JEE (Main)-2026

Session-1

22 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. Two disc having same moment of inertia about their axis. Thickness is t_1 and t_2 and they have same density. If $\frac{R_1}{R_2}=\frac{1}{2}$, then find $\frac{t_1}{t_2}$.

(1) $\frac{1}{16}$ (2) 16

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

Answer (2)

Sol. $\pi R^2 t\rho\frac{R^2}{2}=I$

So $\frac{I_1}{I_2}=\frac{t_1\rho R_1^4}{t_2\rho R_2^4}$

$\Rightarrow \frac{t_1}{t_2}=\left(\frac{R_2}{R_1}\right)^4=16$

2. In series R-L circuit, voltage of battery is 10 V. Resistance & inductance are 10 Ω and 10 mH respectively. Find energy stored in the inductor when current reaches $\frac{1}{e}$ times of maximum value

(1) 0.67 mJ (2) 1.33 mJ

(3) 0.33 mJ (4) 0.50 mJ

Answer (1)

Sol. $\varepsilon=\frac{L}{2}\frac{i_0^2}{e^2}$

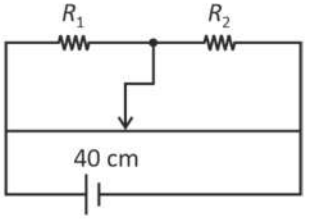
$I_0=\frac{\varepsilon}{R}=1\,A$

$=\frac{1}{2}\times10^{-2}\times\frac{1}{e^2}$

$=10^{-2}\times0.067$

= 0.67 mJ

3. In a potentiometer null point for two resistances R_1 and R_2 is at 40 cm as shown. If 16 Ω is connected in parallel to R_2 then null point is at 50 cm then R_1 and R_2 are respectively



(1) 16 Ω, 48 Ω (2) 32 Ω, $\frac{32}{3}$ Ω

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

Answer (3)

Sol. $\frac{R_1}{R_2}=\frac{40}{60}=\frac{2}{3}$

$3R_1 = 2R_2$

$\frac{R_1(R_2+16)}{16R_2}=\frac{1}{1}$

$R_1=\frac{R_2 16}{R_2+16}=\frac{2R_2}{3}$

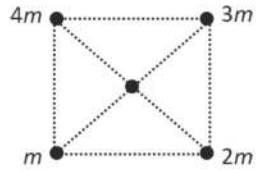
$48 = 2R_2 + 32$

$R_2 = 8$

$R_1=\frac{16}{3}$

4. In the given situation force at center on 1 kg mass is F_1. Now if $4m$ and $3m$ is interchanged the force is F_2.

Given : $\frac{F_1}{F_2}=\frac{2}{\sqrt{\alpha}}$. Find α.

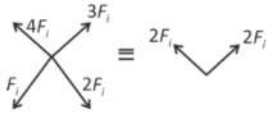


(1) $\alpha = 5$ (2) $\alpha = 3$

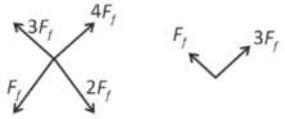
(3) $\alpha = 7$ (4) $\alpha = 1$

Answer (1)

Sol.



$$F_1=\frac{2\sqrt{2}Gm}{a^2}$$



$$F_2=\sqrt{10}F_f=\sqrt{10}\frac{Gm^2}{a^2}$$

$$\frac{F_2}{F_1}=\sqrt{\frac{10}{8}}=\frac{\sqrt{5}}{2}$$

5. Match the column

	Column-I		Column-II
(A)	Thermal Conductivity	(P)	$[ML^2T^{-2}K^{-1}]$
(B)	Boltzmann Constant	(Q)	$[M^1L^{-1}T^{-2}]$
(C)	Spring constant	(R)	$[M^1L^1T^{-3}K^{-1}]$
(D)	Surface tension	(S)	$[M^1L^0T^{-2}]$
		(T)	$[M^1L^2T^{-3}K^{-1}]$
		(U)	$[ML^2T^{-2}]$

(1) A → R ; B → P ; C → S ; D → S

(2) A → T ; B → P ; C → U ; D → S

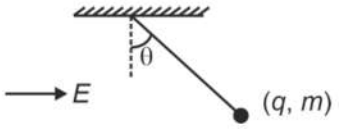
(3) A → R ; B → T ; C → Q ; D → Q

(4) A → T ; B → U ; C → S ; D → Q

Answer (1)

Sol. Theoretical

6. A simple pendulum with bob (mass m & charge q) is in equilibrium in presence of horizontal electric field E then tension in thread is



(1) $mg + qE$ (2) $\sqrt{m^2g^2+q^2E^2}$

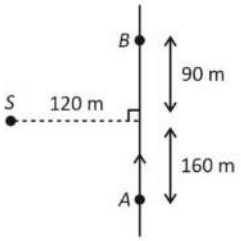
(3) $\sqrt{mg+qE}$ (4) $mg + qE\tan\theta$

Answer (2)

Sol. $\vec{T}+\overrightarrow{mg}+\overrightarrow{qE}=\vec{0}$

$$T=\left(\overrightarrow{mg}+\overrightarrow{qE}\right)=\sqrt{m^2g^2+q^1E^2}$$

7. Detector D moves from A to B and observe the frequencies are differing by 10 Hz. Source is emitting frequency f_0 as shown: Speed of detector is 35 times less than speed of sound. Then f_0 is

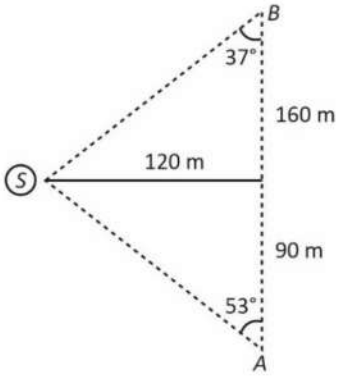


(1) 400 Hz (2) 350 Hz

(3) 250 Hz (4) 150 Hz

Answer (3)

Sol.

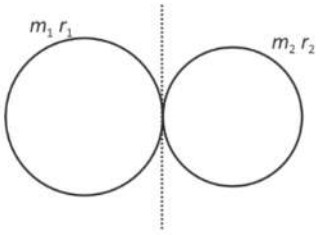


$$f_0\left\{\frac{C+V\cos 53^\circ}{C}-\frac{C-V\cos 37^\circ}{C}\right\}=10$$

$$f_0\left\{\frac{V}{C}\right\}\left\{\frac{7}{5}\right\}=10$$

$$f_0=\frac{50}{7}\times\frac{C}{V}=250\text{ Hz}$$

8. Disk $m_1 = 5$ kg & radius $r_1 = 10$ cm and disk $m_2 = 10$ kg & radius $r_2 = 50$ cm are arranged as shown in figure. Find moment of inertia about an axis through common tangent and parallel to the plane of the disk.



(1) $\frac{31}{8}$ kg m^2 (2) $\frac{57}{64}$ kg m^2

(3) $\frac{41}{8}$ kg m^2 (4) $\frac{51}{16}$ kg m^2

Answer (4)

Sol. $\left(\frac{m_1r_1^2}{4}+m_1r_1^2\right)+\left(\frac{m_2r_2^2}{4}+m_2r_2^2\right)=I$

$$\Rightarrow \left(\frac{1}{100}\times\frac{5}{4}\times 5\right)+\frac{1}{4}\left(\frac{5}{4}\times 10\right)=I$$

$$\Rightarrow \frac{1}{16}+\frac{50}{16}=\frac{51}{16}\text{ kg m}^2$$

9. In adiabatic process the temperature reduces to $\frac{1}{4}$th and volume increases to 8 times. Find adiabatic constant of the gas.

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

(3) $\frac{5}{3}$ (4) $\frac{8}{5}$

Answer (3)

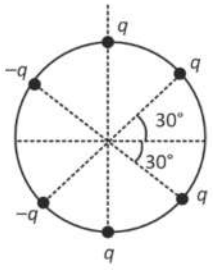
Sol. $TV^{\gamma-1}$ = Constant

$$\Rightarrow TV^{\gamma-1}=\frac{T}{4}(8V)^{\gamma-1}$$

$$\Rightarrow TV^{\gamma-}=\frac{T.V^{\gamma-1}}{4}(8)^{\gamma-1}$$

$$\Rightarrow (2)^2=(2)^{3\gamma-3}\Rightarrow \gamma=\frac{5}{3}$$

10. Six charges (four + q, two – q) are present at circle of radius r and centred at origin as shown. Electric field at origin is

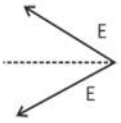


(1) $\frac{\sqrt{3}q}{4\pi\epsilon_0 r^2}\hat{i}$ (2) $\frac{\sqrt{3}q}{4\pi\epsilon_0 r^2}\left(-\hat{i}\right)$

(3) $\frac{\sqrt{3}\,q}{2\pi\epsilon_0 r^2}\left(-\hat{i}\right)$ (4) $\frac{\sqrt{3}\,q}{\pi\epsilon_0 r^2}\left(\hat{i}\right)$

Answer (3)

Sol.



$$E=\frac{2kq}{r^2}\Rightarrow E_{net}=E\sqrt{3}$$

11. An α-particle with KE 7.9 MeV is projected towards a stationary target nucleus of $Z = 79$. Find the distance of closest approach.

(1) 1.44×10^{-14} (2) 2.88×10^{-14}

(3) 1.44×10^{-15} (4) 2.88×10^{-15}

Answer (2)

Sol. $KE = \frac{KZe \times 2e}{d} = 7.9 \times 10^6$

$$d = \frac{9 \times 10^9 \times 2 \times 1.6 \times 10^{-19}}{10^5} = 2.88 \times 10^{-14}$$

12. A planet '*A*' having density ρ and radius R has escape velocity = 10 km/sec. Find the escape velocity of a plant *B* having density and radius both 10% that of plant *A*.

(1) $\frac{1}{\sqrt{10}}$ (2) $\frac{1}{\sqrt{20}}$

(3) $\frac{1}{\sqrt{30}}$ (4) $\frac{1}{\sqrt{50}}$

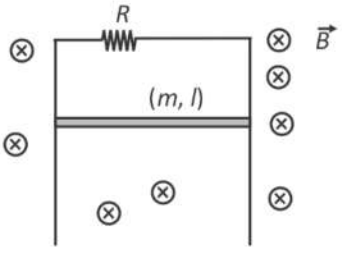
Answer (1)

Sol. $v_e = \sqrt{\frac{Gm \times 2}{R}} = \sqrt{G\rho \frac{8}{3}\pi R^2}$

$$\frac{v_A}{v_B} = \sqrt{\frac{\rho_A}{\rho_B}}\left(\frac{R_A}{R_B}\right) = \sqrt{10} \times 10$$

$$v_B = \frac{v_A}{10\sqrt{10}} = \frac{1}{\sqrt{10}}$$

13. A conducting rod of mass m and length l is moving on a infinite pair of conducting rails as shown. Conducting rails are connected to a resistance R at one end. Motion is in vertical plane and horizontal magnetic field in the region is B. Find terminal speed of rod.



(1) $V_0 = \frac{3mgR}{2B^2l^2}$ (2) $V_0 = \frac{mgR}{2B^2l^2}$

(3) $V_0 = \frac{mgR}{B^2l^2}$ (4) $V_0 = \frac{2mgR}{B^2l^2}$

Answer (3)

Sol. Let V_0 is the terminal speed then power dissipated is

$$\left(\frac{V_0Bl}{R}\right)^2 \cdot R = \frac{V_0^2B^2l^2}{R}$$

and power delivered gravity is mgv_0

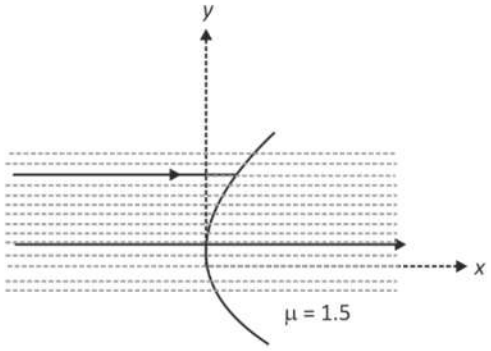
So, $mgV_0 = \frac{B^2l^2}{R} \cdot V_0^2$

$$\Rightarrow \quad \frac{mgR}{B^2l^2} = V_0$$

14. A ray parallel to x axis (principal axis of curved surface.

The x co-ordinate where ray cuts x-axis (in m) is :

(The radius of curvature is 50 cm)



(1) 1.5 (2) 0.5

(3) 1 (4) 2

Answer (1)

Sol. $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} \Rightarrow \frac{1.5}{v} = \frac{0.5}{0.5}$

$V = 1.5$

15. A sinusoidal EMW is given by $\vec{E} = 20\sin\left(\frac{2}{300}x - 10^6 t\right)$ propagating in a non-magnetic material. Dielectric constant of material is

(1) 9×10^4 (2) 3×10^2

(3) 4 (4) 2

Answer (3)

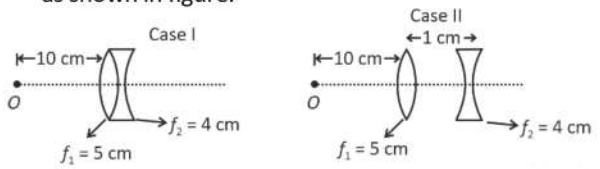
Sol. $K = \frac{\omega}{V} \Rightarrow \frac{2}{300} = \frac{10^6}{V}$

$V = \frac{3\times10^8}{2}$

$\mu = \frac{C}{V} \Rightarrow \mu = 2$

$\frac{C}{V} = \sqrt{\frac{\mu\varepsilon}{\mu_0\varepsilon_0}} \Rightarrow \sqrt{\mu} = 2$

16. Combination of lenses are arranged in case I and case II as shown in figure.



Magnification in two cases are m_1 and m_2. Find $\left|\frac{m_1}{m_2}\right|$.

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

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

Answer (1)

Sol. For Case I

$\frac{1}{f_a} = \frac{1}{5} - \frac{1}{4} = \frac{-1}{20}$

So $\frac{1}{v} + \frac{1}{10} = -\frac{1}{20} \Rightarrow \frac{1}{v} = -\frac{1}{20} - \frac{1}{10} = -\frac{3}{20}$

So $|m_1| = \frac{20}{3\times10} = \frac{2}{3}$

For case II

For 1st lens $\frac{1}{v_1} + \frac{1}{f_0} = \frac{1}{5}$

$\Rightarrow v_1 = 10$ so, $m'_2 = \frac{10}{-10} = -1$

So 2nd lens

$\frac{1}{v_2} - \frac{1}{9} = -\frac{1}{4} \Rightarrow \frac{1}{v_2} = \frac{1}{9} - \frac{1}{4} = \frac{-5}{36}$

So $m''_2 = \left(\frac{36}{-5}\right)\frac{1}{9} = \frac{-4}{5}$

So $m_2 = m'_2 . m''_2 = \left(\frac{4}{5}\right)\times(1) = \frac{4}{5}$

So $\left|\frac{m_1}{m_2}\right| = \frac{2\times5}{3\times4} = \frac{5}{6}$

17. Match the column-I with the correct numerical values of energy/heat in column-II (R is universal gas constant)

	Column-I		Column-II
(A)	1 mole of monoatomic ideal gas undergoes polytopic process $PV^{-1/2}$ with ΔT = 320 K find ΔU	(P)	650 R
(B)	Find heat supplied to 2 moles of gas having heat capacity as $\frac{5}{2}R$ and ΔT = 130K	(Q)	800 R
(C)	Find the ΔU for 1 mole diatomic gas for ΔT = 230K	(R)	480 R

(1) $A \to R$; $B \to P$; $C \to Q$

(2) $A \to P$; $B \to R$; $C \to Q$

(3) $A \to R$; $B \to Q$; $C \to P$

(4) $A \to Q$; $B \to P$; $C \to R$

Answer (1)

Sol. ΔU for any process ${}^nC_V\Delta T$

(A) $\Delta U = 1\times\frac{3R}{2}\times320 = 480\,R$

(B) $\Delta Q - {}^nC_{process}\Delta T = 2\times\frac{5R}{2}\times130 = 650\,R$

(C) $\Delta U = 1\times\frac{5}{2}R\times320 = 800\,R$

18. Statement-I : Fluid exerts pressure on the surface of a solid in contact with it.

Statement-II : The excess potential energy of molecules at the surface of a liquid leads to surface tension.

(1) Both are true and statement-II B correct explanation of Statement-I

(2) Both are true but statement-II is not correct explanation of Statement-I

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

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

Answer (2)

Sol. Theoretical

19. For an object revolving around a planet of mass M and radius R_0 at a distance r from the center of the planet. If area velocity of the object is 10 km^2/sec. Now if density of the planet increases by +10% and radius of planet increases by +10% then find new area velocity at same orbital radius.

(1) 12.1 km^2/sec (2) 10 km^2/sec

(3) 15.5 km^2/sec (4) 8.5 km^2/sec

Answer (1)

Sol. $T^2 = \dfrac{4\pi^2 r^3}{GM}$

So $V_{\text{Area}}^2 = \dfrac{\pi r^2 \cdot \pi r^2 GM}{4\pi^2 r^3} = \dfrac{GMr}{4}$

So $V_{\text{Area}}^2 = \dfrac{G}{4} \cdot r \cdot \dfrac{4}{3}\pi R^3 \rho = \dfrac{\pi}{3} R^3 \rho G r$

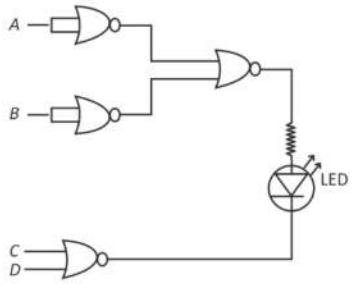
Since r is constant so

$$\frac{V_{2(\text{Area})}^2}{V_{1(\text{Area})}^2} = \frac{\frac{110\rho}{100}\left(\frac{11}{10}\right)^3 \cdot R^3}{\rho R^3}$$

$$\Rightarrow \quad V_{2(\text{Area})}^2 = \left(\frac{11}{10}\right)^4 \times 100$$

$$\Rightarrow \quad V_{2(\text{Area})} = 12.1 \text{ km}^2/\text{sec}$$

20. In the given logic circuit shown in the figure, inputs A, B, C, and D are applied as shown. An LED is connected at the output. In which of the following combinations will the LED glow.



(1) $A = 1, B = 1, C = 0, D = 0$

(2) $A = 1, B = 0, C = 0, D = 0$

(3) $A = 0, B = 1, C = 1, D = 0$

(4) $A = 1, B = 1, C = 1, D = 1$

Answer (4)

Sol. $\overline{\overline{A}+\overline{B}}$ $\overline{C+D}$ are two terminals

AB $\overline{C+D}$ LED glows when forward bias

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.

22.

23.

24.

25.

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 given central metal ions of low spin complex and choose the correct increasing order of unpaired electrons

   Mn^{3+}, Cr^{3+}, Fe^{3+}, Co^{3+}

   (1) $Co^{3+} < Fe^{3+} < Mn^{3+} < Cr^{3+}$

   (2) $Co^{3+} < Mn^{3+} < Fe^{3+} < Cr^{3+}$

   (3) $Cr^{3+} < Mn^{3+} < Cr^{3+} < Fe^{3+}$

   (4) $Cr^{3+} < Mn^{3+} < Co^{3+} < Fe^{3+}$

Answer (1)

Sol.

Low spin

$Mn^{3+} \Rightarrow 3d^4 \Rightarrow$ $\boxed{\uparrow\downarrow}\boxed{1}\boxed{1}\boxed{}\boxed{}$ n = 2

$Cr^{3+} \Rightarrow 3d^3 \Rightarrow$ $\boxed{1}\boxed{1}\boxed{1}\boxed{}\boxed{}$ n = 3

$Fe^{3+} \Rightarrow 3d^5 \Rightarrow$ $\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{1}\boxed{}\boxed{}$ n = 1

$Co^{3+} \Rightarrow 3d^6 \Rightarrow$ $\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{}\boxed{}$ n = 0

2. Match the following and choose the correct option.

List-I	List-II
(a) $[Ag(NH_3)_2]^+$	(i) Fehling's solution
(b) Zn-Hg/HCl	(ii) Clemmensen reduction
(c) $NH_2 - NH_2/KOH$	(iii) Tollens reagent
(d) Cu^{2+}/OH^-	(iv) Wolff-Kishner reduction

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

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

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

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

Answer (3)

Sol. a(iii), b(ii), c(iv), d(i)

3. For the reaction given below at 25°C

   $A_2 \rightleftarrows 2A$

   Find ln K_P

   Given $\left(\Delta G_f^o\right)_A = -50.384$ kJ/mol

   $\left(\Delta G_f^o\right)_{A_2} = -100$ kJ/mol

   (1) 0.43

   (2) 0.23

   (3) 0.31

   (4) 0.53

Answer (3)

Sol. $A_2 \rightarrow 2A$

$\left(\Delta G_f^o\right)_{rxn} = -2\times 50.384 + 100$

$= -0.768$ kJ

$\Delta G^o = -RT\ln K_P$

$-\frac{\Delta G^o}{8.3\times 298} = \ln K_P$

$\frac{0.768\times 1000}{8.3\times 298} = \ln K_P = 0.31$

4. **Statement-I :** Sucrose is dextrorotary and upon hydrolysis it becomes laevorotatory.

Statement-II : Sucrose on hydrolysis gives glucose and fructose such that the laevorotation of glucose is more than dextrorotation of fructose.

(1) Both Statement-I and Statement-II are correct

(2) Both Statement-I and Statement-II are incorrect

(3) Statement-I is correct, Statement-II is incorrect

(4) Statement-II is correct, Statement-I is incorrect

Answer (3)

Sol. Sucrose $\rightleftharpoons$ Glucose + Fructose

D(+) glucose D(–) Fructose

+52.5° –92.4°

5. Which of the following is the correct order of the reactivity of given nucleophiles when treated with CH_3Br in methanol?

F^-, I^-, $C_2H_5O^-$, $C_6H_5O^-$

(1) $I^- > C_2H_5O^- > C_6H_5O^- > F^-$

(2) $I^- > F^- > C_2H_5O^- > C_6H_5O^-$

(3) $I^- > C_2H_5O^- > F^- > C_6H_5O^-$

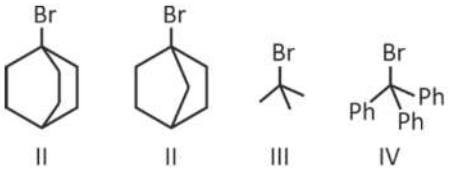
(4) $C_6H_5O^- > F^- > I^- > C_2H_5O^-$

Answer (1)

Sol. Nucleophilicity order of : $I^- > C_2H_5O^- > C_6H_5O^- > F^-$

Greater the size of anion, greater polarisation, greater nucleophilicity.

6. Reactivity of following on the basis of S_N1 mechanism.



(1) IV > III > I > II

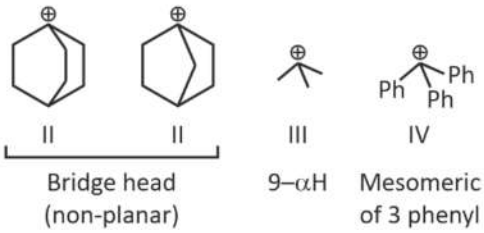
(2) II > IV > II > I

(3) III > IV > I > II

(4) IV > III > II > I

Answer (1)

Sol. For S_N1, more stable carbocation means higher reactivity



IV > III > I > II

II is less stable than I due to higher strain.

7. Given below are two statements.

Statement I : HX bond length is higher in HCl than HF.

Statement II : The lowest boiling point in hydride of group 15 element is having covalency 4.

(1) Both statement I and statement II is correct

(2) Both statement I and statement II is incorrect

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

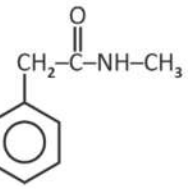
(4) Statement I is incorrect but statement II is correct

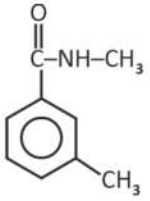
Answer (3)

Sol. Bond length : $\underset{127.4\text{ pm}}{HCl} > \underset{91.7\text{ pm}}{HF}$

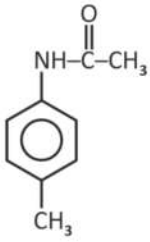
B.P. = $\underset{290\text{ K}}{BiH_3} > \underset{254.6\text{ K}}{SbH_3} > \underset{238.5\text{ K}}{NH_3} > \underset{210.6\text{ K}}{AsH_3} > \underset{185.5\text{ K}}{PH_3}$

8. A compound 'A' with molecular formula $C_9H_{11}NO$ reacts with Br_2/NaOH to give (X). (X) on reaction with $NaNO_2$ in dil. HCl gives compounds (Y). When (Y) is treated with CuCN, followed by hydrolysis gives (Z). The compound (A) on hydrolysis also gives compound (Z). Identify compound (A)

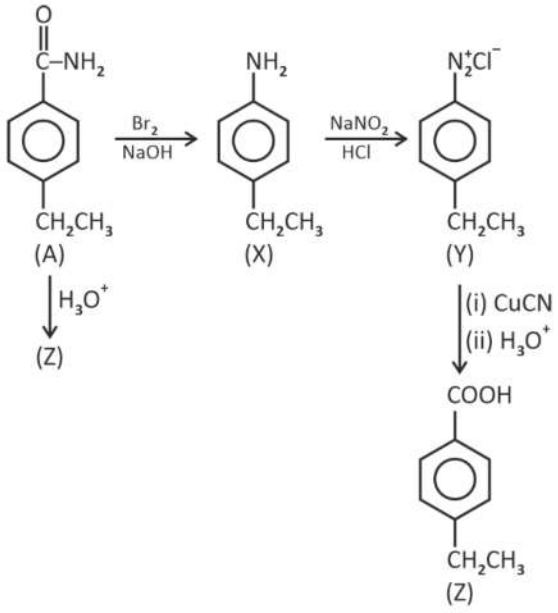
(1) 

(2) 

(3) 

(4) 

Answer (3)

Sol. 

9. Which of the following statement is correct regarding the nature and directive influence of $-NO_2$ group in nitrobenzene.

(1) It is an activating group and ortho/para director

(2) It is a deactivating group and ortho/para director

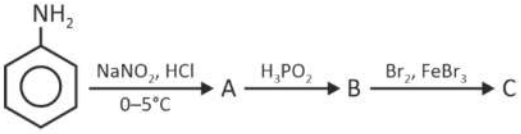
(3) It is a deactivating group and meta director

(4) It is an activating group and meta director

Answer (3)

Sol. $-NO_2$ group is a deactivating group and meta director.

10. Consider the following sequence of reaction and identify A, B and C respectively.



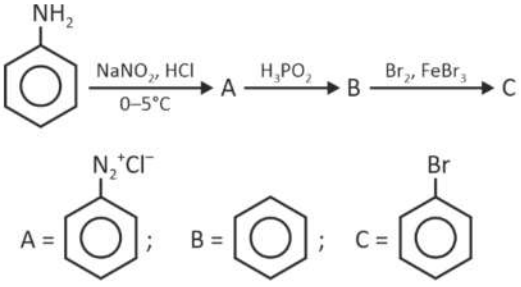
(1) C_6H_5OH, C_6H_6, $C_6H_4Br_2$

(2) $C_6H_5N_2^+Cl^-$, C_6H_6, C_6H_5Br

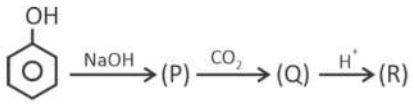
(3) $C_6H_5NO_2$, C_6H_5OH, C_6H_5Br

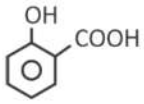
(4) C_6H_5Cl, C_6H_5OH, C_6H_6

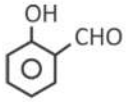
Answer (2)

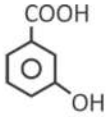
Sol. 

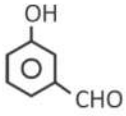
11. In the following reaction sequence, identify compound (R).



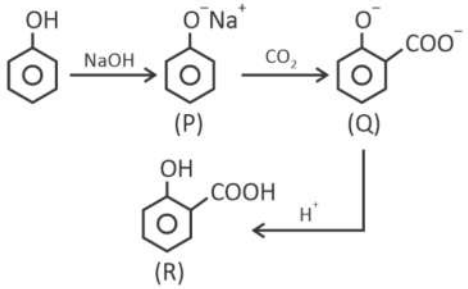
(1) 

(2) 

(3) 

(4) 

Answer (1)

Sol. 

12. Given below are two statements

Statement-I : K_H is constant with change in concentration of gas till solution is dilute at given temperature.

Statement-II : According to Henry's Law, partial pressure of gas in vapour phase is inversely proportional to mole fraction of gas in solution.

(1) Both Statement-I and Statement-II are correct

(2) Both Statement-I and Statement-II are incorrect

(3) Statement-I is correct, Statement-II is incorrect

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

Answer (3)

Sol. According to Henry's Law

$P_{gas} \propto X_{gas}$

Statement-II is incorrect

K_H is dependent on temperature

Statement-I is correct

13. Consider a first order reaction:

$A \rightarrow$ products

3 different solutions are taken and the rate of reaction of

Solution 1 : 100mL 10M 'A' $\rightarrow r_1$

Solution 2 : 200mL 10M 'A' $\rightarrow r_2$

Solution 3 : 100mL 10M 'A' + 100mL water $\rightarrow r_3$

The correct order of the rates of reactions is,

(1) $r_1 = r_2 = r_3$

(2) $r_1 = r_2 < r_3$

(3) $r_1 = r_2 > r_3$

(4) $r_1 < r_2 = r_3$

Answer (3)

Sol. For a first order reaction

$$\frac{-dA}{dt} = k[A]$$

As [A] decreases rate of reaction decreases

14. Bohr's radius of H-atom is 2.12×10^{-10} m. Calculate the energy of electron at this level.

(1) -5.44×10^{-19} J

(2) -2.176×10^{-18} J

(3) -54.4×10^{-19} J

(4) -2.3×10^{-19} J

Answer (1)

Sol. $r_n = a_0 \frac{n^2}{Z}$

$2.12 \times 10^{-10} = 0.529 \times 10^{-10} \frac{n^2}{1}$

$n^2 = 4$

$n = 2$

$E_n = -13.6 \frac{Z^2}{n^2}$ eV

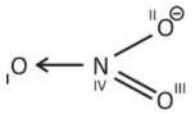
$E_n = -13.6 \frac{1}{2^2}$ eV

$= -3.4$ eV

$= -3.4 \times 1.6 \times 10^{-19}$ J

$= -5.44 \times 10^{-19}$ J

15. Find the formal charge of $\overset{I}{O}$, $\overset{II}{O}$, $\overset{III}{O}$ and $\overset{IV}{N}$ respectively



(1) 0, +1, –1, +2

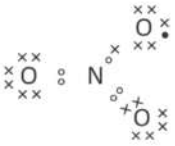
(2) –1, –1, 0, +1

(3) –1, 0, +2, +1

(4) +1, –1, 0, –1

Answer (2)

Sol. Formal charge = Valence e^- – Non-bonding e^- – $\frac{1}{2}$ (Bonding e^-)

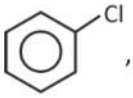


F.C. on O(I) $\Rightarrow 6-6-\frac{1}{2}(2)=-1$

F.C. on O(II) $\Rightarrow 6-6-\frac{1}{2}(2)=-1$

F.C. on O(III) $\Rightarrow 6-4-\frac{1}{2}(4)=0$

F.C. on N(IV) $\Rightarrow 5-0-\frac{1}{2}(8)=+1$

16. For  , the incorrect statement is,

'P'

(1) 'P' is less reactive than benzyl chloride towards nucleophilic substitution reaction.

(2) In 'P', C-Cl bond has partial double bond character

(3) 'Cl' is an ortho-para directing group towards electrophilic aromatic substitution

(4) 'P' can undergo nucleophilic substitution reaction at normal conditions

Answer (4)

Sol. Chlorobenzene (P) does not undergo S_N reaction under normal conditions.

17. Which of the following statement is correct regarding element having atomic number 79.

(1) It's first ionisation enthalpy is maximum in its group

(2) It's first ionisation enthalpy is minimum in its group

(3) It belongs to group 10 of periodic table

(4) It belongs to 5th period of periodic table

Answer (1)

Sol.

IE_1 (kJ/mol)	Cu	Ag	Au
	745	730	890

Au belongs to Group-11 and it is a 6th period element.

18. An element from 1st transition series and another element of 3rd transition series (same group) do not liberate H_2 gas from dilute acids like HCl. Both form halides. The hybridisation state of metal ion halide respectively are

(1) Both sp^3

(2) Both dsp^2

(3) sp^3 and dsp^2

(4) dsp^2 and sp^3

Answer (3)

Sol. Cu and Au do not liberate H_2 gas with dilute acid.

$CuCl_4^{2-} \Rightarrow sp^3$; $AuCl_4^- \Rightarrow dsp^2$

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. Sodium extract of organic compound of 0.1 g is treated with chlorine water and CCl_4 which dissolves in organic solvent to produce a violet colour. Upon treatment with $AgNO_3$ a yellow ppt. of 0.12 g is produced. Calculate the percentage of halide in organic compound.

Answer (65)

Sol. Layer test confirms the presence of iodine in the organic compound on treatment with $AgNO_3$, AgI precipitate is formed.

$$n_{AgI} = \frac{0.12}{235} = 5.1 \times 10^{-4} \text{ mol}$$

mass of I = $5.1 \times 10^4 \times 127$

= 0.0648 g

$$\% \text{ of I} = \frac{0.0648}{0.1} \times 100 = 64.77 \approx 65\%$$

22.

23.

24.

25.

MATHEMATICS

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. If sum of first 4 terms of an A.P is 6 and sum of first 6 terms is 4, then sum of first 12 terms of an A.P is

   (1) –22 (2) –21

   (3) –23 (4) –24

Answer (1)

Sol. $S_4 = \frac{4}{2}[2a+3d] = 6$

$\Rightarrow 2a + 3d = 3$ ...(i)

$S_6 = \frac{6}{2}[2a+5d] = 4$

$\Rightarrow 2a + 5d = \frac{4}{3}$ ...(ii)

Solving (i) & (ii)

$a = \frac{11}{4}$

$d = \frac{-5}{6}$

$S_{12} = 6\left[2\times\frac{11}{4} + 11\times\left(-\frac{5}{6}\right)\right]$

$= -22$

2. The coefficient of x^{48} in the expansion of

   $1\cdot(1+x) + 2\cdot(1+x)^2 + 3\cdot(1+x)^3 + \ldots\ldots + 100\cdot(1+x)^{100}$ is

   (1) $({}^{101}C_{46}) - 100$

   (2) $100({}^{101}C_{49}) - {}^{101}C_{50}$

   (3) $100({}^{101}C_{46}) - {}^{101}C_{47}$

   (4) ${}^{101}C_{47} - {}^{101}C_{46}$

Answer (2)

Sol. Let $y = 1\cdot(1+x) + 2\cdot(1+x)^2 + 3\cdot(1+x)^3 + \ldots\ldots + 100\cdot(1+x)^{100}$

$\therefore (1+x)y = (1+x)^2 + 2\cdot(1+x)^3 + \ldots\ldots\ldots + 100(1+x)^{101}$

$-x\cdot y = (1+x) + (1+x)^2 + (1+x)^3 + \ldots\ldots + (1+x)^{100} - 100(1+x)^{101}$

$y = \frac{1}{x}\cdot\left\{100(1+x)^{101} - \frac{(1+x)(1+x)^{100} - 1}{1+x-1}\right\}$

$y = \frac{1}{x}\cdot\left\{100\cdot(1+x)^{101} - \frac{1}{x}\left((1+x)^{101} - (1+x)\right)\right\}$

$\therefore$ Coeff. of $x^{48} = 100\cdot{}^{101}C_{49} - {}^{101}C_{50}$

3. If the domain of the function

   $\frac{1}{\ln(10-x)} + \sin^{-1}\left(\frac{x+2}{2x+3}\right)$

   is $(-\infty, -a] \cup (-1, b) \cup (b, c)$, then $(b + c + 3a)$ is equal to

   (1) 22

   (2) 24

   (3) 23

   (4) 21

Answer (2)

Sol. Domain of $\frac{1}{\ln(10-x)}$

$\Rightarrow \ln(10-x) \neq 0$

$\Rightarrow 10 - x \neq 1 \qquad x \neq 9$

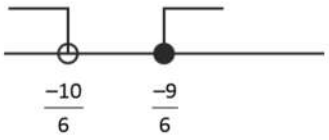
$10 - x > 0 \qquad x < 10$

Domain of $\sin^{-1}\left(\frac{x+2}{2x+3}\right) \Rightarrow -1 \le \frac{x+2}{2x+3} \le 1$

$\Rightarrow \frac{-x-1}{2x+3} \le 0 \Rightarrow \frac{x+1}{2x+3} \ge 0$

$$\frac{3x+5}{2x+3} \geq 0$$

and



$$\Rightarrow x \in \left(\left(-\infty, \frac{-3}{2}\right) \cup [-1, \infty)\right) \cap \left(\left(-\infty, \frac{-10}{6}\right] \cup \left(\frac{-9}{6}, \infty\right)\right)$$

$$\Rightarrow x \in \left(-\infty, \frac{-10}{6}\right) \cup \left[\frac{-6}{6}, \infty\right)$$

$$x \in \left(-\infty, \frac{-5}{3}\right) \cup [-1, \infty)$$

$$\Rightarrow \text{domain of } \frac{1}{\ln(10-x)} + \sin^{-1}\left(\frac{x+2}{2x+3}\right)$$

$$x \in \left(-\infty, \frac{-5}{3}\right] \cup [-1, 10) - \{9\}$$

$$x \in \left(-\infty, \frac{-5}{3}\right] \cup [-1, 9) \cup (9, 10)$$

4. Let $M = \{1, 2, 3, ..., 16\}$ and R be a relation on M defined by xRy if and only if $4y = 5x - 3$. Then, the number of elements required to added in R to make it symmetric is

(1) 2 (2) 3

(3) 4 (4) 5

Answer (1)

Sol. $R = \{(3, 3), (7, 8), (11, 13)\}$ Number of pairs to be added to R to made it symmetric are = 2. Which are (8, 7), (13, 11)

5. The solution of the differential equation $xdy - ydx = \sqrt{x^2 + y^2}dx$ is (where c is integration constant)

(1) $\sqrt{x^2 + y^2} = cx^2 - y$ (2) $\sqrt{x^2 + y^2} = cx^2 + y$

(3) $\sqrt{x^2 + y^2} = cx - y$ (4) $\sqrt{x^2 + y^2} = cx + y$

Answer (1)

Sol. $xdy - ydx = \sqrt{x^2 + y^2}$

divide by x^2 both sides

$$\frac{xdy - ydx}{x^2} = d\left(\frac{y}{x}\right) = \sqrt{1 + \left(\frac{y}{x}\right)^2} \cdot \frac{1}{x}dx$$

$$\Rightarrow \frac{d\left(\frac{y}{x}\right)}{\sqrt{1 + \left(\frac{y}{x}\right)^2}} = \frac{1}{x}dx$$

$$\Rightarrow \log\left(\left(\frac{y}{x}\right) + \sqrt{1 + \left(\frac{y}{x}\right)^2}\right) = \ln(x) + c$$

$$= \ln x + \ln k$$

$$\frac{y}{x} + \sqrt{1 + \left(\frac{y}{x}\right)^2} = xk$$

$$\Rightarrow y + \sqrt{x^2 + y^2} = x^2 k$$

6. The number of values of x satisfying $\tan^{-1}(4x) + \tan^{-1}(6x) = \frac{\pi}{6}$ and $x \in \left[-\frac{1}{2\sqrt{6}}, \frac{1}{2\sqrt{6}}\right]$ is

(1) 1 (2) 0

(3) 2 (4) 3

Answer (1)

Sol. $\tan^{-1}\left[\frac{4x+6x}{1-24x^2}\right]=\frac{\pi}{6}$

$$\frac{10x}{1-24x^2}=\frac{1}{\sqrt{3}}$$

$$\Rightarrow 24x^2+10\sqrt{3}x-1=0$$

$$x=\frac{-10\sqrt{3}\pm\sqrt{300+96}}{48}$$

$$=\frac{-10\sqrt{3}\pm\sqrt{396}}{48}$$

$$=\frac{-10\sqrt{3}\pm2\sqrt{99}}{48}$$

$$=\frac{-5\sqrt{3}\pm\sqrt{99}}{24}$$

$\frac{-5\sqrt{3}-\sqrt{99}}{24}$ (rejected) as $x\in\left[-\frac{1}{2\sqrt{6}},\frac{1}{2\sqrt{6}}\right]$

$$\Rightarrow x=\frac{-5\sqrt{3}+\sqrt{99}}{24}$$

7. The value of $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}}\frac{1}{[x]+4}dx$ is

Where [.] denotes greatest integer function.

(1) $\frac{\pi}{20}+\frac{7}{20}$

(2) $\frac{7\pi}{20}-\frac{7}{60}$

(3) $\frac{7\pi}{20}-\frac{1}{60}$

(4) $\frac{7\pi}{20}+\frac{1}{60}$

Answer (2)

Sol. $\int_{-\frac{\pi}{2}}^{-1}\frac{1}{2}dx+\int_{-1}^{0}\frac{1}{3}dx+\int_{-0}^{1}\frac{1}{4}dx+\int_{1}^{\frac{\pi}{2}}\frac{1}{5}dx$

$$\frac{1}{2}x\Big]_{-\frac{\pi}{2}}^{-1}+\frac{1}{3}x\Big]_{-1}^{0}+\frac{1}{4}x\Big]_{0}^{1}+\frac{1}{5}x\Big]_{1}^{\frac{\pi}{2}}$$

$$\frac{1}{2}\left[-1+\frac{\pi}{2}\right]+\frac{1}{2}(0-(-1))+\frac{1}{4}(1-0)+\frac{1}{5}\left(\frac{\pi}{2}-1\right)$$

$$-\frac{1}{2}+\frac{\pi}{4}+\frac{1}{3}+\frac{1}{4}+\frac{\pi}{10}-\frac{1}{5}$$

$$\frac{7\pi}{20}-\frac{7}{60}$$

8. If $\frac{\cos^2 48^\circ-\sin^2 12^\circ}{\sin^2 24^\circ-\sin^2 6^\circ}=\frac{\alpha+\sqrt{5}\beta}{2}$. Then, the value of ($\alpha$ + β) is

(1) 3

(2) 2

(3) 4

(4) 1

Answer (3)

Sol. $\frac{\cos^2 48^\circ-\sin^2 12^\circ}{\sin^2 24^\circ-\sin^2 6^\circ}=\frac{\cos(48^\circ+12^\circ)\cos(48^\circ-12^\circ)}{\sin(24^\circ+6^\circ)\sin(24^\circ-6^\circ)}$

$$=\frac{\cos60^\circ\cos(36^\circ)}{\sin30^\circ\sin18^\circ}=\frac{\cos36^\circ}{\sin18^\circ}$$

$$=\frac{\frac{\sqrt{5}+1}{4}}{\frac{\sqrt{5}-1}{4}}=\frac{\sqrt{5}+1}{\sqrt{5}-1}\times\frac{\sqrt{5}+1}{\sqrt{5}+1}$$

$$=\frac{5+1+2\sqrt{5}}{4}=\frac{6+2\sqrt{5}}{4}$$

$$=\frac{3+\sqrt{5}}{2}$$

α = 3, β = 1

α + β = 4

9. If $\int (\cos x)^{-5/2}(\sin x)^{-11/2}\,dx$

$= \frac{p_1}{q_1}(\cot x)^{9/2} + \frac{p_2}{q_2}(\cot x)^{5/2} + \frac{p_3}{q_3}(\cot x)^{1/2} - \frac{p_4}{q_4}(\cot x)^{-3/2} + c$

(where c is constant of integration), then value of $\frac{15p_1p_2p_3p_4}{q_1q_2q_3q_4}$ is

(1) 14

(2) 16

(3) 10

(4) 9

Answer (2)

Sol. $\int (\cos x)^{-5/2}(\sin x)^{-11/2}dx$

$= \int \frac{1}{(\cos x)^{5/2}(\sin x)^{-1/2}}dx$

$= \int \frac{1}{(\cot x)^{5/2}\sin^8 x}dx$

$= \int \frac{\operatorname{cosec}^2 x}{(\sin^6 x)(\cot x)^{5/2}}dx$

= Let $\cot x = t \Rightarrow -\operatorname{cosec}^2 dx = dt$

$= 1 + \cot^2 x = \operatorname{cosec}^2 x = (1 + t^2)$

$\Rightarrow \int \frac{(1+t^2)^3(-dt)}{t^{5/2}}$

$\Rightarrow \int \frac{(t^6 + 3t^4 + 3t^2 + 1)(-dt)}{t^{5/2}}$

$\Rightarrow -\int \left(t^{7/2} + 3t^{3/2} + 3t^{-1/2} + t^{-5/2}\right)dt$

$\Rightarrow -\frac{t^{9/2}}{\frac{9}{2}} - \frac{3t^{5/2}}{\frac{5}{2}} - \frac{3t^{1/2}}{\frac{1}{2}} - \frac{t^{-3/2}}{-\frac{3}{2}} + c$

$= -\frac{2}{9}\cot x^{9/2} - \frac{9}{5}\cot x^{5/2} - 6\cot x^{1/2} + \frac{2}{3}(\cot x)^{-3/2} + c$

$\Rightarrow 15\left(-\frac{2}{9} \times -\frac{6}{5} \times 6 \times \frac{2}{3}\right) = 16$

10. The value(s) of α for which the line $\alpha x + 2y = 1$ never touches the hyperbola $\frac{x^2}{9} - \frac{y^2}{1} = 1$ is/are

(1) $R - \left\{-\frac{\sqrt{5}}{2}, \sqrt{\frac{5}{2}}\right\}$

(2) $R - \left\{-\sqrt{5}, \sqrt{5}\right\}$

(3) $R - \left\{-\frac{\sqrt{5}}{3}, \frac{\sqrt{5}}{3}\right\}$

(4) R

Answer (3)

Sol. $\frac{x^2}{9} - \frac{y^2}{1} = 1$

Line $\alpha x + 2y = 1$

$T : y = mx \pm \sqrt{9m^2 - 1}$

$T : 2y = -\alpha x - 1$

$\frac{1}{2} = -\frac{m}{\alpha} = \frac{\sqrt{9m^2 - 1}}{-1}$

$\frac{1}{4} = 9m^2 - 1$

$\frac{5}{36} = m^2 \Rightarrow m = \pm\frac{\sqrt{5}}{6}$

$-2m = \alpha$

$\boxed{\alpha = \pm\frac{\sqrt{5}}{3}}$

For $\alpha = \pm\frac{\sqrt{5}}{3}$, the $\alpha x + 2y = 1$ will become tangent.

$\therefore$ The value of α for which line will not become tangent is $R - \left\{\pm\frac{\sqrt{5}}{3}\right\}$.

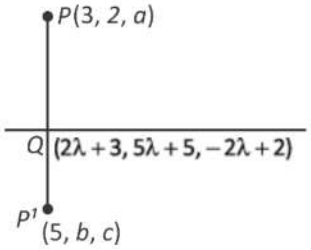
11. If the image of the point $P(3, 2, a)$ reflected about the line $\frac{x-3}{2}=\frac{y-5}{5}=\frac{z-2}{-2}$ is $(5, b, c)$. Then the value of $a^2 + b^2 + c^2$ is

(1) $\frac{4849}{8}$ (2) $\frac{4245}{4}$

(3) $\frac{3947}{8}$ (4) $\frac{2429}{4}$

Answer (1)

Sol.



Q is the mid-point of PP'

$\therefore \frac{5+3}{2}=2\lambda+3 \Rightarrow \lambda=\frac{1}{2}$

$\frac{b+2}{2}=5\lambda+5=\frac{5}{2}+5=\frac{15}{2}$

$\Rightarrow b = 3$

$\frac{a+c}{2}=-2\lambda+2=1$

$\Rightarrow a + c = 2$ ...(i)

Now,

$2(5 - 3) + 5(b - 2) + (-2)(c - a) = 0$

$\Rightarrow c - a = \frac{59}{2}$ ...(ii)

From (i) & (ii)

$c=\frac{63}{4}, a=\frac{-55}{4}$

$\therefore a^2 + b^2 + c^2 = \frac{4849}{8}$

12. If probability distribution is given by

x	0	1	2		3	4	5	6	7
$P(x)$	k	$2k^2$	$6k^2$		$2k^2 + k$	$4k$	k	k	k

Then, the value of $P(3 < x \le 6)$ is

(1) 0.6 (2) 0.8

(3) 0.4 (4) 0.2

Answer (1)

Sol. $10k^2 + 9k = 1$

$10k^2 + 9k - 1 = 0$

$10k^2 + 10k - k - 1 = 0$

$10k(k + 1) - 1(k + 1) = 0$

$k=\frac{1}{10}$, $\boxed{k=-1} \rightarrow$ Not possible

$\Rightarrow \boxed{k=\frac{1}{10}}$

$P(3 < x \le 6) = P(x = 4) + P(x = 5) + P(x = 6)$

$= \frac{4}{10}+\frac{1}{10}+\frac{1}{10}$

$= \frac{6}{10}=\frac{3}{5}$

$= 0.6$

13.

14.

15.

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. If $A=\begin{bmatrix}2 & 3\\ 3 & 5\end{bmatrix}$, then the value of $\left|A^{2025} - 3A^{2024} + A^{2023}\right|$ is

Answer (16)

Sol. $|A|^{2023}\left|A^2-3A+I\right|$

$|A| = 1$

Now,

$|(A^2 - 3A + I)|$

$$\Rightarrow \left|\begin{bmatrix}13 & 21\\ 21 & 34\end{bmatrix}-3\begin{bmatrix}2 & 3\\ 3 & 5\end{bmatrix}+\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\right|$$

$$\Rightarrow \left|\begin{bmatrix}8 & 12\\ 12 & 20\end{bmatrix}\right|$$

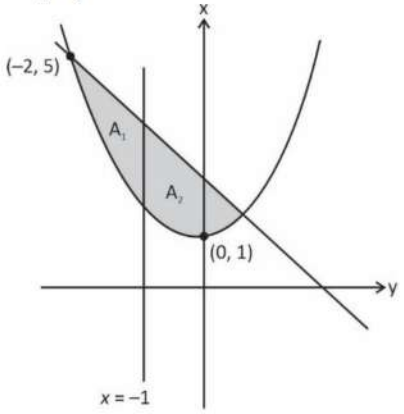
$= 8 \times 20 - 12 \times 12$

$= 16$

22. If the area of the region $\{(x, y): x^2 + 1 \le y \le 3 - x\}$ is divided by the line $x = -1$ in the ratio $m : n$ (where m and n are coprime natural numbers). Then, the value of $m + n$ is

Answer (27)

Sol.



$y = 3 - x$

$y = x^2 + 1$

$3 - x = x^2 + 1$

$x^2 + x - 2 = 0$

$(x + 2)(x - 1) = 0$

$\Rightarrow x = -2, 1$

$$A_1 = \int_{-2}^{-1}\left((3-x)-(x^2+1)\right)dx$$

$$A_1 = \int_{-2}^{-1}\left(3-x-x^2-1\right)dx$$

$$\boxed{A_1 = \frac{7}{6}}$$

$$A_2 = \int_{-1}^{1}\left((3-x)-\left(x^2+1\right)\right)dx$$

$$\boxed{A_2 = \frac{10}{3}} \Rightarrow A_1 : A_2 = \frac{\frac{7}{6}}{\frac{10}{3}} = \frac{7}{20}$$

$\Rightarrow m + n = 27$

23. The number of solution(s) of equation $x|x + 4| + 3|x + 2| + 3 = 0$ is/are equal to

Answer (3.00)

Sol. If $x \ge -2$

Then $x(x + 4) + 3(x + 2) + 3 = x^2 + 7x + 9$

$$\Rightarrow x = \frac{-7 \pm \sqrt{49-36}}{2}$$

$$= \frac{-7 \pm \sqrt{13}}{2} \Rightarrow x = \frac{-7+\sqrt{13}}{2}$$

If $-4 \le x < -2$

$x(x + 4) + 3(-x - 2) + 3 = x^2 + x - 3 = 0$

$$\Rightarrow x = \frac{-1 \pm \sqrt{1+12}}{2} = \frac{-1 \pm \sqrt{13}}{2}$$

$$\text{in } x \in (-4, -2),\ x = \frac{-1-\sqrt{13}}{2}$$

If $x \in (-\infty, -4)$

$x(-x - 4) + 3(-x - 2) + 3 = -x^2 - 7x - 3$

$$= -(x^2 + 7x + 3) = x = \frac{-7 \pm \sqrt{37}}{2}$$

$$\Rightarrow x = \frac{-7-\sqrt{37}}{2}$$

$\Rightarrow 3$

24.

25.

❑ ❑ ❑