

JEE (Main)-2026

Session-1

21 January 2026 Shift-1

Memory-Based Answers & Solutions (Physics, Chemistry, and Mathematics)

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.

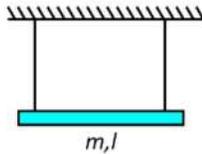
PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

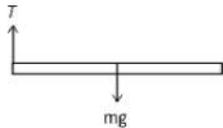
1. A rod of mass m and length l is attached to two ideal strings. Find tension in left string just after right string is cut.



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

Answer (2)

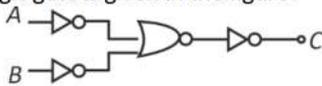
Sol. $\alpha = \frac{mg \frac{l}{2}}{ml^2} = \frac{3g}{2l}$



$$a_{\text{com}} = \frac{3g}{4}$$

$$T = \frac{mg}{4}$$

2. Which logic gate is given in the figure?



- (1) XOR (2) NOR
 (3) NAND (4) OR

Answer (3)

Sol. $\overline{\overline{A+B}} = \overline{AB}$

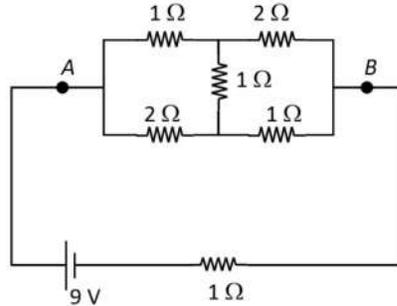
3. Find dimensions of $\frac{A}{B}$ if $\left(P + \frac{At^2}{B}\right) + \frac{1}{2}\rho V^2 = \text{constant}$ where $P \rightarrow$ pressure, $\rho \rightarrow$ density, $V \rightarrow$ speed.

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

Answer (2)

Sol. $\left[\frac{At^2}{B}\right] = [P] = ML^{-1}T^{-2}$
 $\left[\frac{A}{B}\right] = ML^{-1}T^{-4}$

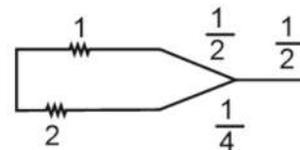
4. Find the heat produced in external circuit (AB) in one minute.



- (1) 1181.25 J (2) 1311.25 J
 (3) 1207.50 J (4) 1410.50 J

Answer (1)

Sol. You can use Kirchoff's law or star-delta



$$R_{AB} = \frac{\frac{3}{2} \times \frac{9}{4}}{\frac{3}{2} + \frac{9}{4}} + \frac{1}{2} = 1.4 \Omega ; P = i^2 R$$

5. An α -particle having kinetic energy 7.7 MeV is approaching fixed gold nucleus (atomic number is 79).

Find distance of closest approach.

- (1) 1.72 nm (2) 6.2 nm
 (3) 16.8 nm (4) 0.2 nm

Answer (1)

Sol. ${}^4_2\text{He} \xrightarrow{v} \dots\dots v + 79e$

$$\frac{1}{2}mv^2 = \frac{K(2e)(79e)}{r^2}$$

$$7.7 \times 10^6 \times 1.6 \times 10^{-19} \text{ J} = \frac{9 \times 10^9 \times 158 \times (1.6 \times 10^{-19})^2}{r^2}$$

$$r^2 = \frac{2275.2 \times 10^{-10}}{7.7 \times 10^6}$$

$$r = 17.2 \times 10^{-8}$$

$$r = 17 \text{ nm}$$

$$296 \times 10^{-16}$$

6. An air filled capacitor of capacitance C is filled with dielectric ($k = 3$) of width $d/3$, where d is separation between plates. The new capacitance is

- (1) $\frac{9}{5}C$ (2) $\frac{5}{4}C$
 (3) $\frac{4}{3}C$ (4) $\frac{9}{7}C$

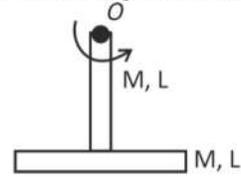
Answer (4)

Sol. $C = \frac{\epsilon_0 A}{\frac{d_1}{k_1} + \frac{d_2}{k_2}}$

$$\frac{\epsilon_0 A}{\frac{d}{3 \times 3} + \frac{2d}{3}}$$

$$= \frac{9\epsilon_0 A}{d + 6d} = \frac{9\epsilon_0 A}{7d}$$

7. Find the moment of inertia of system formed using two identical rods about the given axis of rotation as shown



- (1) $\frac{17}{12}ML^2$ (2) $\frac{13}{12}ML^2$
 (3) $\frac{2}{3}ML^2$ (4) $\frac{3}{4}ML^2$

Answer (1)

Sol. For vertical rod about O $I_{10} = \frac{ML^2}{3}$

For horizontal rod about O $I_{20} = \frac{ML^2}{12} + ML^2 = \frac{13}{12}ML^2$

$$I_{O_{\text{sys}}} = I_{10} + I_{20} = \frac{17}{12}ML^2$$

8. If electric field of EM wave is given by $60[\sin(3 \times 10^{14}t) + \sin(12 \times 10^{14}t)]$ at $x = 0$ falls on a photo sensitive material having work function 2.8 eV. Find the maximum kinetic energy (M eV) of ejected electrons.

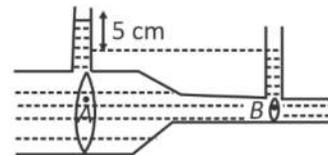
- (1) 2.52 eV (2) 2.16 eV
 (3) 2.00 eV (4) 2.34 eV

Answer (2)

Sol. $\frac{h\nu}{c} = 4.963 \text{ eV}$

$$KE_{\text{max}} = 4.963 - 2.8 = 2.163 \text{ eV}$$

9. Find volume flow rate in the venturi meter given below in which water is flowing.



[cross section area at A & B is A & a , $\frac{A}{a} = 2$. $4A = \sqrt{3}$ m^2 . $P = 1000 \text{ kg/m}^3$.]

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

Answer (1)

Sol. $P_A + \frac{1}{2} \rho V_A^2 = P_B + \frac{1}{2} \rho V_B^2$

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

$$\Rightarrow V_B^2 - V_A^2 = 1$$

and $AV_A = aV_B$

$$\Rightarrow 3V_A^2 = 1 \Rightarrow V_A = \frac{1}{\sqrt{3}}$$

10. An ideal solenoid is kept with its axis vertical. Current I_0 is flowing in the solenoid. A charge Q is thrown downward inside the solenoid its acceleration of the charge particle is a then

- (1) $a > g$ (2) $a = g$
 (3) $a < g$ (4) $a = 0$

Answer (2)

Sol. $\vec{V} \parallel \vec{B} \Rightarrow F_m = 0$

$$a = g$$

11. Wave propagates whose electric field is given by $\vec{E} = 69 \sin(\omega t - kx) \hat{j}$ find the direction of magnetic field

- (1) \hat{k} (2) $-\hat{k}$
 (3) $\frac{\hat{i} + \hat{j}}{\sqrt{2}}$ (4) $\frac{\hat{i} - \hat{j}}{\sqrt{2}}$

Answer (1)

Sol. $\hat{E} \Rightarrow \hat{j}, \hat{C} \Rightarrow \hat{i}$

$$\vec{E} \times \vec{B} = \vec{C}$$

$$B = \hat{k}$$

12. Two rods of equal length of 60 cm each are joined together end to end. Coefficient of linear expansions of the rods are $24 \times 10^{-6} \text{ C}^{-1}$ and $1.2 \times 10^{-5} \text{ C}^{-1}$. Their temperatures are same and equal to 30°C which is increased to 100°C . Find final length of the combination (in cm).

- (1) 120.1321 (2) 120.1123
 (3) 120.1512 (4) 120.1084

Answer (3)

Sol. $\Delta l_1 + \Delta l_2 = 60 (3.6 \times 10^{-5} \times 70)$

$$\Rightarrow 15.12 \times 10^{-2} \text{ cm} = 0.1512 \text{ cm}$$

$$l_f = 120 + 0.1512 = 120.1512 \text{ cm}$$

13. Find change in internal energy of gas if its temperature changes by 10K. Number of moles of gas is 10, C_P (specific heat at constant pressure of the gas is 7 cal/K-mol) and R (gas constant) = 2 cal/K.

- (1) 500 cal (2) 1000 cal
 (3) 250 cal (4) 100 cal

Answer (1)

Sol. $C_P - C_V = R = 2$

$$C_V = 5$$

$$\Delta V = nC_V \Delta T = 10 \times 5 \times 10 = 500 \text{ cal}$$

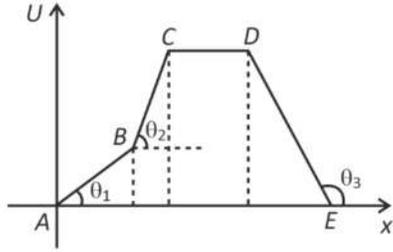
14. Two mechanical wave on strings of equal length (L) tension (T) having linear mass density $\frac{\mu_1}{\mu_2} = \frac{1}{2}$. Find the ratio of time taken for a wave pulse to travel from one end to the other in both strings. (ignore gravity)

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

Answer (2)

Sol. $C = \sqrt{\frac{T}{\mu}}$ and $t = \frac{L}{C}$ $t \propto \sqrt{\mu} \Rightarrow \frac{t_1}{t_2} = \sqrt{\frac{1}{2}}$

15. A curve is given between potential energy of a particle and its position on x-axis.



Given: $\tan\theta_1 = 1$, $\tan\theta_2 = 3$, $\tan\theta_3 = \frac{-1}{2}$

If F_{AB} be force acting on the particle during A to B similarly F_{BC} , F_{CD} and F_{DE} are the forces during B to C, C to D and D to E respectively. Arrange magnitudes of these forces in decreasing order

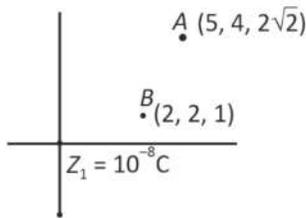
- (1) $F_{BC} > F_{AB} > F_{CD} > F_{DE}$ (2) $F_{BC} > F_{AB} > F_{DE} > F_{CD}$
 (3) $F_{AB} > F_{BC} > F_{DE} > F_{CD}$ (4) $F_{BC} > F_{DE} > F_{AB} > F_{CD}$

Answer (2)

Sol. $F = -\frac{dU}{dx}$

\therefore Higher the slope greater the force.

16. Find out work done in moving a $2\mu\text{C}$. Choose from A to B.



- (1) $6\ \mu\text{J}$ (2) $120\ \text{mJ}$
 (3) $34.3\ \mu\text{J}$ (4) $24.2\ \mu\text{J}$

Answer (3)

Sol. $w = U_2 - U_1 = 9 \times 10^9 \times 10^{-8} \times 2 \times 10^{-6} \left(\frac{1}{3} - \frac{1}{7} \right)$
 $= 34.3\ \mu\text{J}$

17.
18.
19.
20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. 21. A satellite is revolving around a planet in orbit radius of $1.5R$. Additional minimum energy required to transfer the satellite to new orbit radius of $3R$ is (m and M are mass of satellite & planet) $\frac{GMm}{\lambda R}$ then X is

Answer (6)

Sol. $M.E = \frac{-GMm}{2a}$

$W = \Delta M = M_f - M_i$

$= \frac{-GMm}{2(3R)} - \left(-\frac{GMm}{2(1.5R)} \right)$

$= +\frac{GMm}{R} \left\{ -\frac{1}{6} + \frac{1}{3} \right\}$

$= \frac{GMm}{6R}$

22. There are two springs of spring constants $k_1 = (20 \pm 0.2)$ N/m and $k_2 = (30 \pm 0.3)$ N/m. If they are connected in parallel then percentage error in equivalent spring constant of combination is ____%.

Answer (1)

Sol. $\Delta k = \Delta k_1 + \Delta k_2 = 0.5$

$K_{eq} = 50\ \text{N/m}$

$\% \text{ error} = \frac{0.5}{50} \times 100 = 1$

23. In a YDSE set up, a slab of width t is inserted in front of one of slit. The interference pattern shifts by 0.2 cm on the screen. If the refractive index of slab is 1.5 than t is $N \mu\text{m}$ (screen distance 50 cm and slits separation 1 mm) then N is _____

Answer (8)

Sol. Path difference by shift is neutralised from path

$$\text{difference by slab } \frac{dy}{D} = (\mu - 1)t$$

$$\frac{10^{-3}}{0.5} \times 0.2 \times 10^{-2} = \frac{1}{2} \times t$$

$$10^{-3} \times \frac{2}{5} \times 2 \times 10^{-2} = t$$

$$10^{-5} \times \frac{4}{5} = t$$

$$0.8 \times 10^{-5} = 8 \mu\text{m} = t$$

24. A particle of mass 1 kg, initially resting at origin, starts moving under the influence of a force $\vec{F} = 4t^3\hat{i} - 3t^2\hat{j}$. If the speed of the particle at $t = 1$ is $\sqrt{\alpha}$, then value of α is

Answer (2)

$$\text{Sol. } v_x = 4t^3 = \frac{dv_x}{dt}$$

$$v_x = 1 \text{ m/s}$$

$$v_y = -3t^2$$

$$v_y = 1 \text{ m/s}$$

$$v = \sqrt{2} \text{ m/s}$$

25. Focal length of objective lens and eyepiece lens are 1.25 cm and 5 cm and tube length is 26 cm. Find magnification of compound microscope in normal adjustment.

Answer (104)

$$\text{Sol. } M = \frac{L}{f_0} \cdot \frac{D}{f_e}$$

$$= \frac{26}{1.25} \times \frac{25}{5}$$

$$M = 104$$

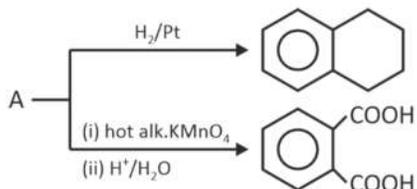
CHEMISTRY

SECTION - A

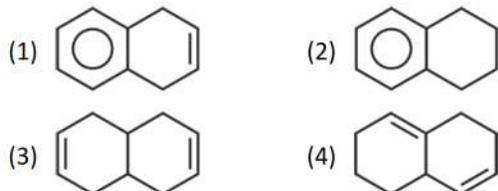
Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

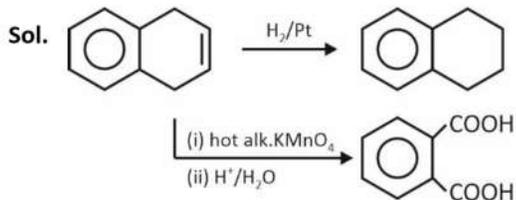
1. Consider the following reaction :



Then 'A' will be



Answer (1)



2. In Sulphur estimation, 0.7 g of an organic compound gives 1 g of $BaSO_4$ by Carius method. What is the % of 'S' in compound?

- (1) 19.61
- (2) 23.85
- (3) 27.93
- (4) 14.57

Answer (1)

Sol. % of S = $\frac{1}{0.7} \times 32 \times 100 = 19.61\%$

3. Which of the following is the correct order with respect to the property indicated?

- (1) $Cl > F$ (Ionisation energy)
- (2) $K_2O > Na_2O > Al_2O_3$ (Basic nature)
- (3) $K > Na > Al > Mg$ (Metallic character)
- (4) None of these

Answer (2)

Sol. $F > Cl$: First ionisation energy (due to small size of F)

$K > Na > Mg > Al$: Metallic character (It decreases from Left to Right across the period and increases from Top to Bottom.

4. Given below are two statements.

Statement I : Arginine and Tryptophan are essential amino acids.

Statement II : Glycine does not have any chiral carbon.

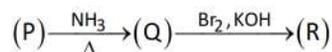
In the light of the above statements, which is the correct option.

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

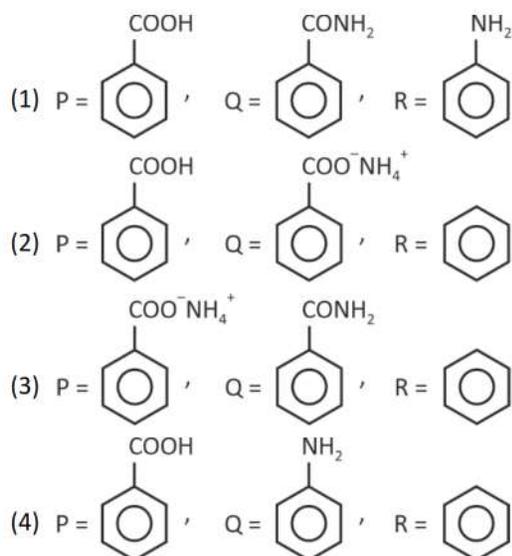
Answer (1)

Sol. Arginine and Tryptophan both are essential amino acids. Glycine does not contain any chiral centre.

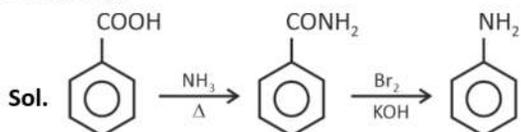
5. Observe the following reaction sequence:



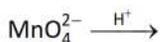
Which of the following is the correct structure for P, Q and R?



Answer (1)



6. In the following reaction,



Manganate ion undergoes disproportionation in acidic medium to form

- (1) $\text{MnO}_2, \text{MnO}_4^-$ (2) MnO, MnO_2
 (3) $\text{MnO}_2, \text{Mn}_2\text{O}_3$ (4) $\text{MnO}_4^-, \text{MnO}$

Answer (1)

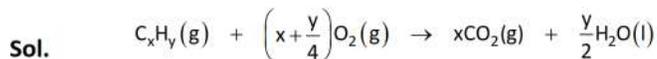
Sol. MnO_4^{2-} disproportionates in acidic solution to gives MnO_4^- and MnO_2



7. 80 mL of an organic compound is mixed with 264 mL O_2 and ignited. It gives 224 mL of gaseous mixture at NTP. After passing through KOH 64 mL of gas remains. The organic compound is

- (1) C_2H_4 (2) C_2H_2
 (3) C_4H_{10} (4) C_3H_6

Answer (2)



$$t=0 \quad 80 \text{ mL} \quad 264 \text{ mL}$$

$$(V_{\text{CO}_2} + V_{\text{O}_2})_{\text{after reaction}} = 224 \text{ mL}$$

After passing through KOH, 64 mL gas left

$$(V_{\text{O}_2})_{\text{left}} = 64 \text{ mL}$$

$$(V_{\text{O}_2})_{\text{used}} = 200 \text{ mL}$$

$$(V_{\text{CO}_2})_{\text{formed}} = 224 - 64 = 160 \text{ mL}$$

$$1 \text{ mL } \text{C}_x\text{H}_y \rightarrow x \text{ mL } \text{CO}_2$$

$$80 \text{ mL} \rightarrow 160 \text{ mL } \text{CO}_2$$

$$\boxed{x=2}$$

$$\frac{V_{\text{C}_x\text{H}_y}}{1} = \frac{(V_{\text{O}_2})_{\text{used}}}{x + \frac{y}{4}}$$

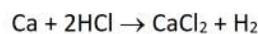
$$80 = \frac{200}{\left(2 + \frac{y}{4}\right)}$$

$$160 + 20y = 200$$

$$20y = 40$$

$$\boxed{y=2} \text{ formula } \text{C}_2\text{H}_2$$

8. Consider the following reaction



We have 14 g Ca reacts with excess of HCl. Choose the incorrect option.

- (1) Mass of CaCl_2 produced is 38.85 g
 (2) Mole of H_2 produced is 0.35 mol
 (3) Volume of H_2 produced at STP is 7.84 L
 (4) Mass of CaCl_2 produced is 3.885 g

Answer (4)



$$\frac{14}{40} = 0.35 \text{ mol}$$

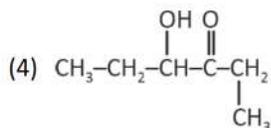
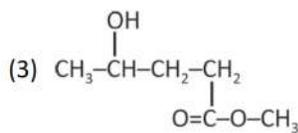
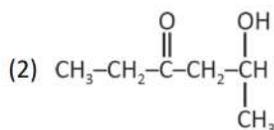
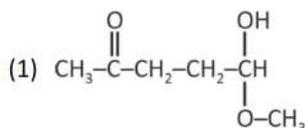
$$n_{\text{CaCl}_2} = 0.35$$

$$W_{\text{CaCl}_2} = 38.85 \text{ g}$$

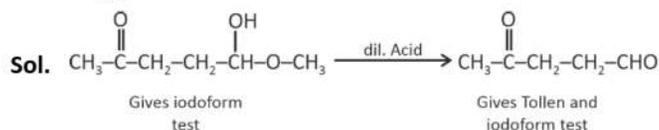
$$n_{\text{H}_2} = 0.35$$

$$V_{\text{H}_2} \text{ at STP} = 0.35 \times 22.4 = 7.84 \text{ L}$$

9. $\text{C}_6\text{H}_{12}\text{O}_3$ gives positive iodoform test on hydrolysis with dil. Acid. The hydrolysis product formed gives Tollens' and iodoform test both. Find structure of $\text{C}_6\text{H}_{12}\text{O}_3$.



Answer (1)



10. Given below are two statements :

Statement I : All the pairs of molecules (PbO , PbO_2); (SnO , SnO_2) and (GeO , GeO_2) contain amphoteric oxides.

Statement II : AlCl_3 , BH_3 , BeH_2 and NO_2 all have incomplete octet.

In the light of the above statements, choose the correct option.

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

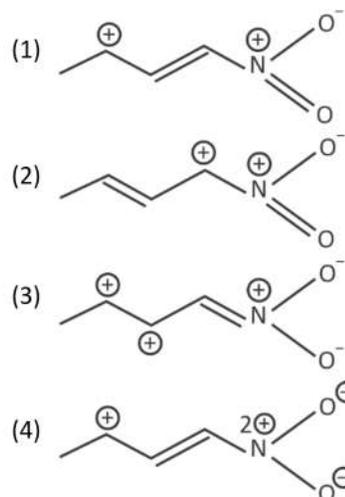
Answer (4)

Sol. • SnO , SnO_2 , PbO , PbO_2 are amphoteric oxides.

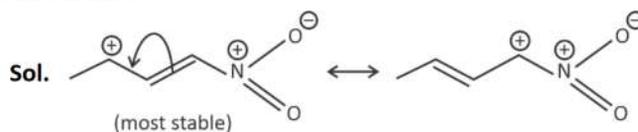
• GeO_2 is acidic.

• GeO is distinctly acidic.

11. Which of the following resonating structure is the most stable?

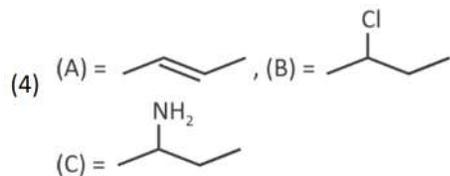
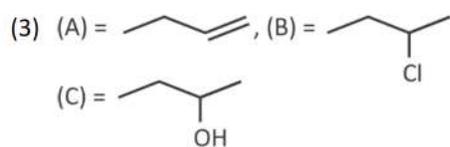


Answer (1)



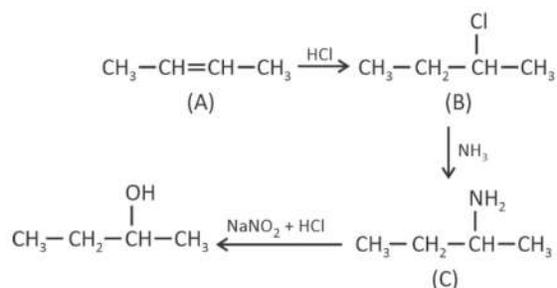
12. Consider the following statements.

- (A) Propanal and Propanone are functional isomers
- (B) Ethoxyethane and methoxypropane are metamers
- (C) But-2-ene shows optical isomerism
- (D) But-1-ene and But-2-ene are functional isomers
- (E) Pentane and 2, 2-dimethylpropane are chain isomers



Answer (4)

Sol.



16.
17.
18.
19.
20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. For two chemical reactions A and B, if the difference between their activation energy is 20 kJ at 300 K ($R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$). Determine $\ln \frac{K_2}{K_1}$.

Answer (8)

Sol. For reaction A,

$$k_1 = A e^{-\frac{E_{a1}}{RT}}$$

For reaction B,

$$k_2 = A e^{-\frac{E_{a2}}{RT}}$$

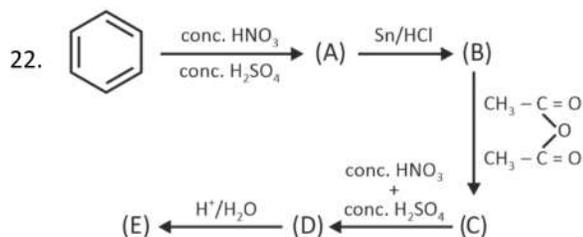
$$\frac{k_2}{k_1} = \frac{e^{-\frac{E_{a2}}{RT}}}{e^{-\frac{E_{a1}}{RT}}}$$

$$\frac{k_2}{k_1} = e^{-\frac{E_{a2} + E_{a1}}{RT}}$$

$$\ln \frac{k_2}{k_1} = \frac{-E_{a2} + E_{a1}}{RT}$$

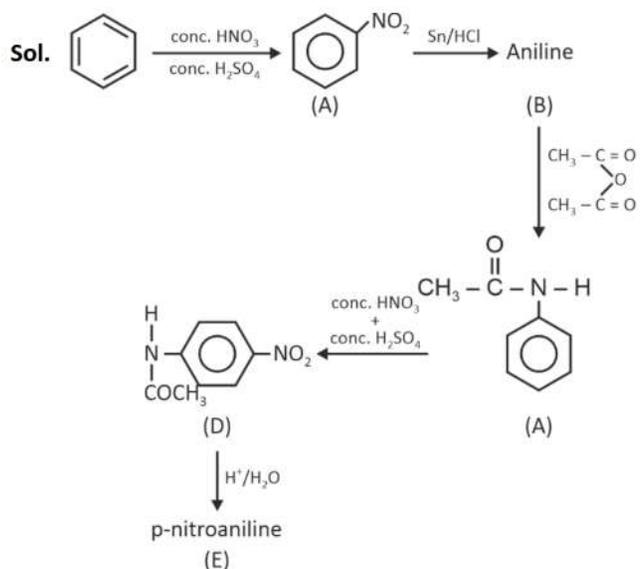
$$\ln \frac{k_2}{k_1} = \frac{20000}{8.3 \times 300}$$

$$\ln \frac{k_2}{k_1} \approx 8$$



% of N in compound E is _____

Answer (20)



$$\% \text{ of N} = \frac{14 \times 2 \times 100}{138} = 20.28 \approx 20$$

23. 1 g of AB_2 is dissolved in 50 g solvent such that $\Delta T_f = 0.689$. When 1 g AB is dissolved in 50 g of same solvent, ΔT_f is 1.176. Find molar mass of AB_2 . $K_f = 5 \text{ K kg/mol}$.

AB_2 and AB are non electrolyte. (Report to nearest integer)

Answer (145 g)

Sol. Let 'a' and 'b' are atomic weight of 'A' and 'B' respectively

$$0.689 = 5 \left[\frac{1}{a+2b} \times \frac{1000}{50} \right] \quad \dots(1)$$

$$1.176 = 5 \left[\frac{1}{a+b} \times \frac{1000}{50} \right] \quad \dots(2)$$

$$\frac{0.689}{1.176} = \frac{a+b}{a+2b} = \frac{1}{1.7}$$

$$\Rightarrow 1.7a + 1.7b = a + 2b$$

$$0.7a = 0.3b$$

$$b = \frac{7}{3}a$$

$$\text{Now, } 1.176 = \left[\frac{1}{a + \frac{7}{3}a} \times 20 \right] \times 5 = \frac{300}{10a}$$

$$\Rightarrow a = \frac{30}{1.176} = 25.51$$

$$b = \frac{7}{3}a = 59.52 \text{ g}$$

$$M_{AB_2} = 25.51 + 2 \times 59.52 = 144.55 \text{ g}$$

24. Out of the following, how many compounds have tetrahedral geometry?

NH_4^+ , XeF_4 , $[NiCl_4]^{2-}$, $[PtCl_4]^{2-}$, $[Cu(NH_3)_4]^{2+}$, BF_3 and $[Ni(CO)_4]$

Answer (3)

Sol.

Species		Geometry
NH_4^+	\Rightarrow	Tetrahedral
XeF_4	\Rightarrow	Octahedral
$[NiCl_4]^{2-}$	\Rightarrow	Tetrahedral
$[PtCl_4]^{2-}$	\Rightarrow	Square planar
$[Cu(NH_3)_4]^{2+}$	\Rightarrow	Square planar
BF_3	\Rightarrow	Triangular Planar
$[Ni(CO)_4]$	\Rightarrow	Tetrahedral

25.

$$\int dy + \int \frac{dx}{1+x^2} - \int \frac{\tan^{-1}x}{1+x^2} dx = 0$$

Or $y + \tan^{-1}x - I = 0$, where

$$I = \int \frac{\tan^{-1}x}{1+x^2} dx$$

Let $\tan^{-1}x = t$

$$\frac{1}{1+x^2} dx = dt$$

$$\int t ds \Rightarrow \frac{t^2}{2} = \frac{(\tan^{-1}x)^2}{2}$$

$$\Rightarrow y + \tan^{-1}x - \frac{(\tan^{-1}x)^2}{2} + c = 0$$

$$\therefore y(0) = 1 \quad 1 + c = 0 \Rightarrow c = -1$$

$$\Rightarrow y = \frac{(\tan^{-1}x)^2}{2} - \tan^{-1}x + 1$$

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

4. The value of

$$\int_0^{\pi/2} |\sin x + \sin 2x + \sin 3x| dx \text{ is}$$

(1) $\frac{8}{3}$

(2) $\frac{7}{3}$

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

(4) 3

Answer (2)

Sol. $\therefore \sin x + \sin 3x = \sin(2x - x) + \sin(2x + x)$

$$= 2\sin 2x \cos x$$

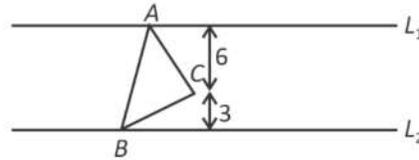
$$\therefore \sin 3x + \sin 2x + \sin x = \sin 2x (2\cos x + 1)$$

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

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

$$= \frac{-\cos 2x}{2} \Big|_0^{\pi/2} + \left(\frac{-4}{3} (\cos^3 x) \right) \Big|_0^{\pi/2} = \frac{7}{3}$$

5. If L_1 and L_2 are two parallel lines and $\triangle ABC$ is an equilateral triangle then area of triangle ABC is



(1) $7\sqrt{3}$

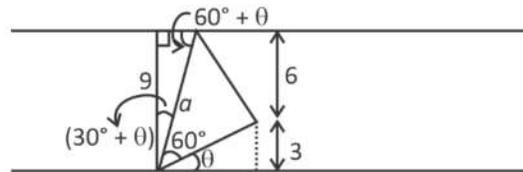
(2) $4\sqrt{3}$

(3) $21\sqrt{3}$

(4) 84

Answer (3)

Sol. Let a be the side of $\triangle ABC$



$$\sin \theta = \frac{3}{a}$$

$$\sin(60^\circ + \theta) = \frac{9}{a}$$

$$\Rightarrow \frac{\sqrt{3}}{2} \times \sqrt{1 - \frac{9}{a^2}} + \frac{3}{a} \times \frac{1}{2} = \frac{9}{a}$$

$$\Rightarrow \sqrt{3}(\sqrt{a^2 - 9}) + 3 = 18$$

$$\Rightarrow 3(a^2 - 9) = 15^2$$

$$\Rightarrow a^2 - 9 = 15 \times 5$$

$$\Rightarrow a^2 = 84$$

$$\text{Area} = \frac{\sqrt{3}}{4} a^2 = 21\sqrt{3}$$

6. Consider a set $S = \{a, b, c, d\}$. Then number of reflexive as well as symmetric relations from $S \rightarrow S$ are

- (1) 1024 (2) 256
 (3) 16 (4) 64

Answer (4)

Sol. Number of such relations:

From $A \rightarrow A$ such that

$n(A) = N$ is

$$\Rightarrow 2^{\binom{N^2 - N}{2}}$$

for $N = 4 \Rightarrow 2^6 = 64$

Alter :

$$\begin{bmatrix} \Theta & - & - & - \\ \Theta & \Theta & - & - \\ \Theta & \Theta & \Theta & - \\ \Theta & \Theta & \Theta & \Theta \end{bmatrix} \Rightarrow \text{each } \Theta \text{ has two choices}$$

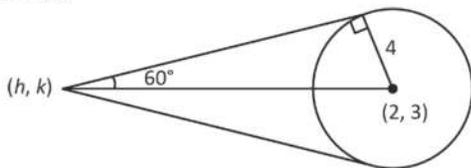
$\Rightarrow 2^6 = 64$

7. The locus of point of intersection of tangent drawn to the circle $(x - 2)^2 + (y - 3)^2 = 16$, which sub-tends an angle of 120° is

- (1) $3x^2 + 3y^2 - 12x - 18y - 25 = 0$
 (2) $x^2 + y^2 - 12x - 18y - 25 = 0$
 (3) $3x^2 + 3y^2 + 12x + 18y - 25 = 0$
 (4) $x^2 + y^2 + 12x + 18y - 25 = 0$

Answer (1)

Sol.



$$x^2 + y^2 - 14x - 6y - 3 = 0$$

$$\tan 60^\circ = \frac{4}{\sqrt{h^2 + k^2 - 4h - 6k - 3}}$$

squaring both side

$$3(h^2 + k^2 - 4h - 6k - 3) = 16$$

To get locus replace h, k by x and y ;

$$3x^2 + 3y^2 - 12x - 18y - 9 - 16 = 0$$

$$3x^2 + 3y^2 - 12x - 18y - 25 = 0$$

8. If a_1, a_2, a_3, \dots are the terms of an increasing geometric progression such that

$$a_1 + a_3 + a_5 = 21,$$

$$a_1 a_3 a_5 = 64$$

then $a_1 + a_2 + a_3$ is

- (1) 5 (2) 7
 (3) 10 (4) 15

Answer (2)

Sol. Let $a_3 = P, a_1 = \frac{P}{r^2}, a_5 = Pr^2$

$$\Rightarrow P + \frac{P}{r^2} + Pr^2 = 21$$

$$\text{and } P \times \frac{P}{r^2} \times Pr^2 = 64 \Rightarrow P^3 = 64 = 4^3$$

$$\Rightarrow P = 4$$

$$\Rightarrow 1 + \frac{1}{r^2} + r^2 = \frac{21}{4} \Rightarrow r^4 - \frac{17}{4}r^2 + 1 = 0$$

$$r^2 = \frac{\frac{17}{4} \pm \sqrt{\frac{289}{16} - 4}}{2} = \frac{\frac{17}{4} \pm \frac{15}{4}}{2} = 4, \frac{1}{4}$$

$$\Rightarrow r = \pm 2, \pm \frac{1}{2}$$

$$\Rightarrow a_1 + a_2 + a_3 = \frac{P}{r^2} + \frac{P}{r} + P$$

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

$$= 1 + 2 + 4 = 7$$

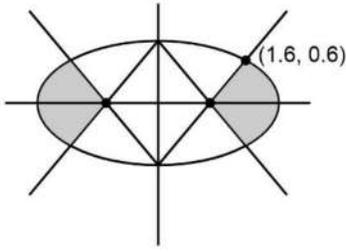
9. Ellipse $E: \frac{x^2}{36} + \frac{y^2}{16} = 1$, A hyperbola confocal with ellipse

E and eccentricity of hyperbola is equal to 5. The length of latus rectum of hyperbola is, if principle axis of hyperbola is x-axis?

- (1) $\frac{96}{\sqrt{5}}$ (2) $24\sqrt{5}$
 (3) $18\sqrt{5}$ (4) $12\sqrt{5}$

Answer (1)

Sol.



$$4 \int_0^{0.6} [\sqrt{4-4y^2} - (1+y)] dy$$

$$I_1 = 4 \int_0^{\frac{3}{5}} \sqrt{4-4y^2} dy, \text{ put } y = \sin\theta, dy = \cos\theta d\theta$$

$$\Rightarrow I_1 = \int_0^{\theta} 2\cos^2 \theta d\theta = \int_0^{\theta} (1 + \cos^2 \theta) d\theta = \left[\theta + \frac{\sin 2\theta}{2} \right]_0^{\theta}$$

$$\therefore \sin = \frac{3}{5}, \cos\theta = \frac{4}{5}, \sin 2\theta = \frac{24}{25}$$

$$\Rightarrow I_1 = \left(\sin^{-1} \frac{3}{5} + \frac{12}{25} \right), I_2 = \int_0^{\frac{3}{5}} (1+y) dy = \frac{39}{50}$$

$$\Rightarrow \text{Area} = 4 \sin^{-1} \left(\frac{3}{5} \right) - \frac{6}{5}$$

18.

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. If $x^2 + x + 1 = 0$, then

$$\left(x + \frac{1}{x} \right)^4 + \left(x^2 + \frac{1}{x^2} \right)^4 + \left(x^3 + \frac{1}{x^3} \right)^4 + \dots + \left(x^{25} + \frac{1}{x^{25}} \right)^4 \text{ is}$$

Answer (145)

Sol. $x^2 + x + 1 = 0 \begin{cases} \leftarrow w \\ \leftarrow w^2 \end{cases}$

$$\left(w + \frac{1}{w} \right)^4 + \left(w^2 + \frac{1}{w^2} \right)^4 + \left(w^3 + \frac{1}{w^3} \right)^4 + \dots$$

$$\left(w^{25} + \frac{1}{w^{25}} \right)^4$$

$$\sum \left(w^k + \frac{1}{w^k} \right)^4$$

$$k = 3x \Rightarrow w^{3x} + \frac{1}{w^{3x}} = 2$$

$$k \neq 3x \Rightarrow w^k + \frac{1}{w^k} = -1$$

$$\sum_{k=1}^{25} \left(w^k + \frac{1}{w^k} \right)^4 \Rightarrow 8(1+1+2^4) + 1$$

$$= 145$$

22. The sum of roots of the equation $|x-1|^2 - 5|x-1| + 6 = 0$ is

Answer (4)

Sol. $|x-1|^2 - 5|x-1| + 6 = 0$

Let $|x-1| = t$

$$t^2 - 5t + 6 = 0$$

$$(t-3)(t-2) = 0$$

$$t = 2, 3$$

$$|x-1| = 2 \text{ or } |x-1| = 3$$

$$x-1 = \pm 2 \text{ or } x-1 = \pm 3$$

$$\Rightarrow x = 3, -1, 4, -2$$

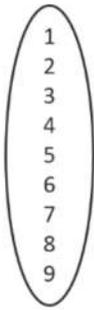
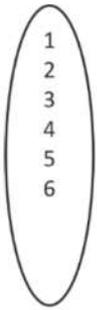
$$\Rightarrow \text{Sum} = 3 - 1 + 4 - 2$$

$$= 4$$

23. If $A = \{1, 2, 3, 4, 5, 6\}$, $B = \{1, 2, 3, \dots, 8, 9\}$. Then the number of strictly increasing functions from $A \rightarrow B$ such that $f(i) \neq i \forall i = 1, 2, 3, 4, 5, 6$ are

Answer (28)

Sol.



Case (i) If $f(1) = 2$ then 7C_5 functions

Case (ii) $f(1) = 3$ then 6C_5

Case (iii) $f(1) = 4$ then 5C_5

$$\Rightarrow 21 + 6 + 1 = 28$$

24.

25.

