JEE (Main)-2025 (Online) Session-2
Memory Based Question with & Solutions
(Physics, Chemistry and Mathematics)
2nd April 2025 (Shift-2)

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

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.

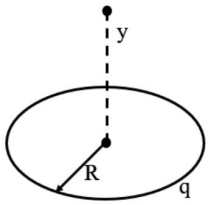
MEMORY BASED QUESTIONS JEE–MAIN EXAMINATION – APRIL, 2025

(Held On Wednesday 2nd April, 2025) TIME : 3 : 00 PM to 6 : 00 PM

PHYSICS

SECTION-A

1. Find 'y' so that electric field E is maximum on the axis of ring



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

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

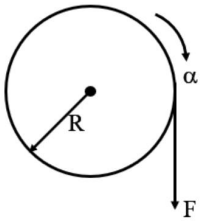
Ans. **(2)**

Sol. $E_{axis} = \frac{KQx}{\left(R^2 + x^2\right)^{3/2}}$

$\frac{dE}{dx} = 0$

$x = \pm\frac{R}{\sqrt{2}}$

2. Find moment of inertia of pulley



(1) $\frac{FR}{\alpha}$ (2) $\frac{FR}{2\alpha}$

(3) $\frac{2FR}{\alpha}$ (4) $\frac{2FR}{3\alpha}$

Ans. **(1)**

Sol. $\tau = I\alpha$

$I = \frac{FR}{\alpha}$

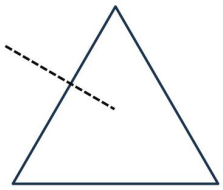
3. An equilateral prism is made of a material of refractive index $\sqrt{2}$. Find angle of incidence for minimum deviation of the light ray.

(1) 45° (2) 60°

(3) 37° (4) 30°

Ans. **(4)**

Sol. For minimum deviation r = 30°



$1 \times \sin i = \sqrt{2} \times \frac{1}{2}$

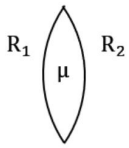
$\sin i = \frac{1}{\sqrt{2}}$

$i = 45°$

$\delta = i + e - A$

$= 90 - 60 = 30°$

4. Find which option results in same 'f', as shown in the figure, if μ is same (R_1 & R_2 are in SI unit) :-



(1) $R_1 = 6,\ R_2 = \frac{1}{6}$ and $R_1 = 8,\ R_2 = \frac{1}{8}$

(2) $R_1 = 6,\ R_2 = \frac{1}{6}$ and $R_1 = \frac{1}{6},\ R_2 = 6$

(3) $R_1 = 8,\ R_2 = \frac{1}{6}$ and $R_1 = \frac{1}{6},\ R_2 = 6$

(4) None of these

Ans. **(2)**

Sol. $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

5. Dimensional formula of $\frac{1}{\mu_0\varepsilon_0}$ (where m_0 is permeability and e_0 is permittivity of free space) should be:

(1) L^2T^{-2} (2) LT^{-1}

(3) MLT^{-1} (4) ML^2T^{-2}

Ans. **(1)**

Sol. $C = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$

$$C^2 = \frac{1}{\mu_0 \varepsilon_0}$$

$$\left[\frac{1}{\mu_0 \varepsilon_0}\right] = \left[L^2 T^{-2}\right]$$

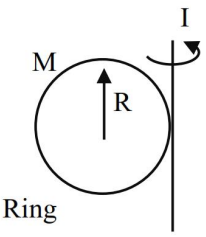
6. The moment of inertia of ring of mass M and radius R about an axis passing through tangential point in the plane of ring is:

(1) $\frac{5MR^2}{2}$ (2) $\frac{3MR^2}{2}$

(3) $\frac{4MR^2}{3}$ (4) $\frac{2MR^2}{3}$

Ans. **(2)**

Sol.



$$I = \frac{MR^2}{2} + MR^2$$

$$= \frac{3MR^2}{2}$$

7. Two water drops each of radius of r coalesce to from a bigger drop. If T is the surface tension, surface energy released in this process

(1) T $4\pi r^2(2 - 2^{2/3})$ (2) T $4\pi r^2(1 - 2^{2/3})$

(3) T $4\pi r^2(2 - 4^{2/3})$ (4) T $4\pi r^2(2 - 8^{2/3})$

Ans. **(1)**

Sol. $2 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$

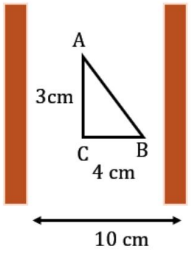
$2^{1/3} r = R$

$E_I = 2 \times T \times 4\pi r^2$

$E_F = T \times 4\pi \left(2^{1/3}\pi\right)^2$

$E_{I-F} = T \times 4\pi r^2 \left(2 - 2^{2/3}\right)$

8. The figure shows the plates of a parallel plate capacitor with a separation 10 cm and charged to a potential difference V. Find the potential difference between B and A



(1) $\frac{2v}{5}$ (2) $\frac{V}{2}$

(3) $\frac{V}{5}$ (4) $\frac{3v}{5}$

Ans. **(1)**

Sol. $\Delta V = \int \vec{E}.\overrightarrow{dr}$

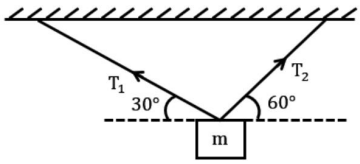
$\left|\frac{\Delta V}{d}\right| = |E|$

$\frac{\frac{V}{10}}{\frac{V_{BA}}{4}} = 1$

$\frac{V}{10} = \frac{V_{BA}}{4}$

$V = \frac{2V}{5}$

9. A block of mass m is suspended in a vertical plane with the help of two light strings as shown. Find the ratio of tensions $\frac{T_1}{T_2}$



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

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

Ans. **(2)**

Sol. $T_1 \cos 30° = T_2 \cos 60°$

$\frac{T_1}{T_2} = \frac{\frac{1}{2}}{\frac{\sqrt{3}}{2}}$

10. A solenoid having area A and length 'l' is filled with a material having relative permeability 2. The magnetic energy stored in the solenoid is:

(1) $\frac{B^2 A\ell}{4\mu_0}$ (2) $\frac{B^2 A\ell}{2\mu_0}$

(3) $B^2 A\ell$ (4) $\frac{B^2 A\ell}{\mu_0}$

Ans. **(1)**

Sol. $U = \frac{B^2}{2\mu}$

$U = \frac{B^2}{2(2)\mu_0} \times A\ell$

$U = \frac{B^2 A\ell}{4\mu_0}$

11. First Bohr orbit of H^+ is radius r_0. Find ground state radius of Li^{+2}

(1) $\frac{r_0}{3}$ (2) $4r_0$

(3) $2r_0$ (4) $3r_0$

Ans. **(1)**

Sol. $r \propto \frac{n^2}{z}$

$r \propto \frac{1}{z}$

$\frac{r_{Li^{2+}}}{r_{H^+}} = \frac{1}{3}$

$r_{Li^{2+}} = \frac{r_0}{3}$

12. $_1H^2 + _1H^2 \rightarrow {}_2He^4$

If binding energy per nucleon of deuterium is 1.1 eV and of helium is 7.0 eV. Find energy released in reaction :-

(1) 2.8 eV (2) 23.6 eV

(3) 14.8 eV (4) None

Ans. **(2)**

Sol. $2_1H^2 \rightarrow {}_2He^4$

$\Delta E = 4 \times BE\ {}_2He^4 - (2 \times {}_1H^2)$

$= (4 \times 7.0 - 4 \times 1.1)$ eV

$= 4 \times 5.4$ MeV $= 23.6$ eV

13. A satellite of mass 500 Kg is moving in a radius 'r' around Earth; where r = 220 km. Find K.E. of satellite :-

(1) 4.5×10^{10} J (2) 4.5×10^{9} J

(3) 4.5×10^{11} J (4) None

Ans. **(4)**

Sol. $KE = \frac{1}{2}\frac{GM_sM_p}{r}$

$= \frac{6.67\times10^{-11}\times500\times6\times10^{24}}{2\times220\times10^3}$

$= 50 \times 10^{10}$ J

14. A positively charged particle is moving along X-axis has De-Broglie wavelength 'λ'. Now a magnetic field is switched on in +Y direction. Find the new wavelength when particle's velocity becomes parallel to +Z direction :-

(1) $\frac{\lambda}{\sqrt{2}}$ (2) λ

(3) $\frac{\lambda}{3}$ (4) $\frac{\lambda}{4}$

Ans. **(2)**

Sol. $\lambda = \frac{h}{p} = \frac{h}{mv}$

$\lambda' = \lambda.$

15. Statement-I : For a polar linear isotropic material. If E = 0, then dipole moment of material is 0.

Statement-II : In absence of $\vec{E}$, the dielectric is non-polar.

(1) Statement-I is correct, statement-II is correct and statement-II is correct explanation of statement-I.

(2) Statement-I is correct, statement-II is correct and statement-II is not the correct explanation of statement-I.

(3) Statement-I is correct and statement-II is incorrect.

(4) Statement-I is incorrect and statement-II is correct.

Ans. **(3)**

Sol. Linear dielectrics

$\vec{P} = \gamma\vec{E}$

If $\vec{E} = 0$, then $\vec{P} = 0$.

16. Two galvanometers G_1 and G_2 are having resistors $R_1 = 5W$ and $R_2 = 7W$, number of turns $N_1 = 21$, $N_2 = 15$, magnetic fields $B_1 = 0.25$ T, $B_2 = 0.50$T and area of coil $A_1 = 3.6 \times 10^{-3}$ cm^2 and $A_2 = 1.8 \times 10^{-3}$ cm^2. Find the ratio of their voltage sensitivity (same spring in both)

(1) $\frac{5}{7}$ (2) $\frac{49}{20}$

(3) $\frac{49}{25}$ (4) $\frac{7}{5}$

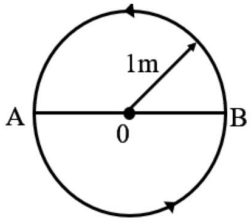
Ans. **(3)**

Sol. **Voltage sensitivity** $= \frac{NAB}{CR}$

$\frac{\chi_1}{\chi_2} = \frac{N_1}{N_2} \times \frac{A_1}{A_2} \times \frac{B_1}{B_2} \times \frac{R_2}{R_1}$

$= \frac{21}{15} \times \frac{36}{18} \times \frac{0.25}{0.5} \times \frac{7}{5} = \frac{49}{25}$

17. A particle moves on a circular path of radius 1 m. Find displacement when it moves from A → B → A → B. Also its distance as it moves from A → B → A → B → A.



(1) Distance = 2 m, Displacement = 4π m

(2) Distance = 2 m, Displacement = 5π m

(3) Distance = 4π m, Displacement = 2 m

(4) Distance = 5π m, Displacement = 2 m

Ans. **(3)**

Sol. Displacement A → B → A → B.

= A → B

= 2R = 2m

Distance : A → B → A → B → A

= 2 complete circle

= 4π m

18. Match the list-I with the list-II

(i) Heat capacity	(a) $J\ kg^{-1}\ K^{-1}$
(ii) Specific heat capacity	(b) $J\ K^{-1}$
(iii) Latent heat	(c) $W\ m^{-1}\ K^{-1}$
(iv) Thermal conductivity	(d) $J\ kg^{-1}$

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

(2) (i) – (b), (ii) – (a), (iii) – (c), (iv) – (a)

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

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

Ans. **(4)**

Sol. (i) Heat capacity $\frac{J}{kg\,K}$

(ii) Specific heat capacity $\frac{J}{K}$

(iii) Latent heat $\frac{J}{kg}$

(iv) thermal conductivity $\frac{W}{m\,K}$

19. Which of the following option is correct for an adiabatic process :-

(1) PV = constant (2) PT = constant

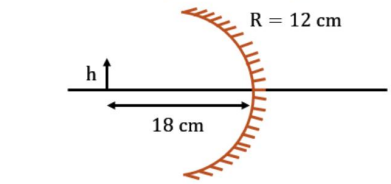
(3) WD $\propto T_2 - T_1$ (4) None of these

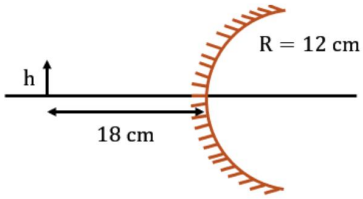
Ans. **(3)**

Sol. $W_{adia} = \frac{nR}{\gamma - 1}[T_1 - T_2]$

$\Rightarrow WD \propto T_2 - T_1$

20. Find the ratio of heights of images :





(1) 2 (2) 4

(3) 6 (4) 8

Ans. **(1)**

Sol. $\frac{1}{v_1} - \frac{1}{18} = -\frac{1}{6}$ $\qquad$ $\frac{1}{v_2} - \frac{1}{18} = \frac{1}{6}$

$\frac{1}{v_1} = \frac{1}{18} - \frac{1}{6}$ $\qquad$ $\frac{1}{v_2} = \frac{1}{18} + \frac{1}{6}$

$= \frac{-2}{18}$ $\qquad$ $\frac{1}{v_2} = \frac{4}{18}$

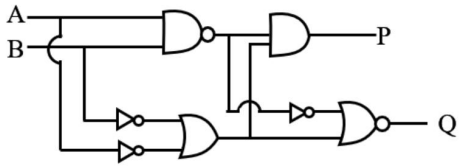
$v_1 = -9$ cm $\qquad$ $v_2 = \frac{9}{2}$ cm

$\left|\frac{h_i}{h_o}\right| = \left|-\frac{v}{u}\right| \Rightarrow h_i \propto v$

$\frac{h_1}{h_2} = \frac{v_1}{v_2} = \frac{9}{9} \times 2 = 2$

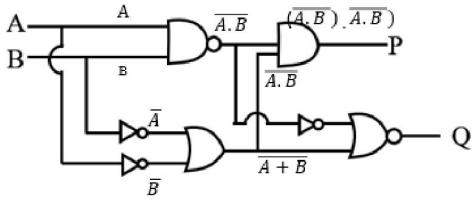
SECTION-B

1. Find the output of the circuit.



Ans. **(0)**

Sol.



$$\left(\overline{A.B}\right)\left(\overline{A.B}\right)=0$$

$$\left(\overline{A.B}\right)AB=0$$

CHEMISTRY

SECTION-A

1. Correct order of electronegativity in below elements

(a) $1s^2 2s^2 2p^3$ (b) $1s^2 2s^2 2p^4$

(c) $1s^2 2s^2 2p^5$ (d) $1s^2 2s^2 2p^2$

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

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

Ans. **(2)**

Sol. (a) $1s^2 2s^2 2p^3 \Rightarrow$ N

(b) $1s^2 2s^2 2p^4 \Rightarrow$ O

(c) $1s^2 2s^2 2p^5 \Rightarrow$ F

(d) $1s^2 2s^2 2p^2 \Rightarrow$ C

Moving from left to right in a period EN increase as Z_{eff} increases.

EN order : C < N < O < F

EN on Pauling scale : 2.5 3.0 3.5 4.0

Ans. c > b > a > d

2. Nature of compounds TeO_2 and TeH_2 is _____ and _____ respectively.

(1) Oxidising and reducing agent respectively

(2) Highly acidic and highly basic respectively

(3) Reducing and Basic respectively

(4) Basic and oxidising

Ans. **(1)**

Sol. In group 16 oxides TeO_2 acts as oxidising agent due to inert pair effect, +2 oxidation state is more stable so +4 changes into +2 ($Te^{\oplus 4}$ gets reduced to $Te^{\oplus 2}$).

In group 16 hydrides TeH_2 acts as reducing agent because in group 16 hydrides down the group E–H bond length increase so, tendency to loose H atom increases, thus reducing nature increases.

$TeO_2 \Rightarrow$ oxidising agent

$TeH_2 \Rightarrow$ reducing agent

3. Sodium nitroprusside test is used for detection of which of the following species in organic compounds

(1) SO_4^{2-} (2) S^{2-}

(3) Na^+ (4) PO_4^{3-}

Ans. **(2)**

Sol.

$$S^{-2} + Na_2[Fe(CN)_5(NO)] \downarrow$$

$$Na_4[Fe(CN)_5(NOS)]$$

Purple

4. Which of the following is the correct order of enthalpy of atomization of 3d-series?

(1) Ni > Cu > Mn > Zn

(2) Zn > Cu > Mn > Ni

(3) Cu > Mn > Ni > Zn

(4) Mn > Ni > Cu > Zn

Ans. **(1)**

Sol. For metals

Enthalpy of atomisation generally depends an metallic bond strength and sublimation enthalpy order of enthalpy of atomisation in 3d-series among Ni, Cu, Mn & Zn.

Ni > Cu > Mn > Zn

Zn $\Rightarrow$ weakest metallic bond strength among 3d series.

Mn $\Rightarrow$ Low enthalpy of atomisation due to exceptional crystal lattice structure.

Enthalpy of atomisation (kJ/mole)

Mn $\rightarrow$ 281

Ni $\rightarrow$ 430

Cu $\rightarrow$ 339

Zn $\rightarrow$ 126

5. Among the following molecules which one has sp^3d hybridized having lone pair and having different bond length:

XeF_2, XeF_4, PF_5, SF_4

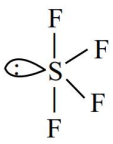
(1) XeF_2 (2) XeF_4

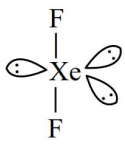
(3) PF_5 (4) SF_4

Ans. **(4)**

Sol.

			lone pair
XeF_2	$\Rightarrow$	sp^3d	3
XeF_4	$\Rightarrow$	sp^3d^2	2
PF_5	$\Rightarrow$	sp^3d	0
SF_4	$\Rightarrow$	sp^3d	1





6. In adiabatic process, the magnitude of work done in case of one step & infinite step follows order:

(1) $|W_{rev}|_{expansion} > |W_{Irrev}|_{expansion}$

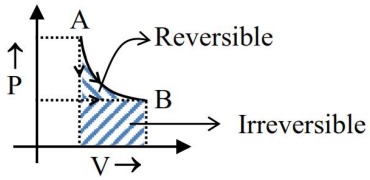
(2) $|W_{rev}|_{expansion} < |W_{Irrev}|_{expansion}$

(3) $|W_{rev}|_{expansion} = |W_{Irrev}|_{expansion}$

(4) Can't be predicated

Ans. **(1)**

Sol.



$|W_{rev}|_{expansion} > |W_{Irrev}|_{expansion}$

7. The d-orbital electronic configuration of the complex among $[Co(en)_3]^{3+}$, $[Co(F)_6]^{3-}$.$[Mn(H_2O)_6]^{2+}$ and $[Zn(H_2O)_6]^{2+}$ that has highest CFSE is

(1) $t_{2g}^3eg^2$ (2) $t_{2g}^6eg^4$

(3) $t_{2g}^6eg^0$ (4) $t_{2g}^4eg^2$

Ans. **(3)**

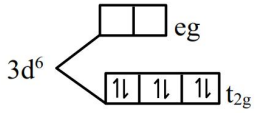
Sol. CFSE order $M^{3\oplus} > M^{2\oplus}$

General ligand strength order : C-donor > N-donor > O-donor > halogen and other donor

According to above order CFSE maximum for $[Co(en)_3]^{3\oplus}$

For $[Co(en)_3]^{3\oplus} \Rightarrow$ octahedral complex

$Co^{3\oplus} \Rightarrow 3d^6$



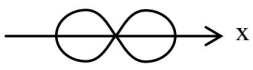
d-orbital electronic configuration : t_{2g}^6, eg^0

8. Consider the following statements

(A) Value of *l* gives shape of orbital

(B) Ψ represent wave function of an electron

(C) Electron density of p_x orbital in xy plane is zero

(D) $2p_x$ orbital is 

The correct statement(s) are

(1) (A) and (D) only

(2) (A), (C) and (D) only

(3) (A), (B) and (D) only

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

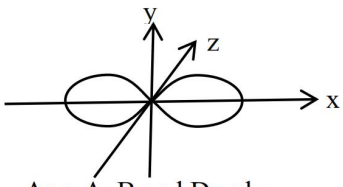
Ans. **(3)**

Sol. (A) Azimuthal quantum no. (ℓ) $\Rightarrow$ represents shape of orbital

(B) Ψ $\Rightarrow$ represents wave function of an electron and amplitude of electron wave

(C) Lobes of p_x orbital are present in xy and xz planes and nodal plane is yz plane, so electron density of p_x orbital is zero in yz plane

(D) $2p_x$ orbital is oriented along x-axis



Ans. A, B and D only

9. For the reversible reaction $A(g) \rightleftharpoons B(g) + C(g)$. The degree of dissociation is α at pressure P_T, then

(1) If $P_T >> K_P$, then $\alpha \approx 1$

(2) If P_T increases, then α decreases

(3) If P_T increases, then α increases

(4) If $K_P >> P_T$, then α tend to 0

Ans. **(2)**

Sol. According to Le-chatlier principal

If P_T increases reaction will shift toward less moles, means backward reaction

Hence α decreases.

10. The number of unpaired electrons and hybridization of $[Mn(CN)_6]^{3-}$, respectively are:

(1) 4 and d^2sp^3 (2) 4 and sp^3d^2

(3) 2 and d^2sp^3 (4) 2 and sp^3d^2

Ans. **(3)**

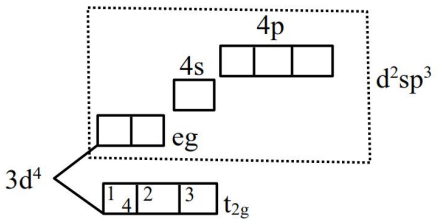
Sol. $[Mn(CN)_6]^{3-}$

$CN^- \Rightarrow$ strong field ligand

In presence of SFL $\Delta_0 > P$

Pairing is possible in t_{2g}

$Mn^{3\oplus} \Rightarrow 3d^4$



Unpaired electrons (n) = 2

Hybridisation $\Rightarrow d^2sp^3$

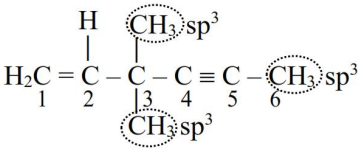
11. In 3, 3-dimethylhex-1-en-4-yne, the number of sp, sp^2 and sp^3 carbon atoms, respectively are

(1) 2, 2, 4 (2) 2, 2, 2

(3) 4, 2, 2 (4) 2, 4, 2

Ans. **(1)**

Sol.



$sp^2 = C_1, C_2$

$sp = C_4, C_5$

12. Statement-I: Melting point of neopentane is greater than that of n-pentane.

Statement-II: Neopentane give only one mono-substituted product.

(1) Statement I and Statement II both are correct.

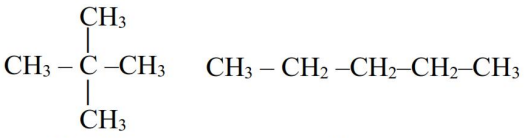
(2) Statement I is correct but Statement II is incorrect.

(3) Statement I is incorrect but Statement II is correct.

(4) Statement I and Statement II both incorrect.

Ans. **(1)**

Sol. Statement-I:

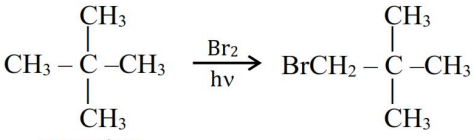


neopentane n-pentane

m.p. – (–16.6°C) m.p. – (–129.8°C)

Symmetrical compounds have higher m.p.

Statement-II:



neopentane

Only one mono-substituted product.

13. The four different amino acids are given A, B, C and D. Calculate the number of tetrapeptides formed including all the four amino acids.

(1) 8 (2) 16

(3) 24 (4) 32

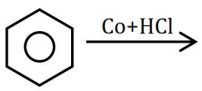
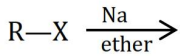
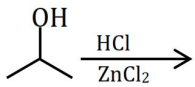
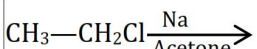
Ans. **(3)**

Sol. Tetrapeptide is formed using 4 amino acids it has 3 peptide linkages the number of permutations in which they can be arranged = 4!

$= 4 \times 3 \times 2 \times 1$

$= 24$

14. Match the column

	Column -I		Column - II
(P)	Finkelstein reaction	(I)	
(Q)	Lucas reaction	(II)	
(R)	Wurtz reaction	(III)	
(S)	Gattermann koch reaction	(IV)	

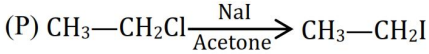
(1) P-IV, Q-III, R-II, S-I

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

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

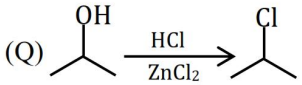
(4) P-III, Q-II, R-I, S-IV

Ans. **(1)**

Sol. (P) 

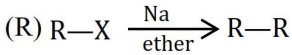
Finkelstein reaction

Halogen exchange reaction

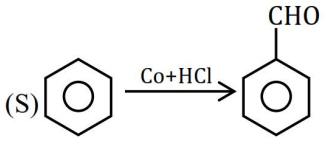
(Q) 

White turbidity

Lucas test

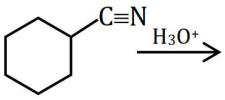
(R) 

Wurtz reaction

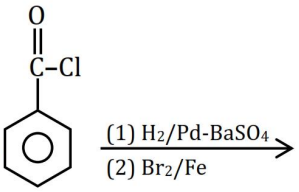
(S) 

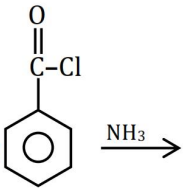
Gattermann koch reaction

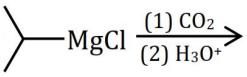
15. Out of following reaction in how many reaction final product has –COOH functional group ?

(A) 

(B) $R-C\equiv N \xrightarrow[(2)\ H_3O^+]{(1)\ SnCl_2 + HCl}$

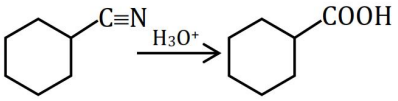
(C) 

(D) 

(E) 

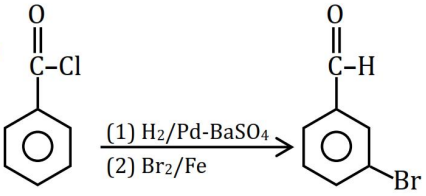
(1) Only A, E (2) Only A, B, C
(3) Only D, E (4) Only A, C, D

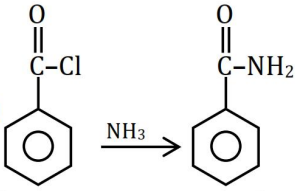
Ans. **(1)**

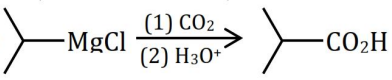
Sol. (A) 

(B) $R-C\equiv N \xrightarrow[(2)\ H_3O^+]{(1)\ SnCl_2 + HCl} R-\overset{O}{\overset{\|}{C}}-H$

Stephen's reaction

(C) 

(D) 

(E) 

Preparation of carboxylic acids from Grignard reagent

16. Match list-I with list-II and select the correct option

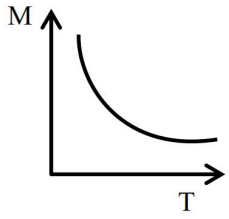
List – I (Pair of molecules)		**List – II (Purification method)**	
(A)	Glycerol and spent-lye	(I)	Steam distillation
(B)	Water and aniline	(II)	Fractional distillation
(C)	Petrol and Diesel	(III)	Distillation under reduced pressure
(D)	Aniline and $CHCl_3$	(IV)	Distillation

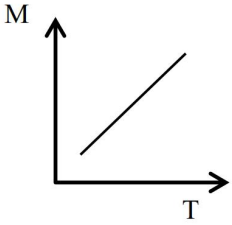
(1) A-IV, B-I, C-II, D-III
(2) A-III , B-II, C-I, D-IV
(3) A-IV, B-II, C-I, D-III
(4) A-III, B-I, C-II, D-IV

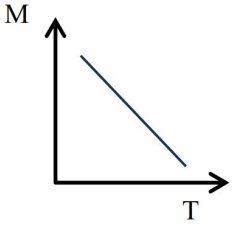
Ans. **(4)**

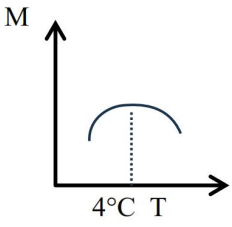
Sol. (A) Glycerol and spent-lye → Distillation under reduced pressure
(B) Water and aniline → Steam distillation
(C) Petrol and Diesel → Fractional distillation
(D) Aniline and $CHCl_3$ → Distillation

17. 1 M NaCl solution is prepared at 0°C in H_2O Now it is heated then find correct graph between molarity and temperature.

(1) 

(2) 

(3) 

(4) 

Ans. **(4)**

Sol. $M = \frac{n}{V}$

For H_2O

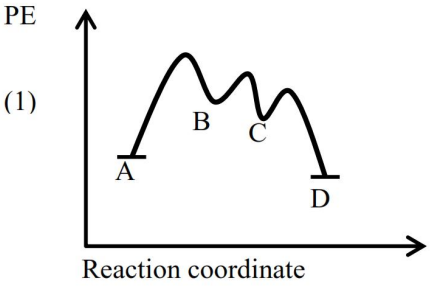
$$0°C \xrightarrow{\boxed{d\uparrow V\downarrow}} 4°C \xrightarrow{\boxed{d\downarrow V\uparrow}} \text{higher temperature}$$

18. Consider the following reactions:

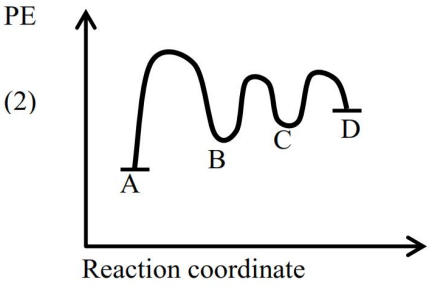
$$A \xrightarrow[\text{slow}]{\Delta H>0} B \xrightarrow[\text{fast}]{\Delta H<0} C \xrightarrow[\text{fast}]{\Delta H<0} D$$

Then correct graph will be

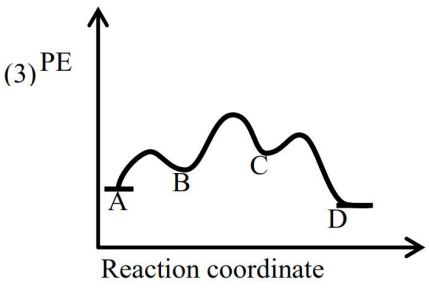
(1)



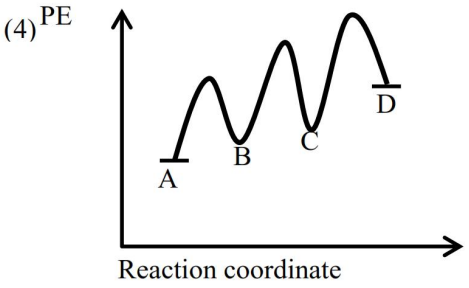
(2)



(3)



(4)

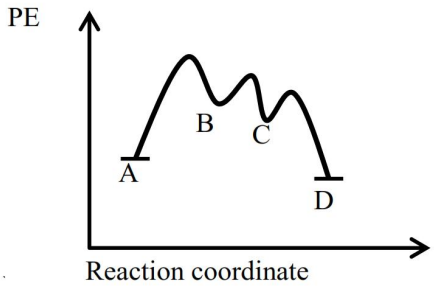


Ans. **(1)**

Sol. $H > 0 : A > B$

$\Delta H < 0 : C < B$

$\Delta H < 0 : D < C$



SECTION-B

19. 0.1 g of organic compound was subjected to estimation of N by Duma's method. Volume of N_2 evolved at 0°C, 1 atm was 11.2 mL. Find % nitrogen in organic compound.

Ans. **(14)**

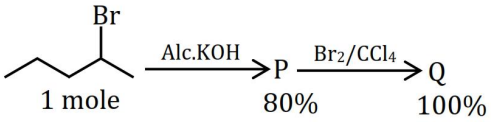
Sol. $n_{N_2} = \frac{11.2}{22400} = 5\times10^{-4}$

Mass of $N_2 = 5 \times 10^{-4} \times 28$

$\%$ of $N_2 = \frac{5\times10^{-4}\times28}{0.1}\times100$

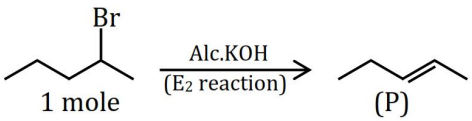
$1400 \times 10^{-4} \times 100 = 14\%$

20. Mass of Q formed is x (gm). Find the value of x

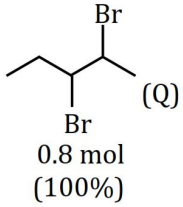


Ans. **(184)**

Sol.



0.8 mol
(80%)



0.8 mol
(100%)

Mass of Q formed = 0.8 mol × molar mass of Q

= 0.8 × 230

= 23 × 8 g

= 184 g

21. If the percentage w/v for NaOH is 0.2 and resistivity is 870 milliohm metre. Then, calculate Λ m (in S cm^2mol^{-1}).

Ans. **(230)**

Sol. $\Lambda_n = \dfrac{K \times 1000}{C}$

$k = \dfrac{1}{\rho} = \dfrac{1000}{870} ohm^{-1}m^{-1}$

$= 1.15 \times 10^{-2}\ ohm^{-1}\ cm^{-1}$

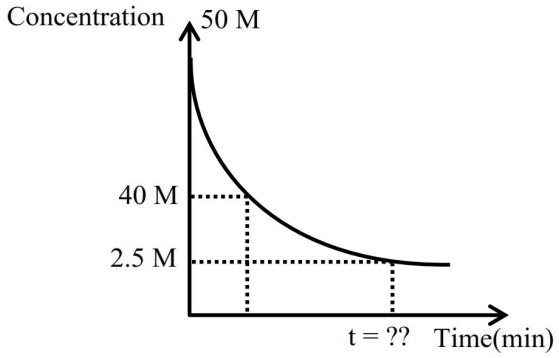
$\Rightarrow$ 0.2 g NaOH in 100 ml solution

$$M = \frac{\frac{0.2}{40}}{\frac{100}{1000}} = 0.05$$

$$\Rightarrow \Lambda_m = \frac{1.15 \times 10^{-2} \times 10^3}{5 \times 10^{-2}}$$

$\Lambda_m = 230$

22. Concentration vs time graph for first order reaction is given



Find out time required for concentration to become 2.5 M (in min) (Nearest integer)

Ans. **(65)**

Sol. $\Rightarrow k = \dfrac{1}{t} \ln \dfrac{C_o}{C_t}$

$\Rightarrow k = \dfrac{1}{5} \ln \dfrac{5}{4}$

$\Rightarrow t = \dfrac{1}{k} \ln \dfrac{50}{2.5} = \dfrac{1}{k} \ln 20$

$\Rightarrow t = \dfrac{5 \ln 20}{\ln \frac{5}{4}}$

$\Rightarrow t = 65$ min

MATHEMATICS

SECTION-A

1. If $\theta \in \left[-\frac{7\pi}{6}, \frac{4\pi}{3}\right]$, then number of solutions of $\sqrt{3}\text{cosec}^2\theta - 2\left(\sqrt{3}-1\right)\text{cosec}\,\theta - 4 = 0$, is ____.

Ans. **(6)**

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

$\Rightarrow \cos ec\theta = \frac{-2}{\sqrt{3}}, \cos ec\theta = 2$

$\Rightarrow \sin\theta = \frac{-\sqrt{3}}{2}, \sin\theta = \frac{1}{2}$

$\theta = p\pi + (-1)^P\left(\frac{-\pi}{3}\right),$

$\theta = n\pi + (-1)^n\frac{\pi}{6}$

Number of solutions = 6

2. If the domain of the function $f(x) = \frac{1}{\sqrt{3x+10-x^2}} + \frac{1}{\sqrt{x+|x|}}$ is (a, b) then $(1 + a)^2 + b^2$ is equal to

(1) 25 (2) 16

(3) 24 (26)

Ans. **(4)**

Sol. $3x + 10 - x^2 > 0 \Rightarrow x^2 - 3x - 10 < 0$

$\Rightarrow (x - 5)(x + 2) < 0 \Rightarrow x \in (-2, 5)$ ...(i)

$x + |x| > 0 \Rightarrow x > 0$ …(ii)

Domain will be (0, 5)

$\Rightarrow a = 0, b = 5$

$(1 + a)^2 + b^2 = 1 + 25 = 26$

3. Total number of terms in an A.P. are even. Sum of odd terms is 24 and sum of even term is 30. Last term exceeds the first term by $\frac{21}{2}$. Find the total number of terms.

Ans. **(8)**

Sol. Let number of terms = 2n

Let first term of AP is a and common difference is 2d

a, a + 2d, a + 4d, ……

$\frac{n}{2}\left[2a + (n-1)2d\right] = 24$

$n[a + (n - 1)d] = 24$ ….(1)

a + d, a + 3d, a + 5d, ……

$\frac{n}{2}\left[2(a+d) + (n-1)2d\right] = 30$

$n[(a + d) + (n - 1)d] = 30$

$24 + nd = 30$ ….(2)

$\left[a + (2n - 1)d\right] - a = \frac{21}{2}$

$(2n-1)d = \frac{21}{2}$

$2nd - d = \frac{21}{2}$

$12 - d = \frac{21}{2}$

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

$nd = 6 \Rightarrow n = \frac{6\times 2}{3} = 4$

$\Rightarrow$ no. of term = 8

4. Find the eccentricity of ellipse in which length of minor axis is equal to one fourth of the distance between foci

(1) $\frac{4}{\sqrt{17}}$ (2) $\frac{2}{\sqrt{17}}$

(3) $\frac{7}{\sqrt{17}}$ (4) $\frac{8}{\sqrt{17}}$

Ans. **(1)**

Sol. $E: \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, a > b$

$2b = \frac{1}{4}\times 2ae$

$\Rightarrow 4\frac{b}{a}=e$

$\Rightarrow 16\frac{b^2}{a^2}=e^2$

$\Rightarrow 16(1-e^2)=e^2$

$\Rightarrow 16=17e^2$

$e^2=\frac{16}{17}$

$e=\frac{4}{\sqrt{17}}$

5. $\lim\limits_{x\to 0}\frac{\cos(2x)+a\cos(4x)-b}{x^4}$ is finite, then a+b is equal to

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

(3) 2 (4) 1

Ans. **(3)**

Sol. Use expansion of $\cos x=1-\frac{x^2}{2!}+\frac{x^4}{4!}.....$

$$\lim_{x\to 0}\frac{\left(1-\frac{(2x)^2}{2!}+\frac{(2x)^4}{4!}-.....\right)+a\left(1-\frac{(4x)^2}{2!}+\frac{(4x)^4}{4!}.....\right)-b}{x^4}$$

$$\Rightarrow \lim_{x\to 0}\frac{(1+a-b)-(2+8a)x^2+\left(\frac{16}{24}+\frac{2^8}{24}\right)x^4.....}{x^4}$$

Limit is finite:

$\therefore$ 1 + a – b = 0 and 2 + 8a = 0 $\Rightarrow a=\frac{-1}{4}$

$\Rightarrow$ b – a = 1 $\Rightarrow b+\frac{1}{4}=1 \Rightarrow b=\frac{3}{4}$

$\therefore$ 4(a + b) = 2

6. If $\frac{dy}{dx}+2y\sec^2 x=2\sec^2 x+3\tan x.\sec^2 x$ and $f(0)=\frac{5}{4}$. Then the value of $12\left(y\left(\frac{\pi}{4}\right)-\frac{1}{e^2}\right)$ is equal to

Ans. **(21)**

Sol. $\frac{dy}{dx}+2y\sec^2 x=\sec^2 x(2+3\tan x)$

I.F. $e^{\int 2\sec^2 x}=e^{2\tan x}$

$y\cdot e^{2\tan x}=\int e^{2\tan x}(2+3\tan x)\sec^2 x dx$

$=\int e^{2t}(2+3t)dt$

$=e^{2t}+\frac{3te^{2t}}{2}-\frac{3e^{2t}}{4}$

$\Rightarrow y\cdot e^{2\tan x}=e^{2\tan x}\left(1+\frac{3\tan x}{2}-\frac{3}{4}\right)+c$

Since $f(0)=\frac{5}{4}$

$\Rightarrow \frac{5}{4}=1-\frac{3}{4}+c$

$\Rightarrow$ c = 1

$\Rightarrow y=\frac{1}{4}+\frac{3\tan x}{2}+e^{-2\tan x}$

Now, $y\left(\frac{\pi}{4}\right)=\frac{1}{4}+\frac{3}{2}+e^{-2}$

So, $12\left(y\left(\frac{\pi}{4}\right)-\frac{1}{e^2}\right)=12\left(\frac{7}{4}\right)=21$

7. If two vectors $\vec{a}$ and $\vec{b}$ is given by $\vec{a}=\hat{\imath}+2\hat{\jmath}+3\hat{k}$ and $\vec{b}=-\hat{\imath}+4\hat{\jmath}+8\hat{k}$ and the vectors $\vec{c}$ and $\vec{d}$ are related as $(\vec{a}-\vec{c})\times\vec{b}=5\hat{\imath}-2\hat{\jmath}+3\hat{k}$ and $\vec{b}\times\vec{c}=\vec{d}$. Then $|\vec{a}.\vec{d}|$ is equal to

(1) 12 (2) 8

(3) 10 (4) 7

Ans. **(3)**

Sol. $\vec{a}=\hat{i}+2\hat{j}+3\hat{k}$ & $\vec{b}=-\hat{i}+4\hat{j}+8\hat{k}$

$(\vec{a}-\vec{c})\times\vec{b}=5\hat{i}-2\hat{j}+3\hat{k}$

$\vec{b}\times\vec{c}=\vec{d}$

$|\vec{a}\cdot\vec{d}|=|\vec{a}\cdot(\vec{b}\times\vec{c})|=|[\vec{a}\ \vec{b}\ \vec{c}]|$

$\Rightarrow((\vec{a}\times\vec{b})-(\vec{c}\times\vec{b}))\cdot\vec{a}=(5\hat{i}-2\hat{j}+3\hat{k})\cdot(\hat{i}+2\hat{j}+3\hat{k})$

$[\vec{a}\ \vec{b}\ \vec{c}]=5-4+9=10$

$|[\vec{a}\ \vec{b}\ \vec{c}]|=10$

8. If the mean and variance of eight observations a, b, 8, 12, 10, 6, 4, 13 is 9 and 9.25 respectively. Then a + b + ab is equal to

(1) 76 (2) 84

(3) 79 (4) 103

Ans. **(4)**

Sol. $\frac{a+b+8+12+10+6+4+13}{8}=9$

$\Rightarrow a+b+53=72$

$\Rightarrow a+b=19$

$\frac{\sum x_i^2}{8}-9^2=9.25$

$\Rightarrow a^2+b^2+8^2+12^2+10^2+6^2+4^2+13^2$

$=(81+9.25)\times 8$

$\Rightarrow a^2+b^2+64+144+100+36+16+169$

$=648+74$

$\Rightarrow a^2+b^2=193$

$ab=\frac{(a+b)^2-(a^2+b^2)}{2}=\frac{361-193}{2}=84$

$\Rightarrow a+b+ab=19+84=103$

9. If $y=\cos\left(\frac{\pi}{3}+\cos^{-1}\left(\frac{x}{2}\right)\right)$, then which of the following is true.

(1) $x^2-2xy+8y^2=2$

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

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

(4) $x^2-5xy+4y^2=8$

Ans. **(2)**

Sol. $y=\frac{1}{2}\cdot\frac{x}{2}-\frac{\sqrt{3}}{2}\cdot\sqrt{1-\frac{x^2}{4}}$

$\Rightarrow y-\frac{x}{4}=-\frac{\sqrt{3}}{2}\sqrt{1-\frac{x^2}{4}}$

$\Rightarrow y^2+\frac{x^2}{16}-\frac{xy}{2}=\frac{3}{4}\left(1-\frac{x^2}{4}\right)$

$\Rightarrow 16y^2+x^2-8xy=12-3x^2$

$\Rightarrow 4x^2+16y^2-8xy=12$

$\Rightarrow x^2+4y^2-2xy=3$

10. If the curve $x^2=4y$ intersects the line $y=2(x+6)$ at (a,b) in 2nd quadrant, then $\int_a^b\frac{x^4}{1+5^x}dx$ is

(1) $\frac{512}{5}$ (2) $\frac{1024}{5}$

(3) $\frac{32}{5}$ (4) $\frac{16}{5}$

Ans. **(2)**

Sol. $x^2=4y$ $\quad y=2(x+6)$

$x^2=4(2(x+6))$

$\Rightarrow x^2-8x-48=0$

$\Rightarrow x^2-12x+4x-48=0$

$\Rightarrow x=-4\ ;\ x=12$

So, $x=-4$ as it is second quadrant

$y=\frac{x^2}{4}=4$

So, $(a,b)=(-4,4)$

$I=\int_{-4}^{4}\frac{x^4}{1+5^x}dx$

By king

$I=\int_{-4}^{4}\frac{x^4}{1+5^{-x}}dx$

$I=\int_{-4}^{4}\frac{x^4.5^x}{1+5^x}dx$

$2I=\int_{-4}^{4}x^4\left(\frac{1+5^x}{1+5^x}\right)dx=2\int_0^4x^4dx$

$I=\frac{x^5}{5}\Big|_0^4=\frac{1024}{5}$

11. Let f: $[1,\infty)\to[2,\infty)$ be a differentiable function. If $10\int_1^x f(t)dt=5xf(x)-x^5-9$ for all $x\geq 1$, then the value of $f(3)$ is

(1) 18 (2) 22

(3) 32 (4) 26

Ans. **(3)**

Sol. $10\int_1^x f(t)dt=5xf(x)-x^5-9$

$\Rightarrow 10f(x)=5f(x)+5xf'(x)-5x^4$

$\Rightarrow f(x)=xf'(x)-x^4$

$\frac{dy}{dx}-\frac{1}{x}y=x^3$

I.F. $=e^{\int\frac{-1}{x}dx}=\frac{1}{x}$

$y.\frac{1}{x}=\int x^3.\frac{1}{x}dx+c$

$\Rightarrow\frac{y}{x}=\frac{x^3}{3}+c$

Since f(1) = 2 $\Rightarrow$ c = $\frac{5}{3}$

So now we have to find f(3) or y(3)

So, $\frac{y(3)}{3} = \frac{27}{3} + \frac{5}{3}$

$\Rightarrow$ y(3) = 32

12. $4\int_0^1 \frac{1}{\sqrt{3+x^2}+\sqrt{1+x^2}}\,dx - 3\ell n\sqrt{3}$ is equal to

(1) $3-\sqrt{2}+\ell n\left(\sqrt{2}+1\right)$

(2) $2+\sqrt{2}-\ell n\left(\sqrt{3}+1\right)$

(3) $2-\sqrt{2}-\ell n\left(\sqrt{2}+1\right)$

(4) $2-\sqrt{3}-\ell n\left(\sqrt{3}+1\right)$

Ans. (3)

Sol. $4\left[\int_0^1 \frac{\left(\sqrt{3+x^2}-\sqrt{1+x^2}\right)}{2}dx\right] - 3\ell n\sqrt{3}$

$\Rightarrow 2\left[\left(\frac{x}{2}\sqrt{3+x^2}+\frac{3}{2}\ell n\left|x+\sqrt{3+x^2}\right|\right)-\left(\frac{x}{2}\sqrt{1+x^2}+\frac{1}{2}\ell n\left|x+\sqrt{1+x^2}\right|\right)\right]_0^1 - 3\ell n\sqrt{3}$

$\Rightarrow 2\left[\left\{\frac{1}{2}\times 2+\frac{3}{2}\ell n|3|-\frac{1}{2}\times\sqrt{2}-\frac{1}{2}\ell n\left(1+\sqrt{2}\right)\right\}-\left\{\frac{3}{2}\ell n\sqrt{3}\right\}\right]-3\ell n\sqrt{3}$

$\Rightarrow 2+3\ell n3-\sqrt{2}-\ell n\left(1+\sqrt{2}\right)-3\ell n\sqrt{3}-3\ell n\sqrt{3}$

$\Rightarrow 2-\sqrt{2}-\ell n\left(\sqrt{2}+1\right)$

13. The image of the point (1,0,3) in the line joining the points A (4,7,1) and $B(3,5,3)$ is $Q(\alpha, \beta, \gamma)$, then $\alpha+\beta+\gamma$ is equal to

(1) 13 (2) $\frac{47}{3}$

(3) 18 (4) $\frac{46}{3}$

Ans. **(4)**

Sol. $\frac{x-4}{1} = \frac{y-7}{2} = \frac{z-1}{-2} = \lambda$

$(\lambda+3)(1)+(2\lambda+7)2+(-2-2\lambda)(-2)=0$

$\lambda+3+4\lambda+14+4+4\lambda=0$

$\Rightarrow \lambda = -\frac{21}{9}$

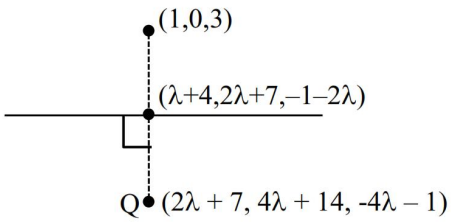
Now, coordinates of Q will be

(2λ + 7, 4λ + 14, -4λ – 1)

α + β + γ = 2λ + 20

$= 2\left(\frac{-21}{9}\right)+20$

$= \frac{46}{3}$



14. If the system of equations

$2x+\lambda y+3z=5$

$3x+2y-z=7$

$4x+5y+\mu z=9$

has infinitely many solutions, then $(\lambda^2+\mu^2)$ is equal to

(1) 22 (2) 18

(3) 26 (4) 30

Ans. **(3)**

Sol. $D_2 = \begin{vmatrix} 2 & 5 & 3 \\ 3 & 7 & -1 \\ 4 & 9 & \mu \end{vmatrix} = 0$

$\Rightarrow 2(7\mu+9)-5(3\mu+4)+3(27-28)$

$\Rightarrow 14\mu+18-15\mu-20-3=0$

$\Rightarrow \mu = 5$

$D_3 = \begin{vmatrix} 2 & \lambda & 5 \\ 3 & 2 & 7 \\ 4 & 5 & 9 \end{vmatrix} = 0$

$\Rightarrow 2(18-35)-\lambda(27-28)+5(15-8)=0$

$\Rightarrow -34+\lambda+35=0$

$\Rightarrow \lambda = -1$

So, $\lambda^2+\mu^2 = 1+25 = 26$

15. If the sum of the series

$\frac{1}{1+4\cdot 1^4}+\frac{2}{1+4\cdot 2^4}+\frac{3}{1+4\cdot 3^4}+\cdots+\frac{10}{1+4\cdot 10^4}$

is $\frac{m}{n}$, where m and n are natural coprime umbers, then $(m+n)$ is equal to

(1)289 (2) 276

(3) 225 (4) 389

Ans. **(2)**

Sol. $T_r = \dfrac{r}{1+4\cdot r^4} = \dfrac{\frac{r}{4}}{\frac{1}{4}+r^4} = \dfrac{1}{4}\dfrac{r}{\left(r^2+\frac{1}{2}-r\right)\left(r^2+\frac{1}{2}+r\right)}$

$$T_r = \frac{1}{8}\frac{2r}{\left(r^2+\frac{1}{2}+r\right)\left(r^2+\frac{1}{2}-r\right)}$$

$$\Rightarrow T_r = \frac{1}{8}\left[\frac{1}{r^2+\frac{1}{2}-r} - \frac{1}{r^2+\frac{1}{2}+r}\right]$$

$$S = \frac{1}{8}\left[\frac{1}{1^2+\frac{1}{2}-1} - \frac{1}{10^2+\frac{1}{2}+10}\right]$$

$$= \frac{1}{4} - \frac{1}{884} = \frac{220}{884} = \frac{55}{221}$$

M + n = 276.

16. A bag is randomly selected and a ball is drawn. If drawn ball is red, then probability that ball is selected from bag I is p. If ball drawn is green then probability that ball is selected from bag III is q. Then $\frac{1}{p}+\frac{1}{q}$ equals to

	Red	**Blue**	**Green**
Bag-I	3	3	4
Bag-II	4	3	3
Bag-III	5	2	3

Sol. $p = \dfrac{\frac{1}{3}\times\frac{3}{10}}{\frac{1}{3}\left(\frac{3}{10}+\frac{4}{10}+\frac{5}{10}\right)} = \frac{3}{12} = \frac{1}{4}$

$$q = \frac{\frac{1}{3}\times\frac{3}{10}}{\frac{1}{3}\left(\frac{4}{10}+\frac{3}{10}+\frac{3}{10}\right)} = \frac{3}{10}$$

$$\frac{1}{p}+\frac{1}{q} = 4+\frac{10}{3} = \frac{22}{3}$$

17. Let the point P of the focal chord PQ of the parabola $y^2 = 16x$ be (1,-4). If the focus of the parabola divides the chord PQ in the ratio $m:n$, $\gcd(m,n)=1$, then m^2+n^2 is equal to

(1) 17 (2) 10

(3) 37 (4) 4 26

Ans. **(1)**

Sol. $P\ at^2, 2at \Rightarrow P\ 4t^2, 8t = (1,-4)$

$$\Rightarrow t = \frac{-1}{2};\ Q\left(\frac{a}{t^2}, \frac{-2a}{t}\right)$$

S(4, 0) is the focus

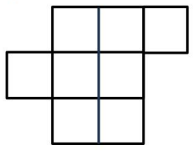
& PS = a + at²

$$QS = a + \frac{a}{t^2}$$

$$\frac{PS}{QS} = t^2 = \frac{4}{1} = \frac{m^2}{n^2}$$

$m^2 + n^2 = 17$

18. The no. of ways, in which the letters, A,B,C,D,E can be placed in the 8 boxes of the figure below, so that no row remains empty and at most one letter can be placed in a box is :

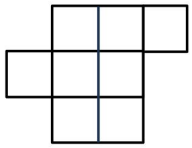


(1) 960 (2) 5880

(3) 5760 (4) 840

Ans. **(3)**

Sol.



A, B, C, D, E 5 objects can be occupy row-wise as follows

R_1	3	1	2	2	1
R_2	1	3	2	1	2
R_3	1	1	1	2	2

So, solution is

$$\left(\left({}^3C_3\ {}^3C_1\ {}^2C_1 + {}^3C_1\ {}^3C_3\ {}^2C_1\right) + \left({}^3C_2 {}^3C_2 {}^2C_1 + {}^3C_2\ {}^3C_1\ {}^3C_2 + {}^3C_1\ {}^3C_2\ {}^2C_2\right)\right)\times 5!$$

$$= \left((12) + (18+9+9)\right)\times 5!$$

$$= (12 + 36) \times 120$$

$$= 48 \times 120 = 5760$$