Memory Based Answers & Solutions

Time : 3 hrs. *for* M.M. : 300

JEE (Main)-2025 (Online) Phase-1

(Physics, Chemistry and Mathematics)

23 Jan 2025 (Evening Shift)

IMPORTANT INSTRUCTIONS:

(1) The test is of **3 hours** duration.

(2) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.

(3) This question paper contains **Three Parts**. **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is **Mathematics**. Each part has only two sections: **Section-A** and **Section-B**.

(4) **Section - A :** Attempt all questions.

(5) **Section - B :** Attempt all questions.

(6) **Section - A (01 – 20)** contains 20 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

(7) **Section - B (21 – 25) contains** 5 **Numerical value** based questions. The answer to each question should be rounded off to the **nearest integer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

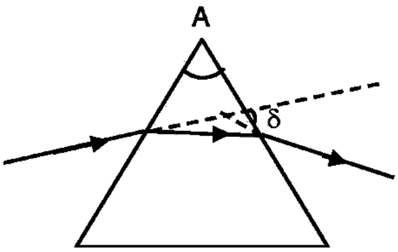
PART I : PHYSICS

1. If angle of prism is equals to angle of minimum deviation. Given that n = $\sqrt{3}$, then angle of prism is :

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

Ans. (1)

Sol.



We know that

$$n = \frac{\frac{\sin(A+\delta_{min})}{2}}{\sin\left(\frac{A}{2}\right)}$$

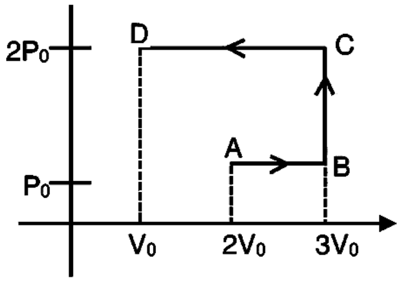
$$\sqrt{3} \Rightarrow \frac{\sin(A)}{\sin(A/2)} = \frac{2\sin A/2\cos A/2}{\sin(A/2)}$$

$$\frac{\sqrt{3}}{2} = \cos(A/2)$$

$$\frac{A}{2} = \frac{\pi}{6}$$

$$A = \frac{\pi}{3}$$

2. Find total work done by gas from A to D?



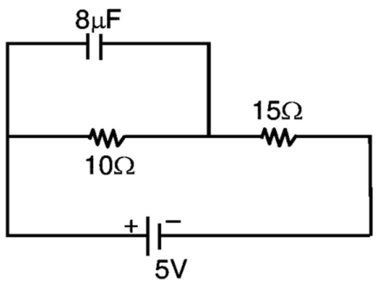
(1) $-3\ P_0V_0$ (2) $3\ P_0V_0$ (3) $2\ P_0V_0$ (4) $5\ P_0V_0$

Ans. (1)

So. $W = (P_0 \times V_0) + 0 + 2P_0(-2V_0)$

$W = -3P_0V_0$

3. Find the charge on capacitor in steady state



(1) 8μC (2) 16μC (3) 100μC (4) 16mC

Ans. (2)

Sol. Current through $10\Omega \Rightarrow I = \frac{5}{25} = 0.2\,A$

Potential drop across $10\Omega \Rightarrow V = IR = 0.2 \times 10 = 2V$

then charge stored on capacitor

$Q = CV = 8\times 10^{-6} \times 2$

$Q = 16\ \mu C$

4. A satellite is nine times closer to earth compared to moon. Time period of moon is 27 days then time period of satellite is

(1) 3 days (2) 9 days (3) 1 day (4) $3\sqrt{3}$ days

Ans. **(3)**

Sol. $\frac{T_1}{T_2} = \left(\frac{r_1}{r_2}\right)^{3/2}$

$T_1 = T_2\left(\frac{r_1}{r_2}\right)^{3/2}$

$= 27\left(\frac{r_e/9}{r_e}\right)^{3/2}$

$= \frac{27}{9^{3/2}} = \frac{27}{27} = 1$ day

5. In a series LCR circuit, inductance L = 100 μH and capacitance C = 10 nF. The angular frequency of the source when current has maximum amplitude in the circuit is

(1) $\frac{10^4}{2\pi}$ rad/s (2) $\frac{10^5}{2\pi}$ rad/s (3) 10^5 rad/s (4) 10^6 rad/s

Ans. **(4)**

Sol. $\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10^{-4} \times 10^{-8}}} = 10^6$ rad/s

6. A concave mirror has a focal length 'f'in air. What is the focal length of this mirror when it is completely immersed in a liquid of refractive index μ ?

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

Ans. **(3)**

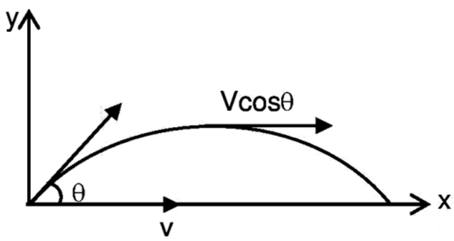
Sol. f (mirror) is independent from μ

7. A particle is projected with kinetic energy K with an angle $\frac{\pi}{3}$ from horizontal, then what will be kinetic energy at its maximum height ?

(1) $\frac{3K}{4}$ (2) $\frac{K}{4}$ (3) 0 (4) K

Ans. **(2)**

Sol.



$(K)_{\text{max height}} = \frac{1}{2}m[v(\cos\theta)]^2$

$= \frac{1}{2}mv^2(\cos 60°)^2$

$K_{min} = \frac{K}{4}$

8. **Statement I :** Graph of frequency f of x-ray & atomic number z of heavy nucleus is straight line, in x-ray emission.

Statement II : Graph of square root of frequency $\sqrt{f}$ of x-ray & atomic number z of heavy nucleus is straight line in x-ray emission.

(1) Statement 1 is correct & statement 2 is correct.
(2) Statement 1 is incorrect & statement 2 is correct.
(3) Statement 1 is correct & statement 2 is incorrect.
(4) Statement 1 is incorrect & statement 2 is incorrect.

Ans. **(2)**

Sol. from Mosley's law

$\sqrt{f} = a\,(z - b)$

so option (2) is correct.

9. When light of wave length λ is incident on a metal of work function w = 2.14 ev and stopping potential for electron is found to be 2 volt then find wavelength of incident light
[use hc = 1242 ev–nm]

(1) 100 nm (2) 200 nm (3) 300 nm (4) 400 nm

Ans. **(3)**

Sol. $E = K_m + W$

$\frac{hc}{\lambda} = 2ev + 2.14\ ev$

$\lambda = \frac{1242\,ev - nm}{4.14\,ev} = 300\ nm$

10. The value of E_0 is 9.3 V/m and C is 3×10^8 m/s. Find the value of B_0?

(1) 3.3×10^{-8} T (2) 3.1×10^{-8} T (3) 27.9×10^{-8} T (4) 27.9×10^{8} T

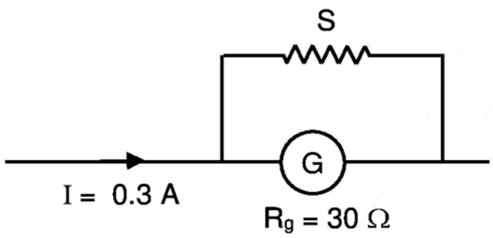
Ans. **(2)**

Sol. $E_0 = 9.3$ V/m $C = 3 \times 10^8$ m/s

$E_0 = C.B_0$

$B_0 = \frac{E_0}{C} = \frac{9.3\ v/m}{3 \times 10^8} = 3.1 \times 10^{-8}\ T$

11.



For making ammeter of maximum current 0.3 Amp, a shunt is used in parallel with galvanometer of resistance 30 Ω. Maximum galvanometer current is 2 milli ampere. If the value of shunt resistance is $\frac{30}{x}\ \Omega$, what will be the value of x

(1) 149 (2) 298 (3) 300 (4) 49

Ans. **(1)**

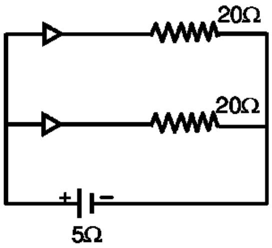
Sol. $I_gR_g = (I - I_g)(s)$

$(2mA)(30) = (300\ mA - 2mA)(s)$

$s = \frac{30 \times 2}{298} = \frac{30}{149}\Omega = \frac{30}{x}$

$x = 149$

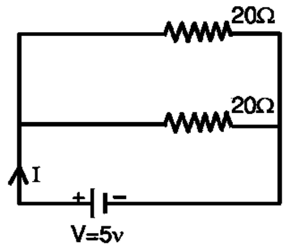
12. Find current through battery. If both diodes are ideal



(1) 0.2 A (2) 0.5 A (3) 0.125 A (4) 12.5 A

Ans. **(2)**

Sol.



$I = \frac{V}{Req} = \frac{5}{10}$

$I = 0.5\ A$

13. **Statement-1 :** Binding energy is independent of atomic number

Statement-2 : Nuclear Force are long range force

(1) Statement 1 is correct & statement 2 is correct.

(2) Statement 1 is incorrect & statement 2 is correct.

(3) Statement 1 is correct & statement 2 is incorrect.

(4) Statement 1 is incorrect & statement 2 is incorrect.

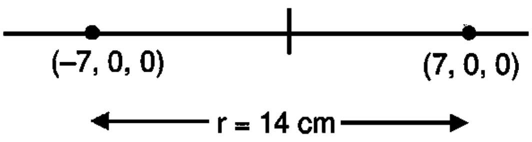
Ans. **(4)**

14. Two charges $7\mu C$ and $-4\mu C$ are placed at (–7, 0, 0) cm and (7, 0, 0) cm. Find the electrostatic potential energy of two charge system? (Given $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$)

(1) 1.6 J (2) 0.9 J (3) 2.5 J (4) 1.8 J

Ans. **(4)**

Sol.



$E = \frac{kq_1q_2}{r} = \frac{9\times10^9 \times 7\times10^{-6} \times 4\times10^{-6}}{14\times10^{-2}}$

$E = 1.8\ J$

15. If equation of wave travelling in a medium is given by $y = 10\sin(3t + 0.1x)$ then what is the velocity of wave and direction ?

(1) $30\hat{i}$ m/sec (2) $30(-\hat{i})$ m/sec (3) $0.3\ \hat{i}$ m/s (4) $0.3(-\hat{i})$ m/s

Ans. **(2)**

Sol. $V_\omega = \frac{\omega}{k} = \frac{3}{0.1} = 30$ m/sec

direction of wave = $-\hat{i}$

16. A spring has tension 5N at x_1 extension and 7N at x_2 extension. Determine the tension in the spring when extension is $5x_1 - 2x_2$

(1) 11 N (2) 39 N (3) 25 N (4) 12 N

Ans. **(1)**

Sol. $kx_1 = 5$

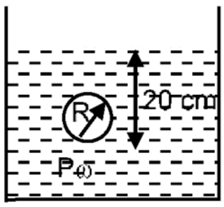
$kx_2 = 7$

$T = k(5x_1 - 2x_2)$

$5kx_1 - 2kx_2$

$= 25 - 14 = 11$ N

17. Find pressure inside the bubble with respect to atmospheric pressure which is 10^5 N/m^2 & density of water $P_\omega = 10^{-3}$ kg/cm^3 & surface tension of bubble is 72×10^{-3} N/m (R = 1mm)



(1) 2000 pa (2) 2288 pa (3) 2144 pa (4) 1856 pa

Ans. **(3)**

Sol. $P_{bubble} - P_{atm} = \nu gh + \frac{2T}{R}$

$= \frac{10^{-3}}{10^{-6}} \times 10 \times 20 \times 10^{-2} + \frac{2 \times 72}{10^{-3}} \times 10^{-3}$

$= 2 \times 10^3 + 144$

$= 2000 + 144 = 2144$ pa

18. A disc of mass M and radius R is rotating about its axis. If the angle rotated about its axis as a function of time 't' is $\theta = 10t^2 - 8t$, then find the power delivered to the disc at t = 2sec is :

(1) 120 watt (2) 320 watt (3) 220 watt (4) 440 watt

Ans. **(2)**

Sol. $\tau = I\alpha$

$P = \tau . \omega$

$= I\alpha\omega$

$= \frac{MR^2}{2} . \frac{d^2\theta}{dt^2} . \frac{d\theta}{dt}$

$= \frac{MR^2}{2}$. (20)(20t – 8)

$= 10\ MR^2\ (20\ t - 8)$

at t = 2second

$P = 10\ MR^2\ (40 - 8) = 320\ MR^2$ watt

19. In a YDSE experiment slits width are given as D and xD. If ratio of I_{max} and I_{min} is 9 : 4, then find value of x

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

Ans. **(1)**

Sol. We know that

$I \propto$ width of a slit

So $\frac{I_2}{I_1} = \frac{xD}{D} = x$

$I_2 = xI_1$

now $\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2$

$= \left(\frac{1+\sqrt{\frac{I_2}{I_1}}}{1-\sqrt{\frac{I_2}{I_1}}}\right)^2$

$= \left(\frac{1+\sqrt{x}}{1-\sqrt{x}}\right)^2 = \frac{9}{4}$

$\Rightarrow \frac{1+\sqrt{x}}{1-\sqrt{x}} = \frac{3}{2}$

$\Rightarrow 2+2\sqrt{x} = 3-3\sqrt{x}$

$\Rightarrow 5\sqrt{x} = 1$

$\Rightarrow \sqrt{x} = \frac{1}{5}$

$x = \frac{1}{25}$

20. The temperature of a body of mass m and specific heat capacity s is raised slowly from T_1 to T_2. The change is entropy of the system is

(1) $ms\ell n\left(\frac{T_2}{T_1}\right)$ (2) $2ms\ell n\left(\frac{T_2}{T_1}\right)$ (3) $ms\ell n\left(\frac{T_1}{T_2}\right)$ (4) zero

Ans. **(1)**

Sol. $d\delta = \frac{d\theta}{T}$

$\int ds = \int m.s. \frac{dT}{T}$

$\Delta s = ms\ell n\left(\frac{T_2}{T_1}\right)$

21. Match the following.

(A) Magnetic permeability (P) $[M^1A^{-1}T^{-2}]$

(B) Torsional constant (Q) $[L^2A^1]$

(C) Magnetic field (R) $[M^1L^2T^{-2}]$

(D) Magnetic moment (S) $[M^1L^1A^{-2}T^{-2}]$

(1) A $\rightarrow$ R; B$\rightarrow$S; C$\rightarrow$P; D$\rightarrow$Q (2) A $\rightarrow$ S; B$\rightarrow$R; C$\rightarrow$P; D$\rightarrow$Q

(3) A $\rightarrow$ S; B$\rightarrow$R; C$\rightarrow$Q; D$\rightarrow$P (4) A $\rightarrow$ S; B$\rightarrow$P; C$\rightarrow$R; D$\rightarrow$Q

Ans. **(2)**

Sol. M = iA [L^2A^1]

F = iℓB

$[B] = \frac{[F]}{[i\ell]} = \frac{M^1L^1T^{-2}}{[A^1L^1]} = M^1A^{-1}T^{-2}$

$\tau = c\theta$

$c = \frac{\tau}{\theta} = [F.d] = [M^1L^2T^{-2}]$

22. A fluid of density ρ flows through a horizontal pipe with a variable cross-section. At two different cross-sections, A and B, the fluid has velocities V_A and V_B, and pressures P_A and P_B respectively. Determine the correct relationship between velocities at these sections.

(1) $V_A - V_B = \frac{\rho}{2(P_B^2 - P_A^2)}$

(2) $V_A - V_B = \frac{2(P_A - P_B)}{\rho}$

(3) $V_A^2 - V_B^2 = \frac{2(P_B - P_A)}{\rho}$

(4) $V_A^2 - V_B^2 = \frac{2(P_A - P_B)}{\rho}$

Ans. **(3)**

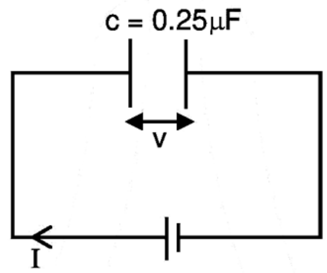
Sol. $P_A + \frac{1}{2}\rho V_A^2 = P_B + \frac{1}{2}\rho V_B^2$ (Using Bernolli's equation)

$\frac{1}{2}\rho V_A^2 - \frac{1}{2}\rho V_B^2 = P_B - P_A$

$\frac{1}{2}\rho(V_A^2 - V_B^2) = P_B - P_A$

$V_A^2 - V_B^2 = \frac{2(P_B - P_A)}{\rho}$

23. Find the rate of change of Voltage $\frac{dv}{dt}$. Given I = 0.25 mA.



(1) 10^{-3} v/s (2) 10^3 v/s (3) 6.25×10^{-11} (4) 6.25×10^{-9} v/s

Ans. **(2)**

Sol. We know that

$I = C\frac{dv}{dt}$

$\frac{dv}{dt} = \frac{I}{c} = \frac{0.25 \times 10^{-3}}{0.25 \times 10^{-6}}$

$\frac{dv}{dt} = 10^3 \text{ v/s}$

24. The energy in a system varies with position and time as $E(x, t) = x^3e^{-\beta t}$ (where $\beta = 0.3\ sec^{-1}$). Given that the percentage error in x = 1.2% and that the percentage error in t = 1.6%. Find the maximum percentage error in E at t = 5 sec.

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

Ans. **(3)**

Sol. $E = x^3\, e^{-\beta t}$

$\ell nE = 3\ell nx - \beta t$

$$\frac{\Delta E}{E} = \frac{3\Delta x}{x} + \beta\Delta t$$

$$\frac{\Delta t}{t} \times 100 = 1.6$$

$\Delta t \times 100 = 1.6 \times t = 1.6 \times 5 = 8$

$$\frac{\Delta E}{E} \times 100 = \frac{3\Delta x}{x} \times 100 + \beta(\ \Delta t \times 100)$$

$$= 3 \times 1.2 + 0.3 \times 8 = 3.6 \times 2.4 = 6\%$$

1. 81 gm of Al when made to react with 128 gm of oxygen forms ....gm of Al_2O_3.

Ans. **(153)**

Sol. (L.R.)

$4Al + 3O_2 \longrightarrow 2Al_2O_3$

81 gm 128 gm

= 3 mole = 8 mole

$\frac{3}{4} = 0.75$ $\frac{128}{16} = \frac{8}{3} = 2.667$

4 Al ≡ 2 mole Al_2O_3

$\therefore$ 3 mol of Al ≡ $\frac{2}{4} \times 3$ mole of Al_2O_3

= 1.5 × (54 + 48) = 153 gm

2. Minimum melting point among group-14 elements corresponds to atomic number :

(1) 6 (2) 14 (3) 50 (4) 32

Ans. **(3)**

Sol. $_6C$ = 4373 K ; $_{14}Si$ = 1693 K ; $_{32}Ge$ = 1218 K ; $_{50}Sn$ = 505 K

3. What will be effect on pH of water when it is heated ?

(1) Increase (2) decrease

(3) Remains same (4) pH first increases then decreases

Ans. **(2)**

Sol. As T ↑, Kw ↑ $\therefore$ pH ↓

4. Match the following list-I with List-II :

List-I		**List-II**	
(a)	Bronze	(1)	Cu + Zn
(b)	Stainless Steel	(2)	Cu + Sn
(c)	UK silver coin	(3)	Fe + Cr + Ni
(d)	Brass	(4)	Cu + Ni

(1) (a) → (2) ; (b) → (3) ; (c) → (4) ; (d) → (1) (2) (a) → (3) ; (b) → (2) ; (c) → (4) ; (d) → (1)

(3) (a) → (2) ; (b) → (3) ; (c) → (1) ; (d) → (4) (4) (a) → (3) ; (b) → (2) ; (c) → (1) ; (d) → (4)

Ans. **(1)**

Sol. Bronze – Cu + Sn; Stainless steel – Fe + Cr + Ni

UK silver coin – Cu + Ni ; Brass – Cu + Zn

5. **S-1 :** $\sqrt{\nu}$ vs Atomic number gives a straight line graph.

S-2 : ν vs Mass number gives a straight line graph.

(1) **S-1** true ; **S-2** false (2) **S-1** false ; **S-2** true

(3) Both **S-1** & **S-2** are true (4) Both **S-1** & **S-2** are false

Ans. **(1)**

Sol. $\sqrt{\nu}$ vs Atomic number gives a straight line graph.

(Moseley's law)

6. 0.01 mole of an organic compound containing 10% hydrogen on complete combustion produces 0.9 g H_2O. Molecular mass of organic compound is ....u.

Ans. **(100)**

Sol. Let organic compound be $C_xH_yO_z$

Applying POAC on H.

$$0.01 \times x = \left(\frac{0.9}{18}\right) \times 2 \qquad \therefore x = 10$$

$$\frac{10}{100} \times MM = 10 \qquad \therefore MM = 100\ u$$

7. Central atom has d^4 configuration in which complexes :

(i) $[NiF_6]^{2-}$ (ii) $[Fe(CN)_6]^{3-}$ (iii) $[Cr_2(CH_3COO)_4(H_2O)_2]$

(iv) $[Mn(CN)_6]^{3-}$ (v) $[FeO_4{}^{2-}]$

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

Ans. **(1)**

Sol. $Ni^{4+} : d^6$; $Fe^{3+} : d^5$; $Cr^{2+} : d^4$; $Mn^{3+} : d^4$; $Fe^{6+} : d^2$

8. By using relation

$\Delta G = \Delta H - T\Delta S$

Which of the following is incorrect for spontaneous reaction at a given temperature

(1) $\Delta H > 0, \Delta S > 0$

(2) $\Delta H > 0, \Delta S < 0$

(3) $\Delta H < 0, \Delta S > 0$

(4) $\Delta H < 0, \Delta S < 0$

Ans. **(2)**

Sol. $\Delta H > 0$ & $\Delta S < 0 \Rightarrow \Delta G > 0$ at all temperature.

9. Vapour pressure decreases by 10 mm of Hg when mole fraction of non volatile solute is 0.2. What is the mole fraction of non volatile solute if vapour pressure decreases by 20 mm of Hg ?

(1) 0.4 (2) 0.1 (3) 0.8 (4) 0.2

Ans. **(1)**

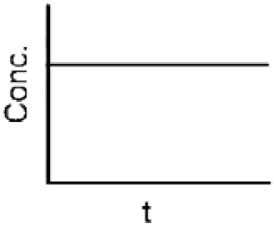
Sol. $$\frac{P_0 - P_S}{P_0} = X_{solute}$$

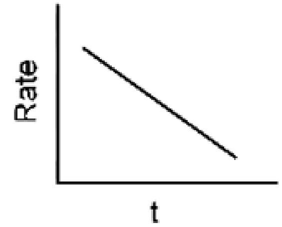
$$\therefore \frac{(P_0 - P_S)}{(P_0 - P_S)_2} = \frac{X_{Solute\ 1}}{X_{solute\ 2}}$$

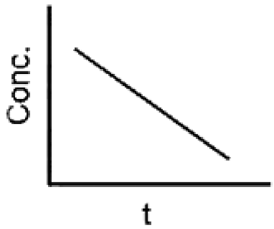
$$\therefore \frac{10}{20} = \frac{0.2}{X_{solute\ 2}}$$

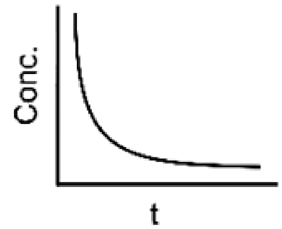
$$\therefore X_{Solute\ 2} = 0.4$$

10. Which one of the following plots represents zero order reaction ?

(1) 

(2) 

(3) 

(4) 

Ans. **(3)**

Sol. For zero order :

Rate = constant (Straight line parallel to X-axis in rate vs t graph)

$C_t = C_0 - kt$ (........with –ve slope in conc. vs t graph)

11. $X_2Y_{(g)} \rightleftharpoons X_{2(g)} + \frac{1}{2}Y_{2(g)}$ The correct relationship between K_P, α and equilibrium pressure P is

(1) $K_P = \dfrac{\alpha^{1/2}P^{1/2}}{(2+\alpha)^{3/2}}$

(2) $K_P = \dfrac{\alpha^{1/2}P^{3/2}}{(2+\alpha)^{3/2}}$

(3) $K_P = \dfrac{\alpha^{3/2}P^{1/2}}{(2+\alpha)^{1/2}(1-\alpha)}$

(4) $K_P = \dfrac{\alpha^{1/2}P^{1/2}}{(2+\alpha)^{1/2}}$

Ans. **(3)**

Sol.

	$X_2Y_{(g)} \rightleftharpoons$	$X_{2(g)}$ +	$\frac{1}{2}Y_{2(g)}$
t = 0	a	0	0
$t = t_{eq}$	a – x	x	x/2

For a mole, x moles are dissociated

For 1 mole, $\frac{x}{a}$ moles = α are dissociated

$x = a\alpha$

	$X_2Y_{(g)} \rightleftharpoons$	$X_{2(g)}$ +	$\frac{1}{2}Y_{2(g)}$
At $t=t_{eq}$	$a - a\alpha$	$a\alpha$	$\frac{a\alpha}{2}$

$$n_{total} = a + \frac{a\alpha}{2} = a\left(1+\frac{\alpha}{2}\right)$$

$$P_{A(g)} = \frac{a(1-\alpha)P}{a\left(1+\frac{\alpha}{2}\right)} = \frac{(1-\alpha)P}{1+\frac{\alpha}{2}};$$

$$P_{B(g)} = \frac{a\alpha \cdot P}{a\left(1+\frac{\alpha}{2}\right)} = \frac{\alpha P}{1+\frac{\alpha}{2}};$$

$$P_{C(g)} = \frac{(a\alpha/2)\cdot P}{a\left(1+\frac{\alpha}{2}\right)} = \frac{(\alpha/2)\cdot P}{1+\frac{\alpha}{2}}$$

$$K_P = \frac{P_B \cdot (P_C)^{1/2}}{P_A} = \frac{\left(\frac{\alpha}{1+\frac{\alpha}{2}}P\right)\left(\frac{\frac{\alpha}{2}P}{1+\frac{\alpha}{2}}\right)^{1/2}}{\frac{(1-\alpha)P}{\left(1+\frac{\alpha}{2}\right)}}$$

$$K_P = \frac{\alpha \cdot \alpha^{1/2} \cdot P^{1/2}}{(2+\alpha)^{1/2}(1-\alpha)} = \frac{\alpha^{3/2} \cdot P^{1/2}}{(2+\alpha)^{1/2}(1-\alpha)}$$

12. Statement I : For a particular shell, maximum number of orbital is n^2.
Statement II : For a given subshell, number of orientation lies from $-\ell$ to $+\ell$ including zero.
(1) S–I and S–II both are correct
(2) S–I and S–II both are incorrect
(3) S–I is correct and S–II is incorrect
(4) S–I is incorrect and S–II is correct

Ans. (1)

Sol. For a particular shell, maximum number of orbital is n^2.
For a given subshell, number of orientation lies from $-\ell$ to $+\ell$ including zero.

13. Calculate the following E° values of given half cell.

$E^0_{Ag+Ag} = 0.8$ V

$E^0_{Zn^{2-}/Zn} = -0.76$ V

$E^0_{Cu^{2-}/Cu} = 0.34$ V

$E^0_{Mg^{2+}/Mg} = -2.36$ V

Then which of the following will have the most negative value of ΔG^o
(1) $Zn/Zn^{2+} \,||\, Cu^{2+}/Cu$
(2) $Ag/Ag^{+} \,||\, Mg^{2+}/Mg$
(3) $Zn/Zn^{2+} \,||\, Mg^{2+}/Mg$
(4) $Cu/Cu^{2+} \,||\, Ag^{+}/Ag$

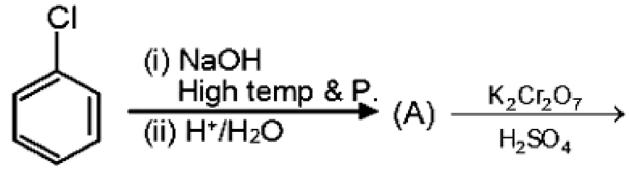
Ans. (1)

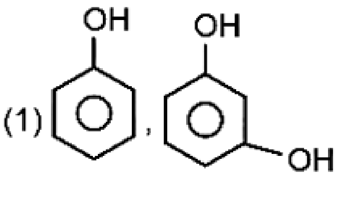
Sol. $E^0_{Cell\ 1} = 1.1$ V; $E^0_{Cell\ 2} = -3.16$ V; $E^0_{Cell\ 3} = -1.6$ V; $E^0_{Cell\ 4} = 0.46$ V

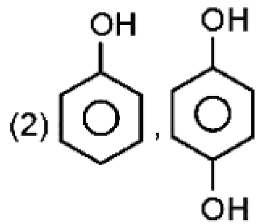
Greater the +ve value of E^0_{Cell}, more negative will be ΔG^o.

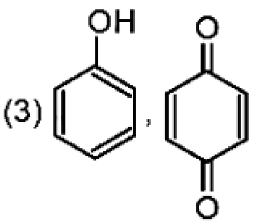
14. α-Helix protein & β-pleated belong to which of the following structure of protein.
(1) Primary (2) Secondary (3) Tertiary (4) Quaternary

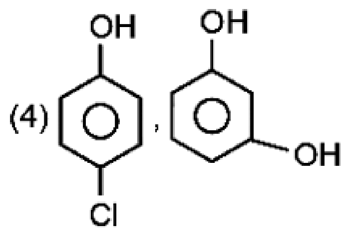
Ans. (2)

15.  Predict (A) & (B)?

(1) 

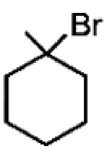
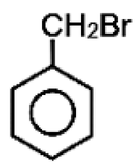
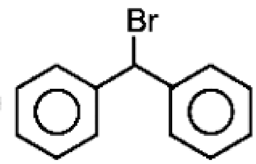
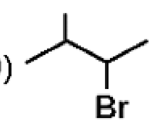
(2) 

(3) 

(4) 

Ans. **(3)**

16. Rate of solvolysis of the following compounds is.

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

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

Ans. **(2)**

17. $R-CH=O \xrightarrow[H_2O]{K} R-CH(OH)_2$

Statement-I : For HCHO relative rate is 2892 due to small size of 'H' atoms.

Statement-II : For CCl_3CHO relative rate is 2000 due to –I effect of Cl.

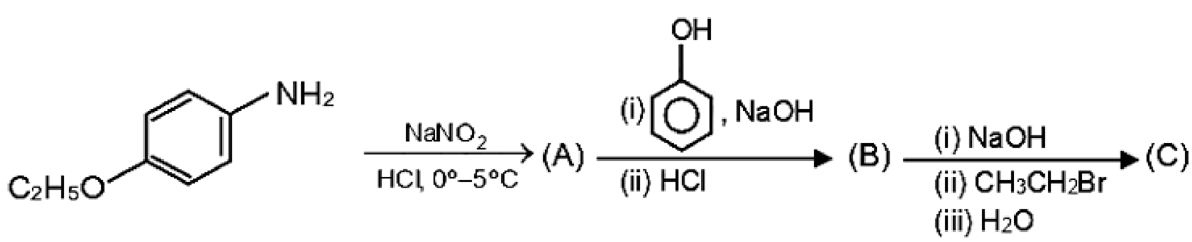
(1) Both Statement I and statement II are true

(2) Both statement I and statement II are false

(3) Statement I is true but statement II is false

(4) Statement I is false but statement II is true

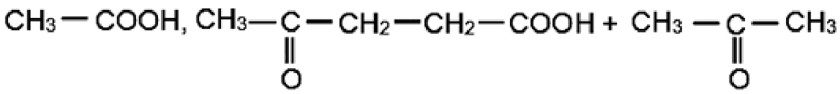
Ans. **(1)**

18. 

no. of sp^3 'C' atoms in (C) is.

Ans. **(4)**

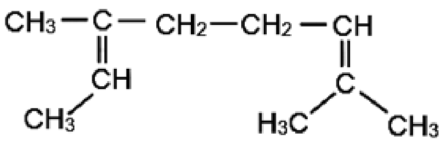
19. An unknown compound 'X' that consumes two moles of H_2, X on oxidation with $KMnO_4$ / $H^{\oplus}$ gives following products.



Find no of σ bonds in compound 'X'

Ans. **(27)**

Sol.

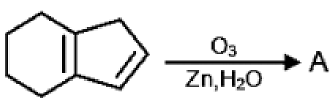


20. **Statement-1 :** Melting point of phenol & alcohols increases with increase in carbon atoms.
Statement-2 : Phenol and alcohols has higher melting point than ether and haloalkanes.

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

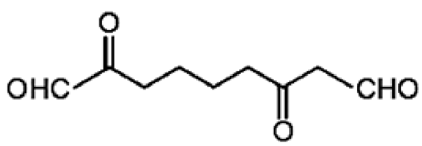
Ans. **(1)**

21.

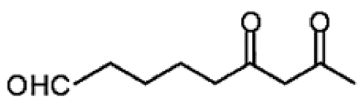


Product A is.

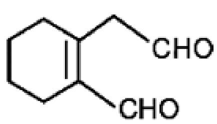
(1)



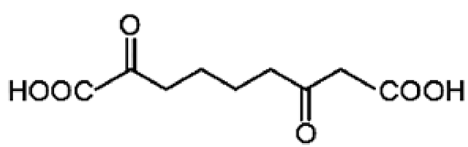
(2)



(3)



(4)



Ans. **(1)**

1. If the square of the shortest distance between the lines $\frac{x-1}{1}=\frac{y-1}{2}=\frac{z+3}{-3}$ and $\frac{x+1}{2}=\frac{y+3}{4}=\frac{z+5}{-5}$ is $\frac{m}{n}$, where m, n are coprime numbers then m + n is equal to:

(1) 6 (2) 9 (3) 14 (4) 21

Ans. (2)

Sol. $d=\left|\frac{\overrightarrow{AB}.(\vec{p}\times\vec{q})}{|\vec{p}\times\vec{q}|}\right|$

A = (2, 1, – 3) ; B = (– 1, – 3, –5) , $\vec{p}=\hat{i}+2\hat{j}-3\hat{k}$, $\vec{q}=2\hat{i}+4\hat{j}-5\hat{k}$

$\overrightarrow{AB}=-3\hat{i}-4\hat{j}-2\hat{k}$

$$\bar{p}\times\bar{q}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 1 & 2 & -3\\ 2 & 4 & -5\end{vmatrix}=2\hat{i}-\hat{j}$$

$$d=\left|\frac{-6+4}{\sqrt{4+1}}\right|=\frac{2}{\sqrt{5}}$$

$$d^2=\frac{4}{5}=\frac{m}{n}$$

m + n = 9

2. In how many ways 5 boys & 4 girls can sit in a row so that either all boys sit together or no two boys sit together

(1) 5!.4! (2) 4!.4! (3) 3!.4! (4) 6!.4!

Ans. (4)

Sol. B_1 B_2 B_3 B_4 B_5

All boys together + no two boys are together

= (4+1)! 5! + 5! $^4C_4$ ×4!

= 5! 5! + 5! 1. 4!

= 5! (5!+4!)

= 5!4! (5+1) = 6!.4!

3. Let $f(x)=6+16\cos\left(\frac{\pi}{3}-x\right)\cos\left(\frac{\pi}{3}+x\right)\cos x\sin 3x\cos 6x$, if range of f(x) is [α, β] then the distance of (α, β) from 3x + 4y + 12 = 0 is

Ans. (11)

Sol. Using these properties

$$4\cos\left(\frac{\pi}{3}-x\right)\cos\left(\frac{\pi}{3}+x\right)\cos x=\cos(3x)$$

2sinx cosx = sin2x

$$f(x)=6+16\cos\left(\frac{\pi}{3}-x\right)\cos\left(\frac{\pi}{3}+x\right)\cos x\sin 3x\cos 6x$$

f(x) = 6 + sin12x

range of sin12x ∈ [–1, 1]

range of f(x) ∈ [5, 7]

the distance of point (5, 7) from line 3x + 4y + 12 = 0
using distance formula

$$\frac{|3(5)+4(7)+12|}{\sqrt{3^2+4^2}} = 11$$

4. A = (a_{ij}) given $A\begin{bmatrix}0\\1\\0\end{bmatrix}=\begin{bmatrix}0\\0\\1\end{bmatrix}$, $\mathbf{A}\begin{bmatrix}4\\1\\3\end{bmatrix}=\begin{bmatrix}0\\1\\0\end{bmatrix}$, $A\begin{bmatrix}2\\1\\2\end{bmatrix}=\begin{bmatrix}1\\0\\0\end{bmatrix}$. The value of a_{23} is__________.

(1) 2 (2) –1 (3) 4 (4) –2

Ans. **(2)**

Sol. $A_{3\times3}$

$$\begin{bmatrix}a & b & c\\x & y & z\\\ell & m & n\end{bmatrix}\begin{bmatrix}0\\1\\0\end{bmatrix}=\begin{bmatrix}0\\0\\1\end{bmatrix} \Rightarrow 1 \quad \begin{matrix}b=0\\y=0\\m=1\end{matrix} \quad ......(1)$$

$$\begin{bmatrix}a & b & c\\x & y & z\\\ell & m & n\end{bmatrix}\begin{bmatrix}4\\1\\3\end{bmatrix}=\begin{bmatrix}0\\1\\0\end{bmatrix} \Rightarrow 1 \quad \begin{matrix}4a+b+3c=0\\4x+y+3z=\perp\end{matrix} \quad ......(2)$$

$$\begin{bmatrix}a & b & c\\x & y & z\\\ell & m & n\end{bmatrix}\begin{bmatrix}2\\1\\2\end{bmatrix}=\begin{bmatrix}1\\0\\0\end{bmatrix} \Rightarrow 1 \quad \begin{matrix}2a+b+2c=1\\2x+y+2z=0\\3\ell+m+2n=0\end{matrix} \quad ......(3)$$

Eq. (1) and (2) and (3)

z = – 1 = a_{23}

5. The system of equations x + y + z = 6, x + 2y + 5z = 9, x + 5y + λz = μ has no solution if:

(1) λ ≠ 17 and μ = 18 (2) λ ≠ 17 and μ ≠ 18

(3) λ = 17 and μ ≠ 18 (4) λ = 17 and μ = 18

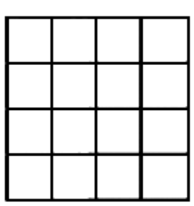
Ans. **(3)**

Sol.
$$\left[\begin{array}{ccc|c}1 & 1 & 1 & 6\\1 & 2 & 5 & 9\\1 & 5 & \lambda & \mu\end{array}\right] \sim \left[\begin{array}{ccc|c}1 & 1 & 1 & 6\\0 & 1 & 4 & 3\\0 & 4 & \lambda-1 & \mu-6\end{array}\right] \sim \left[\begin{array}{ccc|c}1 & 1 & 1 & 6\\0 & 1 & 4 & 3\\0 & 0 & \lambda-17 & \mu-18\end{array}\right]$$

λ = 17 and μ ≠ 18.

If has no solution λ must be 17 and μ should not be 18.

6. If a square is divided in 4 × 4 squares. If two squares are chosen randomly then the probability that the squares doesn't share common side is –



(1) $\frac{3}{8}$ (2) $\frac{4}{5}$ (3) $\frac{8}{9}$ (4) $\frac{2}{5}$

Ans. **(2)**

Sol. Total ways for selecting any two squares = $^{16}C_2$

Total ways for selecting common side squares

Case I : Horizontal side common = 3 × 4

Case II : Vertical side common = 3 × 4

Case I : Horizontal side common = 3 × 4

Case II : Vertical side common = 3 × 4

Probability = $\frac{\text{No. of event occuring}}{\text{Total events}}$

Probability that the squares doesn't share common side = 1 – Probability that the squares share common side

Probability that the squares doesn't share common side = $1 - \frac{24}{^{16}C_2}$

Probability = $\frac{4}{5}$

7. If $I = \int_0^{\pi/2} \frac{\sin^{3/2} x}{\sin^{3/2} x + \cos^{3/2} x} dx$ then the value of

$\int_0^{2I} \frac{x \sin x \cos x dx}{\sin^4 x + \cos^4 x}$

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

Ans. **(2)**

Sol. $I = \int_0^{\pi/2} \frac{\sin^{3/2} x}{\sin^{3/2} x + \cos^{3/2} x} dx$

Using property $\int_0^a f(x)\,dx = \int_0^a f(a-x)\,dx$ (P-5)

$I = \int_0^{\pi/2} \frac{\cos^{3/2} x}{\sin^{3/2} x + \cos^{3/2} x} dx$

Add

$2I = \int_0^{\pi/2} 1 dx = \pi/2$

Now, $\int_0^{\pi/2} \frac{x \sin x \cos x dx}{\sin^4 x + \cos^4 x}$

(P-5) & Add.

$\frac{1}{2} \int_0^{\pi/2} \frac{(\pi/2) \sin x \cos x dx}{\sin^4 x + \cos^4 x}$

$\frac{\pi}{4} \int_0^{\pi/2} \frac{\tan x \sec^2 x dx}{\tan^4 x + 1}$

$\tan^2 x = t$

$2\tan x \sec^2 x\, dx = dt$

$$\frac{\pi}{8}\int_0^{\infty}\frac{1}{t^2+1}\,dt = \frac{\pi}{8}\left[\tan^{-1}t\right]_0^{\infty} dt = \frac{\pi}{8}\times\frac{\pi}{2} = \frac{\pi^2}{16}$$ **Ans.**

8. $\int x^3 \sin x\, dx = g(x) + c$ then $8g\left(\frac{\pi}{2}\right) + 8g'\left(\frac{\pi}{2}\right) = \alpha\pi^3 + \beta\pi^2 + \gamma$ find $\alpha + \beta - \gamma = ?$

Ans. **(55)**

Sol. $\int \underset{I}{x^3} \underset{II}{\sin x}\, dx = I = g(x) + c$ .....(i)

Applying by parts we get

$I = -x^3\cos x + 3x^2 \sin x + 6x\cos x - 6\sin x + c$

$\therefore \quad g(x) = -x^3\cos x + 3x^2\sin x + 6x\cos x - 6\sin x$

$g\left(\frac{\pi}{2}\right) = \frac{3\pi^2}{4} - 6$

Differentiating (i)

$g'(x) = x^3\sin x$

$g'\left(\frac{\pi}{2}\right) = \frac{\pi^3}{8}$

$8g\left(\frac{\pi}{2}\right) + 8g'\left(\frac{\pi}{2}\right) = \pi^3 + 6\pi - 48$

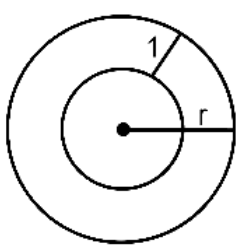
Hence

$\alpha + \beta - \gamma = 55$

9. A chocolate ball is coated with ice of thickness 1 cm. The rate of melting the ice is $\frac{1}{4\pi}$ cm/sec while volume of ice is reducing at a rate of 81 cm^3/sec. The surface area of chocolate is_____.

Ans. **(512π)**

Sol.



$V = \frac{4}{3}\pi r^3$

$\frac{dv}{dt} = 4\pi r^2 \frac{dr}{dt}$

$81 = 4\pi \times r^2 \times \frac{1}{4\pi}$

$r = 9$

Surface area of inner ball is

$4\pi(r-1)^2 = 4\pi(8)^2 = 512\pi$

10. $y = \left(x - y\frac{dx}{dy}\right)\sin\left(\frac{x}{y}\right)$, x(y) = x and $x(1) = \frac{\pi}{2}$, then the value of cos (x(2)) is:

(1) $2(\log 2)^2 - 1$ (2) $2(\log 2)^2 + 1$ (3) $3(\log 2) - 1$ (4) $3(\log 2) + 1$

Ans. **(1)**

Sol. $\frac{x}{y} = v$ (let)

$x = vy$

$\frac{dx}{dy} = y\frac{dv}{dy} + v$

$y = \left(x - y\frac{dx}{dy}\right)\sin\left(\frac{x}{y}\right)$

$1 = \left(\frac{x}{y} - \frac{dx}{dy}\right)\sin\left(\frac{x}{y}\right)$

$1 = \left(v - y\frac{dv}{dy} - v\right)\sin v$

$1 = -\left(y\frac{dv}{dy}\right)\sin v$

$-\int \frac{dy}{y} = \int (\sin v)\, dv$

$-\log|y| = -\cos(v) + c$

$\log|y| = \cos\left(\frac{x}{y}\right) - c$

$|y| = e^c \,.\, e^{\cos(x/y)}$

$Y = \lambda \,.\, e^{\cos(x/y)}$

$1 = \lambda \,.\, e^0$ $X(1) = \frac{\pi}{2}$

$Y = e^{\cos(x/y)}$

$\text{Log } y = \cos\left(\frac{x}{y}\right)$

So,

$X(2) = 2\cos^{-1}(\log 2)$

$= \cos(2\cos^{-1}(\log 2)$

$= 2(\cos(\cos^{-1}(\log 2)))^2 - 1$

$= 2(\log 2)^2 - 1$

11. Let $M\left(1,\frac{1}{2}\right)$ be the mid-point of a chord to the ellipse $\frac{x^2}{4}+\frac{y^2}{2}=1$. Then the length of the chord is:

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

Ans. **(3)**

Sol. $\because$ Equation of chord is given by **T** = S_1

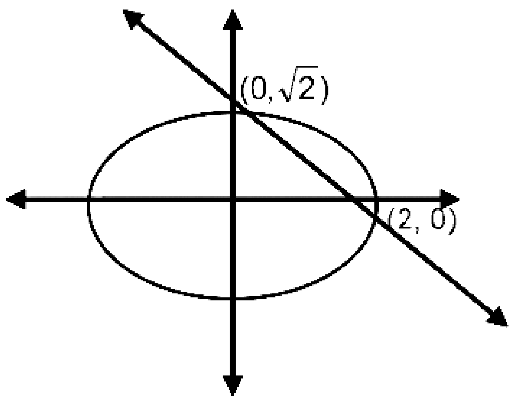
$\Rightarrow$ Equation of chord : $\frac{x.1}{4}+\frac{y.\frac{1}{2}}{2}-1=\frac{1}{4}+\frac{(1/2)^2}{2}-1$

$\Rightarrow$ $\frac{x}{4}+\frac{y}{4}-1=\frac{1}{4}+\frac{1}{8}-1$

$\Rightarrow$ $\frac{x}{4}+\frac{y}{4}=\frac{3}{8}$

$\Rightarrow$ 2x + 2y = 3.

$\Rightarrow$ $y = \frac{3-2x}{2}$



On substituting $y = \frac{3-2x}{2}$ in equation of ellipse we will get point of intersection of line and ellipse.

$\Rightarrow$ $\frac{x^2}{4}+\frac{\left(\frac{3-2x}{2}\right)^2}{2}=1$ $\Rightarrow$ $\frac{x^2}{4}+\frac{9-12x+4x^2}{8}=1$

$\Rightarrow$ $\frac{2x^2+4x^2-12x+9}{8}=1$

$\Rightarrow$ $6x^2 - 12x + 9 = 8$

$\Rightarrow$ $6x^2 - 12x + 1 = 0$

$y = \frac{3}{2}-x$

$y_1 - y_2 = \frac{3}{2} - x_1 - \left(\frac{x}{2}-x_2\right) = x_2 - x_1$

$y=\sqrt{(x_1-x_2)^2+(y_1-y_2)^2}$

$y=\sqrt{(x_1-x_2)^2+(x_2-x_1)^2}$

$y=\sqrt{2}\sqrt{(x_1+x_2)^2-4x_1x_2}$

$y=\sqrt{2}\sqrt{4-4\times\frac{1}{6}}$ $\Rightarrow$ $y=\sqrt{4-\frac{2}{3}} = \frac{\sqrt{2}\sqrt{10}}{\sqrt{3}} = 2\sqrt{\frac{5}{3}}$

12. α, β are the roots of $x^2 - px + q = 0$ are 10^{th}, 11^{th} terms of A.P. of common difference $\frac{3}{2}$, sum of first 11 terms of this A.P. is 88 then q – 2p is:

Ans. **(158)**

Sol. $\alpha = a + 9d$

$\beta = a + 10d$

$S_{11} = \frac{11}{2}[2a+10d]$

$2a + 10d = 16$

$a + 5d = 8$

$d = \frac{3}{2}$

$a + 5\times\frac{3}{2} = 8 \quad \Rightarrow \quad a = \frac{1}{2}$

$\alpha = \frac{1}{2} + 9\times\frac{3}{2} = \frac{28}{2} = 14$

$\beta = \frac{1}{2} + 10\times\frac{3}{2} = \frac{31}{2}$

$P = \alpha + \beta$ and $q = \alpha\beta$

$P = 14 + \frac{31}{2}$

$P = \frac{59}{2}$

$q = 14\times\frac{31}{2}$

$= 217$

Then $q - 2p$

$\Rightarrow$ $217 - 59$

$=$ 158 Ans.

13. Coefficients of x and x^2 in the expansion of $(1 + x)^p (1 - x)^q$ are 1 and –2 respectively. Then 2p – q is:

Ans. **(4)**

Sol. $(1+x)^p = (1+px + \frac{p(p-1)}{2}x^2+..........)$

$(1-x)^q = (1-qx + \frac{q(q-1)}{2}x^2+..........)$

$p - q = 1$

$\frac{q(q-1)}{2} + \frac{p(p-1)}{2} - pq = -2$

$q = 2$

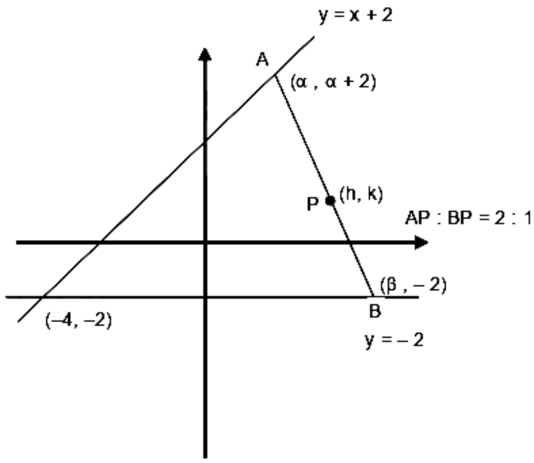
$p = 3$

$q - 2p = -4$

14. A rod AB of length 8 units moving with A on $x - y + 2 = 0$ and B on $y + 2 = 0$. Locus of point P dividing AB in the ratio 2 : 1 internally is $9(x^2 + \alpha y^2 + \beta xy + \gamma x + 28y) - 76 = 0$, then the value of $\alpha - \beta - \gamma$ is:

Ans. **(23)**

Sol.



AB = 8 so AP = 16/3 and BP = 8/3

$(h-\beta)^2 + (k+2)^2 = \frac{64}{9}$ ____(i)

$\frac{2\beta+\alpha}{3} = h$ _____(ii)

$\frac{-4+\alpha+2}{3} = k$ ______(iii)

from (ii) & (iii)

$\beta = \frac{3h-3k-2}{2}$ ______(iv)

from (i) & (iv) eliminate β

$$\left(h - \left(\frac{3h-3k-2}{2}\right)\right)^2 + (k+2)^2 = \frac{64}{9}$$

$$\frac{(3k-h)^2 + 4 + 4(3h-k)}{4} + (k+2)^2 = \frac{64}{9}$$

$9(13k^2 + 28k + h^2 - 6hk - 4h + 20) = 4 \times 64$

Replacing (h, k) with (x, y)

$9(13y^2 + 28y + x^2 - 6xy - 4x) - 76 = 0$

$\alpha - \beta - \gamma = 13 + 6 + 4 = 23$

15. $\lim_{x\to\infty}\left(\frac{2x-5}{3x-2}\right)\frac{(3x-1)^{x/2}}{(\sqrt{3x+2})^x}$

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

Ans. **(1)**

Sol. $= \lim_{x\to\infty}\left(\frac{2-\frac{5}{x}}{3-\frac{2}{x}}\right)\left(\frac{3x-1}{3x+2}\right)^{x/2}$

$= \frac{2}{3}\lim_{x\to\infty}\left(\frac{3x-1}{3x+2}\right)^{x/2}$ (1^∞ form)

$$= \frac{2}{3}\lim_{x\to\infty}\left(\frac{3x-1}{3x+2}\right)^{x/2} \qquad (1^{\infty}\text{ form})$$

$$= \frac{2}{3}.e^{\lim_{x\to\infty}\left(\frac{3x-1}{3x+2}-1\right)\frac{x}{2}} = \frac{2}{3}.e^{\lim_{x\to\infty}\left(\frac{3x-1-3x-2}{3x+2}\right)\frac{x}{2}} = \frac{2}{3}.e^{\lim_{x\to\infty}\left(\frac{-3}{2}\right)\left(\frac{1}{3+\frac{2}{x}}\right)} = \frac{2}{3}.e^{-\frac{1}{2}} = \frac{2}{3\sqrt{e}}$$

16. Let S be the region consisting of points (x, y) such that $-1 \le x \le 1$ and $0 \le y \le a + e^{|x|} - e^{-|x|}$. If area bounded by the region is $2\left(\frac{e^2+8e+1}{e}\right)$. Then the value of 'a' is:

Ans. (10)

Sol. Let $f(x) = a + e^{|x|} - e^{-|x|}$

$f(-x) = a + e^{|x|} - 6^{-|-x|} = a + e^{|x|} - e^{-|x|}$

$\therefore$ f(x) = f(–x)

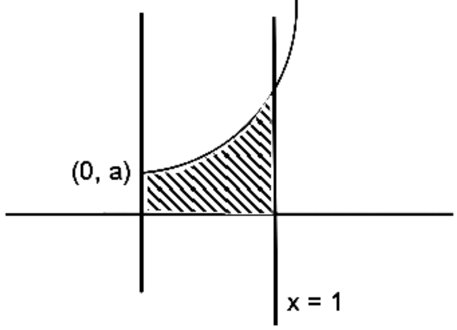
$\therefore$ f(x) is even function

graph of (x) is symmetric about y–axis

f(0) = a,

$f'(x) = e^x + e^{-x} > 0$ [for $x \ge 0$]

f(x) is increasing [for $x \ge 0$]



Let shaded area = A

required area 2A (graph is symmetric about y-axis)

$$a = \int_0^1 (a + e^x - e^{-x})dx = \left[ax + e^x + e^{-x}\right]_0^1 = \left(a + e + \frac{1}{e}\right) - (2) = A$$

required area = 2A = $2\left[\frac{e^2 + e(a-2) + 1}{e}\right]$

by comparing a – 2 = 8

a = 10

17. Let A and B are two sets such that

$A = \{(x,y)| \quad |x+y| \ge 3,\ x, y \in R\}$;

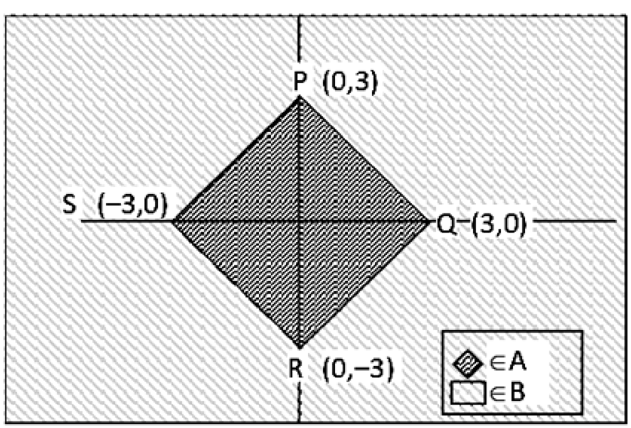
$B = \{(x,y)| \quad |x|+|y| \le 3,\ x, y \in R\}$

Let $C = A \cap B$

The sum of all possible values of x + y is:

Ans. (0)

Sol.



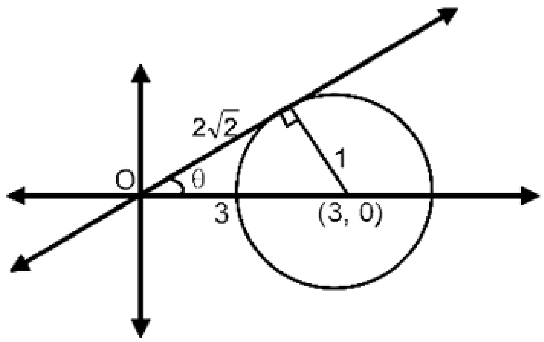
PQ + RS = 0

18. If z = x + iy, x, y ∈ R be a complex number such that $|z - 3| \le 1$, then the equation of the line with largest slope passing through origin and z :

(1) $x - 2\sqrt{2}y = 0$ (2) $x + 2\sqrt{2}y = 0$ (3) $2\sqrt{2}x + y = 0$ (4) $2\sqrt{2}x - y = 0$

Ans. **(1)**

Sol.



$$\tan\theta = \frac{1}{2\sqrt{2}}$$

$$y = mx$$

$$\Rightarrow \quad y = \frac{1}{2\sqrt{2}}x$$

$$\Rightarrow \quad x - 2\sqrt{2}y = 0$$