06/04/2026

Evening

Aakash

Medical | IIT-JEE | Foundations

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Memory Based
Answers & Solutions

for

Time : 3 hrs. M.M. : 300

JEE (Main)-2026 (Online) Phase-2

(Physics, Chemistry and Mathematics)

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. Minimum deviation for an equilateral prism is 30°, refractive index is

(1) $\sqrt{2}$

(2) $\sqrt{3/2}$

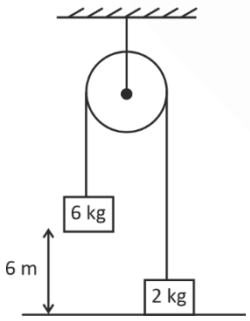
(3) 2

(4) 4

Answer (1)

Sol. $\mu = \dfrac{\sin\left(\dfrac{60+30}{2}\right)}{\sin\dfrac{60}{2}} = \dfrac{1/\sqrt{2}}{1/2} = \sqrt{2}$

2. If system given below is released from rest then find speed of 6 kg block just before hitting ground: (g = 10 m/s^2)



(1) 6.20 m/s (2) 7.74 m/s

(3) 4.70 m/s (4) 5.20 m/s

Answer (2)

Sol. $a = \dfrac{60-20}{8}$

$\Rightarrow a = 5$ m/s^2

And $v^2 = 2 \times 5 \times 6$

$v = \sqrt{60}$

$\Rightarrow v = 7.74$ m/s

3. Find electric field, for given electrostatic potential field, at point $p(2, 3)$; $v = 5(x^2 - y^2)$.

(1) $-20\hat{i} + 30\hat{j}$

(2) $20\hat{i} + 30\hat{j}$

(3) $30\hat{i} - 20\hat{j}$

(4) $30\hat{i} + 20\hat{j}$

Answer (1)

Sol. $\vec{E} = -5(2x)\hat{i} + 5(2y)\hat{j}$

$= 10\left(-2\hat{i} + 3\hat{j}\right)$

4. $H_1^2 + H_1^2 \longrightarrow He_1^4$

Binding energy per nucleon of H_1^2 and H_2^4 are 1.1 MeV and 7 MeV respectively. Find energy released in the nuclear reaction given above.

(1) 23.6 MeV

(2) 24.1 MeV

(3) 5.9 MeV

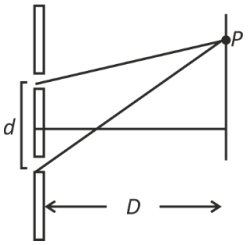
(4) 3 MeV

Answer (1)

Sol. $\Delta E = 7 \times 4 - 2 \times 2.2$

$\Rightarrow 23.6$ MeV

5. In standard YDSE wavelength λ = 7000 Å, d = 5 mm; D = 50 cm. I_0 is the intensity due to individual source on the screen. P is the point on screen such that intensity at 'P' is equal to I_0. Find the minimum distance of 'P' from center of screen.



(1) 35 μm

(2) $\frac{70}{3}$ μm

(3) 17.5 μm

(4) 50 μm

Answer (2)

Sol. $A^2 = A_0^2 + A_0^2 + 2A_0^2\cos\phi$

$\Rightarrow A^2 \propto I_0$

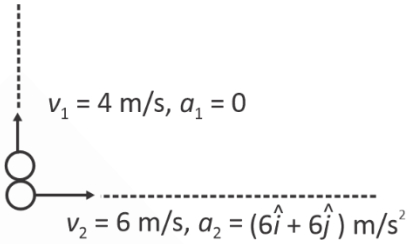
So, $I_0 = 2I_0(1+\cos\phi)$

So $\cos\phi = -\frac{1}{2} \quad \Rightarrow \phi = \frac{2\pi}{3}$

So distance of 'P' will be $\frac{\lambda D}{d \times 3}$

$\Rightarrow \gamma = \frac{7000 \times 10^{-10} \times 50}{100 \times 5 \times 10^{-3} \times 3} = \frac{70}{3}$ μm

6. For two equal masses. One of the mass is having initial velocity $v_1 = 4$ m/s $\hat{j}$ and acceleration $a_1 = 0$ m/s^2. Other having initial velocity of $v_2 = 6$ m/s $\hat{i}$ and acceleration $a_2 = (6\hat{i} + 6\hat{j})$ m/s^2. Initially both were located at origin. Find the trajectory of center of mass.



(1) Circular (2) Ellipse

(3) Parabolic (4) Straight line

Answer (3)

Sol. for (1) $x_1 = 0$; $y_1 = 4t$

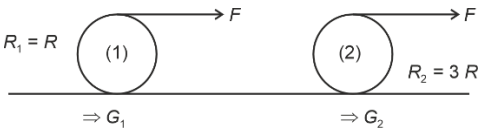
For (2) $x_2 = \left(6t + \frac{1}{2} \times 6t^2\right) = 6t + 3t^2$

$y^2 = 3t^2$

Center of mass is having constant acceleration which is not along the direction of initial velocity.

So trajectory will be parabolic

7. Solid sphere (1) of mass 5 M, hollow sphere (2) of mass M are pulled tangentially without slipping. Acceleration a_1 and a_2 are in ratio of____. Radius are shown in diagram



(1) $\frac{5}{21}$ (2) 1

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

Answer (1)

Sol. $\frac{a_1}{a_2}=\frac{F(2R)R\times\frac{5}{3}M(3R)^2}{\frac{7}{5}(5M)R^2\times F(6R)3R}$

$=\frac{2\times15}{7\times18}=\frac{10}{7\times6}=\frac{5}{21}$

8. When mass 200 g hangs from ceiling via spring in equilibrium, the extension in the spring is observed to be 2 mm. Find angular frequency of its SHM & energy stored in spring in equilibrium position respectively

(1) 50 rad/s & 2 mJ

(2) $50\sqrt{2}$ rad/s & 2 mJ

(3) 100 rad/s & 4 mJ

(4) 150 rad/s & 4 mJ

Answer (2)

Sol. $K=\frac{mg}{x}$

$\omega=\sqrt{\frac{K}{m}}$

$\omega=\sqrt{\frac{g}{x}}$

$\Rightarrow \omega=\sqrt{\frac{10}{2\times10^{-3}}}$

$\Rightarrow \omega=\frac{100}{\sqrt{2}}=50\sqrt{2}$

Also $U=\frac{1}{2}Kx^2$

$\Rightarrow \frac{1}{2}\frac{mg}{x}x^2$

$\Rightarrow \frac{1}{2}mgx$

$\Rightarrow \frac{1}{2}\times\frac{200}{1000}\times10\times2\times10^{-3}$

$\Rightarrow 2\times10^{-3}$ J

9. 2 moles of ideal mono-atomic gas at temperature T and 6 moles of ideal diatomic gas at temperature $2T$ are mixed together. Find the equilibrium temperature of mixture.

(1) $\frac{13}{6}T$ (2) $\frac{11}{8}T$

(3) $\frac{13}{8}T$ (4) $\frac{11}{6}T$

Answer (4)

Sol. $2\cdot\frac{3}{2}R(T)+6\cdot\frac{5}{2}R(2T)$

$=2\times\frac{3}{2}RT_0+6\times\frac{5}{2}RT_0$

$\Rightarrow RT(3+30)=RT_0(3+15)$

$\Rightarrow T_0=\frac{33T}{18}=\frac{11}{6}T$

10. an inclined plane is inclined at angle 45° with horizontal. If a block is released an it, it takes twice the time for it to come down compared to if it was smooth. Find friction coefficient of the inclined plane.

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

(3) $\frac{3}{4}$ (4) 1.2

Answer (3)

Sol. $t = \sqrt{\frac{2S}{a}}$

If time is twice that means acceleration must be one fourth.

$\therefore$ mg sin45° – μmg cos45° = $\frac{mg}{4\sqrt{2}}$

$\Rightarrow 1(1-\mu) = \frac{1}{4}$

$\boxed{\mu = \frac{3}{4}}$

11. Spherical charged body having potential 100 volt and capacitance C_0 = 100 μF is brought into contact with identical (uncharged) spherical body. Find the loss of energy.

(1) 250 mJ (2) 100 mJ

(3) 50 mJ (4) 150 mJ

Answer (1)

Sol. Initial charge $Q = C_0V_0$

$E(c) = \frac{C_0V_0^2}{2}$

Finally $E(f) = \frac{\left(C_0V_0^2\right)}{2\times 2C_0} = \frac{C_0V_0^2}{4}$

So $\Delta u = \frac{C_0V_0^2}{4} = \frac{100\times 10^{-6}\times 10^4}{4}$

Δu = 250 mJ

12. Propagation vector $\vec{K}$ & electric field vector $\vec{E}$ of an EMW of angular frequency ω is given. Magnetic field will be

(1) $\frac{\vec{E}\times\vec{K}}{\omega}$

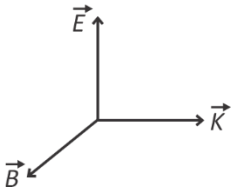
(2) $(\vec{E}\times\vec{K})\omega$

(3) $\frac{\vec{K}\times\vec{E}}{\omega}$

(4) $(\vec{K}\times\vec{E})\omega$

Answer (3)

Sol.



$\frac{\vec{K}\times\vec{E}}{KE} = \frac{\vec{B}}{B}$

$\frac{\vec{K}\times\vec{E}}{\frac{\omega}{C}CB} = \frac{\vec{B}}{B}$

13. Match the following lists and choose correct options:

List-I		List-II	
A	h(Planck's constant)	1	$ML^0T^{-3}K^{-4}$
B	G(Gravitational constant)	2	$M^1L^2T^{-1}$
C	σ (Stefans constant)	3	$M^1L^2T^{-2}k^{-1}$
D	k (Boltzmann constant)	4	$M^{-1}L^3T^{-2}$

(1) A → 2; B → 4 ; C → 1; D → 3

(2) A → 2; B → 4 ; C → 2; D → 1

(3) A → 2; B → 1 ; C → 4; D → 3

(4) A → 1; B → 2 ; C → 3; D → 4

Answer (1)

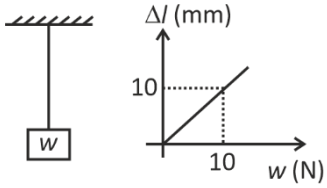
Sol. $\{G\} = M^{-1}L^3T^{-2}$

$\{\sigma\} = ML^0T^{-3}k^{-4}$

$\{n\} = ML^2T^{-1}$

$\{k\} = ML^2T^{-2}k^{-1}$

14. Graph is between weight of *b* block & extension in wire. Area of cross-section of wire is 10^{-5} m^2 & length 1 m. Find its Youngs modulus.



(1) 10^{11} N/m^2

(2) 10^8 N/m^2

(3) 10^{12} N/m^2

(4) 10^{10} N/m^2

Answer (2)

Sol. $Y = \frac{Fl}{A\Delta l}$

$\Rightarrow Y = \frac{10 \times 1}{10^{-5} \times 10 \times 10^{-3}}$

$Y = 10^8\ \text{N/m}^2$

15. Galvanometer shows full deflection when shunted by 2 ohm & is fed with 500 mA. Instead when this galvanometer is used in series with 470 Ω resister, again it shows full deflection for at range of 10 V. Resistance of galvanometer is

(1) 45 Ω

(2) 50 Ω

(3) 60 Ω

(4) 25 Ω

Answer (2)

Sol. $I_g(G + R) = 10$

$I_g(G) = 2(500\ \text{mA} - I_g)$

$I_g(G + R) = 10$

$I_gG = 1 - 2I_g$

$I_g(G + 2) = 1$

$I_g(G + R) = 10$

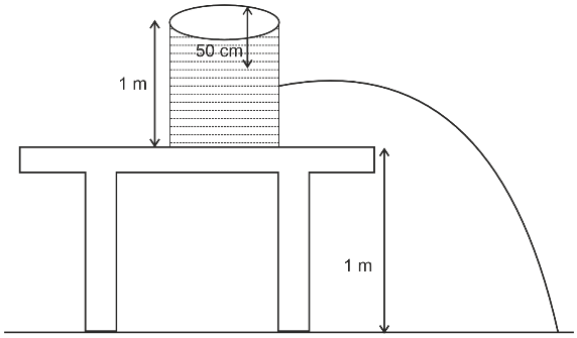
$\frac{G+2}{27+G} = \frac{1}{10}$

$10G + 20 = 270 + G$

$9G = 450$

$G = 50$

16. In diagram shown below, hole is made in completely filled cylinder 50 cm below the top. Find range covered by leaking water on ground.



(1) $\sqrt{3}$ m

(2) $\sqrt{2}$ m

(3) $\sqrt{4}$ m

(4) $\sqrt{6}$ m

Answer (1)

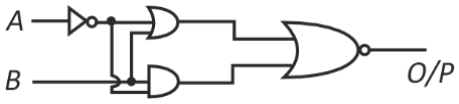
Sol. $V = \sqrt{2gh}$

$t = \sqrt{\frac{2 \times 1{\cdot}5}{g}}$

$\therefore$ Range $= \sqrt{2gh} \times \sqrt{\frac{2 \times 1{\cdot}5}{g}}$

$\Rightarrow \sqrt{2 \times \frac{1}{2} \times 3} = \sqrt{3}$ m

17. Find output for (1) $A = 0, B = 1$ & (2) $A = 1, B = 1$



(1) (1) 0, (2) 0

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

(3) (1) 0 , (2) 1

(4) (1) 1, (2) 0

Answer (1)

Sol. $o/P = \overline{(\bar{A}+B)+\bar{A}\cdot B}$

$\Rightarrow \bar{\bar{A}}+B\cdot\bar{\bar{A}}\cdot B$

$\Rightarrow A\cdot\bar{B}\cdot(A+\bar{B})$

$\Rightarrow A\cdot\bar{B}+A\cdot\bar{B}$

$\Rightarrow A\cdot\bar{B}$

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 percentage change in radius of sphere is 2% then find the % change in the volume of sphere.

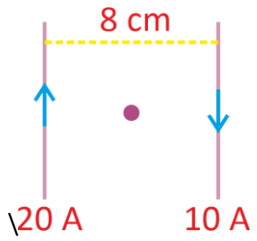
Answer (6)

Sol. $v = \frac{4}{3}\pi r^3$

$\frac{\Delta v}{v} = 3\left(\frac{\Delta r}{r}\right)$

So, $\left(\frac{\Delta v}{v}\times 100\right)$ = 3 × 2 = 6%

22. Magnetic field at middle of two parallel wires carrying current of 20 A and 10 A in opposite direction is ___ μT.

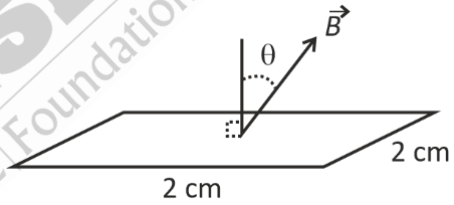


Answer (150)

Sol. $B = \frac{\mu_0(30)}{2\pi\times 4\times 10^{-2}} = 2\times 10^{-7}\times 7.5\times 10^2$

= 15 × 10^{-5}

23. The maximum magnitude of EMF induced in square loop of side 2 cm due to major ranging magnetic field $\vec{B} = 0.4\sin(300t)$ which is making θ = 60° with normal to plane of loop is *X* mV



Answer (24)

Sol. $\phi = Ba^2\cos\phi = a^2B_0\sin\omega t\cos\phi$

$\varepsilon = B_0a^2\cos\omega t\cos\phi$

$= 0.4\times 4\times 10^{-4}\times 300\times\frac{1}{2} = 150\times 1.6\times 10^{-4} = 24$ mV

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. Highest X-O bond order is
(X is central atom)
(1) F_2O
(2) CO
(3) H_2O
(4) CO_2

Answer (2)

Sol. $:C \leftleftharpoons O$

2. The hybridisation states of Ni in the 3 complexes $Ni(CO)_4$, $[Ni(NH_3)_6]^{2+}$, $[Ni(CN)_4]^{2-}$ are
(1) dsp^2, sp^3d^2, sp^3
(2) sp^3, sp^3d^2, sp^3
(3) sp^3, sp^3d^2, dsp^2
(4) sp^3, d^2sp^3, dsp^2

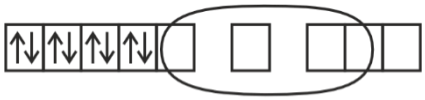
Answer (3)

Sol. $[Ni(CO)_4], Ni \rightarrow 3d^8 4s^2 \equiv \underbrace{3d^{10} 4s^o 4p^o}_{sp^3}$

$[Ni(NH_3)_6]^{2+}\ Ni^{2+} \rightarrow 3d^8 4s^o$

sp^3d^2

$[Ni(CN)_4]^{2-}, Ni^{2+} \rightarrow 3d^8$



dsp^2

3. In a period, ionisation energy of the extreme left and electronegativity of extreme right element is respectively_____. (Don't consider Noble gases).
(1) Lowest/Highest (2) Lowest/Lowest
(3) Highest/Lowest (4) Highest/Highest

Answer (1)

Sol. I.E. decrease from right to left in period and
E.N. increases from left to right in period.

4. Given,

$$k = Ae^{-\frac{2800\ K}{T}}$$

Find activation energy
(1) 23.28 kJ/mol (2) 56 kcal/mol
(3) 232.8 kJ/mol (4) 5600 kcal/mol

Answer (1)

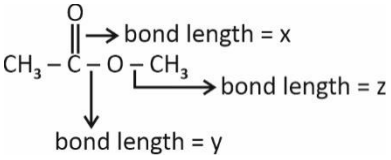
Sol. $\frac{-E_a}{RT} = \frac{2800\ K}{T}$

$$\frac{E_a}{R} = 2800\ K$$

$$E_a = 2800\ K \times 8.314\ J\ mol^{-1}\ K^{-1}$$

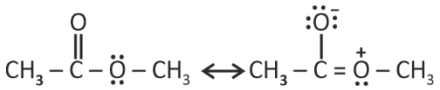
E_a = 23279.2 J mol = 23.28 kJ/mol

5. Compare the bond length x, y and z in the following compound



(1) x = y = z (2) x = y < z
(3) x < y < z (4) x < y = z

Answer (3)

Sol. 

6. Energy of hydrogen like species is given as 54.3 eV. The n and z respectively are

(1) 1, 2

(2) 2, 2

(3) 2, 1

(4) 1, 1

Answer (1)

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

$\frac{z^2}{n^2} = \frac{54.3}{13.6} = 4$

7. Match : For ideal monoatomic gas,

(A)	Isothermal reversible expansion	(1)	$w = -nRT\ln\frac{V_f}{V_i}$
(B)	Adiabatic reversible expansion	(2)	$w = \frac{nR}{\gamma - 1}(T_f - T_i)$
(C)	Adiabatic irreversible expansion	(3)	$w = nC_v(T_f' - T_i)$ $T_f' > T_f$
(D)	Free expansion	(4)	w = 0

(1) A → 4, B → 2, C → 3, D → 1

(2) A → 2, B → 1, C → 3, D → 4

(3) A → 1, B → 2, C → 3, D → 4

(4) A → 1, B → 3, C → 2, D → 4

Answer (3)

Sol. Isothermal reversible

$w = -nRT\ln\frac{V_f}{V_i}$

Adiabatic reversible

$w = \frac{nR}{\gamma - 1}(T_f - T_i)$

Adiabatic irreversible

$w = nC_v(T_f' - T_i)$

Free expansion

w = 0

8. Consider the following statements and choose the correct option

Statement I : Out of SF_4, SF_6, H_2S, SO_2 and SO_3 molecules, only 4 molecules do not follow octet rule

Statement II : H_2O, SO_2 and H_2S have only 1 lone pair on central atom

(1) Statement I is correct, statement II is incorrect

(2) Statement I is incorrect, statement II is correct

(3) Both statement I and statement II are correct

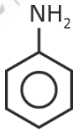
(4) Both statement I and statement II are incorrect

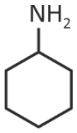
Answer (1)

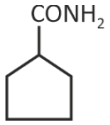
Sol. I. SF_4, SF_6, SO_2 and SO_3 do not follow octet rule

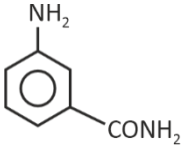
II. H_2O and H_2S have 2 lone pair on central atom

9. Which of the following can be obtained from phthalimide reaction and also give carbylamine reaction.

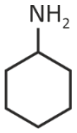
(1) 

(2) 

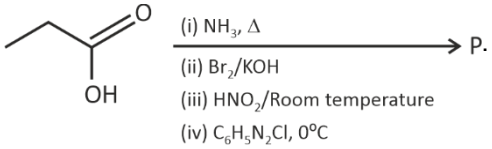
(3) 

(4) 

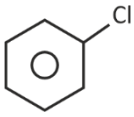
Answer (2)

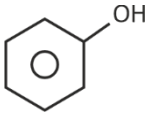
Sol. Only  can be prepared by Gabriel phthalimide reaction and gives carbylamine reaction.

10. Consider the reaction,

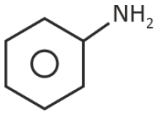


P is

(1) 

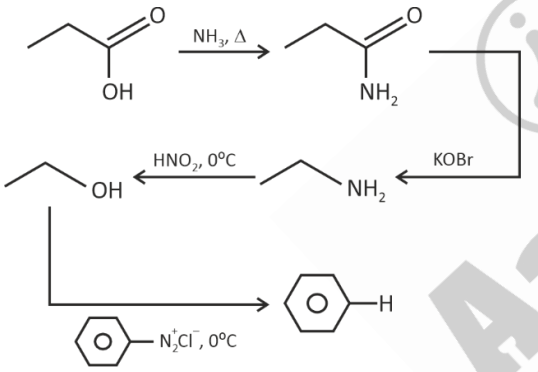
(2) 

(3) 

(4) 

Answer (3)

Sol.



11. Consider the following reaction

$$A \xrightarrow[+\text{conc. } H_2SO_4]{FeSO_4\text{ (fresh)}} B \text{ (Brown ring)}$$

'A' and 'B' can be respectively

(1) $NaNO_2$, $[Fe(H_2O)_5NO]^{2+}$

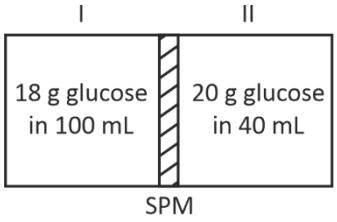
(2) $NaNO_3$, $[Fe(H_2O)_6]^{2+}$

(3) $NaNO_2$, $[Fe(H_2O)_6]^{2+}$

(4) $NaNO_3$, $[Fe(H_2O)_4(NO_2)_2]^{2+}$

Answer (1)

Sol. NO_2^- / NO_3^- $\Rightarrow$ gives brown ring test and complex formed is $[Fe(H_2O)_5NO]^{2+}$

12. 

Statement I : Glucose solution move from vessel II to vessel I through SPM.

Statement II : The osmotic pressure of vessel II is greater that of vessel I.

(1) Statement I and statement II both correct

(2) Statement I and statement II both incorrect

(3) Statement I correct and statement II incorrect

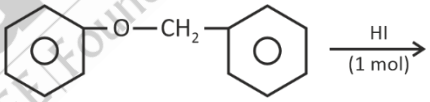
(4) Statement I incorrect and statement II correct

Answer (4)

Sol. Only solvent molecules can pass SPM not solute or solution.

$\Rightarrow$ Concentration of vessel II > I

13. Consider the statements in respect of following reaction and choose the correct option.



Statement I : Cleavage of O – CH_2 bond is taking place.

Statement II : Iodobenzene and benzyl alcohol are product of this reaction.

(1) Statement I is correct and Statement II is incorrect

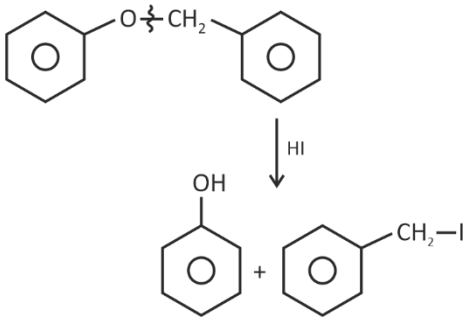
(2) Statement I is incorrect and Statement II is correct

(3) Both of Statement I and Statement II are correct

(4) Both of Statement I and Statement II are incorrect

Answer (1)

Sol.



14. The concentration of A_xB_y is CM and its dissociation constant is K. Find the degree of dissociation (α) of A_xB_y.

Consider α to be negligible in comparison to 1

(1) $\left(\frac{K}{c^{(x+y-1)}\cdot x^x\cdot y^y}\right)^{1/(x+y)}$

(2) $\left(Kc^{(x+y-1)}\cdot x^x y^y\right)^{(x+y)}$

(3) $\left(\frac{K}{c^{(x+y-1)}\,x^x y^y}\right)^{(x+y)}$

(4) $\left(Kc^{(x+y-1)}\cdot x^x\cdot y^y\right)^{1/(x+y)}$

Answer (1)

Sol.

	A_xB_y	$\rightleftharpoons$	xA^{y+}	+	yB^{x-}
	C		0		0
	$C(1-\alpha)$		$xc\alpha$		$yc\alpha$

$$K=\frac{(xc\alpha)^x\times(yc\alpha)^y}{c(1-\alpha)}$$

$$K=\frac{x^x y^y c^{x+y}\alpha^{x+y}}{c}$$

$$K=x^x y^y c^{(x+y-1)}\cdot\alpha^{(x+y)}$$

$$\alpha=\left[\frac{K}{x^x y^y c^{(x+y-1)}}\right]^{1/(x+y)}$$

15. Choose the correct option.

(1) IE_1 of Cr > IE_1 of Mn

(2) IE_2 of Cr > IE_2 of Mn

(3) IE_2 of Cr < IE_1 of Mn

(4) IE_2 of Mn > IE_2 of Cr

Answer (2)

Sol.

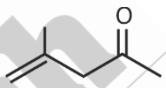
	Cr	Mn
IE_1(KJ/mol)	653	717
IE_2(KJ/mol)	1592	1509

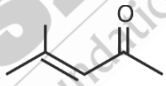
16. Consider the following reaction

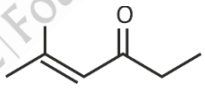
$$CH_3CN \xrightarrow[(ii)\ H_3O^+]{(i)\ CH_3MgBr} P$$

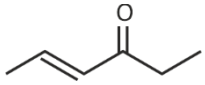
$$CH_3C\equiv CH \xrightarrow[H_2SO_4]{Hg^{2+}} Q$$

$$P+Q \xrightarrow[dil,\ \Delta]{Ba(OH)_2} \text{Product}$$

(1) 

(2) 

(3) 

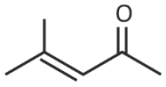
(4) 

Answer (2)

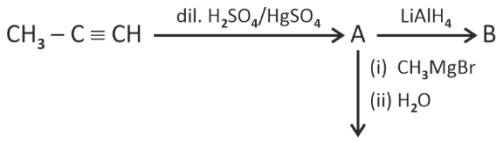
Sol.

P ⇒ 

Q ⇒ 

$$P+Q \xrightarrow[OH^-]{dil}$$ 

17. Consider the following reaction sequence



C

Which of the following test can be used to distinguish between B and C

(1) Luces test

(2) Fehling solution

(3) Benedict's test

(4) Tollen's test

Answer (1)

Sol. (A) $\Rightarrow CH_3-\overset{\overset{O}{\|}}{C}-CH_3$

(B) $\Rightarrow CH_3 - CH(OH) - CH_3$

(C) $\Rightarrow CH_3-\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3$

B and C can be distinguish by Lucas test

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. For the reaction, $C_4H_8(g) \rightleftharpoons 2C_2H_4(g)$ 75% dissociation of C_4H_8 is observed and total equilibrium pressure is 1 atm at 298 K.

Find magnitude of ΔG° in KJ/mol (nearest integer)

$\left(\log \frac{9}{1.75} = 0.71\right)$.

$R = 8.3\ JK^{-1}mol^{-1}$

Answer (4)

Sol. $C_4H_8 \rightleftharpoons 2C_2H_4(g)$

P 0

P – 0.75P 0.75 P × 2

0.25P 1.5P

0.25P + 1.5P = 1

1.75P = 1

$P = \frac{1}{1.75}$

$K_p = \frac{(1.5P)^2}{0.25P}$

= 9P

= 9/1.75

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

= –8.3 × 298 × 2.303 log (9/1.75)

= 5696.2 × 0.71

= 4.044 KJ

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 :

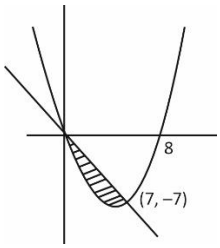
1. The area (in square units) of the region $\{(x, y) : x^2 - 8x \le y \le -x\}$ is :

(1) $\frac{343}{6}$ (2) $\frac{241}{6}$

(3) $\frac{221}{6}$ (4) $\frac{323}{6}$

Answer (1)

Sol.



Point of intersection of $y = x^2 - 8x$ and $y = -x$ is (0, 0) are (7, –7)

required are $= \int_0^7 (-x - x^2 + 8x)dx$

$= \int_0^7 (7x - x^2)dx$

$= \left[\frac{7x^2}{2} - \frac{x^3}{2}\right]_0^7$

$= \frac{343}{2} - \frac{343}{3}$

$= \frac{343}{6}$

2. Sum of $1 + \frac{1}{2}\left(1^2 + 2^2\right) + \frac{1}{3}\left(1^2 + 2^2 + 3^2\right) + \ldots$ upto 10 terms is

(1) $\frac{313}{2}$ (2) $\frac{315}{2}$

(3) 313 (4) 315

Answer (2)

Sol. $T_n = \frac{1}{n} \times \frac{n(n+1)(2n+1)}{6}$

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

$S_n = \sum_{n=1}^{10} T_n = \frac{1}{6}\sum_{n=1}^{10} 2n^2 + 3n + 1$

$= \frac{1}{6}\left[2 \times \frac{10 \times 11 \times 21}{6} + \frac{3 \times 10 \times 11}{2} + 10\right]$

$= \frac{315}{2}$

3. $\int_{-1}^{1} \frac{x^3 + |x| + 1}{x^2 + |x| + 1} dx$ is equal to

(1) $\ln 3 - \frac{\pi}{3\sqrt{3}}$ (2) $\ln 3 + \frac{\pi}{3\sqrt{3}}$

(3) $\frac{\pi}{3\sqrt{3}}$ (4) $\frac{-\pi}{3\sqrt{3}}$

Answer (2)

Sol. $\int_0^1 \frac{2|x| + 2}{x^2 + |x| + 1} dx$

$2\int_0^1 \frac{x+1}{x^2 + x + 1} dx = \int_0^1 \frac{2x+1}{x^2 + x + 1} dx + \int_0^1 \frac{1}{x^2 + x + 1} dx$

$$= \ln\left|x^2+x+1\right|\Big]_0^1 + \int_0^1 \frac{1}{\left(x+\frac{1}{x}\right)^2+\frac{3}{4}}dx$$

$$= \ln 3 + \frac{2}{3\sqrt{3}}\tan^{-1}\left(\frac{x+\frac{1}{2}}{\frac{\sqrt{3}}{2}}\right)\Bigg]_0^1$$

$$= \ln 3 + \frac{2}{\sqrt{3}}\left(\tan^{-1}\sqrt{3} - \tan^{-1}\frac{1}{\sqrt{3}}\right)$$

$$= \ln 3 + \frac{\pi}{3\sqrt{3}}$$

4. If matrix $A = \begin{bmatrix} 1 & 0 & 0 \\ 3 & 1 & 0 \\ 3 & 3 & 1 \end{bmatrix}$ and matrix $[b_{ij}] = B = A^{99} - I_{3\times 3}$, then the value of $\left(\frac{b_{31}+b_{32}}{b_{21}}\right)$ is equal to

(1) 147

(2) 149

(3) 160

(4) 159

Answer (2)

Sol. $A = \begin{bmatrix} 1 & 0 & 0 \\ 3 & 1 & 0 \\ 3 & 3 & 1 \end{bmatrix}$

$$A - I = \begin{bmatrix} 0 & 0 & 0 \\ 3 & 0 & 0 \\ 3 & 3 & 0 \end{bmatrix} = C \text{ (say)}$$

$A = (I + C)$

$A^{99} = (I + C)^{99}$

$$C^2 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 9 & 0 & 0 \end{bmatrix}, C^3 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} = O_{3\times 3}$$

$A^{99} = I^{99} + {}^{99}C_{98}I^{98}C^1 + {}^{99}C_{97}I^{97}C^2 + 0 + 0$

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} + 99\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 3 & 0 & 0 \end{bmatrix}\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 3 & 3 & 0 \end{bmatrix} + {}^{99}C_{27}\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 9 & 0 & 0 \end{bmatrix}$$

$$A^{99} - I\begin{bmatrix} 1 & 0 & 0 \\ 297 & 1 & 0 \\ 43956 & 297 & 1 \end{bmatrix} - \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$A^{99} - I = B = \begin{bmatrix} 1 & 0 & 0 \\ 297 & 1 & 0 \\ 43956 & 297 & 1 \end{bmatrix}$$

$\Rightarrow b_{31} = 43956$

$b_{32} = 299$, $b_{21} = 297$

$$\Rightarrow \frac{b_{31}+b_{32}}{b_{21}} = \frac{43956}{297} + 1$$

$= 149$

5. The value of x for which

$$\sin^{-1}\left(\frac{2}{3}\sqrt{1-x^2}\right) = \cot^{-1}\left(2\sqrt{x}\right) \text{ is}$$

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

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

Answer (1)

Sol. $\sin^{-1}\left(\frac{2}{3}\sqrt{1-x^2}\right) = \cot^{-1}(2\sqrt{x})$

$$\sin^{-1}\left(\frac{2}{3}\sqrt{1-x^2}\right) = \sin^{-1}\left(\frac{1}{\sqrt{1+4x}}\right)$$

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

Squaring both sides

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

$4(1 - x^2)(1 + 4x) = 9$

$4(1 + 4x - x^2 - 4x^3) = 9$

$4 + 16x - 4x^2 - 16x^3 = 9$

$16x^3 + 4x^2 - 16x + 5 = 0$

$x = \frac{-5}{4}, \frac{1}{2}$

but x cannot be negative

$\Rightarrow x = \frac{1}{2}$

6. Consider two vectors

$\vec{a} = 2\hat{i} + 3\hat{j} + 3\hat{k}$,

$\vec{b} = 6\hat{i} + 3\hat{j} + 3\hat{k}$

If $2\vec{a} + 3\vec{b}$ and $\vec{a} - \vec{b}$ are two adjacent sides of a triangle, then the square of area of triangle is

(1) 1800 (2) 900

(3) 902 (4) 680

Answer (1)

Sol. $\vec{a} = 2\hat{i} + 3\hat{j} + 3\hat{k}$

$\vec{b} = 6\hat{i} + 3\hat{j} + 3\hat{k}$

Let $\vec{u} = 2\vec{a} + 3\vec{b} = 2(2\hat{i} + 3\hat{j} + 3\hat{k}) + 3(6\hat{i} + 3\hat{j} + 3\hat{k})$

$= 22\hat{i} + 15\hat{j} + 15\hat{k}$

$\vec{v} = \vec{a} - \vec{b} = -4\hat{i}$

$$\vec{u} \times \vec{v} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 22 & 19 & 15 \\ -4 & 0 & 0 \end{vmatrix}$$

$= -4(15\hat{j} - 15\hat{k}) = 60\hat{j} - 60\hat{k}$

$|\vec{u} \times \vec{v}| = \sqrt{(60)^2 + (-60)^2} = \sqrt{7200}$

Area = $\frac{1}{2}|\vec{u} \times \vec{v}|$

$= \frac{1}{2}\sqrt{7200}$

sq. of area = $\frac{1}{4} \times 7200 = 1800$

7. Consider the function $f: R \to R$ such that

$f(x) = \frac{2x^2 + x + 2}{3x^2 + 2x + 3}$, then $f(x)$ is

(1) one-one & onto (2) one-one & into

(3) many one & onto (4) many one & into

Answer (4)

Sol. $f(x) = \frac{2x^2 + x + 2}{3x^2 + 2x + 3}$

$\Rightarrow y = \frac{2x^2 + x + 2}{3x^2 + 2x + 3}$

$x^2(3y - 2) + x(2y - 1) + 3y - 2 = 0$

since $x \in R$

$\Rightarrow D \geq 0$

$(2y - 1)^2 - 4(3y - 2)^2 \geq 0$

$(2y - 1)^2 - (6y - 4)^2 \geq 0$

$(8y - 5)(-4y + 3) \geq 0$

$(8y - 5)(4y - 3) \leq 0$

$\Rightarrow y \in \left[\frac{5}{8}, \frac{3}{4}\right]$

$\Rightarrow$ range $\neq$ codomain $\Rightarrow$ into and also

$\lim_{x \to \infty} f(x) = \lim_{x \to \infty^-} f(x) = \frac{2}{3}$ and $f(x)$ is continuous

$\Rightarrow$ function is many one

8. The shortest distance between skew lines

$L_1 : \frac{x+5}{2} = \frac{y-1}{12} = \frac{z-2}{-5}$ and

$L_2 : \frac{x-2}{3} = \frac{y-2}{4} = \frac{z-4}{-1}$ is

(1) $\frac{14}{\sqrt{1107}}$ (2) $\frac{13}{\sqrt{1017}}$

(3) $\frac{21}{\sqrt{1701}}$ (4) $\frac{19}{\sqrt{7101}}$

Answer (2)

Sol. $SD = \dfrac{\left(\vec{a}_2 - \vec{a}_1\right)\left(\vec{b}_1 - \vec{b}_2\right)}{|\vec{b}_1 \times \vec{b}_2|}$

$$= \frac{\begin{vmatrix} 2+5 & 2-1 & 4-2 \\ 2 & 12 & -5 \\ 3 & 4 & -1 \end{vmatrix}}{\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 12 & -5 \\ 3 & 4 & -1 \end{vmatrix}}$$

$$= \frac{\begin{vmatrix} 7 & 1 & 2 \\ 2 & 12 & -5 \\ 3 & 4 & -1 \end{vmatrix}}{\sqrt{8^2 + 13^2 + 28^2}}$$

$$= \frac{13}{\sqrt{1017}}$$

9. A circle has centre in the I[st] Quadrant and touches the x-axis at a distance of 3 units from the origin and cutoff an intercept of $6\sqrt{3}$ on y-axis. Then, then length of chord having equation $x - y = 1$ intercepted by the circle is

(1) $2\sqrt{7}$ (2) $3\sqrt{7}$

(3) $\sqrt{7}$ (4) $4\sqrt{7}$

Answer (4)

Sol. Center of the circle = (3, r)

$(x-3)^2 + (y-r)^2 = r^2$

$x^2 + y^2 - 6x - 2ry + 9 = 0$

$2\sqrt{r^2 - 9} = 6\sqrt{3}$

$\sqrt{r^2 - 9} = 3\sqrt{3}$

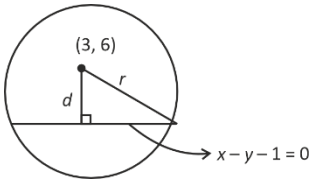
$r^2 - 9 = 27$

$r^2 = 36$

$r = 6$

$(x-3)^2 + (y-6)^2 = 36$

center (3, 6)



$d = \left|\dfrac{3-6-1}{\sqrt{2}}\right| = \dfrac{4}{\sqrt{2}} = 2\sqrt{2}$

Chord length $= 2\sqrt{r^2 - d^2}$

$= 2\sqrt{36 - 8}$

$= 2\sqrt{28} = 4\sqrt{7}$

10. An ellipse having eccentricity $\dfrac{1}{\sqrt{3}}$ and equation of its directrix is $x = 2\sqrt{2}$. A hyperbola whose eccentricity is equal to the length of semi-major axis of ellipse and its length of latus rectum is equal to length of minor axis of ellipse, then the distance between the foci of hyperbola is

(1) $\dfrac{16\sqrt{3}}{5}$ (2) $\dfrac{16\sqrt{6}}{15}$

(3) $\dfrac{17\sqrt{3}}{6}$ (4) $\dfrac{15\sqrt{3}}{6}$

Answer (2)

Sol. Equation = $\dfrac{1}{\sqrt{3}}$

Equation of directrix of ellipse is $x = \pm\dfrac{a}{e}$

$x = 2\sqrt{2}$

$\therefore \dfrac{a}{e} = 2\sqrt{2}$

$a = 2\sqrt{2} \times \dfrac{1}{\sqrt{3}} = \dfrac{2\sqrt{2}}{\sqrt{3}}$

$e_E^2 = 1 - \dfrac{b^2}{a^2}$

$$\frac{1}{3}=1-\frac{3b^2}{8} \Rightarrow \frac{3b^2}{8}=1-\frac{1}{3}=\frac{2}{3}$$

$$b^2=\frac{2}{3}\times\frac{8}{3}=\frac{16}{9}$$

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

$$e_H=2\sqrt{\frac{2}{3}}$$

$$LR_H=\frac{2b_H^2}{a_H}=2b=\frac{8}{3}$$

$$b_H^2=\frac{4}{3}a_H$$

$$e_H^2=1+\frac{b_H^2}{a_H^2}$$

$$\frac{8}{3}=1+\frac{4a_H}{3a_{H^2}}$$

$$\frac{5}{3}=\frac{4}{3a_H}$$

$$\Rightarrow a_H=\frac{4}{5}$$

Distance between foci of hyperbola is $2a_He_H$

$$=2\times\frac{4}{5}\times\frac{2\sqrt{2}}{\sqrt{3}}$$

$$=\frac{16\sqrt{6}}{15}$$

11. If the mean and variance of the observations 2, 4, α, 8, β, 12, 14 (where $\alpha < \beta$) are 8 and 16 respectively. Then, the equation whose roots are $3\alpha + 2$ and $4\beta + 1$ is

(1) $x^2 - 61x + 820 = 0$ (2) $x^2 - 60x + 340 = 0$

(3) $x^2 - 60x + 81 = 0$ (4) $x^2 - 61x + 810 = 0$

Answer (1)

Sol. Mean = $\frac{40+\alpha+\beta}{7}$

$$\frac{40+\alpha+\beta}{7}=8$$

$\alpha + \beta = 16$

Variance = 16

$$\frac{424+\alpha^2+\beta^2}{7}-64=16$$

$\alpha^2 + \beta^2 = 136$

$\alpha = 6, \beta = 10$

Equation whose roots are $3\alpha + 2$ and $4\beta + 1$.

20, 41

$x^2 - 61x + 820 = 0$

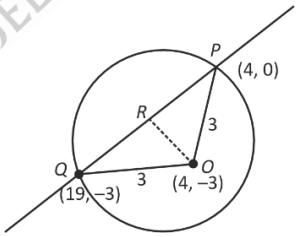
12. The line $x - y = 4$ intercept the circle $(x-4)^2 + (y + 3)^2 = 9$ at point P and Q. There is a point $M(\alpha, \beta)$ on circle such that $MP = MQ$. Then the value of $|6\alpha + 8\beta|$ is equal to

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

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

Answer (1)

Sol.



Slope of given line, $m_1 = 1$

slope of 1st line $m_2 = -1$

Equation of Ist line (OR) :

$y + 3 = -1 (x - 4)$

$x + y = 1$

Pont of intersection of x + y = 1 and $(x-4)^2+(y+3)^2=9$

$(x-4)^2+(1+x)+3)^2=9$

$(x-4)^2+(4+x)^2=9$

$2(x-4)^2=9 \Rightarrow x-4\frac{\pm 3}{\sqrt{2}}$

$x=4\pm\frac{3}{\sqrt{2}}$

$\therefore y=-3\pm\frac{3}{\sqrt{2}}$

$\therefore$ Possible co-ordinates of *M* are

$\left(4+\frac{3}{\sqrt{2}},-3-\frac{3}{\sqrt{2}}\right)$ and $\left(4-\frac{3}{\sqrt{2}},-3+\frac{3}{\sqrt{2}}\right)$

$\therefore |6\alpha+8\beta|=3\sqrt{2}$

13. If $\cos3\theta+2\cos2\theta=-2$, then sum of all possible solutions in $[0, 2\pi]$ is

(1) π (2) 2π

(3) 3π (4) 4π

Answer (4)

Sol. $\cos3\theta+2\cos2\theta+2=0$

$4\cos^3\theta-3\cos\theta+2(2\cos^2\theta-1)+2=0$

$\cos\theta(4\cos^2\theta-3+4\cos\theta)=0$

$\cos\theta(4\cos^2\theta+4\cos\theta-3)=0$

$\cos\theta(4\cos^2\theta+6\cos\theta-2\cos\theta-3)=0$

$\cos\theta(2\cos\theta-1)(2\cos\theta+3)=0$

So, $\cos\theta=0$ or $\cos\theta=\frac{1}{2}$

$\Rightarrow \theta\in\frac{\pi}{2},\frac{3\pi}{2}$ $\Rightarrow \theta=\frac{\pi}{3},\frac{5\pi}{3}$

$\sum\theta=\frac{\pi}{2}+\frac{3\pi}{2}+\frac{\pi}{3}+\frac{5\pi}{3}$

$=4\pi$

14. Let $\lim\limits_{x\to2}\frac{\tan(x-2)\left(rx^2+(p-2)x-2p\right)}{(x-2)^2}=5$. If both roots of the equation $rx^2-px+q=0$ lie in interval (0, 2) then set of values of *q* is $(\alpha, \beta]$ then $16(\beta-\alpha)^2$ is equal to

(1) 2 (2) 1

(3) 4 (4) 8

Answer (2)

Sol. $\lim\limits_{x\to2}\left(\frac{\tan(x-2)}{x-2}\right)\left(\frac{rx^2-(p-2)x+2p}{x-2}\right)=5$

$=\lim\limits_{x\to2}\left(\frac{rx^2-px+2x+2p}{x-2}\right)=5$

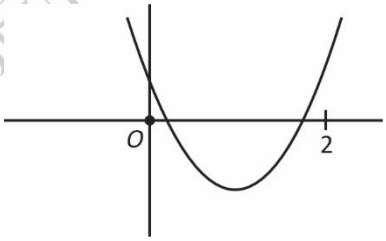
$4r-4=0 \Rightarrow r=1$

$\lim\limits_{x\to2}\frac{2rx+(p-2)}{1}=5$

$4+p-2=5 \Rightarrow p=3$

$\Rightarrow x^2-3x+q=0$ have both roots in (0, 2).

$\Rightarrow$ (i) $D\geq0 \Rightarrow 9-4q\geq0 \Rightarrow q\leq\frac{9}{4}$



$f(0)>0, f(2)>0 \Rightarrow q>0, q>2$

$\Rightarrow q\in\left(2,\frac{9}{4}\right]$

$(\beta-\alpha)^2=\left(\frac{9}{4}-2\right)^2=\left(\frac{1}{4}\right)^2=\frac{1}{16}$

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.

22.

23.

24.

25.

❑ ❑ ❑