) 1465 (4) 1565

Ans. **[4]**

Sol. $2f(x)f'(x)=f^2(x)+(f'(x))^2$

$\Rightarrow (f(x)-f'(x))^2=0$

$\Rightarrow f(x)=f'(x)$

$\Rightarrow \ell n(f(x))=x+c \Rightarrow f(x)=c'e^x$

$f(0)=5 \Rightarrow f(x)=5e^x$

$$\text{Mean} = \frac{f(\ell n1)+f(\ell n2)+\ldots\ldots\ldots+f(\ell n625)}{625}$$

$$= \frac{5[1+2+\ldots\ldots\ldots\ldots+625]}{625} = 1565$$

11. The value of $\int_{\pi/24}^{5\pi/24} \frac{1}{\left(1+\sqrt{\tan 2x}\right)}dx$ is :

(1) $\frac{\pi}{12}$ (2) $\frac{\pi}{6}$ (3) $\frac{\pi}{24}$ (4) $\frac{\pi}{3}$

Ans. **[1]**

Sol. $I = \int_{\pi/24}^{5\pi/24} \frac{1}{\left(1+\sqrt{\tan 2x}\right)}dx$ .....(1)

Apply p-5 $I = \int_{\pi/24}^{5\pi/24} \frac{dx}{1+\sqrt{\tan 2\left(\frac{\pi}{4}-x\right)}}$

$I = \int_{\pi/24}^{5\pi/24} \frac{dx}{\left(1+\sqrt{\cot 2x}\right)}$ .....(2)

Add (1) & (2)

$2I = \int_{\pi/24}^{5\pi/24} 1dx$

$= \frac{\pi}{12}$

12. A rectangle is formed by lines $x=0, y=0, x=3$ and $y=4$. A line perpendicular to $3x+4y+6=0$ divides the rectangle into two equal parts then the distance of the line from point $\left(-1,\frac{3}{2}\right)$ is :

(1) $\frac{17}{10}$ (2) $\frac{10}{17}$ (3) $\frac{15}{17}$ (4) $\frac{18}{17}$

Ans. **[1]**

Sol. $M\left(\frac{3}{2},2\right)$

A line perpendicular to $3x+4y+6=0$ & passing through $\left(\frac{3}{2},2\right)$

$\Rightarrow y-2=\frac{4}{3}\left(x-\frac{3}{2}\right)$

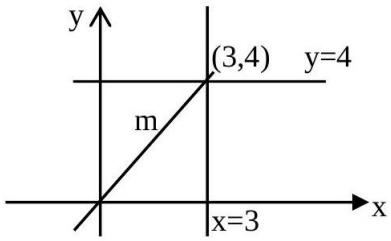
$3y-6=4x-6$

$3y=4x$

$\Rightarrow 4x-3y=0$

Distance from $\left(-1,\frac{3}{2}\right)$ is

$$d=\left|\frac{-4-\frac{9}{2}}{\sqrt{4^2+3^2}}\right|=\frac{17}{10}$$



13. Let $A=\{-2,-1,0,1,2,3,4\}$ and R be a relation defined on set A such that $R\{(x,y):2x+y\le -2,\ x,y\in A\}$

Let $l=$ numbers of elements in R

$m=$ minimum number of elements to be added in R to make it reflexive relation.

$n=$ minimum number of elements to be added in R to make it symmetric relation then ($l+m+n$) is:

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

Ans. **[1]**

Sol. $R\{(-2,a),(-1,b),(0,-2)\}$

$a\in\{-2,-1,0,1,3\}$ $b\in\{-2,-1,0\}$

No of element in $R=5+3+1=9=l$

$R=\{(-2,-2),(-1,-1),.....\}$

minimum number of element to be added to make it reflexive $=5-m$

minimum number of element to be added to make it symmetric $5=n$

$R=\{(-2,-2),(-2,-1),(-2,0),(-2,1),(-2,2),(-2,-1),(-2,0),(0,-2)\}$

$l+m+n=9+5+3=17$

14. If $\begin{vmatrix}0&\cos\alpha&\cos\beta\\ \cos\alpha&0&\cos\gamma\\ \cos\beta&\cos\gamma&0\end{vmatrix}=\begin{vmatrix}1&\cos\alpha&\cos\beta\\ \cos\alpha&1&\cos\gamma\\ \cos\beta&\cos\gamma&1\end{vmatrix}$

then value of $\cos^2\alpha+\cos^2\beta+\cos^2\gamma$ is :

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

Ans. **[2]**

Sol. Let $\cos\alpha=x$

$\cos\beta=y$

$\cos\gamma=z$

$$\begin{vmatrix} 0 & x & y \\ x & 0 & z \\ y & z & 0 \end{vmatrix} = \begin{vmatrix} 1 & x & y \\ x & 1 & z \\ y & z & 1 \end{vmatrix}$$

Expending both sides, we get

$x^2 + y^2 + z^2 = 1$

i.e. $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$

15. $y = \log_5\log_3\log_7\left(9x - x^2 - 13\right)$, If its domain is (m,n) and $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ is a hyperbola having eccentricity $\frac{n}{3}$ & length of lotus rectum is $\frac{8\,m}{3}$. Find $b^2 - a^2$:

Ans. **[7]**

Sol. $\log_3\left(\log_7\left(9x - x^2 - 13\right)\right) > 0$

$\Rightarrow 9x - x^2 - 13 > 7$

$x^2 - 9x + 20 < 0 \Rightarrow 4 < x < 5$

$m = 4, n = 5$

$\Rightarrow e = \sqrt{1 + \frac{b^2}{a^2}} = \frac{5}{3} \Rightarrow \frac{b^2}{a^2} = \frac{25}{9} - 1 = \frac{16}{9}$

$\frac{b}{a} = \frac{4}{3}$

$\Rightarrow \frac{2b^2}{a} = \frac{8m}{3} \Rightarrow \frac{2b^2}{a} = \frac{32}{3}$

$\Rightarrow 2b^2 = \frac{32}{3} \times \frac{3b}{4} \Rightarrow b = 4, a = 3$

$b^2 - a^2 = 16 - 9 = 7$

16. The value of $\frac{{}^{100}C_{50}}{51} + \frac{{}^{100}C_{51}}{52} + \ldots\ldots + \frac{{}^{100}C_{100}}{101}$ is :

(1) $\frac{2^{100}}{101}$ (2) $\frac{2^{101}}{100}$ (3) $\frac{2^{99}}{100}$ (4) $\frac{2^{99}}{99}$

Ans. **[1]**

Sol. $S = \sum_{r=50}^{100} \frac{{}^{100}C_r}{r+1} = \sum_{r=50}^{100} \frac{1}{r+1} \cdot \frac{r+1}{101} \cdot {}^{101}C_{r+1}$

$S = \frac{1}{101} \sum_{r=50}^{100} {}^{101}C_{r+1}$

$= \frac{1}{101} \times \frac{2^{101}}{2} = \frac{2^{100}}{101}$

17. For given vectors $\vec{a}=-\hat{i}+\hat{j}+2\hat{k}$ and $\vec{b}=2\hat{i}-\hat{j}+\hat{k}$ where $\vec{c}=\vec{a}\times\vec{b}$ and $\vec{d}=\vec{c}\times\vec{b}$ then the value of $\left(\vec{a}-\vec{b}\right)\cdot\vec{d}$ is :

(1) –35 (2) –36 (3) –38 (4) –37

Ans. **[1]**

Sol. $\vec{d}=\left(\vec{a}\times\vec{b}\right)\times\vec{b}\ \ \vec{a}\cdot\vec{b}=-1$

$=\left(\vec{a}\cdot\vec{b}\right)\vec{b}-\left(\vec{b}\cdot\vec{b}\right)\vec{a}\ |\vec{a}\ |^2=6$

$\vec{d}=-\vec{b}-6\vec{a}\ |\vec{b}\ |^2=6$

$\left(\vec{a}-\vec{b}\right)\cdot\left(-\vec{b}-6\vec{a}\right)$

$=-\vec{a}\cdot\vec{b}-6\left|\vec{a}\ |^2+\right|b\ |^2+6\vec{a}\cdot\vec{b}$

$=5\vec{a}\cdot\vec{b}+\left|\vec{b}\right|^2-6\left|a\right|^2$

$=-5+6-36$

$=-35$

18. Variates are given as

$-10,-7,-1,x,y,2,9,16$.

If mean $(\mu)=\frac{7}{2}$ and variance $=\frac{293}{4}$

Find mean of $(1+x+y),x,y,|y-x|$:

(1) 16 (2) 19 (3) 11 (4) 13

Ans. **[3]**

Sol. Mean $=\frac{-18+x+y+2+9+16}{8}=\frac{7}{3}$

$=\frac{x+y+9}{8}=\frac{7}{2}\Rightarrow x+y+9=28$; .....(1)

Variance $=\frac{\sum z_i^2}{8}-(\mu)^2=\frac{293}{4}$

$\Rightarrow\frac{10^2+7^2+1^2+x^2+y^2+2^2+9^2+16^2}{8}-\left(\frac{7}{2}\right)^2=\frac{293}{4}$ .....(2)

Solving (1) & (2) $\Rightarrow x=12,y=7$

Mean of $(1+x+y),x,y,|y-x|$ is

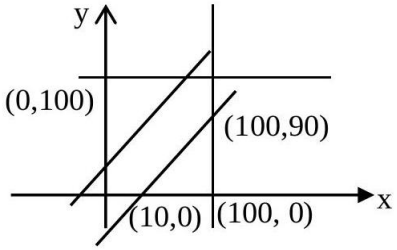
$\Rightarrow\frac{20+12+7+5}{4}=\frac{44}{4}=11$

19. If two numbers a & b are selected from $S=\{1,2,3\ldots\ldots,100\}$ then the probability that $|a-b|\geq 10$ is :

(1) $\frac{891}{1000}$ (2) $\frac{119}{1000}$ (3) $\frac{819}{1000}$ (4) None of these

Ans. **[3]**

Sol. $P = \dfrac{2(1+2+\ldots\ldots+90)}{100\times100} = \dfrac{819}{1000}$



20. Number of solution of equation $\sqrt{3}\cos2\theta + 8\cos + 3\sqrt{3} = 0$ in $\theta \in [-3\pi, 2\pi]$

Ans. **[5]**

Sol. $\sqrt{3}\left(2\cos^2\theta - 1\right) + 8\cos\theta + 3\sqrt{3} = 0$

$2\sqrt{3}\cos^2\theta + 8\cos\theta + 2\sqrt{3} = 0$

$\left(\sqrt{3}\cos + 1\right)\left(\cos\theta + \sqrt{3}\right) = 0$

$\cos\theta = -\dfrac{1}{\sqrt{3}}$

as $-\sqrt{3}$ (reject)

$\therefore \theta =$ will have 5 value in $[-3\pi, 2\pi]$