JEE (Main)-2026

Session-1

23 January 2026 Shift-2

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.

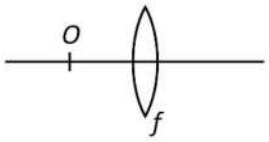
PHYSICS

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. When an object is kept at distance 8 cm and 24 cm from a convex lens magnitude of magnification is same in both cases. Find focal length of the lens.



(1) 32 cm (2) 8 cm

(3) 24 cm (4) 16 cm

Answer (4)

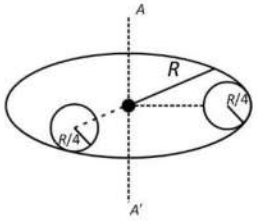
Sol. $m = m = \dfrac{f}{f+\mu}$

$$\frac{f}{f+8} - \left(\frac{f}{f-24}\right)$$

$$-\quad f+24 = f-8$$
$$32 = 2f$$

$F = 16$ cm

2. From a uniform disk of radius R and mass M two small disk of radius $\frac{R}{4}$ is being cut as shown in figure. Find the moment if inertia of the system about exist AA′



(1) $\dfrac{79MR^2}{128}$ (2) $\dfrac{79MR^2}{256}$

(3) $\dfrac{109MR^2}{256}$ (4) $\dfrac{109MR^2}{128}$

Answer (3)

Sol. $\dfrac{MR^2}{2} - \left(\dfrac{MR^2}{16\times 2} + \dfrac{M9R^2}{16}\right)\times 2 = I$

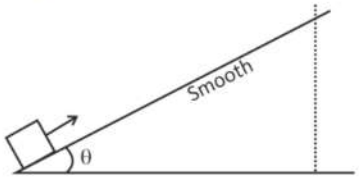
Also $m = \dfrac{M}{16}$

So $I = \dfrac{MR^2}{2} - \dfrac{2MR^2}{16}\left(\dfrac{1}{2}+9\right)$

$$= \frac{MR^2}{2} - \frac{2MR^2}{16\times 16}\times\frac{19}{2}$$

$$= \frac{109}{256}MR^2$$

3. A body is projected up the smooth incline plane having angle of inclination θ with the horizontal as shown in the figure. Find the distance covered before stopping.



(1) $\dfrac{u^2}{2g\cos\theta}$ (2) $\dfrac{u^2}{2g}$

(3) $\dfrac{u^2}{2g\sin\theta}$ (4) $\dfrac{u^2}{2g\tan\theta}$

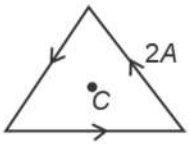
Answer (3)

Sol. $mgh = \dfrac{1}{2}mu^2$

$$\frac{u^2}{2g} = h$$

$$l = \frac{h}{\sin\theta} = \frac{u^2}{2g\sin\theta}$$

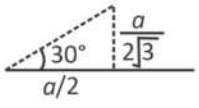
4. In equilateral triangular frame, then is current of 2*A*. The side of frame is $4\sqrt{3}$ cm. Magnetic field at center *C* is



(1) $30\sqrt{3}\ \mu T$ (2) $10\sqrt{3}\ \mu T$

(3) $3\sqrt{10}\ \mu T$ (4) $10\sqrt{10}\ \mu T$

Answer (1)

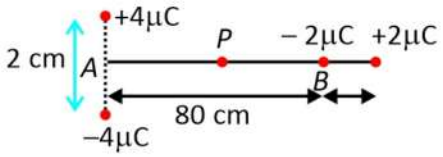
Sol. 

$$B=\frac{\mu_0 i\times 2\times Cu30^\circ}{4\pi\left\{\frac{a}{2\sqrt{3}}\right\}}$$

$$B=\frac{\mu_0\sqrt{3}}{2\pi\times 2\times 10^{-2}} = 10^{-5};$$

$$B_{net}=3\sqrt{3}\times 10^{-5}$$

5. Four charges are kept as shown in the figure. Find magnitude of electric field at point *P*. *P* is midpoint of line *AB*.

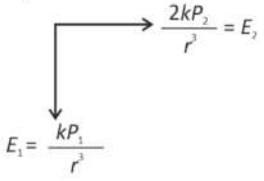


(1) 180 kV/m (2) $\frac{45\sqrt{5}}{8}$ kV/m

(3) 270 kV/m (4) $60\sqrt{3}$ kV/m

Answer (2)

Sol. $P_1=8\times 10^{-8}$ $P_2=2\times 10^{-8}$



$$E_1=\frac{9\times 10^9\times 8\times 10^{-8}}{64\times 10^{03}}, E_2=\frac{9\times 10^9\times 2\times 2\times 10^{-8}}{64\times 10^{-3}}$$

$$=\frac{9}{8}\times 10^4 \qquad =\frac{9}{16}\times 10^4$$

$$E=\frac{9}{16}\sqrt{5}\times 10^4$$

$$=\frac{45\sqrt{5}}{8}\times 10^3$$

6. One mole of diatomic gas is expanding isothermally from *V* to 2*V* at 27°C. If the magnitude of work done by the gas in this case is same as the work done in adiabatic process where initial temperature is 27°C and final temperature is *T*°C. Find the value of *T*. [Use ln2 = 0.7]

(1) −37°C (2) −57°C

(3) −35°C (4) 0°C

Answer (2)

Sol. $\Delta w_1 = NRT\ell n(2) = 300R\ell n(2)$

$$\Delta w_2 = N\frac{5}{2}R(T_i - T)$$

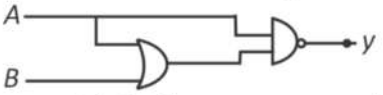
$$\Rightarrow \frac{5}{2}R(300-T)=300R\ell n(2)$$

$$\Rightarrow 300 - T = 120\ell n(2) \qquad [\ell n2 = 0.7]$$

$$\Rightarrow 300 - 84 = T = 216\ K$$

$$\Rightarrow T = -57°C$$

7. Find the truth table for the given circuit.



(1)

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0

(2)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(3)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

(4)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

Answer (1)

Sol. $\overline{A\cdot(A+B)}$

$$\overline{A}+\overline{(A+B)}$$

$$\overline{A}+\overline{A}\cdot\overline{B}=\overline{A}$$

8. An air bubble is moving upward from the bottom of lake having temperature 17°C. At the top the temperature of lake (and bubble) is 27°C. Assume no significant change in the density of the lake water upto its depth of 5m. Find the ratio of volume at top to bottom of the bubble.

(1) 1.25 (2) 1.75

(3) 1.55 (4) 1.85

Answer (3)

Sol. $P_{atm} = 10^5$ N/m^2 $\rho_\omega = 10^3$ kg/m^3

$g = 10$ m/s^2

$$\frac{10^5}{300} \times v_T = \frac{10^5 + 5 \times 10^3 \times g \times v_B}{290}$$

$$\frac{V_T}{V_B} = 1.5 \times \frac{30}{29} = 1.55$$

9. For a medium permeability $\mu = 2\mu_0$ and dielectric constant is 3. Find the ratio of speed in vacuum to speed in medium.

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

(3) $\sqrt{6}$ (4) 6

Answer (3)

Sol. $$v = \frac{1}{\sqrt{\mu\varepsilon}}$$

So $$\frac{c}{v} = \sqrt{\frac{\mu\varepsilon}{\mu_0\varepsilon_0}}$$

$$\frac{c}{v} = \sqrt{6}$$

10. EMF of two cells are measured using potentiometer method. If the balance lengths are 200 cm and 150 cm respectively. If the least count is 1 cm then find % error in calculating $\frac{E_1}{E_2}$.

(1) 1.2% (2) 1.16%

(3) 0.50% (4) 0.75%

Answer (2)

Sol. $$E_1 = \left(\frac{E_0}{l_0}\right) l_1$$

$$E_2 = \left(\frac{E_0}{l_0}\right) l_2$$

$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

So, $$\left(\frac{\Delta l_1}{l_1} + \frac{\Delta l_2}{l_2}\right) \times 100 \approx 1.16\ \%$$

11. A man jumps from a plane, after 2 seconds he open parachute due to which if he retarded with 3 m/s^2. When the man is at 10 m height from ground his speed is 5 m/s. Find height of the plane when he jumped.

(1) 92.5 m (2) 90 m

(3) 85 m (4) 110 m

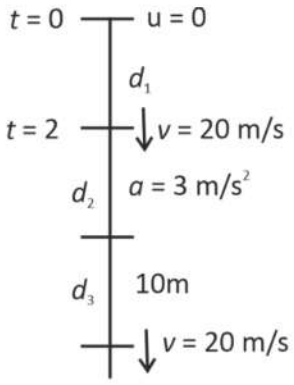
Answer (1)

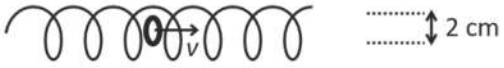
Sol. $d_1 = \frac{1}{2} \times 10 \times 4 = 20$ m

$$d_2 = \frac{400 - 25}{2 \times 3} = \frac{375}{6} = 62.5$$

$d = 20 + 62.5 + 10$

$= 92.5$



12. 

In a long solenoid of cross-section radius of 2 cm and of 500/cm turns density. A ring moves with constant speed 10 cm/s with axis coinciding with axis of solenoid. The radius and resistance of ring is 1 cm and 10Ω. Find heat dissipated in ring while it transverses 10 cm of distance. The current in solenoid is $I = 10\cos(100\pi t)$

(1) 300 μJ (2) 200 μJ

(3) 700 μJ (4) 850 μJ

Answer (2)

Sol. $\phi = BA$

$\phi = \mu_0 niA$

$$\varepsilon = -\mu_0 nA\frac{di}{dt} = \mu_0 nA\, i_0\omega\sin\omega t$$

$$\int P dt = \int \frac{\mu_0^2 n^2 A^2 i_0^2 \omega^2}{R}\sin^2\omega t\, dt$$

$$= \frac{\mu_0^2 n^2 A^2 i_0^2 \omega^2}{R}\times\frac{1}{2}$$

$$= \frac{(4\pi\times10^{-7})^2\times(50000)^2(\pi\times10^{-4})^2 100\times10^4\times\pi^2}{10\times2}$$

$$= \frac{16}{2}\times10\times10^{-14}\times25\times10^8\times10\times10^{-8}\times10^6\times\frac{10}{10}$$

$$= \frac{400}{2}\times10^{1-14+8+1-8+6}$$

$$= \frac{400}{2}\times10^{-6}\text{ J}$$

$= 200 \times 10^{-6}$

13. A small spherical ball of diameter 2 mm & density 10.5 gm/cc is dropped into a large column of viscous liquid. The density of liquid is 1.5 gm/cc and coefficient of viscosity is 10 poise calculate the terminal velocity (g = 10 m/s^2).

(1) 1 cm/s (2) 2 cm/s

(3) 3.5 cm/s (4) 1.5 cm/s

Answer (2)

Sol. $V_t = \frac{2}{9}\frac{r^2 g}{\eta}(\sigma-\rho)$

$= 20 \times 10^{-3}$ m/s $= 2 \times 10^{-2}$ m/s

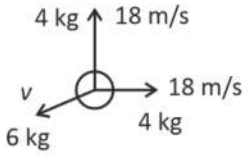
14. A mass of 14 kg is exploded into three fragments of 2 : 2 : 3 and both equal fragments fly off with same speed 18 m/s in mutually perpendicular direction. Then find the speed of the third fragment immediately after the explosion.

(1) $12\sqrt{2}$ (2) $6\sqrt{2}$

(3) $8\sqrt{2}$ (4) $10\sqrt{2}$

Answer (1)

Sol.



$\vec{P}_1 + \vec{P}_2 + \vec{P}_3 = 0$

$\vec{P}_1 + \vec{P}_2 = \vec{P}_3$

$\Rightarrow 6 \times v = \sqrt{2} \times 72$

$V = 12\sqrt{2}$ m/s

15. Speed of sound in air at 0°C is v. Then at what temperature (°C) the speed of sound becomes $2v$?

(1) 732°C (2) 1092°C

(3) 975°C (4) 819°C

Answer (4)

Sol. $v = \sqrt{CT}$

So $\frac{v}{v'} = \sqrt{\frac{T}{T'}}$

$\Rightarrow \frac{v}{v'} = \sqrt{\frac{273}{T}} = \frac{1}{2}$

$\Rightarrow T = 273 \times 4 = 1092$ K

So, $T = 819$°C

16. There is electric field in space given as $\vec{E}=\frac{A}{r^2}\hat{r}$ (A is constant). Thera are two point charges of –2 μC and 7 μC present at (9, 0, 0) and (–9, 0, 0) respectively. If electric potential energy of system is zero then A in SI units is

(1) $0.63 \times 10^{+3}$

(2) –0.325

(3) 1.26×10^{4}

(4) 0.325

Answer (3)

Sol. $\frac{Kq}{r^2}=\frac{A}{r^2}$

$q=\frac{A}{k}$

$U=\sum\frac{kq_iq_j}{r_{ij}}$

$U=\frac{K(-14)\times10^{-12}}{18}+K(5)\frac{A}{k\cdot g}$

$=\frac{9\times10^{9}\times10^{-12}}{18}+K(5)\frac{A}{k\cdot g}$

$U=-7\times10^{-3}+\frac{5A\times10^{-6}}{9}$

$10^{6}\times\frac{63}{5}\times10^{-3}=A$

$12.6 \times 10^{+3} = A$

17. Fission of single nucleus of U-235 liberates energy of 96 MeV. Energy released by fission of 47 gm of uranium is _____.

(1) 1.84×10^{12} J

(2) 3.28×10^{9} J

(3) 1.42×10^{15} J

(4) 3.21×10^{14} J

Answer (1)

Sol. Moles = $\frac{47}{235}=\frac{1}{5}$ mole

N = $\frac{6\times10^{23}}{5}$

E = $NE=\frac{6\times10^{23}}{5}\times96\times10^{6}\times1.6\times10^{-19}$

= $\frac{6\times96\times1.6}{5}=10^{10}$

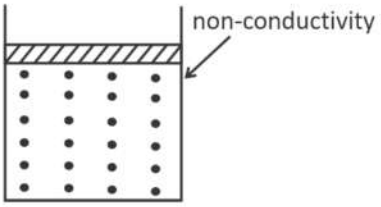
= 1.84×10^{12} J

18. 1 mole of gas is enclosed in a vertical cylinder and sealed with a massless frictionless piston as shown. On supplying 126 J of heat its temperature raised by 4°C. Find the height moved by piston due to the heat transfer. Internal energy of the gas is given by $U = 3nRT$

($P = 10^5$ N/m^2)

($R = 8.3$ J/K)

($A_{piston} = 17$ cm^2)



(1) 12.50 cm

(2) 13.50 cm

(3) 14.50 cm

(4) 15.50 cm

Answer (4)

Sol. $\Delta Q = \Delta U + P\Delta V$

$126 = 3 \times 8.3 \times 4 + 10^5 \times 16 \times 10^{-4} \times h$

$126 = 99.6 + 1.7\, h \times 10^2$

$h = 15.53$ cm

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 r = radius of ball

ρ = density of liquid

σ = density of ball

t = time

A = constant

η = viscosity

For the expression $t = A(\rho)^a (\sigma)^b r^c (\eta)^d$

Then the value of $\frac{c-d}{a+b}$ is

Answer (3)

Sol. $T = \left(\frac{M}{L^3}\right)^{a+b} (L)^c (ML^{-1}T^{-1})^d$

Let $a + b = Z$

Then $Z + d = 0 \Rightarrow Z = -d$

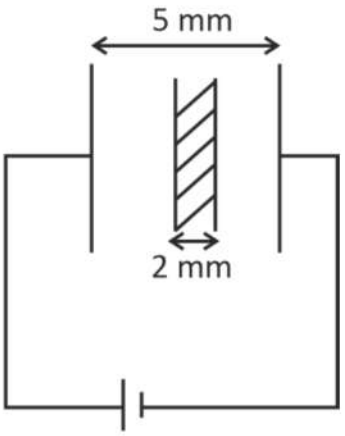
$c - 3Z - d = 0 \quad c - 2Z = 0 \Rightarrow c = 2z$

$-d = 1 ; \; Z = 1 = (a + b)$

$c = 2$

So, $\frac{c-d}{(a+b)} = \frac{2+1}{1} = 3$

22. An empty capacitor is charged with charge Q when attached with battery as shown. Now a mica sheet of 2 mm thickness is inserted and charge on capacitor $\frac{5}{4}a$ then the dielectric constant of mica is _____ .



Answer (2)

Sol. $\frac{Q_1}{Q_2} = \frac{C_1}{C_2} \quad \frac{\frac{Q}{5}}{4} Q = \frac{\frac{\varepsilon_0 A}{d}}{\frac{\varepsilon_0 A}{d - t + \frac{t}{K}}}$

$\Rightarrow \frac{4}{5} = \frac{3 + \frac{2}{K}}{5} \Rightarrow K = 2$

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. For XeO_2F_2, select the correct statement(s).

   (A) It shows see-saw shape.

   (B) Number of lone pair(s) of e^- on Xe is 1.

   (C) $\angle FXeF = 180°$ (approx.)

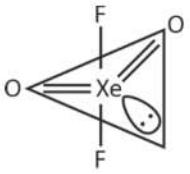
   (D) It has tetrahedral shape.

   (1) (A), (C), (D) Only (2) (A), (B) only

   (3) (A), (B), (C) only (4) (B), (C), (D) only

Answer (3)

Sol.



2. Statement I : Size of O^{2-} is smaller than F^-.

   Statement II : Electronegativity of F is more than that of oxygen.

   In the light of 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

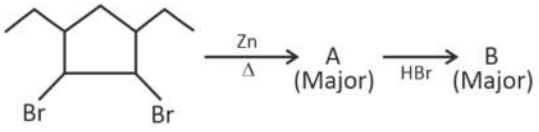
Answer (4)

Sol. Number of proton in O^{2-} is 8 and number of proton in F^- is 9 (both have $10e^-$). So, O^{2-} is larger than F^-

So, Statement I is false.

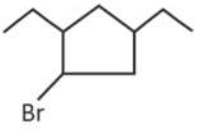
Statement II is true, F is smaller than O, so F is more electronegative than O.

3. Consider the reaction,



Choose the correct option,

(1) A is 

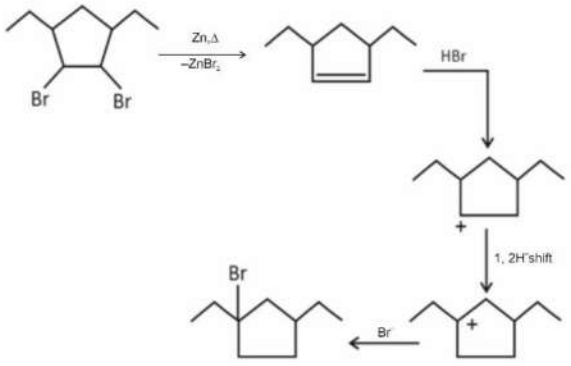
(2) B is 

(3) B is 

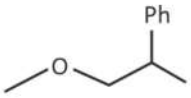
(4) A is 

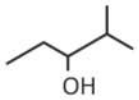
Answer (3)

Sol.



4. Which of the following molecule gives iodoform test.

(1) 

(2) 

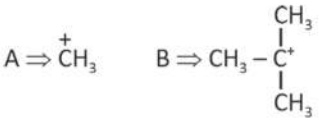
(3) CH_3CH_2OH

(4) CH_3COOH

Answer (3)

Sol. $CH_3CH_2OH \xrightarrow[NaOH]{I_2} HCOO^- + CHI_3 \downarrow$

5. Consider the following intermediates.



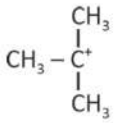
(1) B is more stable than A as it has 9 α hydrogen

(2) A is more stable than B as it has 3 α hydrogen

(3) B is more stable than A due to resonance

(4) A is more stable due to inductive effect

Answer (1)

Sol. 

$\Rightarrow$ more stable as it has 9 α-H

$\Rightarrow$ +I effect is more than B than A

6. DNA is optically active due to the presence of

(1) Purine nitrogenous base

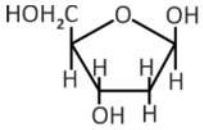
(2) Phosphate molecule

(3) D-pentose sugar

(4) L-pentose sugar

Answer (3)

Sol. DNA is optically active due to D-pentose sugar.



β-D-2-deoxyribose

7. What is the oxidation state of chromium in the product when $K_2Cr_2O_7$ reacts with acidified KI

(1) +6 (2) +3

(3) +4 (4) +5

Answer (2)

Sol. $K_2Cr_2O_7 + 6KI + 7H_2SO_4 \rightarrow Cr_2(SO_4)_3 + 4K_2SO_4 + 3I_2 + 7H_2O$

Cr in product have +3 oxidation state.

8. 250 cc of $x \times 10^{-3}$ M acidified $K_2Cr_2O_7$ solution titrates 750 cc of 0.6 M Mohr's salt completely. Value of x is

(1) 200 (2) 600

(3) 400 (4) 300

Answer (4)

Sol. meq of $K_2Cr_2O_7$ = meq of Mohr's salt

$250 \times x \times 10^{-3} \times 6 = 750 \times 0.6 \times 1$

$\Rightarrow$ $x = 300$

9. Two metals with work function in ratio 1 : 2, are exposed with photons of energy 6 eV. If $KE_A : KE_B$ is 2.642 : 1, then value of ϕ_A and ϕ_B (in eV) are

(1) 2.3, 4.6 (2) 1.4, 2.8

(3) 2.3, 3.6 (4) 3.2, 6.4

Answer (1)

Sol. Let $\phi_A = Y$, then ϕ_B will be 2Y

Let $KE_B = x$, then $KE_A = 2.642x$

$E_i(eV) = \phi(eV) + KE(eV)$

For metal A $\Rightarrow 6 = Y + 2.642x$ ...(I)

For metal B $\Rightarrow 6 = 2Y + x$ ...(II)

From Eq (I) and (II) $Y = 1.642x$

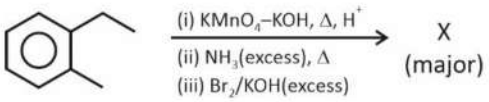
Now put Y in Eq. (II)

$6 = 2(1.642x) + x$

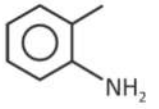
on solving $x = 1.4$, $Y = 1.642 \times 1.4 = 2.3$

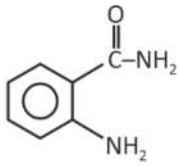
So $\phi_A = Y = 2.3\,eV$, $\phi_B = 2Y = 4.6\,eV$

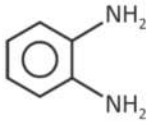
10. Consider the reaction sequence :

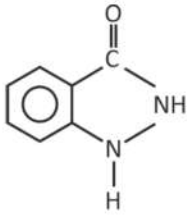


X is,

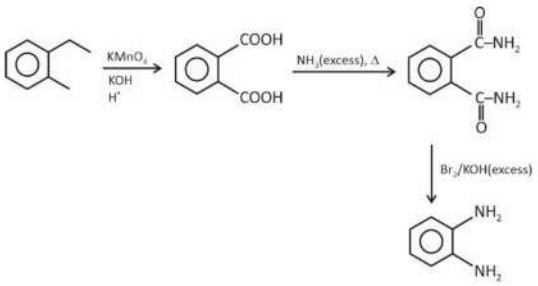
(1) 

(2) 

(3) 

(4) 

Answer (3)

Sol. 

11. Consider the following statement about complexes and its hybridisation.

A. $[CoF_6]^{3-}$; outer orbital complex, sp^3d^2

B. $[Ni(CN)_4]^{2-}$; inner orbital complex; dsp^2

C. $[Co(NH_3)_6]^{3+}$; inner orbital complex; d^2sp^3

D. $[FeF_6]^{3-}$; outer orbital complex; sp^3d^2

Choose the correct statement.

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

(3) A and B only (4) B and C only

Answer (1)

Sol. $[CoF_6]^{3-} \Rightarrow Co^{3+} \Rightarrow 3d^6 \Rightarrow t_{2g}^4 e_g^2$

F^- is WFL $\Rightarrow sp^3d^2$, outer orbital complex.

$[Ni(CN)_4]^{2-} \Rightarrow Ni^{2+}$ with $CN^- \Rightarrow$ SFL $\Rightarrow dsp^2$, inner orbital complex

$[Co(NH_3)_6]^{3+} \Rightarrow Co^{3+} \Rightarrow NH_3$ (SFL) $\Rightarrow d^2sp^3$, inner orbital complex

$[FeF_6]^{3-} \Rightarrow Fe^{3+} \Rightarrow F^-$ (WFL) sp^3d^2, outer orbital complex

12. Consider the following reactions

$PbO_2 + Pb \rightleftharpoons 2PbO; \Delta G_1$

$SnO_2 + Sn \rightleftharpoons 2SnO; \Delta G_2$

Select the correct option?

(1) $\Delta G_1 > 0,\ \Delta G_2 > 0$ (2) $\Delta G_1 < 0,\ \Delta G_2 > 0$

(3) $\Delta G_1 < 0,\ \Delta G_2 < 0$ (4) $\Delta G_1 > 0,\ \Delta G_2 < 0$

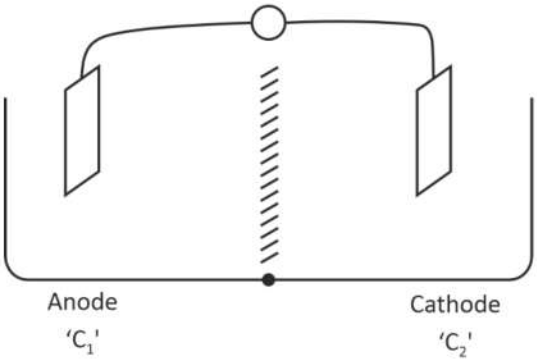
Answer (2)

Sol. Due to inert pair effect, Pb(II) is more stable than Pb(IV)

$\therefore$ $PbO > PbO_2$ (stability)

$SnO_2 > SnO$ (stability)

13. Consider a galvanic cell, made up of two H_2–electrodes,



Both compartments contain the same metal electrodes. If concentrations of H^+ in anode and cathode are C_1 and C_2 respectively, then $E_{cell} > 0$ when, (p_{H_2} = 1 atm in both compartments)

(1) $C_2 < C_1$

(2) $C_2 = C_1$

(3) $C_2 > C_1$

(4) $C_2 = 0.5\ C_1$

Answer (3)

Sol. $\text{LHE}: \underset{C_1}{\frac{1}{2}H_2} \rightarrow \underset{C_1}{H^+} + e^-$

$\text{RHE}: \underset{C_2}{H^+} + e^- \rightarrow \frac{1}{2}H_2$

$\text{Net}: \underset{C_2}{H^+} \rightarrow \underset{C_1}{H^+}$

$$E = E^\circ - \frac{0.0591}{1} \ln \frac{C_1}{C_2}$$

$$E_{cell} = 0.0591 \ln \frac{C_2}{C_1}$$

$C_2 > C_1$ for E_{cell} = +ve.

14. A compound P with molecular formula C_6H_7N is sparingly soluble in water. However on reaction with HCl, it becomes soluble. On reaction with KOH + $CHCl_3$, it gives foul smelling compound Q. The number of different type(s) of H atoms present in P is

(1) 4

(2) 5

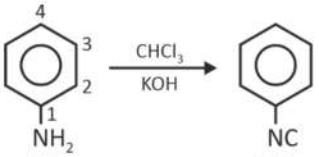
(3) 7

(4) 8

Answer (1)

Sol. C_6H_7N D.U. = 4

$C_6H_5NH_2 + HCl \rightarrow C_6H_8N^+Cl^-$ (Water soluble)



(P) (Q)

Foul smell

Number of different type of H = 4

15. X & Y are elements from group 15. The difference in electronegativity values of X and phosphorus is more than difference in electronegativity of phosphorus and Y. Element X and Y respectively are

(1) N and As

(2) As and Sb

(3) As and N

(4) As and Bi

Answer (1)

Sol. EN of N = 3.0

P = 2.1

As = 2.0

Sb = 1.9

Bi = 1.9

ΔEN(N and P) = 0.9

ΔEN (As and P) = 0.1

ΔEN (Sb and P) = 0.2

ΔEN (Bi and P) = 0.2

16. Given below are two statements.

Statement I: Potassium hypoiodite (KOI) can act as a reducing agent in reaction with H_2O_2.

Statement II: When NaOCl reacts with KI in acidic medium, NaOCl acts as oxidising agent.

In the light of 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 (1)

Sol. $H_2O_2 + KOI \rightarrow KI + H_2O + O_2$

$NaOCl + 2KI + 2HCl \rightarrow NaCl + 2KCl + I_2 + H_2O$

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. In estimation of chlorine by Carius method, 0.245 g organic compound gave 0.5453 g AgCl. Find percentage of chlorine in the organic compound

Answer (55)

Sol. $$\% \text{ of Cl} = \frac{\frac{0.5453}{143.5} \times 35.5}{0.245} \times 100$$

$= 55.06\%$

22. How many of the following complex(es) have unpaired electrons

$[Ni(CO)_4]$, $[NiCl_4]^{2-}$, $[PtCl_4]^{2-}$, $[PdCl_4]^{2-}$

Answer (1)

Sol. $[Ni(CO)_4] = 3d^{10} \Rightarrow sp^3$

n = 0

$[PtCl_4]^{2-} \Rightarrow 5d^8 \Rightarrow dsp^2$

n = 0

$[NiCl_4]^{2-} \Rightarrow 3d^8 \Rightarrow sp^3$

n = 2

$[PdCl_4]^{2-} \Rightarrow 4d^8 \Rightarrow dsp^2$

n = 0

23. An ideal solution is formed by mixing 3 mole of A and 1 mole of B and the vapour pressure of solution is found to be 500 mm Hg. After further addition of 1 mole A, vapour pressure of solution becomes 520 mm Hg. Find P_A^o.

Answer (600)

Sol. $P_S = X_A P_A^o + X_B P_B^o$

$$500 = \frac{3}{4} \times P_A^o + \frac{1}{4} \times P_B^o$$

$2000 = 3P_A^o + P_B^o$ ...(i)

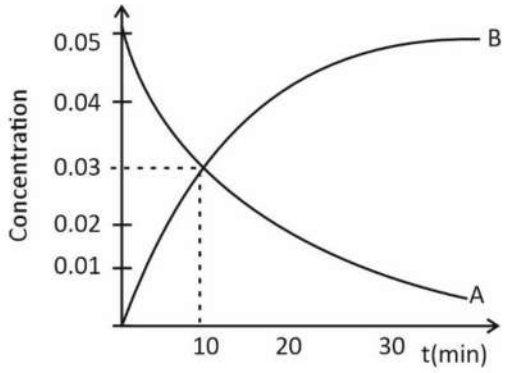
After adding 1 mole of A,

$$520 = \frac{4}{5}P_A^o + \frac{P_B^o}{5}$$

$$2600 = 4P_A^o + P_B^o \qquad \text{...(ii)}$$

(ii) – (i) $\Rightarrow$ 600 mm = P_A^o

24. For a reaction $\underset{(g)}{A} \longrightarrow \underset{(g)}{nB}$, a concentration vs. time curve is,



Find 10 n

Answer (15)

Sol. For the reaction,

$$-\frac{dA}{dt} = +\frac{1}{n}\frac{dB}{dt}$$

$$\frac{0.05-0.03}{10} = \frac{1}{n}\left(\frac{0.03-0}{10}\right)$$

$$\frac{0.02}{0.03} = \frac{1}{n}$$

n = 1.5

25. Consider the following reaction

$$X_2(g) + Y_2(g) \rightleftharpoons 2Z(g)$$

3 mol of X_2, 3 mol of Y_2 and 9 mol of Z are present at equilibrium and the volume of container is 1L. If 10 mol of Z is added at equilibrium, calculate the number of moles of Z at new equilibrium

Answer (15)

Sol. at eq^n $\underset{3\,mol}{X_2(g)} + \underset{3\,mol}{Y_2(g)} \rightleftharpoons \underset{9\,mol}{2Z(g)}$

$$K_{eq} = \frac{(9)^2}{3\times 3} = \frac{9\times 9}{3\times 3} = 9$$

when 10 mol of Z is added reaction moves in backward direction

$$\underset{3+x}{X_2(g)} + \underset{3+x}{Y_2(g)} \rightleftharpoons \underset{19-2x}{2Z}$$

$$9 = \frac{(19-2x)^2}{(3+x)^2}$$

$$3 = \frac{19-2x}{3+x}$$

9 + 3x = 19 – 2x

5x = 10

$$x = \frac{10}{5} = 2$$

moles of Z at new equilibrium

= 19 – 2 × 2

= 15

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 :

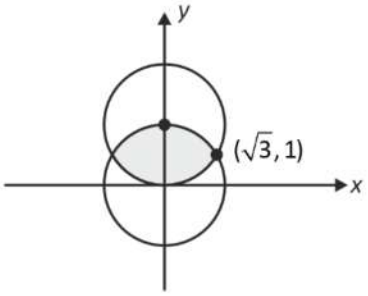
1. The area (in square units) between the curves $x^2 + y^2 = 4$ and $x^2 + (y-2)^2 = 4$ is

(1) $\frac{8\pi}{3} - 2\sqrt{3}$ (2) $\frac{8\pi}{3} + \sqrt{3}$

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

Answer (1)

Sol.



$$A = 2\int_0^{\sqrt{3}} \left(\sqrt{4-x^2} - \left(2 - \sqrt{4-x^2}\right)\right) dx$$

$$= 2\left(\left[x\sqrt{4-x^2} + 4\sin^{-1}\left(\frac{x}{2}\right)\Big|_0^{\sqrt{3}} - 2(\sqrt{3})\right]\right)$$

$$= 4\left(\frac{2\pi}{3} - \frac{\sqrt{3}}{2}\right) \text{sq. units} = \frac{8\pi}{3}$$

2. Number of ways to distribute 6 identical oranges among 4 persons such that each gets at least one orange is

(1) 8

(2) 10

(3) 12

(4) 13

Answer (2)

Sol. $x_1 + x_2 + x_3 + x_4 = 6, \quad x_i \geq 1$

$\Rightarrow x_1' + x_2' + x_3' + x_4' = 2 \quad x_i' \geq 0$

$\Rightarrow$ Number of ways $= {}^{2+4-1}C_{4-1}$

$= {}^5C_3 = 10$ ways

3. The minimum value of $\cos^2\theta + 6\sin\theta\cos\theta + 3\sin^2\theta + 3$

(1) -1 (2) 1

(3) $5 + \sqrt{10}$ (4) $5 - \sqrt{10}$

Answer (4)

Sol. $\cos^2\theta + 6\sin\theta\cos\theta + 3\sin^2\theta + 3$

$4 + 3\sin 2\theta + 2\sin^2\theta$

$4 + 3\sin 2\theta + 1 - \cos 2\theta$

$E = 5 + 3\sin 2\theta - \cos 2\theta$

$E_{\min} = 5 - \sqrt{10}$

4. Let $A = \{1, 2, 3, \ldots, 9\}$; xRy iff $x - y$ is multiple of 3.

S_1 : Number of elements in R is 36

S_2 : R is equivalence relation

(1) S_1 & S_2 both are correct

(2) S_1 is correct but S_2 is not correct

(3) S_2 is correct but S_1 is not correct

(4) S_1 & S_2 both are incorrect

Answer (3)

Sol. S_1 : $(x, y) \equiv (3k_1, k_2)$ OR $(3k_1 + 1, 3k_2 + 1)$ OR $(3k_1 + 2, 3k_2 + 2)$

$\equiv 3 \times 3 + 3 \times 3 + 3 \times 3$

$= 27$ elements

S_1 is incorrect.

R is reflexive, symmetric as well as transitive relation.

as $(x, x) \in R \qquad \forall x \in A$

$(x, y) \in R \rightarrow (y, x) \in R$

$(x, y) \in R$ and $(y, z) \in R \Rightarrow (x, z) \in R$.

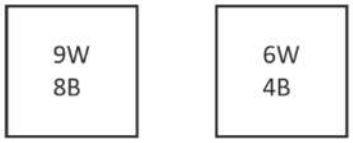
5. Let there are 2 bags A and B. Bag A has 9 white, 8 black balls and bag B has 6 white balls, 4 black balls. From a bag B, a ball is randomly selected and put into the bag A. Now, a ball is randomly selected from bag A. If the probability that selected ball is white is $\frac{p}{q}$, $gcd(p, q) = 1$, then $p + q$ is equal to

(1) 21 (2) 23

(3) 22 (4) 24

Answer (2)

Sol.



A : probability of getting white from bag A

B_w : probability of getting white from bag B

B_b : probability of getting black from bag B

$$P\left(\frac{A}{B_w \cup B_b}\right) = P(B_w)P\left(\frac{A}{B_w}\right) + P(B_b)P\left(\frac{A}{B_b}\right)$$

$$= \frac{6}{10}\times\frac{10}{18} + \frac{4}{10}\times\frac{9}{18}$$

$$= \frac{60+36}{180} = \frac{96}{180} = \frac{8}{15}$$

6. The value of $\int \frac{dx}{(4x+6)\sqrt{4x^2+12x+7}}$ is equal to

(1) $\frac{\sqrt{2}}{8}\tan^{-1}\left(\frac{4x^2+12x+7}{\sqrt{2}}\right)+c$

(2) $\frac{\sqrt{2}}{8}\tan^{-1}(4x^2+12x+7)+c$

(3) $\frac{1}{2}\tan^{-1}\left(\frac{4x^2+12x+7}{2}\right)+c$

(4) $\frac{\sqrt{2}}{4}\tan^{-1}\left(\frac{4x^2+12x+7}{\sqrt{2}}\right)+c$

Answer (1)

Sol. $I = \int \frac{(2x+3)}{2.(2x+3)^2\sqrt{4x^2+12x+7}}dx$

Let $4x^2+12x+7 = t^2$

$\therefore \quad (2x+3)dx = \frac{2tdt}{4}$

$\therefore \quad I = \int \frac{2t\,dt}{8.(4x^2+12x+9)t} = \int \frac{dt}{4(t^2+2)}$

$$= \frac{1}{4}\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{t}{\sqrt{2}}\right)$$

$$\therefore \quad I = \frac{\sqrt{2}}{8}\tan^{-1}\left(\frac{4x^2+12x+7}{\sqrt{2}}\right)+c$$

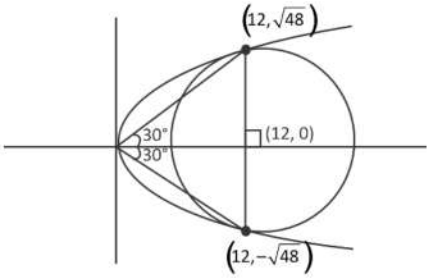
7. Let A and B are points on parabola $y^2 = 4x$ such that OAB is an equilateral triangle such that O is the vertex of parabola and AB is perpendicular to axis of parabola, then the minimum distance of circle as A and B as diametric points from the point O is

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

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

Answer (2)

Sol.



$\Rightarrow$ circle is

$$(x-12)^2 + \left(y-\sqrt{48}\right)\left(y+\sqrt{48}\right) = 0$$

$\Rightarrow (x-12)^2 + y^2 = 48 \qquad \Rightarrow$ radius $= 4\sqrt{3}$

Minimum distance is $12-\sqrt{48}$

$= 4\left(3-\sqrt{3}\right)$

8. The mean and variance of following data is μ and 19, respectively.

Class interval	4 – 8	8 – 12	12 – 16	16 – 20
***f* (frequency)**	3	λ	4	7

The value of $\lambda + \mu$ is

(1) 19 (2) 20

(3) 13 (4) 17

Answer (1)

Sol. $\mu = \frac{3\times b+\lambda\times 10+4\times 14+7\times 18}{14\times\lambda} = \frac{10\lambda+200}{14+\lambda}$

$$19=\sigma^2=\frac{3\times 6^2+\lambda(10)^2+4(14)^2+7(18)^2}{14+\lambda}-\left(\frac{10\lambda+200}{14+\lambda}\right)^2$$

$\Rightarrow \lambda = 6$

$\mu = 13$

$\lambda + \mu = 19$

9. If $\vec{a},\vec{b}$ and $\vec{c}$ are such that $\vec{a}\times\vec{b}=2(\vec{a}\times\vec{c})$ and angle between $\vec{b}$ and $\vec{c}$ is 60°, if $|\vec{a}|=1,|\vec{b}|=4,|\vec{c}|=3$, then $|\vec{a}.\vec{c}|$ is

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

(3) $\frac{6}{\sqrt{7}}$ (4) $\frac{9}{\sqrt{7}}$

Answer (3)

Sol. $\because \quad \vec{a}\times\vec{b}=2\vec{a}\times\vec{c}$

$\therefore \quad \vec{a}\times(\vec{b}-2\vec{c})=0$

$\therefore \quad \vec{b}-2\vec{c}=\lambda\vec{a}$ ...(1) (where $\lambda\in R$)

and $\vec{b}.\vec{c}=|\vec{b}||\vec{c}|\cos 60^\circ = 6$ ... (2)

Squaring both sides of equation (1) we get :

$|\vec{b}|^2+4|\vec{c}|^2-4\vec{b}.\vec{c}=\lambda^2|\vec{a}|^2$

$\therefore \quad \lambda^2 = 16+36-24=28$

from (1) : $\vec{b}.\vec{c}-2\vec{c}.\vec{c}=\lambda\vec{a}.\vec{c}$

$$\therefore |\vec{a}.\vec{c}|=\frac{1}{\pm\sqrt{28}}(6-18)=\frac{12}{\sqrt{28}}=\frac{6}{\sqrt{7}}$$

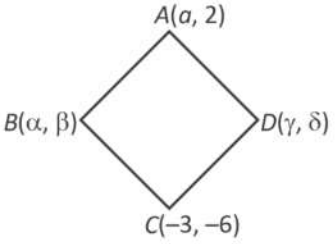
10. Let *A*, *B*, *C*, *D* be rhombus with $A(a, 2)$, $B(\alpha, \beta)$, $C(-3, -6)$ and $D(\gamma, \delta)$, then the value of $|\alpha + \beta + \gamma + \delta|$ is if *AC* is parallel to $y = 2x + 14$ is

(1) 0 (2) 1

(3) 6 (4) 9

Answer (3)

Sol.



$\because$ *AC* is parallel to $y = 2x + 14$

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

Now $\frac{1-3}{2}=\frac{\alpha+\gamma}{2}\Rightarrow \alpha+\gamma=-2$

$\frac{2-6}{2}=\frac{\beta+\delta}{2}\Rightarrow \beta+\delta=-4$

$|\alpha + \beta + \gamma + \delta| = 6$

11.

12.

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 $A=\begin{bmatrix} 0 & 2 & -3 \\ -2 & 0 & -1 \\ 3 & 1 & 0 \end{bmatrix}$ and if $B(I - A) = (I + A)$, where I is identity matrix of order 3, then trace of (BB^T) is

Answer (03.00)

Sol. $B(I-A) = (I+A)$

Since A is skew symmetric matrix

$\Rightarrow A^T = -A$ since, $B^T(I - A^T) = (I + A^T)$

$\Rightarrow B^T(I+A) = (I-A)$

$\Rightarrow BB^T(I+A) = B(I-A) = (I+A)$

$\Rightarrow BB^T(I+A)(I+A)^{-1} = (I+A)(I+A)^{-1}$

$= I_{3\times 3}$

$\Rightarrow$ Trace $(BB^T) = 3$

22. S = No. of 4- digit numbers *abcd* where product of digits is 20

P = No. of 5-digit number *abcde* where product of digits is 20, then

$S + P$ is equal to

Answer (74)

Sol. $\{a, b, c, d\}$

Digits : 5, 4, 1, 1 $\Rightarrow$ No. of arrangement $\Rightarrow \frac{4!}{2!} = 12$

5, 2, 2, 1 $\Rightarrow$ No. of arrangement $\Rightarrow \frac{4!}{2!} = 12$

$\Rightarrow S = 12 + 12 = 24$

$\{a, b, c, d, e\}$

Digits : 5, 4, 1, 1, 1 $\Rightarrow$ No. of arrangement $\Rightarrow \frac{5!}{3!} = 20$

5, 2, 2, 1, 1 $\Rightarrow$ No. of arrangement $\Rightarrow \frac{5!}{2!2!} = 30$

$\Rightarrow P = 20 + 30 = 50$

$S + P = 74$

23. Let S be the set defined as

$S=\left\{x : \int_0^x t^2 \sin(t-x)dt = x^2 \text{ and } x \in [0, 1000]\right\}$, then number of elements in S is

Answer (1)

Sol. Let $I = \int_0^x t^2 \sin(t-x)dt$

$= \int_0^x (x-t)^2 \sin((x-t)-x)dt$

$= \int_0^x (x-t)^2 \sin(-t)dt$

$= -x^2\int_0^x (\sin t)dt + 2x\int_0^x t\sin t dt - \int_0^x t^2 \sin t dt$

$= -x^2(-\cos t)|_0^x + 2x(\sin t - t\cos t)|_0^x$

$\quad -(2t\sin t + (2-t^2)\cos t)|_0^x$

$= x^2\cos x - x^2 + 2x(\sin x - x\cos x)$

$\quad -2x\sin x + (x^2-2)\cos x + 2$

$= x^2\cos x - x^2 + 2x\sin x - 2x^2\cos x - 2x\sin x$

$\quad + x^2\cos x - 2\cos x + 2$

$= -x^2 - 2\cos x + 2$

$\Rightarrow -x^2 - 2\cos x + 2 = x^2 \Rightarrow 2(1-\cos x) = 2x^2$

$\Rightarrow 2\sin^2\frac{x}{2} = x^2 \Rightarrow x = 0$ only solution

24. The number of solutions of the equation $\log_{(x-3)}(2x^2 - 7x + 3) = 2\log_{(2x-1)}(x-3)$ is equal to

Answer (1)

Sol. $\log_{(x-3)}(2x^2 - 7x + 3) = 2\log_{(2x-1)}(x-3)$

or,

$\log_{(x-3)}(x-3)(2x-1) = 2\log_{(2x-1)}(x-3)$

or,

$1 + \log_{(x-3)}(2x-1) = 2\log_{(2x-1)}(x-3)$

Let $\log_{(x-3)}(2x-1) = y$

$\therefore 1 + y = \frac{2}{y}$

Or, $y^2 + y - 2 = 0$

$\therefore \log_{(x-3)}(2x-1) = 1, -2$

$\therefore \quad 2x-1=x-3$

$\therefore \quad x=-2$ not acceptable.

and $2x-1=(x-3)^{-2}$

$\therefore (2x-1)(x-3)^2=1$

By solving we get :

$(2x-5)(x^2-4x+2)=0$

$\therefore \quad x=\frac{5}{2}, 2+\sqrt{2}, 2-\sqrt{2}$

Only $x=2+\sqrt{2}$ satisfy the equations

$\therefore$ Number of solutions = 1.

25. If a sequence <a_n> satisfy the relation $\sum_{k=1}^{n} a_k = \alpha n^2 + \beta n$, and a_{10} = 56 and $a_6 = 2a$, then $(\alpha + \beta)$ is equal to

Answer (20)

Sol. $\sum_{k=1}^{n} a_k = \alpha n^2 + \beta n$

$a_{10} = 56 = a + 9d$

$a_6 = 2a_1 \Rightarrow a + 5d = 2a$

$= a + 5d$

$\Rightarrow 14d = 56 \Rightarrow d = 4$ and $a = 20$

$\sum_{k=1}^{n} a_k = \frac{n}{2}\left(2\times 20 + (n-1)4\right)$

$= 20n + 2(n)(n-1)$

$= 2n^2 + 18n$

$\Rightarrow \alpha = 2, \beta = 18 \Rightarrow \alpha + \beta = 20$

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