

Joint Entrance Examination

Question Booklet Code **P**

Practice Set 1

Max. Marks: 360

→ **Read the Following Instructions Carefully**

1. Immediately fill the particulars on this page of the test booklet with blue / black ball point pen. Use of pencil is strictly prohibited.
2. The test is of 3 hours duration.
3. The test booklet consists of 90 questions. The maximum marks are 360.
4. There are three parts in the question paper A, B, C consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage. Each question is allotted 4 (four) marks for correct response.
5. Candidates will be awarded marks as stated in above instructions for correct response of each question. $\frac{1}{4}$ (one fourth) marks will be deducted for indicating incorrect response of each question. There is no negative marking for unattempted questions.
6. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per above instructions.
7. No candidate is allowed to carry any textual material, printed or written, bits of papers, paper, mobile phone, any electronic device, etc., except the Admit Card inside the examination hall/room.
8. Rough work is to be done on the space provided for this purpose in the test booklet only. This space is given at the bottom of pages.

Name of the Candidate (in Capital Letters)

Roll Number (in Figures)

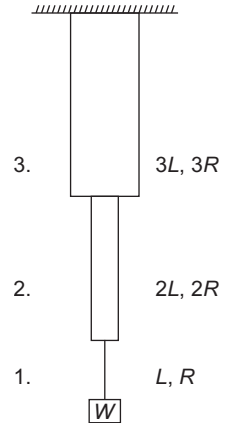
--	--	--	--	--	--	--

 in Words _____

PART A Physics

1. Three wires of same material (Young's modulus Y) but length L , $2L$ and $3L$ and radii R , $2R$ and $3R$ respectively are joined end to end and weight w is suspended as shown below. Then, the elastic potential energy of system neglecting the self weight is

- (a) $\frac{5 w^2 L}{8 \pi R^2 Y}$
 (b) $\frac{5 w^2 L}{6 \pi R^2 Y}$
 (c) $\frac{13 w^2 L}{9 \pi R^2 Y}$
 (d) $\frac{11 w^2 L}{12 \pi R^2 Y}$

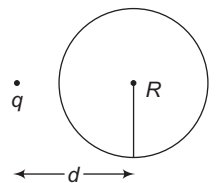


2. Three discs A, B and C having radii 2 m, 4 m and 6 m respectively are coated with carbon black on their outer surfaces. The wavelength corresponding to maximum intensities are 300 nm, 400 nm and 500 nm respectively. The power radiated by them are Q_A , Q_B and Q_C respectively

- (a) Q_A is maximum
 (b) Q_B is maximum
 (c) Q_C is maximum
 (d) $Q_A = Q_B = Q_C$

3. When a point charge q is brought near to a neutral conducting hollow sphere of radius R . Distance between these is d , then

- (a) d would remain constant with time
 (b) d would decrease with time
 (c) d would increase with time
 (d) d can increase or decrease depending upon whether the charge is positive or negative



4. A particle is moving in xy -plane with a constant speed v_0 such that its y displacement is given by $y = \alpha e^{\frac{-2v_x}{\sqrt{3}v_0}}$, where v_x is component of velocity along x -axis. y displacement of the particle when slope of tangent on its path is $-\frac{1}{\sqrt{3}}$, is

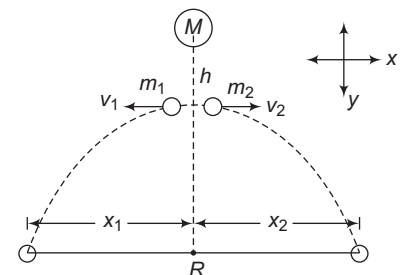
- (a) αe^{-1}
 (b) αe^{-2}
 (c) zero
 (d) $\alpha^2 e$

5. When a H-atom in ground state is excited by monochromatic radiation of photon energy 12.75 eV. Then, the number of emission lines will be (given its ionisation energy is 13.6 eV)

- (a) one
 (b) two
 (c) four
 (d) six

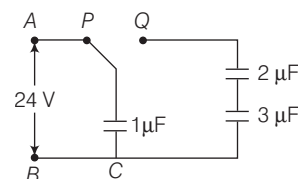
6. The ball starts falling from same height and after falling some height it breaks into two parts m_1 and m_2 . Finally, they reach the earth surface. Choose the correct option.

- (a) R will depend on h
 (b) if $m_1 > m_2$, then $x_1 < x_2$
 (c) the centre of mass of the two balls (system) will shift towards the heavier part
 (d) None of the above



7. A constant potential difference between A and B is applied. When the switch is shifted from position P to position Q, then

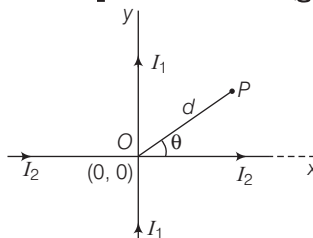
- (a) charge on $2\mu\text{F}$ capacitor is approximately $13\mu\text{C}$
 (b) potential difference across $3\mu\text{F}$ capacitor is approximately 4.3 V
 (c) potential difference across $1\mu\text{F}$ capacitor is approximately 11 V
 (d) All of the above



8. The actual value of a line is 5.32 m . First person take the measurement of the line as 4.23 and another person takes the measurement as 4.9 .

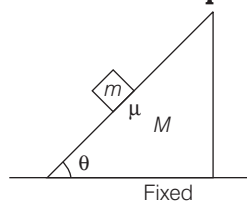
- (a) first person is more accurate less precise
 (b) second person is less accurate more precise
 (c) first person is less accurate more precise
 (d) None of the above

9. Two wire carrying currents I_1 and I_2 are placed in a horizontal plane as given below. Then, magnetic field at point P in the same plane shall be (given $OP = d$)



- (a) $\frac{\mu_0}{2\pi d} [-I_1 \sin \theta + I_2 \cos \theta] \hat{k}$
 (b) $\frac{\mu_0}{2\pi d} \left[\frac{I_1}{\sin \theta} + \frac{I_2}{\cos \theta} \right] \hat{k}$
 (c) $\frac{\mu_0}{2\pi d} [-I_1 \sin \theta - I_2 \cos \theta] \hat{k}$
 (d) $\frac{\mu_0}{2\pi d} \left[\frac{-I_1}{\cos \theta} + \frac{I_2}{\sin \theta} \right] \hat{k}$

10. If the block is at rest, then choose the correct option.



- (a) $mg \sin \theta$ must be equal to $\mu mg \cos \theta$
 (b) f_s must be equal to $\mu mg \cos \theta$
 (c) f_s may be equal to $mg \sin \theta$
 (d) f_s must be equal to $mg \sin \theta$

11. A diesel engine takes in 5 moles of air at 20°C and 1 atm, and compresses it adiabatically to $\frac{1}{10}$ th of the original volume, If air is diatomic then work done and change in internal energy is

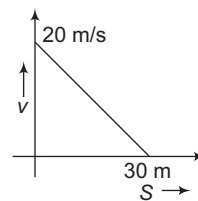
- (a) $-46\text{ kJ}, 46\text{ kJ}$
 (b) $36\text{ kJ}, -36\text{ kJ}$
 (c) $46\text{ kJ}, -46\text{ kJ}$
 (d) $-36\text{ kJ}, 36\text{ kJ}$

12. If proton and α -particle are accelerated by same potential V. Then, the ratio of their wavelengths $\lambda_p : \lambda_\alpha$ would be

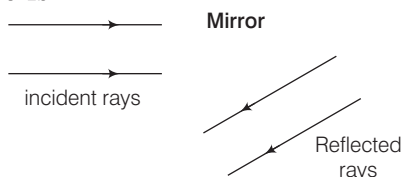
- (a) $2\sqrt{2} : 1$
 (b) $1 : 2\sqrt{2}$
 (c) $2 : 1$
 (d) $1 : 2$

13. If the velocity v of a particle moving along a straight line decreases linearly with its displacement S is 20 ms^{-1} to a value approaching to zero at $S = 30 \text{ m}$, then acceleration of the particle at $S = 15 \text{ m}$, is

- (a) $\frac{2}{3} \text{ ms}^{-2}$ (b) $-\frac{2}{3} \text{ ms}^{-2}$
(c) $\frac{20}{3} \text{ ms}^{-2}$ (d) $-\frac{20}{3} \text{ ms}^{-2}$

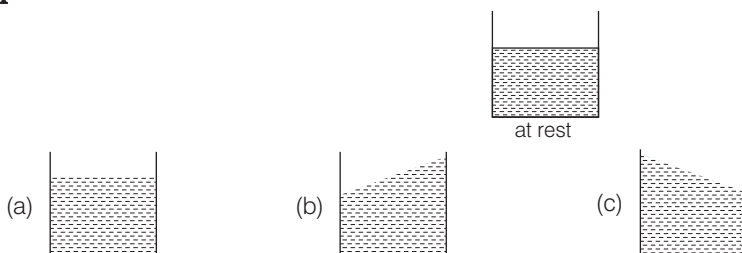


14. The mirror in the below case is



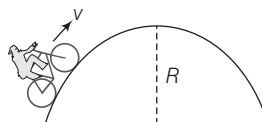
- (a) convex (b) concave (c) plane (d) None of these

15. If the beaker in the below diagram accelerates towards right, choose the correct level of liquid.



(d) None of these

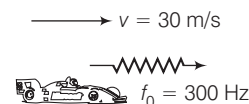
16. A cyclist is moving on a circular path with a constant speed, the value of normal reaction for the complete path



- (a) increase (b) decrease
(c) remains constant (d) first increase then decrease

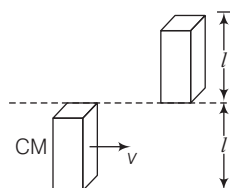
17. A car is moving towards a wall, the frequency of reflected sound observed by car is ($v_{\text{sound}} = 330 \text{ m/s}$)

- (a) 330 Hz (b) 360 Hz
(c) 300 Hz (d) zero



18. A bar of mass m length l is in pure translatory motion with its centre of mass velocity v . It collides with and sticks to another identical bar at rest as shown in figure. Assuming that after collision it becomes one composite bar of length $2l$, the angular velocity of the composite bar will be

- (a) $\frac{3v}{4l}$, anti-clockwise (b) $\frac{4v}{3l}$, anti-clockwise
(c) $\frac{3v}{4l}$, clockwise (d) $\frac{4v}{3l}$, clockwise

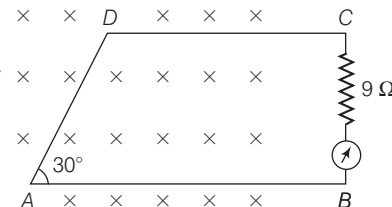


19. The property which is exhibited by all the substances is

- (a) diamagnetism (b) paramagnetism (c) ferromagnetism (d) None of these

20. A loop ABCD is moving with velocity v towards right. The magnetic field is 2 T. Loop is connected to a resistance of $9\ \Omega$. If steady current of 2 A flows in the loop, then value of v if loop has resistance of $4\ \Omega$ is (Given $AD = 30\text{ cm}$)

- (a) 60 m/s (b) 30 m/s
(c) 33.33 m/s (d) 20 m/s



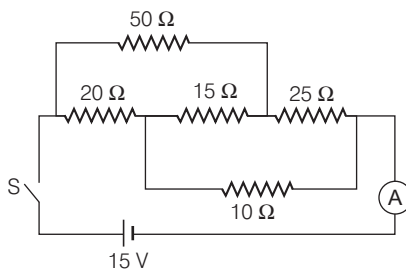
21. If only conservative forces are working in the system and we apply some external force

- (a) $W_{\text{ext}} = \Delta U$ (always) (b) $W_{\text{conservative}} = -\Delta U$ (always)
(c) $W_{\text{ext}} = \Delta U + \Delta \text{KE}$ (always) (d) $W_{\text{conservative}} = -\Delta \text{KE}$

22. In double slit experiment, a glass plate of refractive index 1.5 of thickness t is introduced in the path of one of the interfering beams of wavelength λ . The position of central maxima has got shifted by $\frac{2\lambda D}{d}$. Then, what would be the thickness of plate?

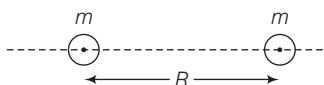
- (a) 4λ (b) 2λ (c) λ (d) 3λ

23. What shall be the reading in ammeter when switch S is closed?



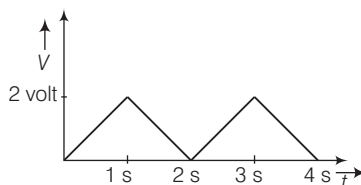
- (a) 0.7 A (b) 1 A (c) 1.3 A (d) 1.5 A

24. Two balls of radius r each are placed at a distance R and left. The speed of each ball when they collide



- (a) $v = \left[-2Gm \left(\frac{1}{R} + \frac{1}{r} \right) \right]^{1/2}$ (b) $v = \sqrt{-Gm \left(\frac{1}{R} - \frac{1}{2r} \right)}$
(c) $v = \left[-2Gm \left(\frac{1}{R} + \frac{1}{2r} \right) \right]^{1/2}$ (d) $v = \left[-Gm \left(\frac{1}{2R} + \frac{1}{r} \right) \right]^{1/2}$

25. The rms value of voltage of the waveform shown below is



(a) 1 V

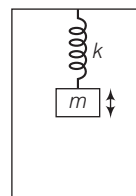
(b) $\sqrt{2}\text{ V}$

(c) 2 V

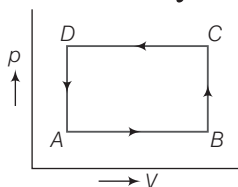
(d) $\frac{1}{2}\text{ V}$

26. A spring block system starts executing SHM in a stationary lift when left under gravity. The wire of the lift breaks at a moment when the spring comes in its natural length. Then,

- (a) the block will still oscillate
 (b) the block will oscillate but its equilibrium position will be changed
 (c) the block will not execute SHM
 (d) the block will oscillate but the maximum compression will become $\frac{mg}{k}$



27. Choose the correct statement for an isolated system.



- (a) $\Delta U(C \rightarrow D)$ = negative
 (b) $\Delta Q(A \rightarrow B)$ = + positive
 (c) $\Delta U = (A - B - C - D - A) \neq 0$
 (d) $\Delta Q(D \rightarrow A) = 0$

28. Electromagnetic waves propagate in the direction parallel to the vector

- (a) \mathbf{E} (b) \mathbf{B} (c) $\mathbf{E} \times \mathbf{B}$ (d) $\mathbf{B} \times \mathbf{E}$

29. Statement I pseudo force is used only when we observe from an accelerated frame.
 Statement II Law of inertia is valid only from the unaccelerated frames.

- (a) Both Statement I and Statement II are true and the Statement II is the correct explanation of the Statement I
 (b) Both Statement I and Statement II are true but the Statement II is not the correct explanation of the Statement I
 (c) Statement I is true but Statement II is false
 (d) Both Statement I and Statement II are false

30. Statement I When two charged spheres are connected to each other by thin conducting wire, charge flow from bigger sphere to smaller sphere if initial charges on them are same.
 Statement II Electrostatic energy will be lost in redistribution.

- (a) Both Statement I and Statement II are true and the Statement II is the correct explanation of the Statement I
 (b) Both Statement I and Statement II are true but the Statement II is not the correct explanation of the Statement I
 (c) Statement I is true but Statement II is false
 (d) Statement I is false but Statement II is true

PART B Chemistry

31. In the following reaction, $\text{As}_2\text{S}_3 + \text{H}^+ + \text{NO}_3^- \longrightarrow \text{NO} + \text{H}_2\text{O} + \text{AsO}_4^{3-} + \text{SO}_4^{2-}$, the equivalent weight of As_2S_3 is related to molecular weight by

- (a) $\frac{M}{14}$ (b) $\frac{M}{28}$ (c) $\frac{M}{7}$ (d) $\frac{M}{10}$

32. $\text{H}_3\text{BO}_3 \xrightarrow{100^\circ\text{C}} \text{X} \xrightarrow{160^\circ\text{C}} \text{Y} \xrightarrow{\text{Red hot}} \text{B}_2\text{O}_3$, then X and Y are respectively

- (a) X = tetra boric acid, Y = borax (b) X = borax, Y = tetra boric acid
(c) X = tetra boric acid, Y = meta boric acid (d) X = meta boric acid, Y = tetra boric acid

33. Arrange the following in correct order of increasing dipole moment.

I. 1, 2, 3-trichloro benzene

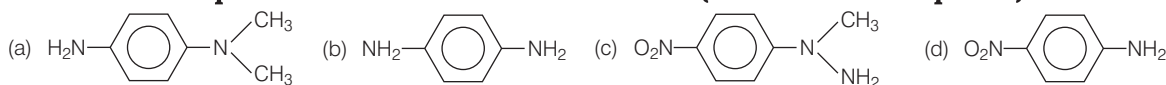
II. 1, 4-dichloro benzene

III. 1, 2, 4-trichloro benzene

IV. 1, 3, 5-trichloro benzene

- (a) II = IV < III < I (b) II < IV < I < III (c) II < III < IV < I (d) I < III < II = IV

34. An organic compound having molecular formula $\text{C}_6\text{H}_4\text{NO}_2\text{F}$ is a cyclic compound when treated with DMF and $(\text{CH}_3)_2\text{NH}$ produces A which on further treatment with H_2/Pt produces B. What is the possible molecular structure of B? (an aromatic compound)



35. A solution containing sulphate and sulphite ion can be easily distinguished by

- (a) FeSO_4 (b) $\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}]$ (c) BaCl_2 (d) $\text{Na}_3[\text{Co}(\text{NO}_2)_6]$

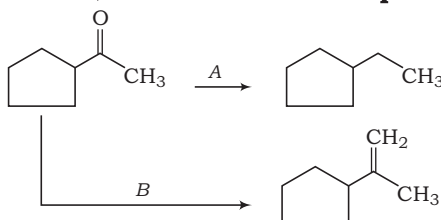
36. $\text{A (aq)} \longrightarrow \text{B (aq)} + \text{C (aq)}$ is a first order reaction.

Time	t	∞
Moles of reagent	x_1	x_2

Reaction progress is measured with the help of titration of reagent P, if all A, B and C reacted with reagent have n factors $\left[n \text{ factor} : n = \frac{\text{mol. wt.}}{\text{eq. wt.}} \right]$ in the ratio 1 : 2 : 3 with the reagent. The k in terms of t, x_1 and x_2 is

- (a) $k = \frac{1}{t} \ln \left(\frac{x_2}{x_2 - x_1} \right)$ (b) $k = \frac{1}{t} \ln \left(\frac{2x_2}{x_2 - x_1} \right)$ (c) $k = \frac{1}{t} \ln \left(\frac{4x_2}{5(x_2 - x_1)} \right)$ (d) $k = \frac{1}{t} \ln \left(\frac{8x_2}{x_2 - x_1} \right)$

37. On the basis of following reaction, choose the correct option regarding A and B respectively.



- (a) $\text{PPh}_3=\text{CH}_2$, Zn-Hg/HCl (b) $\text{PPh}_3=\text{CH}_2$, LiAlH_4
(c) NaBH_4 , Zn-Hg/HCl (d) Zn-Hg/HCl , $\text{PPh}_3=\text{CH}_2$

38. Match Column I with Column II and select the correct code.

Column I	Column II
Metal Ions	Magnetic Moments (BM)
A. Ni^{2+}	1. $\sqrt{35}$
B. Cr^{3+}	2. $\sqrt{30}$
C. Mn^{2+}	3. $\sqrt{24}$
D. Fe^{2+}	4. $\sqrt{15}$
	5. $\sqrt{8}$

Codes

	A	B	C	D
(a)	3	2	5	1
(b)	4	5	3	2
(c)	5	4	1	3
(d)	2	5	4	3

39. Two components A and B form an ideal solution. The mole fraction of A and B in ideal solutions are X_A and X_B , while that of in vapour phase, these components have their mole fractions as Y_A and Y_B then, the slope and intercept of plot of $\frac{1}{Y_A}$ vs $\frac{1}{X_A}$ will be

- (a) $\frac{p_B^0}{p_A^0}, \frac{p_A^0 - p_B^0}{p_A^0}$ (b) $\frac{p_B^0}{p_A^0}, \frac{p_A^0 + p_B^0}{p_A^0}$ (c) $\frac{p_A^0}{p_B^0}, \frac{p_A^0 - p_B^0}{p_A^0}$ (d) $\frac{p_A^0}{p_B^0}, \frac{p_A^0}{p_A^0 - p_B^0}$

40. $\text{CaCO}_3(\text{s}) \xrightarrow{\text{Heat}} \text{X}(\text{s}) + \text{Z}(\text{g})$

$\text{X}(\text{s}) \xrightarrow{\text{Carbon, heat}} \text{C}(\text{s}) + \text{D}(\text{g})$

$\text{C}(\text{s}) + \text{H}_2\text{O} \longrightarrow \text{E}(\text{g})$.

Then, compound E(g) and C(s) will be

- (a) C_2H_2 , CaO (b) C_2H_2 , CaC_2 (c) CH_4 , CaC_2 (d) CH_4 , CaO

41. Arrange the following (I to IV) in the order of increasing masses.

I. 0.5 mole of O_3

II. 3.01×10^{23} molecules of O_2

III. 5.6 L of CO_2 at STP

IV. 0.5 g atom of O_2

- (a) IV < III < II < I (b) II < I < III < IV (c) II = I < III < IV (d) I < III < IV < II

42. Which of the following is not correctly ordered?

(a) $\text{CH}_3\text{Cl} < \text{CH}_3\text{Br} < \text{CH}_3\text{I} \longrightarrow$ Boiling point

(b) $\text{CH}_3\text{Cl} > \text{CH}_3\text{F} > \text{CH}_3\text{Br} > \text{CH}_3\text{I} \longrightarrow$ Polarity of C—X bond (X = F, Cl, Br, I)

(c) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl} > \text{CH}_3 - \underset{\text{H}}{\overset{\text{CH}_3}{\text{C}}} - \text{CH}_2\text{Cl} > \text{CH}_3 - \underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}} - \text{Cl} \rightarrow$ Boiling point

(d) $\text{CH}_3\text{F} < \text{CH}_3\text{Cl} < \text{CH}_3\text{Br} < \text{H}_2\text{O} < \text{CH}_3\text{I} \rightarrow$ Density

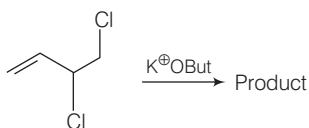
43. A sulphate of a metal A on heating gives two gases B and C and an oxide D, gas B turns $K_2Cr_2O_7$ paper green while gas C forms a trimer in which there is no S—S bond. Compound D with conc. HCl forms a Lewis acid E which exists in a dimer. Identify compounds A, B, C, D and E respectively

(a) FeS, SO_2 , SO_3 , $FeCl_2$, $Fe_2(PO_4)_3$ (b) $FeSO_4$, SO_2 , SO_3 , Fe_2O_3 , $FeCl_3$
 (c) $Al_2(SO_4)_3$, SO_2 , SO_3 , Al_2O_3 , $FeCl_2$ (d) FeS, SO_3 , SO_2 , $Fe_2(SO_4)_3$, $FeCl_3$

44. Fixed volume each of two sols of AgI, one obtained by adding $AgNO_3$ to slight excess of KI and another obtained by adding KI to slight excess of $AgNO_3$ are mixed together. Then,

(a) the two sols will stabilize each other (b) the sol particles will acquire greater electric charge
 (c) the sols will coagulate each other mutually (d) None of the above

45. Which of the following is correct mode of hybridisation for the product formed in following reaction (from left to right)



(a) sp^2, sp^2, sp^2, sp^2 (b) sp^2, sp, sp, sp^2 (c) sp, sp^2, sp^2, sp (d) sp^2, sp^2, sp, sp

46. If the slope of z (compressibility factor versus curve is constant, slope = $\frac{\pi}{246.3} \text{ atm}^{-1}$) at a particular temperature (600 K) and very high pressure, then calculate diameter of the molecules will be

[Given, $N_A = 6.02 \times 10^{23}$, $R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$]

(a) 5 Å (b) 7 Å (c) 4 Å (d) None of these

47. Which of the following cannot be obtained by the reaction of metal carbide with H_2O ?

(a) $Be_2C + H_2O \longrightarrow CH_4$ (b) $Al_4C_3 + H_2O \longrightarrow CH \equiv CH$
 (c) $CaC_2 + H_2O \longrightarrow CH \equiv CH$ (d) $Mg_4C_3 + H_2O \longrightarrow CH_3-C \equiv CH$

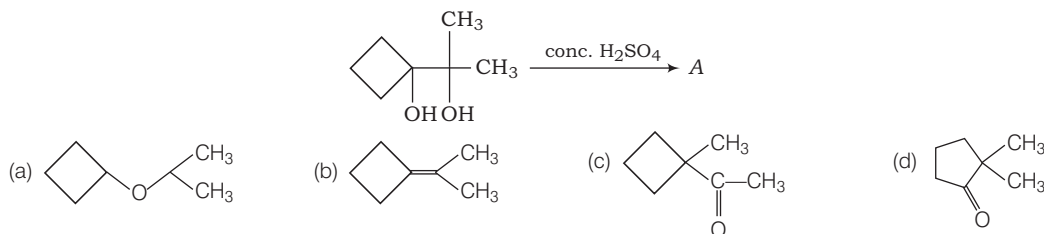
48. Which of the following reaction produces most stable alkene?

(a) 2-chloro butane (b) 2, 3-dichloro butane
 (c) 2, 2-dichloro butane (d) 2, 3-dichloro, 2, 3-dimethyl butane

49. A 0.70 g sample consisting CaC_2O_4 and MgC_2O_4 is heated at 300°C , converting the two salts of $CaCO_3$ and $MgCO_3$. The sample when weighs 0.47 g. If the sample had been heated to 700°C where the products are CaO and MgO. What would be the weight of mixture of oxides?

(a) 0.36 g (b) 0.14 g (c) 0.28 g (d) 1.08 g

50. Identify the correct product formed during the following reaction.



51. $A + HNO_3 \longrightarrow B + NO_2 + H_2O + S$
 $B + \text{Ammonium molybdate} \longrightarrow \text{Yellow precipitate}$
 Then, A will be

(a) PbS (b) Sb_2S_5 (c) CdS (d) As_2S_5

52. If the lowest energy X-rays have $\lambda = 6.11 \times 10^{-8} \text{ m}$, estimate the minimum difference in energy between two Bohr's orbit such that an electronic transition would correspond to the emission of an X-ray. Assuming that the electrons in other shells exert no influence at what Z (minimum) would a transition from the second energy level to the first result in the emission of an X-ray?

(a) 1.2 (b) 2.5 (c) 4.0 (d) 1.4

53. Which is correct statement about P_4O_6 and P_4O_{10} ?

(a) In P_4O_6 each P is joined to three O and in P_4O_{10} each P is linked to four O-atoms
 (b) Both form oxoacids H_3PO_3 and H_3PO_4 respectively
 (c) Both (a) and (b) are correct
 (d) None of the above

54. A well known narcotic analgesic is morphine, the product obtained due to their alkylation and acetylation are respectively.

(a) heroin and codeine (b) heroin and meperidine
 (c) codeine and heroin (d) meperidine and heroin

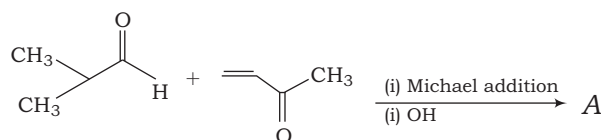
55. The electrolysis of acetate solution produces ethane according to reaction



The current efficiency of the process is 90%. What volume of gases would be produced at 27°C and 760 torr, if the current of 0.5 A is passed through the solution for 96.45 min?

(a) 0.58 L (b) 0.72 L (c) 1.5 L (d) 1 L

56. How many chiral centre are possible for the product of following reaction?



(a) 1 (b) 0 (c) 3 (d) 2

57. Which combination of reactants best represent the amphoteric character of $\text{Zn}(\text{OH})_2$?

I. $\text{Zn}(\text{OH})_2(\text{s})$ and $\text{H}^+(\text{aq})$

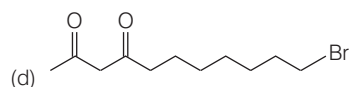
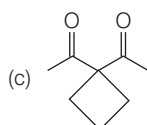
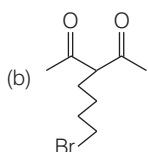
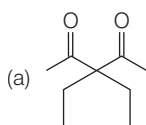
II. $\text{Zn}(\text{OH})_2(\text{s})$ and $\text{OH}^-(\text{aq})$

III. $\text{Zn}(\text{OH})_2(\text{s})$ and $\text{H}_2\text{O}(\text{l})$

IV. $\text{Zn}(\text{OH})_2(\text{s})$ and $\text{NH}_3(\text{aq})$

(a) I and II (b) II and III (c) I and III (d) III and IV

58. A cyclic organic compound A having molecular formula $\text{C}_5\text{H}_8\text{O}_2$ contain active methylene group when treated with tollens reagent, it does not show any positive test but on reaction with NaOX, it show iodoform test, what will be the final product obtained when A will react with excess of sodium ethoxide followed by 1, 4-dibromo butane. (Hint It does not decolourise $\text{Br}_2/\text{H}_2\text{O}$ solution)



59. **Statement I** Product obtained by the following two processes are ecofriendly.

(i) Copolymerisation of 3 hydroxy butanoic acid and 3 hydroxy pentanoic acid.

(ii) Copolymerisation of glycine and amino cupric acid.

Statement II They are easily available to human and contain H-bonding.

- (a) Both Statement I and Statement II are true and the Statement II is the correct explanation of the Statement I
 (b) Both Statement I and Statement II are true but the Statement II is not the correct explanation of the Statement I
 (c) Statement I is true but Statement II is false
 (d) Both Statement I and Statement II are false

60. **Statement I** SiF_6^{2-} is known but SiCl_6^{2-} is not.

Statement II Size of fluorine is small and its lone pair of electrons interacts with d-orbital of silicon strongly.

- (a) Both Statement I and Statement II are true and the Statement II is the correct explanation of the Statement I
 (b) Both Statement I and Statement II are true but the Statement II is not the correct explanation of the Statement I
 (c) Statement I is true but Statement II is false
 (d) Both Statement I and Statement II are false

PART C Mathematics

61. If a complex number z satisfies $|2z + 10 + 10i| \leq 5\sqrt{3} - 5$, then the least principal argument is

- (a) $-\frac{5\pi}{6}$ (b) $-\frac{11\pi}{2}$ (c) $-\frac{3\pi}{4}$ (d) $-\frac{2\pi}{3}$

62. The number of exponent of 2 in $2 \cdot 4 \cdot 6 \cdot 8 \cdot 10 \cdot 12 \dots 1000$ is

- (a) 994 (b) 996 (c) 1000 (d) 500

63. If $f(x)$ and $g(x)$ are continuous functions, then $\int_{\ln \lambda}^{\ln \frac{1}{\lambda}} \frac{f\left(\frac{x^2}{4}\right)[f(x) - f(-x)]}{g\left(\frac{x^2}{4}\right)[g(x) + g(-x)]} dx$ is

- (a) depend on λ (b) a non-zero constant
 (c) zero (d) None of these

64. A rod of length 1 moves such that its end A and B always lie on the lines $3x - y + 5 = 0$ and $y + 5 = 0$, then locus of the point P which divide AB internally in the ratio of 2 : 1.

- (a) $I^2 = \frac{1}{4}(3x + 3y - 5)^2 + (3y + 5)^2$ (b) $I^2 = \frac{1}{4}(3x - 3y + 5)^2 + (3y - 5)^2$
 (c) $I^2 = \frac{1}{4}(3x - 3y - 5)^2 + (3y - 5)^2$ (d) None of these

65. Let A be a matrix of order 3×3 and matrices B, C and D are related such that $B = \text{adj}(A)$, $C = \text{adj}(\text{adj } A)$, $D = (\text{adj}(\text{adj}(\text{adj } ABCD)))$. If $|\text{adj}(\text{adj}(\text{adj}(\text{adj } ABCD)))|$ is $|A|^k$, then k

- (a) is less than 256 (b) has 21 divisors (c) Cannot say (d) is an odd number

66. The distance of point of intersection of lines $\frac{x-4}{1} = \frac{y+3}{-4} = \frac{z+1}{7}$ and $\frac{x-1}{2} = \frac{y+1}{-3} = \frac{z+10}{8}$ from $(1, -4, 7)$, is

- (a) $\sqrt{15}$ (b) $\sqrt{27}$ (c) $\sqrt{26}$ (d) $\sqrt{14}$

67. The number of integral solution of $x^2 + 9 < (x + 3)^2 < 8x + 25$, is
 (a) 3 (b) 4 (c) 5 (d) 7
68. Let \mathbf{a} and \mathbf{c} are unit vectors and $|\mathbf{b}| = 4$ with $\mathbf{a} \times \mathbf{b} = 2\mathbf{a} \times \mathbf{c}$. The angle between \mathbf{a} and \mathbf{c} is $\cos^{-1}\left(\frac{1}{4}\right)$. If $\mathbf{b} - 2\mathbf{c} = \lambda\mathbf{a}$, then λ is equal to
 (a) $1/3, 1/2$ (b) $2/3, 1/3$ (c) $3, -4$ (d) $2, 3$
69. A car is parked by an owner amongst 25 cars in a row not at the two extremes. On his return, he find that exactly 15 places are still occupied. The probability that both the neighbouring places are vacant is
 (a) $\frac{15}{92}$ (b) $\frac{91}{276}$ (c) $\frac{15}{184}$ (d) None of these
70. $\lim_{x \rightarrow \infty} \left(\frac{\frac{1}{p^x} + \frac{1}{q^x} + \frac{1}{r^x} + \frac{1}{s^x}}{4} \right)^{3x}$ where, $p, q, r, s > 0$ is equal to
 (a) $pqrs$ (b) $(pqrs)^3$ (c) $(pqrs)^{\frac{3}{2}}$ (d) $(pqrs)^{\frac{3}{4}}$
71. Consider a parabola $y^2 = 4ax$, if the normal to the parabola at the point $(at^2, 2at)$ cuts the parabola again at $(aT^2, 2aT)$, then
 (a) $T^2 \geq 8$ (b) $T^2 \leq 6$
 (c) $T \in (-\infty, -8) \cup (8, \infty)$ (d) None of these
72. On the interval $[0, 1]$, the function $x^{25} (1 - x)^{75}$ takes its maximum value at the point
 (a) 0 (b) $\frac{1}{4}$ (c) $\frac{1}{2}$ (d) $\frac{1}{3}$
73. The differential equation satisfied by the curves $e^{2y} + 2bx e^y + b^2 = 0$, where, b is a parameter, is
 (a) $(1 + x^2) \frac{d^2y}{dx^2} = 0$ (b) $(x^2 - 1) \left(\frac{dy}{dx} \right)^2 = 1$
 (c) $(x^2 - 1) \frac{d^2y}{dx^2} + 2 = 0$ (d) $(x^2 - x) \frac{dy}{dx} = y^2$
74. If $a \cos 2\theta + b \sin 2\theta = c$ has α and β as its solution, then $\tan \alpha + \tan \beta$ is equal to
 (a) $\frac{2c}{a+b}$ (b) $\frac{2a}{b+c}$ (c) $\frac{2b}{c+a}$ (d) None of these
75. The range of the function $f(x) = [4^x - 2^{x+1} + 1]$ is where $[\cdot]$ denotes greatest integer function.
 (a) positive integers (b) whole numbers (c) prime numbers (d) All integers
76. The mean and variance of 7 observations are 8 and 16 respectively. If 5 of the observations are 2, 4, 10, 12, 14, then the remaining two observations are
 (a) 6, 8 (b) 5, 6 (c) 9, 10 (d) None of these
77. The function $f(x) = [x]^2 - [x^2]$ is discontinuous at
 (a) all integers (b) all integers except 0 and 1
 (c) all integers except 0 (d) all integers except 1

78. Consider the statement.

"If it is raining, then sky is not filled with clouds."

Which among the following is true?

- (a) Contrapositive of the given statement is, "If sky is filled with clouds then it is raining."
- (b) Converse of the given statement is, "If sky is filled with clouds then it is raining."
- (c) "If it is not raining then sky is filled with clouds", is the inverse of the given statement.
- (d) Both (a) and (c) are true

79. If $D_k = \begin{vmatrix} 1 & n & n \\ 2k & n^2 + n - 1 & n^2 + n \\ 2k - 1 & n^2 & n^2 + n + 1 \end{vmatrix}$ and $\sum_{k=1}^n D_k = 56$, then n equals to

- (a) 4
- (b) 6
- (c) 8
- (d) None of these

80. Plane is parallel to the vectors $\hat{i} + \hat{j} + \hat{k}$ and $2\hat{k}$ and another plane is parallel to $\hat{i} + \hat{j}$ and $\hat{i} - \hat{k}$ then the acute angle between $4\hat{i} - \hat{j}$ and the line of intersection of the two planes is

- (a) $\cos^{-1} \frac{1}{\sqrt{2}}$
- (b) $\cos^{-1} \frac{3}{\sqrt{34}}$
- (c) $\cos^{-1} \frac{2}{\sqrt{34}}$
- (d) $\cos^{-1} \frac{5}{\sqrt{34}}$

81. Let, $f'(\sin x) < 0$ and $f''(\sin x) > 0 \forall x \in (0, \pi/2)$ and $g(x) = f(\sin x) + f(\cos x)$, then $g(x)$ is decreasing in

- (a) $(0, \pi/4)$
- (b) $[0, \pi/4]$
- (c) $(0, \pi/4]$
- (d) $[0, \pi/4)$

82. If PQ be a chord of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, which subtends right angle at the centre then its distance from the centre is equal to

- (a) $\frac{ab}{\sqrt{a^2 + b^2}}$
- (b) $\frac{a}{\sqrt{a^2 + b^2}}$
- (c) $\frac{b}{\sqrt{a^2 + b^2}}$
- (d) $\frac{2ab}{\sqrt{a^2 + b^2}}$

83. The area bounded by $y = x^3$, its normal at $(1, 1)$ and x -axis is equal to

- (a) $\frac{7}{4}$
- (b) $\frac{9}{4}$
- (c) $\frac{5}{4}$
- (d) 2

84. Let X be a family of sets and R be a relation on X defined by A is disjoint from B . Then, R is

- (a) reflexive
- (b) symmetric
- (c) anti-symmetric
- (d) transitive

85. If lines $\frac{x-1}{2} = \frac{y-2}{x_1} = \frac{z-3}{x_2}$ and $\frac{x-2}{3} = \frac{y-3}{4} = \frac{z-4}{5}$ lie in the same plane, then for equation $x_1 t^2 + (x_2 + 2)t + a = 0$

- (a) $x_1 - x_2 = 2$
- (b) Sum of roots of above equation = -2
- (c) $2x_1 + x_2 = 3$
- (d) Sum of roots is 3

86. The two adjacent sides of a cyclic quadrilateral are 2 and 5 and the angle between them is 60° . If the area of the quadrilateral is $4\sqrt{3}$, then the remaining two sides are

- (a) 2, 3 (b) 1, 2 (c) 3, 4 (d) 2, 2
87. The coefficient of $a^8b^4c^9d^9$ in $(abc + abd + acd + bcd)^{10}$ is
 (a) $10!$ (b) $\frac{10!}{8!4!9!9!}$ (c) 2520 (d) None of these
88. Let a_n be the n^{th} term of an AP if $\sum_{r=1}^{10^{99}} a_{2r} = 10^{100}$ and $\sum_{r=1}^{10^{99}} a_{2r-1} = 10^{99}$, then the common difference of the AP is
 (a) 1 (b) 9 (c) 10 (d) 10^{99}
89. Let $S \equiv x^2 + y^2 + 2gx + 2fy + c = 0$ be the equation of the circle, then
Statement I The least and the greatest distance of the point $P(10, 7)$ from the circle $x^2 + y^2 - 4x - 2y - 20 = 0$ are 5 and 15 units, respectively.
Statement II A point (x_1, y_1) lies outside a circle $S = x^2 + y^2 + 2gx + 2fy + c = 0$, if $S_1 > 0$ where, $S_1 = x_1^2 + y_1^2 + 2gx_1 + 2fy_1 + c$.
 (a) Both Statement I and Statement II are true and the Statement II is the correct explanation of the Statement I
 (b) Both Statement I and Statement II are true but the Statement II is not the correct explanation of the Statement I
 (c) Statement I is true but Statement II is false
 (d) Statement I is false but Statement II is true
90. Let us define a two events A and B such that $0 < P(A), P(B) < 1$.
Statement I The conditional probability relation between A and B is $P\left(\frac{A}{B}\right) + P\left(\frac{\bar{A}}{B}\right) = \frac{3}{2}$.
Statement II If the event B is already occurred, then

$$P\left(\frac{A}{B}\right) = \frac{P(A \cap B)}{P(B)} \text{ and } P(\bar{B}) = P(A \cap \bar{B}) + P(\bar{A} \cap \bar{B}).$$

 (a) Both Statement I and Statement II are true and the Statement II is the correct explanation of the Statement I
 (b) Both Statement I and Statement II are true but the Statement II is not the correct explanation of the Statement I
 (c) Statement I is true but Statement II is false
 (d) Statement I is false but Statement II is true

Analytical Explanations

Physics

1. (d) **Idea** The elastic potential energy stored in wire is given by

$$E = \frac{1}{2} \times \text{stress} \times \text{strain} \times \text{volume}$$

and stress = Y (strain)
Elastic energy

$$E = \frac{1}{2} \times \text{stress} \times \text{strain} \times \text{volume}$$

$$= \frac{1}{2} \times \frac{(\text{stress})^2}{Y} \times \text{volume}$$

Volumes of three wires are

$$V_1 = (\pi R^2) L = \pi R^2 L$$

$$V_2 = \pi (2R)^2 (2L) = 8 \pi R^2 L$$

$$V_3 = \pi \times (3R)^2 \times (3L) = 27 \pi R^2 L$$

Stresses of three wires are

$$\Rightarrow \sigma_1 = \frac{W}{\text{Area}} = \frac{W}{\pi R^2}$$

$$\sigma_2 = \frac{W}{4\pi R^2} \text{ and } \sigma_3 = \frac{W}{9\pi R^2}$$

Now, $E = E_1 + E_2 + E_3$

$$\begin{aligned} \Rightarrow E &= \frac{1}{2} \cdot \frac{\sigma_1^2}{Y} \cdot V_1 + \frac{1}{2} \cdot \frac{\sigma_2^2}{Y} \cdot V_2 + \frac{1}{2} \cdot \frac{\sigma_3^2}{Y} \cdot V_3 \\ &= \frac{1}{2} \left[\frac{W}{\pi R^2} \right]^2 \cdot \frac{\pi R^2 L}{Y} + \frac{1}{2} \left[\frac{W}{4\pi R^2} \right]^2 \cdot \frac{8\pi R^2 L}{Y} \\ &\quad + \frac{1}{2} \left[\frac{W}{9\pi R^2} \right]^2 \cdot \frac{27\pi R^2 L}{Y} \\ \Rightarrow E &= \frac{W^2 L}{2\pi R^2 Y} + \frac{W^2 L}{4\pi R^2 Y} + \frac{W^2 L}{6\pi R^2 Y} = \frac{11W^2 L}{12\pi R^2 Y} \end{aligned}$$

TEST Edge Question related to stress, strain, Young's modulus, energy stored in wire and work done in stretching wire etc., are frequently asked. Students are advised to go through these concepts deeply and also memorise important formulae.

2. (b) **Idea** The radiant power i.e., energy radiated by a body per unit time is given by

$$\frac{Q}{t} = A\epsilon\sigma T^4$$

$$\Rightarrow Q \propto AT^4$$

$$\text{also } \lambda_m T = \text{constant}$$

$$\Rightarrow Q \propto \frac{A}{(\lambda_m)^4}$$

Power radiated, $Q \propto AT^4$ and $\lambda_m T = \text{constant}$

$$\text{Hence, } Q \propto \frac{A}{(\lambda_m)^4} \text{ or } Q \propto \frac{r^2}{(\lambda_m)^4}$$

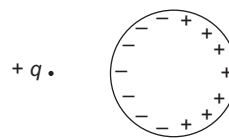
$$Q_A : Q_B : Q_C = \frac{(2)^2}{(3)^4} : \frac{(4)^2}{(4)^4} : \frac{(6)^2}{(5)^4} = 0.05 : 0.0625 : 0.0576$$

i.e., Q_B is maximum.

TEST Edge Question related to Kirchhoff's law, Stefan's law, Newton's law of cooling and Wien's displacement law are frequently asked, students are advised to have better understanding of concept and application of these topics.

3. (b) **Idea** When a charge or charged body brought near to neutral conducting body then due to induction some charge of opposite nature will appear in neutral body due to induction.

Suppose the charge is positive q then if it is brought closer to a conducting sphere it will induce charge in it, whose distribution would look something like this.



Although sphere as a whole would have zero charge but due to induction negative charge will be closer to the $+q$ as compared to positively induced charge and hence d would decrease. Same explanation can be given, if q is negative.

TEST Edge Question related to conduction, induction are asked in examination in which nature of charge, amount of charge etc., are asked. Students are advised to understand these concepts properly to solve problems.

4. (a) **Idea** Here, particle is moving in two-dimensional $(x-y)$ plane, with constant speed so slope of graph $\frac{dy}{dx} = \frac{v_y}{v_x}$ and $v_0 = \sqrt{v_x^2 + v_y^2}$.

$$\text{As slope, } \frac{dy}{dx} = -\frac{1}{\sqrt{3}} = \frac{v_y}{v_x}$$

$$\text{So, } v_x = -v_y \sqrt{3}$$

On squaring and adding

$$v_x^2 + v_y^2 = v_0^2$$


$$3v_y^2 + v_y^2 = v_0^2$$

$$v_y = \pm \frac{v_0}{2}$$

$$v_x = \mp \frac{\sqrt{3}v_0}{2}$$

$$\text{So, } y = \alpha e^{\frac{-2}{\sqrt{3}v_0} \times \frac{\sqrt{3}v_0}{2}} \\ y = \alpha e^{-1}$$

TEST Edge Generally, question in the term of graph are frequently asked, e.g., x - T graph, v - T graph, etc. So, student must study all sort of graph and must know basic concepts like slope of x - T graph will give instantaneous velocity etc.

5. (d)  **Idea** Energy of electron in ground state is $= -$ (ionisation energy)
If n , is the value of excited state, then
number of spectral lines $= \frac{n(n-1)}{2}$

Energy of electron in ground state
 $= -$ (ionisation energy)
 $= -13.6$ eV.
Final energy $= -13.6 + 12.75$
 $= -0.85$ eV

If n be the value of excited state, then

$$-\frac{13.6}{n^2} = -0.85$$


$$\Rightarrow n^2 = 16$$

$$\Rightarrow n = 4$$

Now, the number of spectral lines are

$$= \frac{n(n-1)}{2} = \frac{4 \times 3}{2} = 6 \text{ lines}$$

TEST Edge Energy in Bohr's orbit are frequently asked it can also be asked that how many spectral lines are emitted.

6. (b)  **Idea** If there is no external force acting then linear momentum of system will be conserved.

From conservation of momentum theorem, the X component of momentum is conserved.

$$\text{So, } m_1 v_1 = m_2 v_2$$

$\Rightarrow R$ will not depend on the vertical height h .


$$\text{if } m_1 > m_2$$

$$\text{Then, } v_1 < v_2$$

$$\text{So, } x_1 < x_2$$

The CM of the system of two balls will lie on the same vertical line. It will come down vertically due to gravitational force but it will not move horizontally as $(F_{\text{ext}})_x = 0$

TEST Edge Question based on linear momentum conservation, angular momentum conservation, torque etc., are frequently asked in examination. Students are advised to understand these concepts and their applications.

7. (d)  **Idea** As switch will be shifted then capacitors will not draw more charge from circuit and total charge on $1 \mu\text{F}$ capacitor will be shared by other capacitors according to their capacity.

$$\text{Initially, } Q_1 = 24 \mu\text{C} \quad [\because Q = CV]$$

$$\text{Finally, } V_{CQ} = \frac{24}{\frac{6}{5} + 1} = \frac{24 \times 5}{11} \text{ V}$$


$$Q'_3 = Q'_2 = \frac{6}{5} \times \frac{24 \times 5}{11} = 13 \mu\text{C} \quad (\text{approx})$$

$$Q'_1 = 1 \times \frac{24 \times 5}{11} = 11 \mu\text{C} \quad (\text{approx})$$

$$V'_1 = 11 \text{ V}$$


$$V'_3 = \frac{Q'_3}{C_3} = \frac{13}{3} = 4.3 \text{ V} \quad (\text{approx})$$

TEST Edge Similar questions can be asked in which one has to find potential across each capacitor or potential difference across a branch.

8. (c)  **Idea** Accuracy is related to how much close is observed value to the real value, i.e., if real value is 10.2 then reading 9.1 will be more accurate than 7.1. Whereas precision is related to least count of instruments, i.e., 9.112 is more precise than 9.1.

The observation of first person is measured upto two points of decimal but it is far from the actual value. So, it is less accurate but more precise.

TEST Edge Question related to error analysis is important. These are topics and 1 to 2 questions are asked almost every year.

9. (d)  **Idea** The magnetic field due to a long infinite wire at a perpendicular distance d is given by $|B| = \frac{\mu_0 I}{2\pi d}$ and its direction is given by Right hand thumb rule.

Magnetic field due to wire (I_1) is pointed in downwards direction (according to Right hand thumb rule)

$$\mathbf{B}_1 = \frac{\mu_0 I_1}{2\pi (d \sin \theta)} \cdot (-\hat{k})$$

[$d \sin \theta$ gives perpendicular distance from wire first.]

Field due to wire I_2 will be pointed in upwards direction.

$$\text{So, } \mathbf{B}_2 = \frac{\mu_0 I_2}{2\pi (d \sin \theta)} \cdot (\hat{k})$$

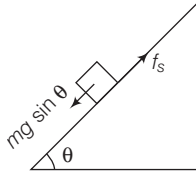
Hence, net field is $\mathbf{B} = \mathbf{B}_1 + \mathbf{B}_2$

$$\left[\mathbf{B} = \left[\frac{-\mu_0 I_1}{2\pi (d \cos \theta)} + \frac{\mu_0 I_2}{2\pi (d \sin \theta)} \right] \hat{k} \right]$$

$$\left[\mathbf{B} = \frac{\mu_0}{2\pi d} \left[\frac{-I_1}{\cos \theta} + \frac{I_2}{\sin \theta} \right] \hat{k} \right]$$

TEST Edge Question from the application of Biot-Savart's law is asked every year in the examination so students are advised to understand the application of this law.

10. (d) If block is at rest f_s must be equal to $mg \sin \theta$.



Here, f_s is equal to less than $(f_s)_{\max}$ will depend on the value of inclination (θ).

11. (a) Let $p_1 = 1 \text{ atm}$, $n = 5 \text{ mol}$, $T_1 = 293 \text{ K}$

$$V_2 = \frac{V_1}{10}$$

Using $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$,

$$\Rightarrow T_2 = T_1 \left(\frac{V_1}{V_2} \right)^{\gamma-1} = 293 (10)^{0.4} = 736 \text{ K}$$

Now,

$$\begin{aligned} \text{Workdone} &= \frac{nR(T_1 - T_2)}{\gamma - 1} \\ &= \frac{5 \times 8.3 \times (293 - 736)}{0.4} = -46 \text{ kJ} \end{aligned}$$

and $\Delta U = \Delta Q - W = 0 - W = 46 \text{ kJ}$

12. (a) KE of proton and α -particle shall be 1 eV and 2 eV respectively.

Now, momentum, $p = \sqrt{2m \text{ KE}}$

\therefore Momentum of proton is $p_p = \sqrt{2m_p \times \text{eV}}$

\therefore Momentum of α -particle whose mass $m_\alpha = 4m_p$ is

$$p_\alpha = \sqrt{8m_p \times (2 \text{ eV})} = \sqrt{16m_p \text{ eV}}$$

\therefore Now, $\lambda = \frac{h}{p}$ [de-Broglie relation]

$$\Rightarrow \frac{\lambda_p}{\lambda_\alpha} = \frac{p_\alpha}{p_p} = \frac{\sqrt{16m_p \text{ eV}}}{\sqrt{2m_p \text{ eV}}} = 2\sqrt{2} : 1$$

13. (d) Slope of line = $-\frac{2}{3}$

$$\text{Equation of line is } (v - 20) = -\frac{2}{3}(S - 0)$$

$$\Rightarrow v = 20 - \frac{2}{3}S \quad \dots(i)$$


Velocity at $S = 15 \text{ m}$,

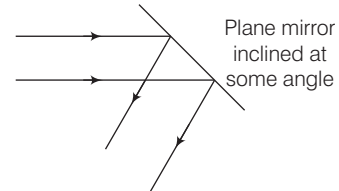
$$\text{i.e., } v = \left. \frac{dS}{dt} \right|_{S=15\text{m}} = 20 - \frac{2}{3}(15) = 10 \text{ ms}^{-1}$$

Differentiating Eq. (i) w.r.t. time,

$$\text{Acceleration} = \frac{dv}{dt} = -\frac{2}{3} \frac{dS}{dt}$$

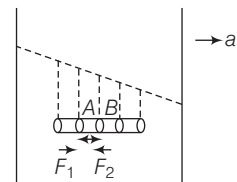
$$\therefore \left. \frac{dv}{dt} \right|_{S=15\text{m}} = -\frac{2}{3} \left. \frac{dS}{dt} \right|_{S=15\text{m}} = -\frac{20}{3} \text{ ms}^{-2}$$

14. (c)  **Idea** If a mirror is rotated at angle θ , then the reflected ray will be rotated through 2θ .



TEST Edge Questions based on size of mirror, distance of image, rotation of mirror are asked in examination. These types of questions are solved with the help of geometry (e.g., congruency of triangles etc.)


15. (c) The liquid is accelerated. Let us consider a small part AB of a virtual cylinder (horizontal)



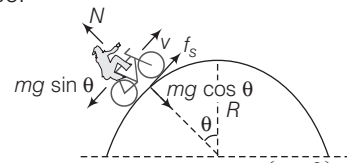
$$F_1 - F_2 = m_{AB} \times a$$

So, $F_1 > F_2$

So, $p_A > p_B$

16. (d)  **Idea** Whenever a body moves in a circular path, a centripetal force starts to act on the body which is always directed towards the centre.

Here, speed will remain constant due to frictional force.




$$\text{Now, } N = mg \cos \theta + \left(\frac{mv^2}{R} \right) \downarrow \text{constant}$$

As θ decreases $mg \cos \theta$ will increase up to the highest point and then again as θ increases $mg \cos \theta$ will decrease.

So, N will first increase and then decrease.

TEST Edge Question based on uniform circular motion, non-uniform circular motion is asked almost every year some may involve concept of energy conservation.

17. (b)  **Idea** Whenever there is relative motion between source and observer then frequency of sound is changed and can be calculated with the help of Doppler effect.

Here wall is an observer, so the frequency received by the wall.

$$\Rightarrow f' = \frac{v}{v - v_{\text{source}}} f_0$$

$$= \frac{330}{330 - 30} \times 300 = \frac{330}{300} \times 300$$

$$= 330 \text{ Hz}$$

The frequency of sound due to reflection will not change and now wall will act as a source with frequency f' and car will act as an observer.

$$\Rightarrow f'' = \frac{v + v_0}{v} f'$$

$$= \frac{330 + 30}{330} f'$$

$$= \frac{360}{330} \times 330 = 360 \text{ Hz}$$

TEST Edge Questions based on Doppler effect of sound are asked frequently and students are advised to study all possible cases of Doppler effect.

18. (a) By law of conservation of angular momentum,

$$\Sigma mvr = (I_{\text{system}}) \omega$$

$$\Rightarrow mv \frac{l}{2} = \frac{(2m)(2l)^2}{12} \omega = \frac{2m(4l^2)}{12} \omega$$

$$\Rightarrow \omega = \frac{3v}{4l} \quad (\text{anti-clockwise})$$

Not that clockwise or anti-clockwise rotation can only be determined here by the given figure.

19. (a) Diamagnetism is exhibited by all the substances. It arises because of motion of electrons inside an atom. But as effects due to diamagnetism are very weak, So, these can not be observed in paramagnetic and ferromagnetic substances.

20. (a) **Idea** When a straight conductor moves with velocity v perpendicular to magnetic field then emf induced is given by $V = Bvl$. Here, it will be $V = Bv(l \sin \theta)$.

Potential difference is $V = Bv(l \sin \theta)$

$$V = 2 \times v \times \frac{30}{100} \times \frac{1}{2} = 0.3 \text{ V}$$

Now, current = $\frac{V}{R}$

$$\Rightarrow 2 = \frac{0.3 \text{ V}}{9}$$

$$\Rightarrow v = 60 \text{ m/s}$$

TEST Edge Questions based on induced emf are frequently asked in examination, students are advised to the concept of motional emf and its application as it is very important topic of electromagnetic induction.

21. (b) If only conservative forces are acting in the system.

$$\Rightarrow W_{\text{ext}} = \Delta U \text{ (if body moves without acceleration)}$$

$$\Rightarrow W_{\text{ext}} = \Delta U + \Delta \text{KE}$$

(if body moves with acceleration)

$$\Rightarrow W_{\text{conservative}} = -\Delta U \text{ (always)}$$

22. (a) Due to insertion of glass plate of refractive index μ of thickness t the optical path becomes μt instead of t . So, net increase in path travelled by wave is, $\mu t - t = (\mu - 1)t$.

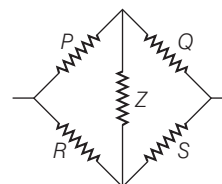
This increase would shift the fringe by a distance of $(\mu - 1)t \times \frac{D}{d}$

$$\text{Now given shift is } (\mu - 1)t \frac{D}{d} = \frac{2\lambda D}{d}$$

$$\Rightarrow (\mu - 1)t = 2\lambda$$

$$\Rightarrow t = \frac{2\lambda}{\mu - 1} = \frac{2\lambda}{1.5 - 1} = 4\lambda$$

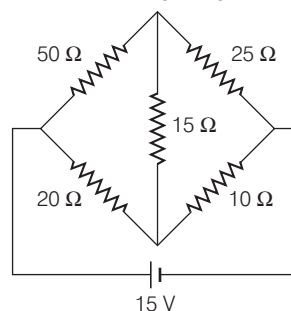
23. (a) **Idea** The given problem is application of balanced Wheatstone bridge, i.e.,



If $\frac{P}{Q} = \frac{R}{S}$, then Z can be removed.

Given, arrangement is a balanced Wheatstone bridge

$$\text{Clearly, } \frac{50}{20} = \frac{25}{10}$$



So, 15Ω resistance can be removed so equivalent resistance is

$$R_{\text{eq}} = \frac{75 \times 30}{75 + 30} = \frac{150}{7}$$

$$\text{So, current } I = \frac{15}{150} \times 7 = 0.7 \text{ A}$$

TEST Edge Concept of Wheat stone bridge can also be applied to capacitor and these problems are in trend.

24. (b) From mechanical energy conservation,

$$\begin{aligned}(\text{TME})_i &= (\text{TME})_f \\ -\frac{Gm^2}{R} &= -\frac{Gm^2}{2r} + 2\left[\frac{1}{2}mv^2\right] \\ v &= \sqrt{-Gm\left[\frac{1}{R} - \frac{1}{2r}\right]}\end{aligned}$$

25. (a) $V_{\text{rms}}^2 = \frac{\int_0^T V^2 dt}{\int_0^T dt}$. Here, $T = 2$ s

Now, $\int_0^T V^2 dt = 2 \int_0^{T/2} V dt$ [because of symmetry]

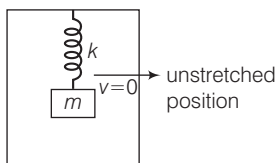
Equation of V from the graph is,

$$V = 2t \quad [0 \leq t \leq 1 \text{ s}]$$

$$\Rightarrow V_{\text{rms}}^2 = \frac{2 \times \int_0^1 2t \cdot dt}{2} = 2 \int_0^1 t \cdot dt = 2 \left[\frac{t^2}{2} \right]_0^1 = 1 \text{ V}$$

$$\Rightarrow V_{\text{rms}} = 1 \text{ Volt}$$

26. (c) At the unstretched position, the speed of block will be zero and spring force is also zero.



So, if lift comes in free fall at this moment the box will become at rest with respect to lift and will not execute SHM.

27. (d) **Idea** In an isolated system no heat is exchanged between system and surrounding during process.

Here as system is isolated $\Delta Q = 0$, for any part of system in graph.

TEST Edge Question from p - V curve are very important from examination point of view, conceptual clarity is necessary to tackle. These problems, a problem which seem difficult may involve a basic concept with which it can be solved easily. Work done in p - V curve, change in internal energy etc., are common questions which are asked in examination.

28. (c) Electromagnetic wave propagate perpendicular to electric and magnetic field vector and in the direction parallel to $\mathbf{E} \times \mathbf{B}$.
29. (a) Both Statement I and Statement II are true and Statement II is the correct explanation of the Statement I.
30. (d) Positive charge flow from higher potential to lower potential and also potential $\propto 1/r$ for sphere. So, smaller sphere have large potential.

Chemistry

31. (b) **Idea** This problem is based on concept of n -factor determination and their equivalent wt. determination.

- Determine the n -factor first
- Then, equivalent wt. = $\frac{\text{molecular wt.}}{n\text{-factor}}$

$$\begin{aligned}\text{Oxidation state of As in AsO}_4^{3-} &= x - 2 \times 4 = -3 \\ x - 8 &= -3\end{aligned}$$

$$x = 5$$

$$\text{Oxidation state of S in SO}_4^{2-} = x - 2 \times 4 = -2$$

$$x = -2 + 8 = +6$$

$$n\text{-factor} = \text{Sum of positive oxidation states}$$

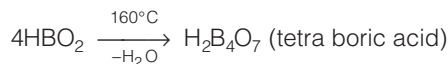
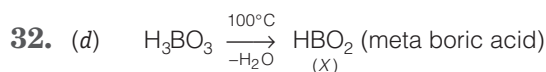
$$= \text{Total oxidation state of } 2\text{AsO}_4^{3-}$$

$$+ \text{Total oxidation state of SO}_4^{2-}$$

$$= 2 \times 5 + 3 \times 6 = 10 + 18 = 28$$

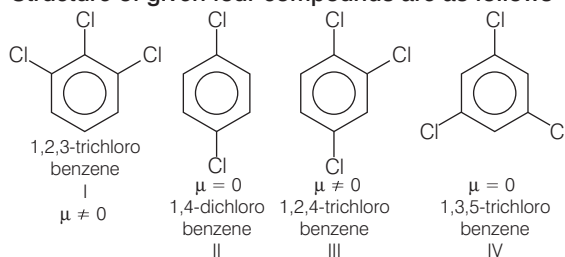
$$\text{Equivalent wt.} = \frac{M}{28}$$

TEST Edge Question related to determination of equivalent wt. of different sols, in different medium may also be asked frequently so, students are advised to study equivalent wt. of KMnO_4 in acidic, basic and neutral medium.

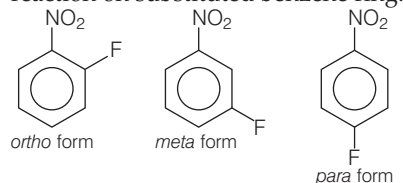


33. (a) This problem contains conceptual mixing of structure of compound and its dipole moment.

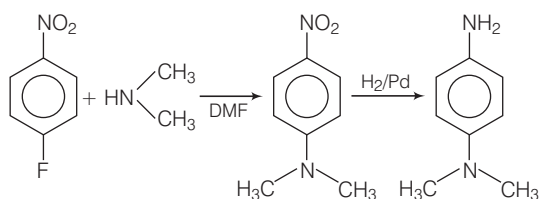
Structure of given four compounds are as follows



34. (a) **Idea** The problem includes conceptual mixing of determination of molecular structure of compound and nucleophilic substitution reaction on substituted benzene ring.



Seeing at the options given on options, we will choose para form as a starting material and the further sequence of chemical reaction will be as follows.

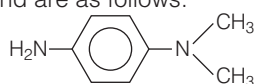


Determination of molecular structure Structure of given compound may be determined as molecular formula = $C_6H_4NO_2F$

$$\text{Degree of unsaturation } (u) = (C + 1) - \frac{H}{2} + \frac{N}{2}$$

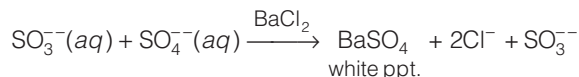
$$= (6 + 1) - \frac{5}{2} + \frac{1}{2} = 7 - 2 = 5$$

Since the organic compound is cyclic hence it must contain benzene ring as final product is also aromatic in nature. Hence, the possible structures of compound are as follows.



TEST Edge Students are advised to go through in depth study of various aromatic electrophilic substitution reaction including mechanism of these types of reactions which may also be asked in JEE Main.

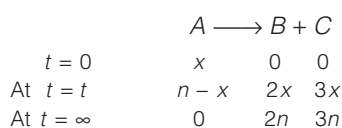
35. (c) This problem is based on concept of separation of sulphate and sulphite ion. This problem can be solved by using the knowledge of reagent.



Thus, sulphite and sulphate get separated easily.

36. (c) **Idea** This problem includes conceptual basis of kinetics of chemical reaction while solving this problem, students are advised to follow the steps
- Write the chemical reaction.
 - Write the concentration of each species below it.
 - Calculate the value of x_1 and x_2 using information supplied in the question.
 - Now, put the values in first order rate equation then come to the correct conclusion.

Let n is the moles of reagent P
when P is reacted with A at time $t = 0$



$$5n = x_2 \Rightarrow n = \frac{x_2}{5}$$

$$\{n - x + 2x + 3x\} = x_1$$

$$n + 4x = x_1, \quad x = \frac{x_1 - n}{4}$$

$$k = \frac{2.303}{t} \log \left(\frac{n}{n - x} \right)$$

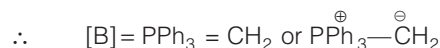
Put x and n ,

$$\text{So,} \quad k = \frac{1}{t} \ln \left(\frac{4x_2}{5(x_2 - x_1)} \right)$$

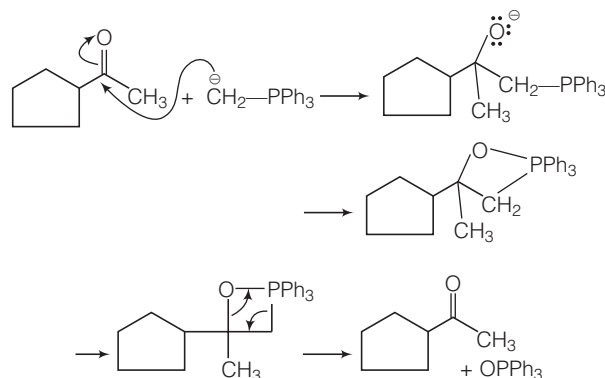
TEST Edge In JEE Main, these types of questions are included to judge the knowledge of student in rate constant involving quantitative approach of student towards solving such type of problem. Question related to rate constant and ideal gas equation can also be asked.

37. (d) **Idea** This problem includes conceptual mixing of Wittig reaction and Clemenson reduction. Student must have a clear idea about reagent used in various name reaction and rearrangement reaction.

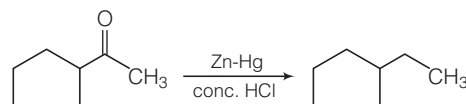
Wittig reaction The conversion of cyclopentyl methyl ketone to 2 cyclopentyl 2 methyl ethene by used of Wittig reagent *i.e.*, phosphorous ylid is known as Wittig reaction as shown in B.



Reaction occurs as follows




Clemenson reduction When carbonyl compound is treated with amalgamated zinc in presence of concentrated HCl, it converts $>C=O$ to $>CH_2$.



This is a direct method for conversion of ketone to hydrocarbon.

TEST Edge In JEE Main, these types of questions are asked frequently to judge the concept of student in various chemical reaction so student are advised to study the name reactions such as Wolf Kishner reduction, birch reduction, etc., which may also be asked.

38. (c)  **Idea** While solving this question, students are advised to use the concept of electronic configuration of metal ions and the magnetic moment of ions. Student must follow following tips to solve this problem.
- Write orbital representation of valence shell orbitals using electronic configuration of metal ion.
 - Count the number of unpaired electrons and calculate the magnetic moment using

$$\mu = \sqrt{n(n+2)} \text{ BM}$$



Unpaired electron(s) = 2

$$\text{Magnetic moment} = \sqrt{n(n+2)} = \sqrt{2(2+2)} = \sqrt{8} \text{ BM}$$



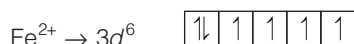
Unpaired electron(s) = 3

$$\text{Magnetic moment} = \sqrt{3(3+2)} = \sqrt{15} \text{ BM}$$



Unpaired electron(s) = 5


$$\text{Magnetic moment} = \sqrt{5(5+2)} = \sqrt{35} \text{ BM}$$



Unpaired electron(s) = 4

$$\text{Magnetic moment} = \sqrt{4(4+2)} = \sqrt{24} \text{ BM}$$

TEST Edge This type of question is a general trend which is asked frequently in JEE Main, students are advised to go through study of magnetic moments of coordination compounds also.

39. (a)  **Idea** This problem includes the concept of Raoult's law and their representation as equation of straight line. While solving this problem, student is advised to follow given tips.
- Write the partial pressure equation using Raoult's law.
 - Put the value of partial pressure to calculate mole fractions.
 - Rearrange the equation in $\frac{1}{Y_A}$ vs $\frac{1}{X_A}$ and determine slope and intercept.

$$p_A = X_A p_A^0$$

$$p_B = X_B p_B^0$$

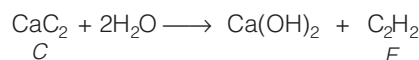
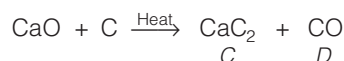
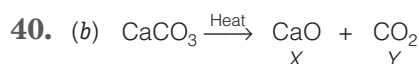
$$\text{and } Y_A = \frac{p_A}{p_A + p_B} = \frac{p_A^0 X_A}{p_A^0 X_A + p_B^0 (1 - X_A)}$$


$$Y_A = \frac{p_A^0 X_A}{X_A (p_A^0 - p_B^0) + p_B^0}$$

$$\frac{1}{Y_A} = \left(\frac{p_A^0 - p_B^0}{p_A^0} \right) + \frac{p_B^0}{p_A^0} \frac{1}{X_A}$$

$$\text{So, slope } \frac{p_B^0}{p_A^0} \text{ and intercept } \frac{p_A^0 - p_B^0}{p_A^0}.$$

TEST Edge Students are advised to study Raoult's law for non-ideal solution which may be asked frequently.



41. (a)  **Idea** To solve this problem student is advised to keep in mind the clear understanding of mole concept.

$$\text{Number of moles} = \frac{\text{Wt. in gram}}{\text{Molecular mass}}$$

$$(I) 0.5 \text{ mol of O}_3 = 24 \text{ g O}_3$$


$$(II) 3.01 \times 10^{23} \text{ molecules of O}_2 = 16 \text{ g O}_2$$

$$(III) 5.6 \text{ L of CO}_2 = \frac{5.6}{22.4} \times 44 = 11 \text{ g CO}_2$$

$$(IV) 0.5 \text{ g atom of O}_2 = 8 \text{ g}$$

$$\text{Hence, IV} < \text{III} < \text{II} < \text{I}$$

TEST Edge These types of problems are asked generally in JEE Main to judge the basic mole concept so students are advised to go through clear study of equivalent wt., stoichiometry etc. Question involving this concept may also be asked.

42. (d)  **Idea** This problem includes conceptual mixig of variom physical properties of haloalkanes viz, boiling point, density and polarity.

So, students are advised to go through in depth study of physical properties of hydrocarbons.

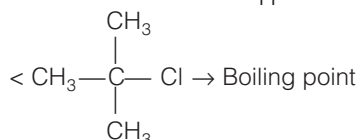
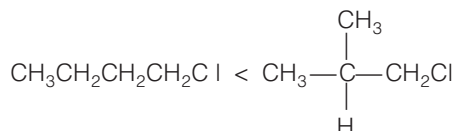
Boiling point Boiling point of haloalkane increases with size of attached halogen.



Size of halogen increases

Polarity of C-X bond increases

Boiling point of haloalkane decreases with increase in branching.

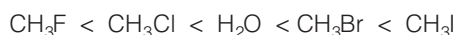


Polarity of C—X bond Polarity of C—X bond mainly depends upon electronegativity of halogen atom. But in case of C—Cl and C—F, the bond polarity is explained by size of halogen here C—F bond is less polar than C—Cl due to very small size of F.



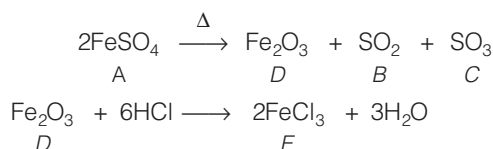
Density of alkyl halide and water Alkyl chloride and fluoride have lesser density than water while alkyl bromide and alkyl iodide have more density than water.

Hence, correct order of density is



TEST Edge In JEE Main, these questions are asked frequently so students are advised to go through in depth of dipole moment, solubility, stability etc., also, which may also be asked.

43. (b) **Idea** This problem can be solved by using the concept of quantitative analysis of inorganic compounds. Look a sight towards option while solving the question and choose the correct possible option using information provided in question.



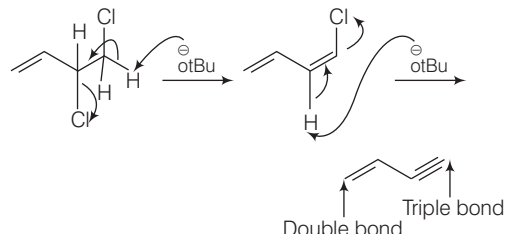
TEST Edge Question based on quantitative analysis of different ions (acid and basic radicals) and dry test of each type of radical may also be asked, so students are recommended to undergo in depth study of wet test and dry test.

44. (c) The sols obtained in the two cases will be oppositely charged so coagulate each other.

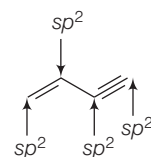
45. (d) **Idea** This problem includes conceptual mixing of elimination reaction and type of hybridisation.

While solving this problem, students are advised to complete the reaction and then go through analysis of hybridisation of each carbon atom depending upon number of π -bonds around C-atom.

The above written reaction is an example of elimination reaction occurs as



The hybridisation of carbon atom when it is bonded by single bond, double bond and tripple bond are sp^3 , sp^2 and sp respectively.



TEST Edge This type of problem including elimination reaction as well as substitution and rearrangement reaction may abo be asked in JEE Main.

The correct order is sp^2 , sp^2 , sp and sp .

46. (d) **Idea** This problem is based on concept of 'van der Waal's equation' which can be solved by using the value of b used in volume correction.

$$b = \frac{4}{3} \pi r^3 + 4N_A$$

and values of compressibility factor at high pressure

$$\text{i.e., } Z = 1 + \frac{bp}{RT}$$

van der Waal's equation

$$\left(p + \frac{n^2a}{V^2}\right)(V - nb) = nRT$$

At high pressure, $Z = 1 + \frac{pb}{RT}$

$$\text{Slope} = \frac{b}{RT}$$

$$b = \frac{\pi}{246.3} \times 0.0821 \times 600 \quad \dots(i)$$

$$\text{and } b = \frac{4}{3} \pi r^3 \cdot 4N_A = \frac{16}{3} \pi r^3 N_A \quad \dots(ii)$$

By Eqs. (i) and (ii), we get

$$\frac{16}{3} \pi r^3 N_A = \frac{\pi}{246.3} \text{atm}^{-1} \times 0.0821 \text{L atm mol}^{-1} \text{K}^{-1} \times 600 \text{K}$$

$$r^3 = \frac{3 \times 0.0821 \text{L mol}^{-1} \times 600}{16 N_A}$$

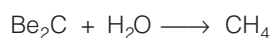
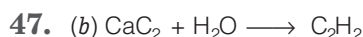
$$r = \sqrt[3]{\frac{3 \times 0.082 \times 600 \text{L}}{16 \times 0.023 \times 10^{23}}}$$

$$= \sqrt[3]{\frac{3 \times 0.082 \times 600}{16 \times 6.023 \times}} \times 10^{-3} \text{ m}^{-23}$$

$$r = 3 \text{ \AA}$$

$$d = 2r = 6 \text{ \AA}$$

TEST Edge These types of problems are asked in JEE Main frequently, students are advised to study the concept of van der Waals' equation at low p , high T and low T also, question may also be asked from that area.

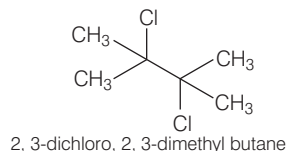
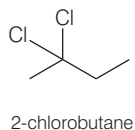
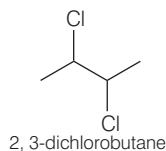
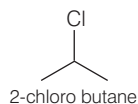


All are alkaline earth metals Group (II) elements.

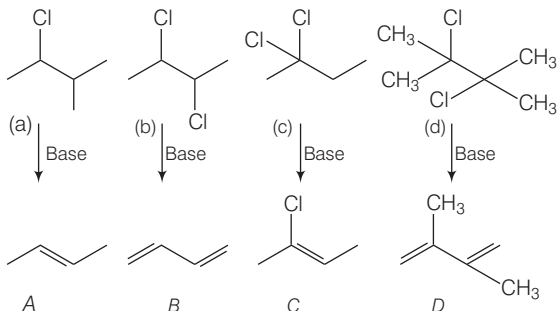
48. (d) **Idea** This problem includes conceptual mixing of molecular structure of organic compound, Sytzeff's rule elimination reaction and conjugation.

This problem may be solved by completing the elimination reaction of each reactants and then comparing stability of product using the Sytzeff's rule and conjugation.

1. Molecular structure of given written names of organic compounds are written first as



According to Sytzeff's rule, more substituted (alkylated) alkene are more stable. When the alkyl halide is treated with base, it undergoes elimination reaction and produces alkene as follows



Conjugation Greater the conjugation greater will be the stability of product.

Hence, D has maximum stability, the correct choice is (d) which is stabilised by conjugation as well as Sytzeff's rule.

TEST Edge Similar type of problem including stability of compound on the basis of inductive effect, resonance, aromatic stability etc., may also be asked in JEE Main frequently.

49. (c) **Idea** While solving this problem, students are advised to use the mole concept and stoichiometry as follows

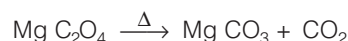
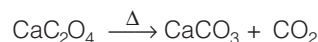
- Consider arbitrary mass of MgC_2O_4 and CaC_2O_4 ($0.7 - x$) and x respectively.

- Write the chemical reaction and calculate weight of both species.

- Finally using information provided in question complete the further calculation.

Let x g = weight of CaC_2O_4

So, wt. of $\text{MgC}_2\text{O}_4 = (0.7 - x)$ g



$$\text{Weight of CaCO}_3 \text{ produced} = \frac{x}{128} \times 100$$

$$\text{Weight of MgCO}_3 \text{ produced} = \frac{0.7 - x}{112} \times 84$$

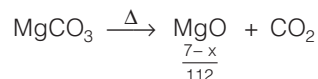
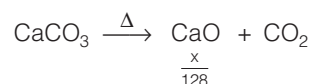
$$\frac{x}{128} \times 100 + \frac{0.7 - x}{112} \times 84 = 0.47$$

$$x = 0.46 \text{ g}$$

Mol. wt. $\text{CaCO}_3 = 100$, $\text{MgCO}_3 = 84$, $\text{CaC}_2\text{O}_4 = 128$,

$\text{MgC}_2\text{O}_4 = 112$

Due to further heating



Weight of CaO and MgO

$$= \frac{0.46}{128} \times 56 + \frac{0.24}{112} \times 40$$

$$= 0.20 + 0.0857$$

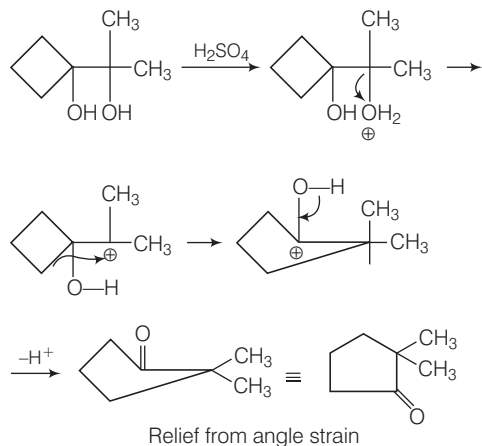
$$= 0.28 \text{ g}$$

TEST Edge Students are advised to also go through clear idea about calculation of amount of product obtained in various chemical reaction which may be titration, precipitation, combustion reaction or any redox reaction using mole concept and stoichiometry.

50. (d) **Idea** This problem includes conceptual mixing of pinacol pinacolone rearrangement involving rearrangement of carbocation. Follow the given steps sequentially by go through formation of carbocation and then notice the possibility of rearrangement and finally complete the reaction.

Pinacol-pinacolone rearrangement

The diol is converted into α -hydroxy ketone when reacted in presence of acid is believe to proceeds through rearrangement of carbocation as shown.



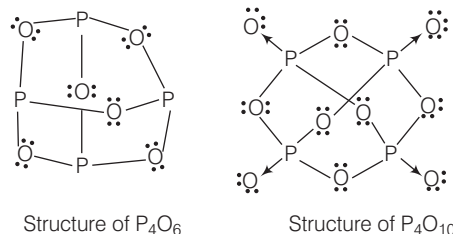
Basic of carbocationic rearrangement is due to relief from angle strain.

TEST Edge These types of questions including concept of a carbocationic rearrangement are asked frequently. Students are advised to study the Baeyer villiger oxidation, Hoffmann bromamide reaction etc., which may be asked in JEE Main.

51. (d) $As_2S_5 + HNO_3 \longrightarrow H_3AsO_4 + NO_2 + H_2O + S$
 $H_3AsO_4 + (NH_4)_2 As MoO_4 \longrightarrow (NH_4)_3 AsO_4 \cdot 12 MoO_3$
 Yellow precipitate

52. (d) $\Delta E = \frac{hc}{\lambda} = \frac{(6.62 \times 10^{-34})(3 \times 10^8)}{6.11 \times 10^{-8}}$
 $= 3.26 \times 10^{-18} J$
 $\Delta E_H = \frac{3}{4} (2.76 \times 10^{-18})$
 $= 1.62 \times 10^{-18} J$
 $\Delta E = \Delta E_H (Z^2)$
 $Z^2 = \frac{\Delta E}{\Delta E_H} = \frac{3.26 \times 10^{-18}}{1.62 \times 10^{-18}}$
 $Z^2 = 2$
 $Z = \sqrt{2} = 1.4$

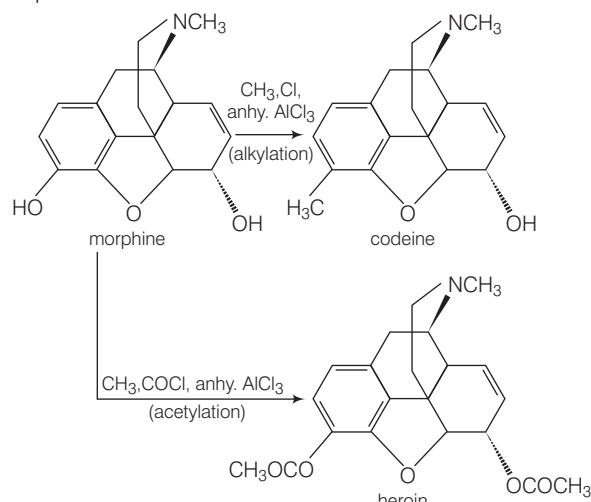
53. (c) **Idea** While solving this problem, students are advised to go through structure of oxides of phosphorus, draw the structure of oxide of phosphorus and choose the correct option regarding P_4O_6 and P_4O_{10} .



TEST Edge Questions related to structures of oxy acids of sulphur and nitrogen are generally asked, students are advised to go through it.

54. (c) **Idea** This problem is directly solved by knowing the Friedal Craft alkylation and Friedal Craft acylation of morphine.

This problem involves conceptual mixing of alkylation and acetylation of morphine. Acetylation and alkylation of morphine gives two different product as follows



TEST Edge In general JEE Main similar type of question relating synthesis and characteristics of aspirin and paracetamol may also be asked.


55. (d) Equivalents of CO_2 produced = $\frac{l \times n \times t}{96500}$
 $= \frac{0.5 \times 0.9 \times 96.5 \times 60}{96500}$
 $= \frac{2605.5}{96500} = 0.027$
 Moles of CO_2 ($n=1$) produced ≈ 0.027
 Moles of C_2H_6 ($n=2$) produced = $\frac{0.027}{2} = 0.0135$

Total moles of gases produced = 0.0405

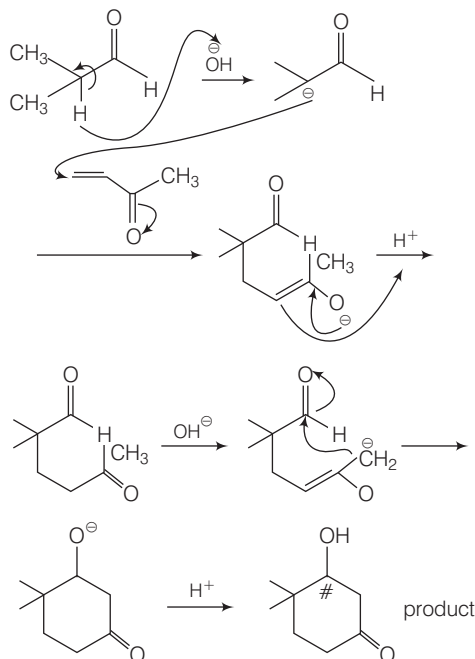
$$V_{\text{gas}} = \frac{nRT}{p}$$

$$= \frac{0.040 \times 0.0821 \times 300}{\frac{760}{760}}$$

$$= 0.997 \text{ L} \approx 1 \text{ L}$$

- 56. (a)**  **Idea** This problem includes conceptual mixing of Michael addition and number of chiral centre.
- Complete the reaction using the concept of Michael addition.
 - Then, complete intramolecular aldol condensation.
 - Now, count number of chiral centre.

Michael addition Addition of nucleophile to enone system is done in such a way that the addition looks like addition at 1st and 4th position of enone is known as Michael addition.



The number of chiral centre in product is 1 represented by #.

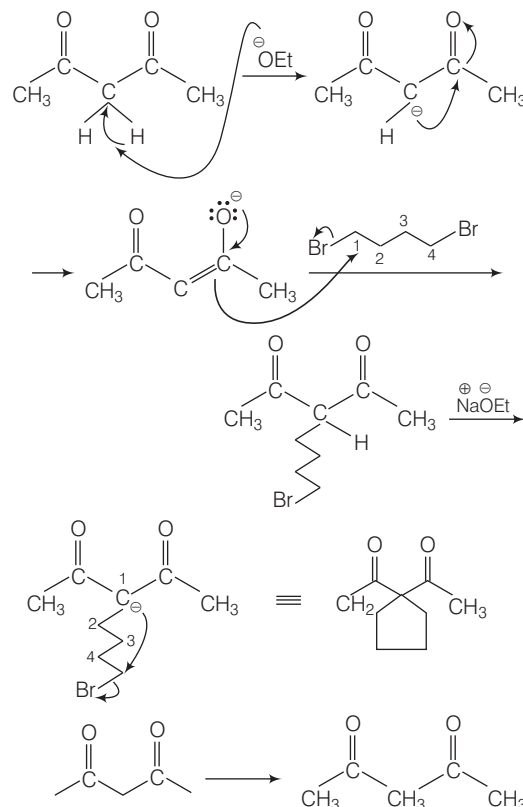
TEST Edge Problems involving two consecutive reactions are asked frequently in JEE Main. So, students are advised to go step by step completion of reaction, Robinson annelation, benzoin condensation, Cannizzaro reactions are also asked in sequence with some other nucleophilic addition reaction.

- 57. (a)** $\text{Zn}(\text{OH})_2$ (s) alongwith H^+ shows acidic nature while $\text{Zn}(\text{OH})_2$ (s) alongwith OH^- shows basic nature. This is why $\text{Zn}(\text{OH})_2$ is amphoteric.

- 58. (a)** This problem involves conceptual mixing of structure determination of carbonyl compound by using different test and nucleophilic substitution reaction. Structure determination of acyclic compound having molecular formula = $\text{C}_5\text{H}_8\text{O}_2$

$$u = (5 + 1) - \frac{8}{2} = 2$$

It does not decolorise the bromine water solution means compound has no $\text{C}=\text{C}$ bond this confirms presence of two keto groups. Since, it also contain active methylene group mean two keto group must be flanked with $-\text{CH}_2-$ group. The compound is 1, 3-diketone and the structure is



Now when this compound is treated with sodium ethoxide produces enolate anion.

The correct answer is choice (a).

TEST Edge Problem occurring *via* carbanionic mechanism are very frequently asked so students are advised to learn the basic principles related to formation of carbanion and their nucleophilic addition reaction.

- 59. (c)** This problem includes conceptual mixing of preparation of biodegradable polymer and cause of ecofriendly nature.

Preparation of biodegradable polymer

- (i) **Preparation of PHBV** Copolymerisation of 3 hydroxy butanoic acid and 3 hydroxy pentanoic acid produce

poly β -hydroxy butyrate – Co β -hydroxy valerate (PHBV).

- (ii) **Preparation of Nylon-2, Nylon 6** Copolymerisation of glycerine and amino caproic acid produces nylon 2, 6.

Cause of Ecofriendly Nature Above prepared both the polymer are ecofriendly due to biodegradable nature of polymer which means it can be reduced to or dissociated to small segments by enzyme or microorganism. The nature of polymer keeps us away from environmental pollution.

Hence, the correct reason is due to easy dissociation of biodegradable polymer to small segments.

60. (a) Both Statement I and Statement II are the correct and Statement II is the correct explanation of the Statement I.

Due to greater size of Cl^- , it cannot accommodate in vacant d orbital of Si. hence existence of SiCl_6^{2-} do not occurs.

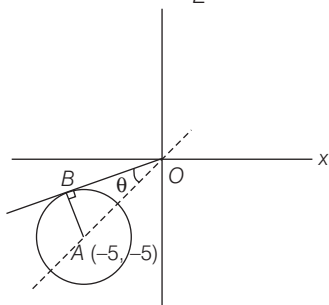
Mathematics

61. (a) It is given that,

$$|2z + 10 + 10i| \leq 5\sqrt{3} - 5$$

$$\therefore |z + (5 + 5i)| \leq \frac{5\sqrt{3} - 5}{2}$$

This equation represents a circle whose centre is $(-5, -5)$ and radius is $\frac{5}{2}(\sqrt{3} - 1)$



Here, $AB = \text{radius} = \frac{5}{2}(\sqrt{3} - 1)$

$$OA = \sqrt{5^2 + 5^2} = 5\sqrt{2}$$

$$\sin \theta = \frac{\frac{5}{2}(\sqrt{3} - 1)}{5\sqrt{2}} = \frac{(\sqrt{3} - 1)}{2\sqrt{2}}$$

$\therefore \theta = 15^\circ$

$$\angle XO B = -(135 + 15) = -150 = -\frac{5\pi}{6}$$

62. (a) **Idea** Here use the concept of greatest integer function such as $[2 \cdot 1] = 2$, $[3 \cdot 4] = 3$

We have, $2 \cdot 4 \cdot 6 \cdot 8 \cdot 10 \cdot 12 \dots 1000$

$$= (2 \times 1)(2 \times 2)(2 \times 3)(2 \times 4) \dots (2 \times 500)$$

$$= 2^{500} (1 \times 2 \times 3 \times 4 \dots \times 500)$$

$$= 2^{500} 500! \quad \text{where } [] \text{ represents GIF}$$

Now, exponent of 2 in $500!$ is

$$= \left[\frac{500}{2} \right] + \left[\frac{500}{2^2} \right] + \left[\frac{500}{2^3} \right] + \left[\frac{500}{2^4} \right] + \left[\frac{500}{2^5} \right] + \left[\frac{500}{2^6} \right] + \left[\frac{500}{2^7} \right] + \left[\frac{500}{2^8} \right]$$

$$= 250 + 125 + 62 + 31 + 15 + 7 + 3 + 1$$

$$= 494$$

Total exponent of 2 are $= 500 + 494 = 994$

TEST Edge Generally in JEE Main, number of exponents of natural number in given expansion related questions are asked. To solve these types of questions, students are advised to understand the basic concept of GIF and also acquainted yourself with the concept of factorial.

63. (c) **Idea** Here $\int_a^b f(x) dx = 0$ if $f(x)$ is an odd function such $f(-x) = -f(x)$.

Let us consider

$$H(x) = \frac{f\left(\frac{x^2}{4}\right)[f(x) - f(-x)]}{g\left(\frac{x^2}{4}\right)[g(x) + g(-x)]}$$

$$H(-x) = \frac{f\left(\frac{x^2}{4}\right)[f(-x) - f(x)]}{g\left(\frac{x^2}{4}\right)[g(-x) + g(x)]}$$

$$= \frac{-f\left(\frac{x^2}{4}\right)[f(x) - f(-x)]}{g\left(\frac{x^2}{4}\right)[g(-x) + g(x)]}$$

$$H(-x) = -H(x)$$

\therefore So, it is an odd function

$$\int_{\ln \lambda}^{-\ln \lambda} \frac{f\left(\frac{x^2}{4}\right)[f(x) - f(-x)]}{g\left(\frac{x^2}{4}\right)[g(x) + g(-x)]} dx = 0$$

$$\therefore \int_{-a}^a f(x) dx = 0$$

If $f(x)$ is odd function.

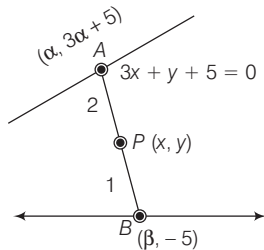
TEST Edge In JEE Main, properties of definite integral based questions are asked. To solve these types of questions, students are advised to learn the properties of definite integral and understand the concept of continuous function.

64. (d) Equation of line is

$$3x - y + 5 = 0 \quad \dots(i)$$

and equation of other line is

$$y = -5 \quad \dots(ii)$$



Let the general point on the line (i) is $(\alpha, 3\alpha + 5)$ and on line (ii) is $(\beta, -5)$

Using section formula

$$x = \frac{\alpha + 2\beta}{3} \Rightarrow 3x = \alpha + 2\beta \quad \dots(iii)$$

$$y = \frac{-10 + 3\alpha + 5}{3} \Rightarrow 3y = 3\alpha - 5 \quad \dots(iv)$$

From Eqs. (iii) and (iv), we get

Solving α and β in terms of x and y

$$\alpha = \frac{3y + 5}{3}, \beta = \frac{9x - 3y - 5}{6}$$

$$l^2 = AB^2 = (\alpha - \beta)^2 + (3\alpha + 10)^2$$

$$l^2 = \frac{1}{4} (3x - 3y - 5)^2 + (3y + 15)^2$$

65. (a) Here, A is a 3×3 matrix and matrices B, C and D are related such that $B = \text{adj}(A), C = \text{adj}(\text{adj}(A)),$

$$D = \text{adj}(\text{adj}(\text{adj}(A)))$$

Let $ABCD = E$, then

$$|\text{adj}(\text{adj}(\text{adj}(\text{adj}(E))))| = |E|^{(3-1)^4} = |E|^{16}$$

$$\begin{aligned} |ABCD|^{16} &= |A|^{16} |B|^{16} |C|^{16} |D|^{16} \\ &= |A|^{16} (|A|^2)^{16} (|A|^4)^{16} (|A|^8)^{16} \\ &= |A|^{16 + 32 + 64 + 128} \\ &= |A|^{240} \end{aligned}$$

$$\Rightarrow |A|^K = |A|^{240}$$

$$\Rightarrow K = 240 < 256$$

66. (c) **Idea** Find the intersection points of the given lines and then get distance from the given point.

Consider the given lines are

$$\frac{x-4}{1} = \frac{y+3}{-4} = \frac{z+1}{7} = \lambda_1 \quad \dots(i)$$

$$\frac{x-1}{2} = \frac{y+1}{-3} = \frac{z+10}{8} = \lambda_2 \quad \dots(ii)$$

From Eqs. (i) and (ii), we get

$$4 + \lambda_1 = 1 + 2\lambda_2$$

$$\Rightarrow \lambda_1 - 2\lambda_2 = -3 \quad \dots(iii)$$

$$-3 - 4\lambda_1 = -1 - 3\lambda_2$$

$$\Rightarrow 4\lambda_1 - 3\lambda_2 = -2 \quad \dots(iv)$$

From Eqs. (iii) and (iv), we get

$$\lambda_1 = 1, \lambda_2 = 2$$

$$\Rightarrow \text{Point of intersection } (4 + 1, -3 - 4, -1 + 7)$$

$$i.e., (5, -7, 6)$$

Distance of $(5, -7, 6)$ from $(1, -4, 7)$

$$= \sqrt{16 + 9 + 1} = \sqrt{26}$$

TEST Edge Distance between two lines, intersection of lines related question are asked. To solve these types of questions, students are advised to learn the formula and understand the concept of line.

67. (c) We have given inequality as

$$x^2 + 9 < (x + 3)^2$$

$$x^2 + 9 < x^2 + 9 + 6x$$

$$6x > 0 \Rightarrow x > 0 \quad \dots(i)$$

Again,

$$(x + 3)^2 < 8x + 25$$

$$\Rightarrow x^2 + 9 + 6x < 8x + 25$$

$$\Rightarrow x^2 - 2x - 16 < 0$$

$$\Rightarrow (x - 1)^2 - 17 < 0$$

$$\Rightarrow (x - 1)^2 < 17$$

$$\Rightarrow x \in (1 - \sqrt{17}, 1 + \sqrt{17})$$

Hence, integral value of x are

$$1, 2, 3, 4, 5$$

68. (c) **Idea** Here $\mathbf{a} \cdot \mathbf{b} = |\mathbf{a}| |\mathbf{b}| \cos \theta$

$$\text{and } |\mathbf{a} \cdot \mathbf{a}| = |\mathbf{a}|^2 = 1$$

Find the value of λ .

It is given that the angle between \mathbf{a} and \mathbf{c} is $\cos^{-1} \frac{1}{4}$

So,

$$\mathbf{a} \cdot \mathbf{c} = |\mathbf{a}| |\mathbf{c}| \left(\cos^{-1} \frac{1}{4} \right)$$

$$\Rightarrow \mathbf{a} \cdot \mathbf{c} = \frac{1}{4} \quad \dots(i)$$

Taking dot product by $\mathbf{a} \cdot \mathbf{b} \cdot \mathbf{c}$, we have

$$\mathbf{a} \cdot \mathbf{b} - 2(\mathbf{a} \cdot \mathbf{c}) = \lambda (\mathbf{a} \cdot \mathbf{a})$$

$$\Rightarrow \mathbf{a} \cdot \mathbf{b} - \frac{1}{2} = \lambda$$

$$\Rightarrow \mathbf{a} \cdot \mathbf{b} = \lambda + \frac{1}{2} \quad \dots(ii)$$

$$\text{Similarly, } \mathbf{b} \cdot \mathbf{c} = 8 - \frac{\lambda^2}{2} - \frac{\lambda}{4} \quad \dots(iii)$$

$$\text{and } \mathbf{b} \cdot \mathbf{c} - 2 = \lambda (\mathbf{a} \cdot \mathbf{c}) \quad \dots(iv)$$

From Eqs. (ii), (iii) and (iv), we get

$$8 - \frac{\lambda^2}{2} - \frac{\lambda}{4} - 2 = \lambda \left(\frac{1}{4} \right)$$

$$\Rightarrow \lambda = 3, -4$$

TEST Edge Generally in JEE Main, angle between two vectors and different types of questions based on scalar product are asked. To solve these types of questions, students are advised to understand the basic concept of scalar product of two vectors.

69. (a) Apart from the owner there are 24 other cars. On his returns 14 cars are left.

$n(S)$ = Number of ways selecting 14 cars out of 24 cars

$$= {}^{24}C_{14}$$

$n(E)$ = Selecting 14 cars (leaving two neighbouring positions) out of 22 cars

$$= {}^{22}C_{14}$$

$$P(E) = \frac{{}^{22}C_{14}}{{}^{24}C_{14}} = \frac{15}{92}$$

70. (d) Consider the given expression

$$\lim_{x \rightarrow \infty} \left(\frac{p^{\frac{1}{x}} + q^{\frac{1}{x}} + r^{\frac{1}{x}} + s^{\frac{1}{x}}}{4} \right)^{3x} \quad [\text{where, } p, q, r, s > 0]$$

Put, $\frac{1}{x} = z$, so that $x \rightarrow \infty \Rightarrow z \rightarrow 0$

$$= \lim_{z \rightarrow 0} \left(\frac{p^z + q^z + r^z + s^z}{4} \right)^{\frac{3}{z}}$$

which is in the form 1^∞ .

$$= e^{\lim_{z \rightarrow 0} \left(\frac{p^z + q^z + r^z + s^z}{4} - 1 \right)^{\frac{3}{z}}}$$

$$= e^{\lim_{z \rightarrow 0} \left(\frac{p^z - 1}{z} + \frac{q^z - 1}{z} + \frac{r^z - 1}{z} + \frac{s^z - 1}{z} \right) \frac{3}{4}}$$

$$= e^{\frac{3}{4} (\log_e p + \log_e q + \log_e r + \log_e s)}$$

$$= e^{\frac{3}{4} \log_e (pqrs)} = (pqrs)^{3/4}$$

71. (a) **Idea** Find the equation of normal at $(at^2, 2at)$ and then given points are also satisfy the equation of normal.

Here, equation of normal to the parabola $y^2 = 4ax$ at the point $(at^2, 2at)$ is

$$y + tx = 2at + at^3 \quad \dots(i)$$

Eq. (i) cuts the parabola again $(aT^2, 2aT)$

Then, $2aT + taT^2 = 2at + at^3$

$$\Rightarrow 2a(T - t) = -at(T^2 - t^2)$$

$$\Rightarrow 2 = -t(T + t) \quad [t \neq T]$$

$$t^2 + tT + 2 = 0$$

$$\text{Since, } t \text{ is real } T^2 - 4 \cdot 2 \cdot 1 \geq 0$$

$$T^2 \geq 8$$

TEST Edge Equation of tangent at parabola and different condition related questions are asked in JEE Main. Students are advised understand the concept of tangent of parabola.

72. (b) **Idea** For maxima or minima $f'(x) = 0$ then value x_1, x_2, x_3, \dots obtained if $f(x) > 0$ at x_1 then it is maximum.

Here, we have given a function.

$$f(x) = x^{25} (1-x)^{75}, x \in [0, 1]$$

$$f'(x) = 25x^{24} (1-x)^{75} - 75x^{25} (1-x)^{74}$$

$$= 25x^{24} (1-x)^{74} [1-x-3x]$$

$$= 25x^{24} (1-x)^{74} (1-4x)$$

For maximum value of $f(x)$, put $f'(x) = 0$

$$25x^{24} (1-x)^{74} (1-4x) = 0$$

$$x = 0, 1, \frac{1}{4}$$

also at $x = 0, y = 0$

at $x = 1, y = 0$

and $x = \frac{1}{4}, y > 0$

So, $f(x)$ attains maximum value at $x = \frac{1}{4}$

TEST Edge The minimum value of function or maximum at open interval or closed interval related questions are asked in JEE Main. To solve these types of questions, students are advised to understand the basic concept of maxima or minima.

73. (b) Given that, $e^{2y} + 2bx e^y + b^2 = 0$

Now, simplify the given equation, we get

$$e^{2y} + 2bx e^y + b^2 x^2 = b^2 x^2 - b^2$$

$$(e^y + bx)^2 = b^2 (x^2 - 1)$$

$$e^y + bx = \pm b \sqrt{x^2 - 1}$$

$$e^y = -b(x \pm \sqrt{x^2 - 1}) \quad \dots(i)$$

Differentiating of Eq. (i) w.r.t. x , we get

$$e^y \frac{dy}{dx} = \frac{-b(x \mp \sqrt{x^2 - 1})}{\sqrt{x^2 - 1}} \quad \dots(ii)$$

From Eqs. (i) and (ii), we get

$$\sqrt{x^2 - 1} \frac{dy}{dx} = \pm 1$$

$$(x^2 - 1) \left(\frac{dy}{dx} \right)^2 = 1$$

74. (c)  **Idea** Here, $\cos 2\theta = \frac{1 - \tan^2 \theta}{1 + \tan^2 \theta}$,

$$\sin 2\theta = \frac{2 \tan \theta}{1 + \tan^2 \theta}$$

and for a quadratic equation

$$ax^2 + bx + c = 0$$

have roots α and β , then

$$\alpha + \beta = -\frac{b}{a}, \quad \alpha\beta = \frac{c}{a}$$

It is given that,

$$a \cos 2\theta + b \sin 2\theta = c$$

$$\Rightarrow a \left[\frac{1 - \tan^2 \theta}{1 + \tan^2 \theta} \right] + b \left[\frac{2 \tan \theta}{1 + \tan^2 \theta} \right] = c$$

$$\Rightarrow a(1 - x^2) + 2bx = c(1 + x^2)$$

(let $x = \tan \theta$)

$$\Rightarrow a - ax^2 + 2bx = c + cx^2$$

$$\Rightarrow (a + c)x^2 - 2bx + (c - a) = 0$$

$$\therefore \text{Sum of roots} = \frac{2b}{a + c}$$

TEST Edge Generally in JEE Main, properties of trigonometric ratio and identities related questions are asked. To solve these types of questions, students are advised to understand the concept of trigonometric ratio.

75. (b) We have given that

$$f(x) = [4^x - 2^{x+1} + 1]$$


$$= [2^{2x} - 2^x \cdot 2 + 1]$$

$$f(x) = [(2^x - 1)^2]$$

$$(2^x - 1)^2 \geq 0 \quad \forall x$$

$$\therefore [(2^x - 1)^2]$$

will give all the integral values which is greater than equal to zero, hence all whole numbers are part of solution.

76. (a)  **Idea** $\therefore \text{Mean} = \frac{\text{Sum of observations}}{\text{Total number of observations}}$

$$\sigma^2 = \frac{1}{n} \sum_{i=1}^n x_i^2 - \left(\frac{1}{n} \sum_{i=1}^n x_i \right)^2$$

Let the remaining two observations x and y . Since mean of 7 observations is 8.

$$\therefore \frac{2 + 4 + 10 + 12 + 14 + x + y}{7} = 8$$

$$\Rightarrow 42 + x + y = 56$$

$$\Rightarrow x + y = 14$$

also variance $(\sigma^2) = 16$

$$\text{Since, } \sigma^2 = \frac{1}{n} \sum_{i=1}^n x_i^2 - \left(\frac{1}{n} \sum_{i=1}^n x_i \right)^2$$

$$\Rightarrow \frac{1}{7} (2^2 + 4^2 + 10^2 + 12^2 + 14^2$$

$$+ x^2 + y^2) - (8)^2 = 16$$

$$\Rightarrow (4 + 16 + 100 + 144$$

$$+ 196 + x^2 + y^2) = 80 \times 7$$

$$[\because (x + y)^2 = 14^2 = 196]$$

$$\Rightarrow x^2 + y^2 = 560 - 460 = 100$$

$$\text{but } (x + y)^2 + (x - y)^2 = 2(x^2 + y^2)$$

$$\Rightarrow 196 + (x - y)^2 = 2 \times 100$$

$$[\because (x + y)^2 = 14^2 = 196]$$

$$\Rightarrow (x - y)^2 = 4$$

$$\Rightarrow (x - y) = \pm 2$$

If $(x - y) = + 2$, then

$$(x + y) = 14 \text{ and } (x - y) = 2$$

$$\therefore x = 8, y = 6$$

$$\text{If } (x - y) = - 2,$$

$$\text{Then, } (x + y) = 14 \text{ and } (x - y) = - 2$$

$$\Rightarrow x = 6, y = 8$$

So, the remaining two observations are 6 and 8.

TEST Edge Median, mode and standard deviation related questions are asked. To solve these types of questions, understand the relation between above.

77. (d) The given function is $[x]^2 - [x^2]$

$[x]$ is continuous for all non-integers.

$$\text{let } x = n \in \mathbb{Z}$$

$$f(x) = n^2 - n^2 = 0$$

Now, if $h > 0$ is small,

$$f(n + h) = [n + h]^2 - [(n + h)^2]$$

$$= n^2 - [n^2 + 2nh + h^2]$$

$$= n^2 - n^2$$

$$= 0 \quad \dots(i)$$

$$f(n - h) = [n - h]^2 - [(n - h)^2]$$

$$= (n - 1)^2 - [n^2 - 2nh + h^2]$$

$$= (n - 1)^2 - (n^2 - 1)$$

$$= 2(1 - n)$$

$\dots(ii)$

From Eqs. (i) and (ii), we have

$$-n + 1 = 0$$

$$\Rightarrow n = 1$$

$\Rightarrow f(x)$ is continuous at $x = 1$.

78. (c) Let p : It is raining.

and q : Sky is not filled with clouds.

As we know that

Contrapositive of $p \rightarrow q$ is $\sim q \rightarrow \sim p$

and converse of $p \rightarrow q$ is $q \rightarrow p$,

also inverse of $p \rightarrow q$ is $\sim p \rightarrow \sim q$

So, only option (c) is true.

79. (d) It is given that $\sum_{k=1}^1 D_k = 56$

$$\text{where, } D_k = \begin{vmatrix} 1 & n & n \\ 2k & n^2 + n - 1 & n^2 + n \\ 2k - 1 & n^2 & n^2 + n + 1 \end{vmatrix}$$

$$\Rightarrow \begin{vmatrix} \sum_{k=1}^n 1 & n & n \\ \sum_{k=1}^n 2k & n^2 + n + 1 & n^2 + n \\ \sum_{k=1}^n (2k - 1) & n^2 & n^2 + n + 1 \end{vmatrix} = 56$$

$$\Rightarrow \begin{vmatrix} n & n & n \\ n(n+1) & n^2 + n + 1 & n^2 + n \\ n^2 & n & n^2 + n + 1 \end{vmatrix} = 56$$

$$\Rightarrow n(n+1) = 56$$

$$\Rightarrow n = 7$$

80. (b) **Idea** Here, equation of planes passing through the line of intersection of planes. i.e., $f(x) < f(x_2)$

$$\mathbf{r} \cdot \mathbf{n}_1 = d_1 \quad \text{and} \quad \mathbf{r} \cdot \mathbf{n}_2 = d_2$$

$$\text{is } (\mathbf{r} \cdot \mathbf{n}_1 - d_1) + k(\mathbf{r} \cdot \mathbf{n}_2 - d_2) = 0$$

$$\text{or } \mathbf{r} \cdot (\mathbf{n}_1 + k\mathbf{n}_2) = d_1 + kd_2, k \text{ being any scalar.}$$

It is clear from question that normal vector to planes I and II are $2\hat{i} - 2\hat{j}$, $-\hat{i} + \hat{j} - \hat{k}$ and vector parallel to line of intersection of the planes.

$$= (2\hat{i} - 2\hat{j}) \times (-\hat{i} + \hat{j} + \hat{k})$$

$$= 2\hat{i} + 2\hat{j}$$

$$\text{Required angle} = \cos^{-1} \left(\frac{(4\hat{i} - \hat{j}) \cdot (2\hat{i} + 2\hat{j})}{\sqrt{17} \sqrt{8}} \right)$$

$$= \cos^{-1} \left(\frac{3}{\sqrt{34}} \right)$$

TEST Edge Equation of a plane parallel to given plane, angle between two planes related questions are asked. To solve these types of questions, understand the basic concept of plane.

81. (a) **Idea** $\because f(x)$ is said to be decreasing in D_1 (domain) if $\forall x_1, x_2 \in D, x_1 > x_2$. i.e., $f(x_1) < f(x_2)$

Here, $g(x) = f(\sin x) + f(\cos x)$.

Then, differentiate w.r.t. x , we get

$$g'(x) = f'(\sin x) \cdot \cos x - f'(\cos x) \cdot \sin x$$

Again differentiate w.r.t. x , we get

$$\Rightarrow g''(x) = -f'(\sin x) \sin x + \cos^2 x f''(\sin x) + f''(\cos x) \sin^2 x - f'(\cos x) \cos x > 0 \quad \forall x \in \left(0, \frac{\pi}{2}\right)$$

$\therefore g'(x)$ is increasing in $\left(0, \frac{\pi}{2}\right)$.

$$\text{Also } g'(\pi/4) = 0$$

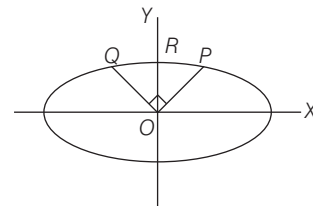
$$\Rightarrow g'(x) > 0 \quad \forall x \in (\pi/4, \pi/2)$$

$$\text{and } g'(x) < 0 \quad \forall x \in (0, \pi/4)$$

Thus, $g(x)$ is decreasing in $(0, \pi/4)$.

TEST Edge Generally in JEE Main the function is increasing on a given interval, related questions are asked. To solve these types of questions, students are advised to understand the basic concept of monotonicity.

82. (a) Consider $x \cos \alpha + y \sin \alpha = p$ be the chord PQ , then p is the desired distance. Homogenizing the equation of the ellipse with the help of this equation, we get the combined equation of OP and OQ .



$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = \left(\frac{x \cos \alpha + y \sin \alpha}{p} \right)^2$$

$$\Rightarrow \left(\frac{1}{a^2} - \frac{\cos^2 \alpha}{p^2} \right) x^2 + \left(\frac{1}{b^2} - \frac{\sin^2 \alpha}{p^2} \right) y^2 - \frac{2xy \sin \alpha \cos \alpha}{p^2} = 0$$

As, $OP \perp OQ$

$$\therefore \frac{1}{a^2} - \frac{\cos^2 \alpha}{p^2} + \frac{1}{b^2} - \frac{\sin^2 \alpha}{p^2} = 0$$

$$\Rightarrow p = \frac{ab}{\sqrt{a^2 + b^2}}$$

83. (a) **Idea** Draw the graph of $y = x^3$ and its normal at $(1, 1)$

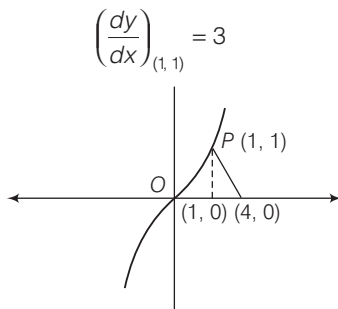
\because Equation of normal at (x_1, y_1) is

$$y - y_1 = -\frac{dx}{dy}(x - x_1)$$

Equation of the curve is given as

$$y = x^3$$

$$\frac{dy}{dx} = 3x^2$$



Normal at $P(1, 1)$ is

$$(y - 1) = -\frac{1}{3}(x - 1)$$

$$3y + x = 4$$

$$\frac{x}{4} + \frac{y}{\frac{4}{3}} = 1$$

So, normal intersect x-axis at $(4, 0)$.

Hence, required area = $\int_0^1 x^3 dx$ + area of triangle

$$= \left[\frac{x^4}{4} \right]_0^1 + \frac{1}{2} \times 3 \times 1$$

$$= \frac{1}{4} + \frac{3}{2} = \frac{7}{4}$$

TEST Edge Area bounded by the different types of curve related questions are asked. To solve these types of questions, students are advised to understand the concept of graph transformation of different curves.

84. (b) Here the relation R of X is defined by

$$R, \{(A, B) \mid A \cap B = \phi\}$$

Now, since $A \cap A \neq \phi$

$$\Rightarrow A R A$$

$$\Rightarrow R \text{ is not reflexive,}$$

$$\text{Let } A, B \in R$$

$$\text{such that } A R B$$

$$\Rightarrow A \cap B = \phi$$

$$\Rightarrow B \cap A = \phi$$

$$\Rightarrow B R A$$

$$\Rightarrow R \text{ is symmetric.}$$

R is not transitive.

For example, take

$$A = \{1, 3\}, B = \{2, 4\}, C = \{3, 6\}$$

$$\text{Then, } A \cap B = \phi \text{ \& } B \cap C = \phi$$

$$\text{But } A \cap C = \{3\} \neq \phi$$

$$\text{So, } A R B \text{ \& } B R C \Rightarrow A R C$$

$$\Rightarrow R \text{ is not transitive.}$$

85. (b) **Idea** \because If lines $\frac{x-x_1}{a_1} = \frac{y-y_1}{b_1} = \frac{z-z_1}{c_1}$

$$\text{and } \frac{x-x_2}{a_2} = \frac{y-y_2}{b_2} = \frac{z-z_2}{c_2}$$

are coplanar, then

$$\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} = 0$$

If the given lines are coplanar, then

$$\begin{vmatrix} 1 & 1 & 1 \\ 2 & x_1 & x_2 \\ 3 & 4 & 5 \end{vmatrix} = 0 \quad \therefore \begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} = 0$$

$$\Rightarrow 2x_1 - x_2 = 2 \quad \dots(i)$$

$$\text{and } x_1 t^2 + (x_2 + 2)t + a = 0$$

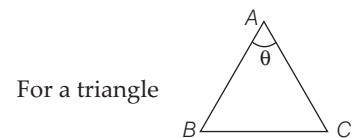
$$\text{Sum of roots} = -\frac{(x_2 + 2)}{x_1}$$

$$= -\frac{(2x_1 - 2 + 2)}{x_1} = -\frac{2x_1}{x_1}$$

$$\text{Sum of roots} = -2$$

TEST Edge Equation of line which lies on plane and equation of line in different form related questions are asked. To solve these types of questions, learn the formula of equation of line in various form.

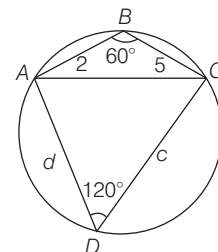
86. (a) **Idea** Sum of opposite angles of a cyclic quadrilateral is 180° .



For a triangle

$$\text{area of } \triangle ABC \text{ is } \frac{1}{2} AB \cdot AC \sin \theta$$

Here, $ABCD$ is cyclic quadrilateral with



$$AB = 2 \text{ and } BC = 5$$

$$\angle ABC = 60^\circ$$

(given)

\therefore The quadrilateral is cyclic

$$\Rightarrow \angle CDA = 180^\circ - 60^\circ$$

$$= 120^\circ$$

$$\text{Let } CD = c \text{ and } DA = d$$

Area of quadrilateral $ABCD$ = area of $\triangle ABC$ + area of $\triangle ACD$

$$= \frac{1}{2} \cdot AB \cdot BC \sin 60^\circ + \frac{1}{2} CD \cdot DA \times \sin 120^\circ$$

$$= \frac{1}{2} \cdot 2.5 \frac{\sqrt{3}}{2} + \frac{1}{2} cd \frac{\sqrt{3}}{2}$$

$$\text{Area of quadrilateral } ABCD = \frac{5\sqrt{3}}{2} + \frac{1}{2} cd \frac{\sqrt{3}}{2}$$

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

$$\Rightarrow \frac{\sqrt{3}}{4} cd = 4\sqrt{3} - \frac{5\sqrt{3}}{2} = \frac{3\sqrt{3}}{2}$$

$$\Rightarrow cd = 6 \quad \dots(i)$$

$$\text{also } AB^2 + BC^2 - 2AB \cdot BC \cos 60^\circ = AC^2$$

$$= CD^2 + DA^2 - 2CD \cdot DA \cos 120^\circ$$

{by cosine rule}

$$\Rightarrow c^2 + d^2 + cd = 19$$

$$\Rightarrow c^2 + d^2 = 13 \quad \dots(ii)$$

From Eqs. (i) and (ii), we get

$$c^2 + d^2 = 13$$

$$\text{and } c^2 d^2 = 36$$

$\Rightarrow c^2$ and d^2 are roots of the equation

$$t^2 - 13t + 36 = 0$$

$$\Rightarrow t = 9, 4$$

$$\Rightarrow c^2 = 9, d^2 = 4$$

$$\text{or } c^2 = 4, d^2 = 9$$

$$\text{or } c = 2, d = 3$$

Hence, other two sides are 2 and 3.

TEST Edge In different form based on quadrilateral related questions are asked. To solve these types of questions, understand the basic concept of quadrilateral and learn the formulae of area of these quadrilaterals.

87. (c) Consider the given expression

$$(abc + abd + acd + bcd)^{10}$$

$$= a^{10} b^{10} c^{10} d^{10} \left[\frac{1}{a} + \frac{1}{b} + \frac{1}{c} + \frac{1}{d} \right]^{10}$$

Coefficient of $a^8 b^4 c^9 d^9$ in

$$(abc + abd + acd + bcd)^{10}$$

$$= \text{Coefficient of } a^{-2} b^{-6} c^{-1} d^{-1}$$

$$\text{in } \left[\frac{1}{a} + \frac{1}{b} + \frac{1}{c} + \frac{1}{d} \right]^{10}$$

$$= \frac{10!}{2! 6! 1! 1!}$$

$$= \frac{10 \times 9 \times 8 \times 7}{2}$$

$$= 2520$$

88. (b) **Idea** For an AP such a_1, a_2, a_3, \dots and common difference be d then $a_2 = a_1 + d$ and follow the conditions given in question.

Let the common difference of the AP be d .

$$a_{2r} = a_{2r-1} + d$$

$$\Rightarrow \sum_{r=1}^{10^{99}} a_{2r} = \sum_{r=1}^{10^{99}} (a_{2r-1} + d)$$

$$\Rightarrow \sum_{r=1}^{10^{99}} a_{2r} = \sum_{r=1}^{10^{99}} a_{2r-1} + 10^{99} d$$

$$\Rightarrow 100^{100} = 10^{99} + 10^{99} d$$

$$\Rightarrow 10 = 1 + d$$

$$\Rightarrow d = 9$$

TEST Edge Sum of n terms of an AP and find the n th or r th term of an AP related questions are asked. To solve these types of questions, students are advised to understand the basic concept of AP.

89. (b) I. Centre of the given $C(2, 1)$ and radius is 5.

\therefore Distance of $P(10, 7)$ from

$$C(2, 1) = \sqrt{(10-2)^2 + (7-1)^2} = \sqrt{64 + 36} = 10$$

\therefore Greatest distance = $5 + 10 = 15$

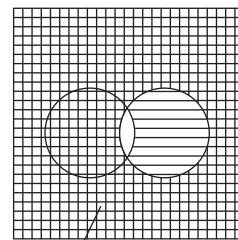
and minimum distance = $10 - 5 = 5$

II. It is also true but it is not a correct explanation of the Statement I.

90. (d) We know that

$$P\left(\frac{A}{\bar{B}}\right) + P\left(\frac{\bar{A}}{\bar{B}}\right) = \frac{P(A \cap \bar{B})}{P(\bar{B})} + \frac{P(\bar{A} \cap \bar{B})}{P(\bar{B})}$$

$$= \frac{P(A \cap \bar{B}) + P(\bar{A} \cap \bar{B})}{P(\bar{B})} = \frac{P(\bar{B})}{P(\bar{B})} = 1$$



$$P(\bar{B}) = P(A \cap \bar{B}) + P(\bar{A} \cap \bar{B})$$

$$\text{Statement II } P\left(\frac{A}{B}\right) = \frac{P(A \cap B)}{P(B)}$$

By definition of conditional probability.

$$P(\bar{B}) = P[u \cap \bar{B}] = P(A \cup \bar{A}) \cap \bar{B}$$

$$= P(A \cap \bar{B}) \cup P(\bar{A} \cap \bar{B})$$

$$= P(A \cap \bar{B}) + P(\bar{A} \cap \bar{B})$$

Statement I is false but Statement II is true. So, option (d) is correct.