

Test *RIDER*

# JEE Advanced

A Single Door Entry to the Various IITs...

## Paper 1

Duration : 3 Hours

Max. Marks : 180

**Please read the instructions carefully. You are allotted 5 minutes specially for this purpose.**

- ▶ This booklet is your question paper. Attempt all the questions.
- ▶ Blank papers, clipboards, log tables, slide rules, calculators, cameras, cellular phones, pagers and electronic gadgets are not allowed.
- ▶ Write your name and roll number in the space provided on the bottom of this page.

### Question Paper Format

- ▶ The question paper consists of three parts (Physics, Chemistry and Mathematics). Each part consists of three sections.
- ▶ **Section 1** contains 10 multiple choice questions. Each question has four choices (a), (b), (c) and (d) out of which only one is correct.
- ▶ **Section 2** contains 5 multiple choice questions. Each question has four choices (a), (b), (c) and (d) out of which one or more than one is/are correct.
- ▶ **Section 3** contains 5 questions. The answer to each question is a single-digit integer, ranging from 0 to 9 (both inclusive)

### Marking Scheme

- ▶ For each question in Section 1, you will be awarded **2 marks** for correct answer and zero mark for unattempted questions. No negative marks will be awarded for incorrect answers in this section.
- ▶ For each question in Section 2, you will be awarded **4 marks** for correct answer(s) and zero mark for unattempted questions. In all other cases, minus one (–1) mark will be awarded.
- ▶ For each question in Section 3, you will be awarded **4 marks** for the correct answer and zero mark for unattempted questions. In all other cases, minus one (–1) mark will be awarded.

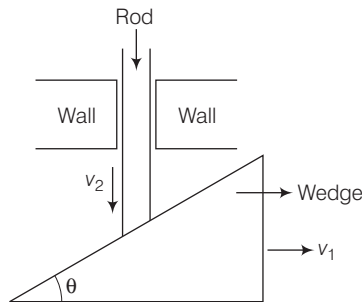
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# Part I

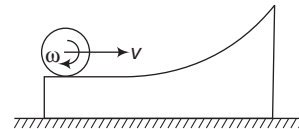
## Section 1 Single Correct Option Type

This section contains **10 multiple choice questions**. Each question has four choices, (a), (b), (c) and (d) out of which **only one** is correct.

1. In the figure shown, all surfaces are smooth then the relation between  $v_1$  and  $v_2$  is

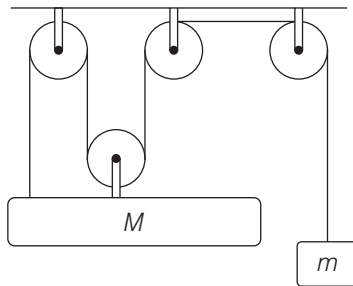


- a.  $v_2 = v_1 \sin \theta$       b.  $v_1 = v_2 \sin \theta$       c.  $v_2 = v_1 \tan \theta$       d.  $v_1 = v_2 \operatorname{cosec} \theta$
2. In given figure, solid cylinder A is initially rolling (without slipping) on the horizontal surface of wedge. All surfaces are smooth and B has no initial velocity, then maximum height attained by cylinder is



- a.  $\frac{v^2}{4g}$       b.  $\frac{v^2}{g}$       c.  $\frac{v^2}{2g}$       d.  $\frac{v^2}{8g}$

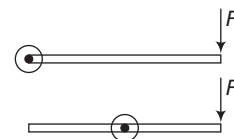
- 3.



In the figure shown all pulley and string are frictionless and massless. Then, the relation between the acceleration of  $m$  and  $M$  is

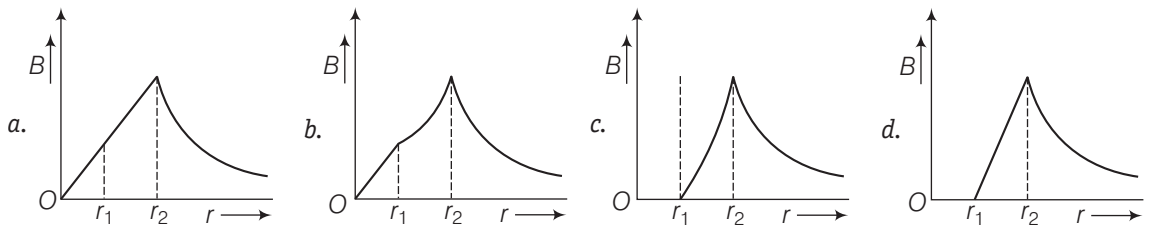
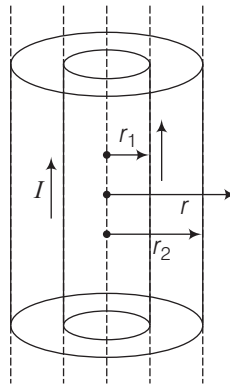
- a.  $a_m = 3a_M$       b.  $a_m = 4a_M$       c.  $a_M = 3a_m$       d.  $a_M = a_m/5$
4. Two long straight parallel wires carry steady currents  $I$  and  $-I$  respectively. The distance between the wires is  $d$ . At a certain instant of time, a point charge  $q$  is at a point equidistant from the two wires in the plane of the wires. Its instantaneous velocity  $\mathbf{v}$  is perpendicular to this plane. The magnitude of the force due to magnetic field acting on the charge at this instant is
- a.  $\frac{\mu_0 I q v}{2\pi d}$       b.  $\frac{\mu_0 I q v}{\pi d}$       c.  $\frac{2\mu_0 I q v}{\pi d}$       d. 0

5. The given figure shows two doors A and B (identical). Same force is applied to them which is always perpendicular to edge. If A takes 3 s to rotate certain angle  $\theta$  then what time will be taken by B to rotate same angle?

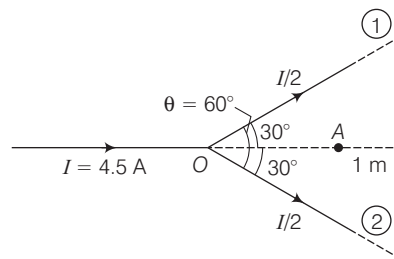


- a. 2 s      b. 4 s      c. 1 s      d. 5 s

6. A solid sphere and a solid cylinder of same mass are rolled down on two inclined planes of heights  $h_1$  and  $h_2$  respectively. If the linear velocity at bottom for both is same then ratio  $h_1 : h_2$  is  
 a. 10 : 21                      b. 21 : 31                      c. 15 : 14                      d. 14 : 15
7. Both the earth and moon are subjected to gravitational force of the sun. As observed from sun, orbit of moon  
 a. will be elliptical  
 b. will not be strictly elliptical because total gravitational force on it is not central  
 c. is not elliptical but will necessary closed path  
 d. deviates considerably from being elliptical due to influence of planets other than the earth
8. There is a long hollow cylindrical wire that carries a current  $I$ . Choose the correct graph between the magnetic field ( $B$ ) and distance ( $r$ ) from the axis of hollow cylinder.

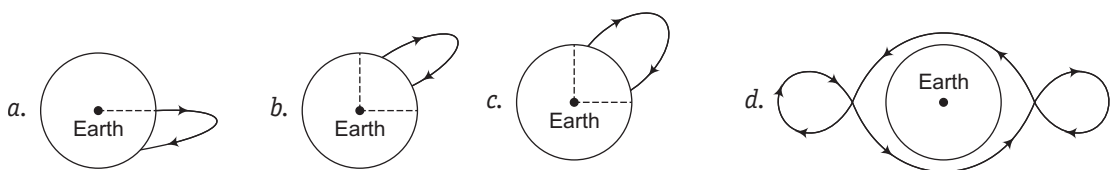


9. The net magnetic field at point A is



- a.  $\frac{\mu_0 I}{2\pi r}$                       b.  $\frac{\mu_0 I}{\pi r}$                       c.  $\frac{2\mu_0 I}{5\pi r}$                       d. None of these

10. Which one among them can be the possible trajectory of projectile?



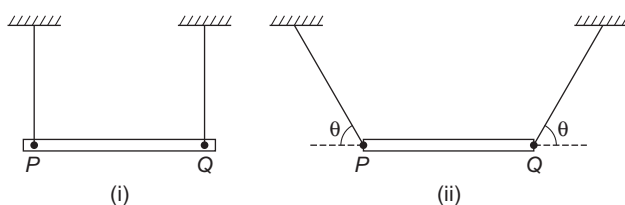
## Section 2 More Than One Correct Option

*This section contains 5 multiple choice questions. Each question has four choices, (a), (b), (c) and (d) out of which one or more than one is/are correct.*

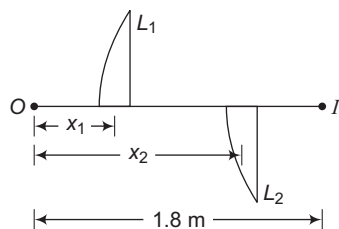
- 11.** Two particles  $A$  and  $B$  executing SHM along same straight line, with same amplitude and same mean position.  $A$  starts its motion from mean position and moves towards positive extreme while  $B$  starts from negative extreme position. Angular frequency of  $A$  is  $\omega_A$  and that of  $B$  is  $\omega_B$ , choose the correct statement (s).

- a. If  $\omega_B = 2\omega_A$ , then when they meet first their velocity will be zero.
- b. If  $\omega_B > 2\omega_A$ , then when they meet first their velocity are in same direction.
- c. If  $\omega_B < 2\omega_A$ , then when they meet their velocity will be in same direction.
- d. Their velocity when they meet does not depend on  $\omega$ .

- 12.** Consider arrangement of two horizontal rods as given. They are at rest by ideal strings.



- a. If string at  $Q$  is cut for (i) then  $\alpha$  of first rod will be  $3g/2L$
  - b. If string at  $Q$  is cut then just after that point  $P$  for (i) will be a stationary point
  - c. If option (b) is applied to (ii) then point  $P$  will have acceleration perpendicular to string connected to  $P$
  - d. Point  $P$  in both cases is an inertial point that's why we can use  $\tau = I\alpha$  about  $P$  in both cases without using pseudo force
- 13.** If a circular coil expands radially in a region of magnetic field and no electromagnetic force is produced in the coil. This is because
- a. the magnetic field is constant
  - b. the magnetic field is in the same plane as the circular coil and it may or may not vary
  - c. the magnetic field has a perpendicular (to the plane of the coil) component whose magnitude is decreasing suitably
  - d. there is a constant magnetic field in the perpendicular (to the plane of the coil) direction.
- 14.** A thin plano-convex lens of focal length  $f$  is split into two halves, one is placed at certain distance to other. Magnification of image by one half is 2 and object and image are at a distance of 1.8 m, then



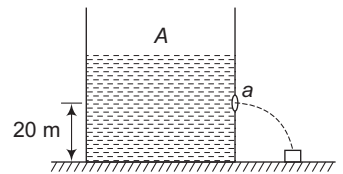
- a.  $x_1 = 0.6$  m
- b.  $x_2 = 1.2$  m
- c.  $f = 0.4$  m
- d. None of these

15. A straight conductor carries a current. Assume that all the free electrons in the conductor move with the same drift velocity  $v$ .  $A$  and  $B$  are two observers on a straight line  $XY$  parallel to the conductor.  $A$  is stationary,  $B$  moves along  $XY$  with a velocity  $v$  in the direction of the free electrons.
- $A$  and  $B$  observe the same magnetic field
  - $A$  observes a magnetic field,  $B$  does not
  - $A$  and  $B$  observe magnetic fields of the same magnitude but opposite directions
  - $A$  and  $B$  do not observe any electric field

### Section 3 Integer Answer Type

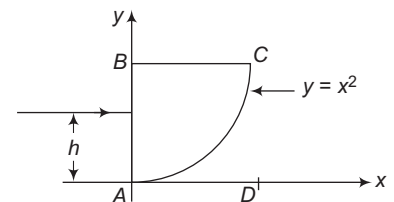
This section contains 5 multiple choice questions. The answer to each question is a single-digit integer, ranging from 0 to 9 (both inclusive).

16. Water is filled in a uniform container of area of cross-section  $A$ . A hole of cross-section area  $a$  ( $\ll A$ ) is made in the container at a height of 20 m above the base. Water streams out and hits a small block placed at some distance from container. With what speed (in  $\text{ms}^{-1}$ ) the block should be moved such that water streams always hits the block? (Given  $\frac{a}{A} = \frac{1}{20}$ ) (Take  $g = 10 \text{ ms}^{-2}$ )

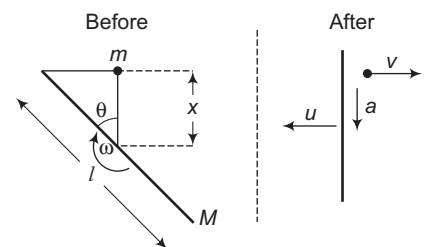


17. A particle is suspended by a light vertical inelastic string of length ' $l$ ' from a fixed support. At its equilibrium position, it is projected horizontally with a speed  $\sqrt{6gl}$ . What is the ratio of the tension in the string in its horizontal position to that in string when the particle is vertically above the point of support?

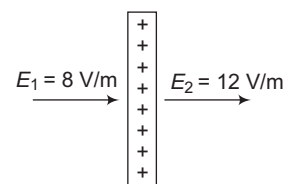
18. The cross-section of a prism as given in figure. One of the refracting surface is given by  $y = x^2$ . A ray of light travelling parallel to  $x$ -axis is incident normally on face  $AB$  and refracted. Find the minimum distance of incidence ray from surface  $AD$ . Refractive index for prism is 3.



19. A long thin rod of length  $l = 90 \text{ cm}$  and mass 600 g, is rotating clockwise on a frictionless horizontal table about its centre of mass, which is stationary. A small ball of mass 300 g is placed on the table at distance  $x$  from the centre of mass of the rod. The rod collides elastically with the ball. After the collision, the rod is translating to the left without rotating and the ball moves to the right. What is the distance  $\left(\frac{x}{5}\right)$  (in cm)?



20. The electric field on two sides of a charged plate is shown in the figure. If the charge density on the plate is  $n\epsilon_0$ , then  $n$  is



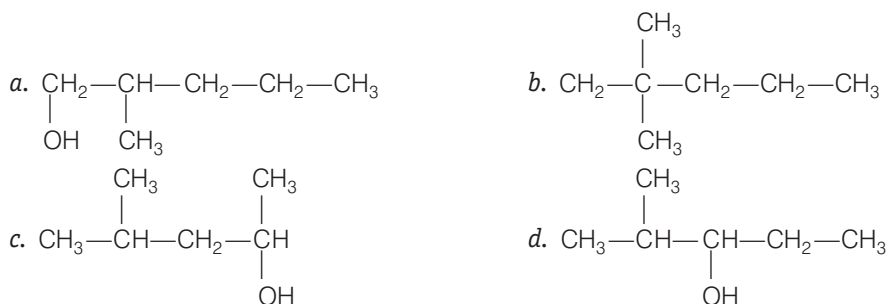
# Part II

## Section 1 Single Correct Option Type

*This section contains 10 multiple choice questions. Each question has four choices, (a), (b), (c) and (d) out of which only one is correct.*

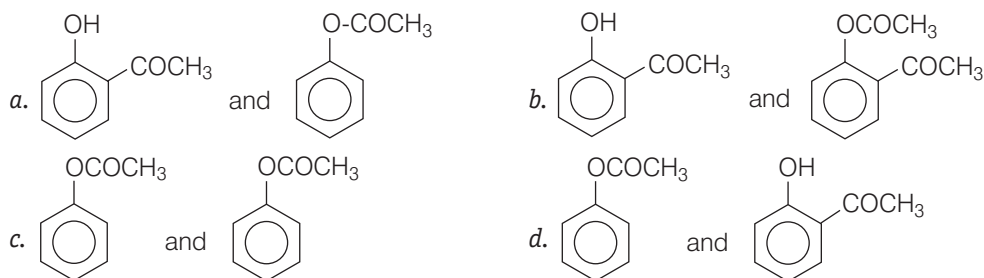
- 21.** The magnetic moment of  $[\text{Mn}(\text{CN})_6]^{3-}$  is 2.8 BM and that of  $[\text{MnBr}_4]^{2-}$  is 5.9 BM. The hybridisation and geometries of these complex ions are
- $\text{sp}^3\text{d}^2$  octahedral and  $\text{dsp}^2$  tetrahedral
  - $\text{d}^2\text{sp}^3$ , octahedral and  $\text{dsp}^2$  square planar
  - $\text{d}^2\text{sp}^3$  octahedral and  $\text{sp}^3$  tetrahedral
  - $\text{sp}^3\text{d}^2$  octahedral and  $\text{sp}^3$  square planar

- 22.** 2-bromo-2-methyl pentane  $\xrightarrow[\Delta]{\text{C}_2\text{H}_5\text{O}^\ominus}$  A  $\xrightarrow[\text{OH}^-, \text{H}_2\text{O}_2]{\text{BH}_3, \text{THF}}$  B, structure of B will be (major)

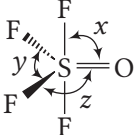


- 23.** A non-stoichiometric compound  $\text{Cu}_{1.8}\text{S}$  is formed due to incorporation of  $\text{Cu}^{2+}$  ions in the lattice of cuprous sulphide. What % of  $\text{Cu}^{2+}$  ion in the total copper content is present in the compound?
- 88.88
  - 89.8
  - 63.5%
  - 11.11

- 24.** What will be the products when carboic acid is treated with (i) acetic anhydride and (ii) acetic anhydride in presence of anhydrous  $\text{AlCl}_3$ , respectively.



- 25.** If  $\lambda_{[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+} = 50$ ;  $\lambda_{\text{ClO}_4^-} = 70$  and the measured resistance was  $33.5 \Omega$  in a cell with cell constant of 0.20, then the solubility of  $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{ClO}_4$  is
- 59.75 m mol/L
  - 49.75 m mol/L
  - 39.75 m mol/L
  - 29.75 m mol/L

26.  $CD_3 - CH=CD - CH_3 \xrightarrow{H^{\oplus}, H_2O} Q$ , then  $Q$  will be
- a.  $CD_3 - \underset{\substack{| \\ OH}}{CH} - \underset{\substack{| \\ D}}{CH} - CH_3$                       b.  $CD_3 - CH_2 - \underset{\substack{| \\ OH}}{CH} - CH_3$
- c.  $CD_3 - CH_2 - \underset{\substack{| \\ OH}}{CD} - CH_3$                       d.  $CD_3 - \underset{\substack{| \\ OH}}{CH} - CH_2 - CH_3$
27. Which of the following has highest value of magnetic moment?
- a.  $Fe^{2+}$                       b.  $Zn^{2+}$                       c.  $Eu^{2+}$                       d.  $Sm^{2+}$
28. Find True (T) and False (F) from the following statements regarding proteins.
- $S_1$  : At isoelectric point amino acid does not migrate under the influence of electric field  
 $S_1$  : Aspartic acid is acidic amino acid  
 $S_1$  : Curding of milk is an example of denaturation of proteins  
 $S_4$  : Fibrous protein is water soluble protein.
- a. TTTT                      b. TFFF                      c. TTTF                      d. TTFT
29. The correct order of bond angle in the following molecule is
- 
- a.  $y = z > x$                       b.  $z > y > x$                       c.  $y > x > z$                       d.  $x > y > z$
30. Which of the following set of compounds have similar structure?
- a.  $ClF_3, I_3^-, BrF_3$  and  $NO_3^-$                       b.  $SF_4, XeF_4, TeF_4$  and  $NO_3^-$
- c.  $BF_3, SO_3, BrF_3$  and  $CO_3^{2-}$                       d.  $SO_3, BF_3, BH_3$  and  $CO_3^{2-}$

## Section 2 More Than One Correct Option

*This section contains 5 multiple choice questions. Each question has four choices, (a), (b), (c) and (d) out of which one or more than one is/are correct.*

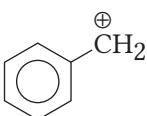
31. A mixture of  $NaCl$  and  $K_2Cr_2O_7$  is gently warmed/heated with  $H_2SO_4$  (conc.) which of the following is/are correct regarding occurring reaction?
- a. A deep red vapour is evolved  
 b. The vapour when passed into  $NaOH$  solution produces a yellow solution of  $Na_2CrO_4$   
 c. Chlorine gas is evolved  
 d. Chromyl chloride is formed
32. If arsenic (III) sulphide solution is obtained by passing  $H_2S$  gas in acidic solution of  $As^{+3}$  ion, which of the following is/are correct regarding this solution?
- a. It has negatively charged colloidal particles  
 b. The colloid flocculates on adding back solution  
 c. After flocculation of  $As_2S_3$ , dispersion medium becomes acidic  
 d. Concentrated  $HNO_3$  can coagulate this solution

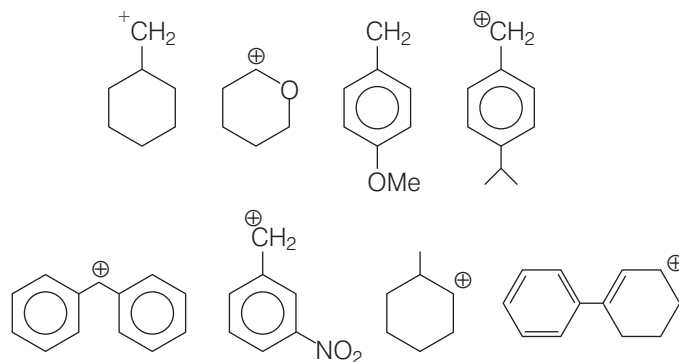
33. Among the sulphates of Cu, Pb, Ag and Ba, which of the following is water soluble?  
 a.  $\text{CuSO}_4$       b.  $\text{PbSO}_4$       c.  $\text{Ag}_2\text{SO}_4$       d.  $\text{BaSO}_4$
34.  $\text{C}_2\text{H}_5\text{O}_4 + (\text{CH}_3\text{CO})_2\text{O} \longrightarrow$   
 Choose the correct statement (s) about above reaction.  
 a. esterification reaction  
 b. acetylation reaction  
 c. In above reaction molecular mass of main product is increased by 42  
 d. In above reaction acyl-oxygen bond of alcohol is broken
35. Which of the following statements incorrect regarding oxy-acids of halogen?  
 a. Oxidation state of Cl in  $\text{HClO}$ ,  $\text{HClO}_2$ ,  $\text{HClO}_3$  and  $\text{HClO}_4$ , is +1, +3, +5 and +7 respectively  
 b. The order of thermal stability is  $\text{HCl} < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}_4$   
 c. Basic strength order is  $\text{HClO} < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}_4$   
 d. Order of Cl—O bond distance  $\text{HClO}_4 < \text{HClO}_3 < \text{HClO}_2 < \text{HClO}$

### Section 3 Integer Answer Type

*This section contains 5 multiple choice questions. The answer to each question is a single-digit integer, ranging from 0 to 9 (both inclusive).*

36. An ideal monoatomic gas is carried out through a process such that  $T \propto V$ . Calculate heat capacity of the gas, if answer is  $C$  then what will be the value of  $2C$ ?

37. Number of carbocations which are more stable than benzyl carbocation 



38. For a real gas (MW = 60), if density at critical point is  $0.80 \text{ g/cm}^3$  and its  $T_C = \frac{4 \times 10^5}{821} \text{ K}$ , then van der Waal's constant  $a$  (in  $\text{atm L}^2 \text{ mol}^{-1}$ ) will be (use concept of significant figure to answer the question)
39.  $\text{Na}_2\text{SO}_3$ ,  $\text{NaCl}$ ,  $\text{Na}_2\text{C}_2\text{O}_4$ ,  $\text{Na}_2\text{HPO}_4$ ,  $\text{Na}_2\text{CrO}_4$ ,  $\text{NaNO}_2$ ,  $\text{CH}_3\text{COONa}$  are separately treated with  $\text{AgNO}_3$  solution. In how many cases white ppt. is/are obtained?
40. Number of corner, shared per tetrahedron of  $2d$  silicate is



# Part III

## Section 1 Single Correct Option Type

This section contains **10 multiple choice questions**. Each question has four choices, (a), (b), (c) and (d) out of which **only one** is correct.

- 41.** A point  $P$  lies inside the circles  $S_1 = x^2 + y^2 - 4 = 0$  and  $S_2 = x^2 + y^2 - 8x + 7 = 0$ . The point  $P$  moves such that its path encloses the greatest possible area and it is always at a fixed distance from the point  $\left(\frac{3}{2}, 0\right)$  in its region. The locus of  $P$  is
- a.  $4x^2 + 4y^2 - 12x + 1 = 0$                       b.  $4x^2 + 4y^2 + 12x - 1 = 0$   
c.  $x^2 + y^2 - 3x - 2 = 0$                       d.  $x^2 + y^2 - 3x + 2 = 0$
- 42.** What will be the value of  $a$  for which integral  $\int_0^\infty \frac{dx}{a^2 + \left(x - \frac{1}{x}\right)^2} = \frac{\pi}{5050}$ ? where  $a^2 \geq 0$
- a. 2225                      b. 2525                      c. 3225                      d. 3525
- 43.** 25 trees are planted in a straight line 5 m apart from each other. To water them the gardener must bring water for each tree separating from a well 10 m. From the first tree in a line with the trees. How far will he move in order to water all the trees beginning with the first if he starts from the well?
- a. 3375 m                      b. 3380 m                      c. 3360 m                      d. 3370 m
- 44.** The solution set of  $\left|\frac{x+1}{x}\right| + |x+1| = \frac{(x+1)^2}{|x|}$  is
- a.  $x : x \geq 0$                       b.  $(0, \infty) \cup \{-1\}$   
c.  $\{-1, 1\}$                       d.  $[1, \infty)$  or  $(-\infty, -1]$
- 45.** 40 teams play a tournament. Each team plays every other team just once. Each game results in a win for one team. If each team has a 50% chance of winning in each game, the probability at the end of tournament, every team has a won a different number of games is
- a.  $\frac{1}{780}$                       b.  $\frac{4!}{37^{80}}$   
c.  $\frac{40!}{2^{780}}$                       d. None of these
- 46.** If the parabola  $y = (a-b)x^2 + (b-c)x + (c-a)$  touches the  $x$ -axis on the interval  $[0, 2)$ , then the line  $ax + by + c = 0$
- a. always touches the fixed point  $(-2, 1)$   
b. always passes through a fixed point  $(2, -1)$   
c. is always tangent to the circle  $x^2 + y^2 = (a+b-c)^2$   
d. represents a family of parallel lines



55. Let  $\mathbf{a}$  and  $\mathbf{c}$  be 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  $\lambda$  equals
- a.  $-4$                       b.  $3$                       c.  $\frac{1}{3}$                       d.  $\frac{1}{4}$

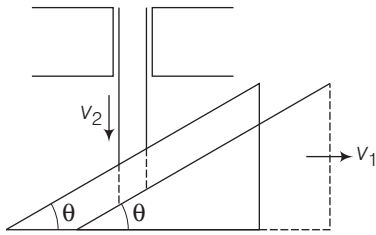
### Section 3 Integer Answer Type

*This section contains 5 questions. The answer to each question is a single-digit integer, ranging from 0 to 9 (both inclusive).*

56. If range of the function  $f(x) = \sin^{-1} x + 2 \tan^{-1} x + x^2 + 4x + 1$  is  $[p, q]$ , then the value of  $(p, q)$  is
57. The plane denoted by  $P_1 : 4x + 7y + 4z + 81 = 0$  is rotated through a right angle about its line of intersection with the plane  $P_2 : 5x + 3y + 10z = 25$ . If the plane in its new position be denoted by  $P$  and the distance of this plane from the origin is  $k$ , then find the value of  $[k/2]$ .  
(where  $[ \cdot ]$  denote greatest integer function)
58. Evaluate  $\int_{1/e}^{\tan x} \frac{t}{1+t^2} dt + \int_{1/e}^{\cot x} \frac{dt}{t(1+t^2)}$
59. Tangents are drawn from the point  $(\alpha, \beta)$  to the hyperbola  $3x^2 - 2y^2 = 6$  and are inclined at angles  $\theta$  and  $\phi$  to the  $x$ -axis. If  $\tan \theta \tan \phi = 2$ , then value of  $2\alpha^2 - \beta^2$  is
60. Total number of solution of  $\sin \{x\} = \cos \{x\}$  where  $\{\cdot\}$  denotes the fractional part in  $[0, 2\pi]$  is equal to

# Analytical Explanations

1. (c) **Idea** Here we will first find the relation between displacement of rod and wedge after which we will differentiate it with respect to time to find the relation between velocity.

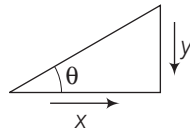


The rod has to be in touch with wedge until it reaches at the bottom of the wedge

$$\text{So, } \tan \theta = \frac{y}{x}, y = x \tan \theta$$

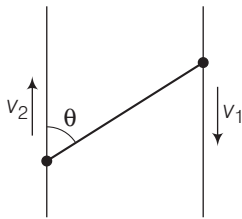
Differentiating with respect to time

$$v_2 = v_1 \tan \theta$$



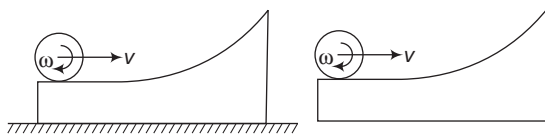
**TEST Edge** This question is based on concept of constraint motion are frequently asked in JEE Advanced. In such question first of all, we have to find relation between displacements and differentiate it, to find corresponding velocities and accelerations. For example, in the following question relation between velocities is given as

$$v_2 \cos \theta + v_1 \cos \theta = v_1$$



2. (a) **Idea** As there is no external force like friction (non conservative force) so mechanical energy of the system will be conserved. The kinetic energy and the linear momentum of the system will also be conserved.

At maximum height, both wedge and cylinder have same horizontal speed.



Now using conservation of mechanical energy (including rotational kinetic energy) and momentum, we can find the required result.

$$\frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{mR^2}{2}\right)\omega^2 = \frac{1}{2}m(v')^2 + \frac{1}{2}m(v')^2 + mgH + \frac{1}{2}\left(\frac{mR^2}{2}\right)\omega'^2$$

$$\frac{mv^2}{2} = m(v')^2 + mgH \quad \dots(i)$$

Using conservation momentum

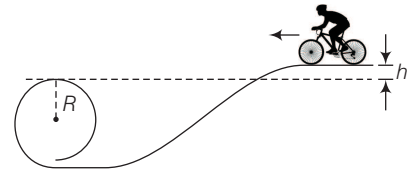
$$mv = 2mv' \quad \dots(ii)$$

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

$$H = \frac{v^2}{4g}$$

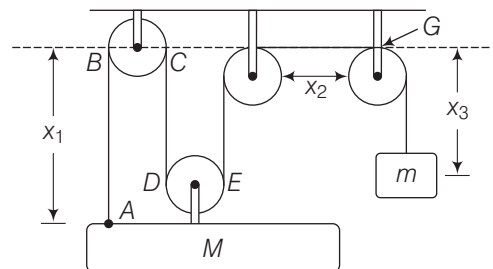
**TEST Edge** Similar question can be asked with a little variation where similar concepts are applied.

⇒ For example, in the situation shown in figure below, we have to determine minimum value of  $h$  for a successful looping if no friction is present?



To solve it, we apply conservation of energy and Newton's law and we will get minimum value of  $h$  will be  $h_{\min} = \frac{R}{2}$ .

3. (c) **Idea** Here we have used the concept that summation of all parts of length of string between coordinates is equal to total length of string. After applying this concept we will differentiate it twice with respect to time to find the relation between acceleration.



As the length of the string is fixed  $l_{AB} + l_{CD} + l_{EF} + l_{FG} + l_{GH} = L$  ( $L$  = total length of string)

$$\Rightarrow x_1 + x_1 + x_1 + x_2 + x_3 = L$$

Differentiating the above expression twice

$$\mathbf{a}_M + \mathbf{a}_M + \mathbf{a}_M + 0 + \mathbf{a}_m = 0$$

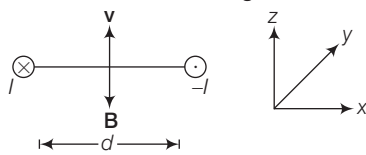
$$[\mathbf{a}_m = -3\mathbf{a}_M] \text{ or } |\mathbf{a}_m| = 3|\mathbf{a}_M|$$

Here the acceleration of plank of mass  $M$  and acceleration of pulley (DE) is  $a_m$ .

**TEST Edge** Similar questions related to mass-pulley system connected with string are important from JEE Advanced point of view and can be solved by using similar concept as we have used earlier. Similar question can be asked in which we have to calculate tension in the string, for this we have to apply Newton's law of motion.

4. (d) **Idea** The point to be noted, force on a charge  $q$  particle moving with a velocity  $v$  in a uniform magnetic field  $B$  is given by  $\mathbf{F}_m = q(\mathbf{v} \times \mathbf{B})$

Net magnetic field due to both the wires will be downwards as shown in figure



$\therefore$  Angle between  $\mathbf{v}$  and  $\mathbf{B}$  is  $180^\circ$

$\therefore$  Magnetic force

$$\mathbf{F}_m = q(\mathbf{v} \times \mathbf{B}) = vB \sin 180 = 0$$

**TEST Edge** The same question can be twisted if the electric field is also present. Remember that when electric and magnetic field are both present then net force on moving charge particle is given by

$$\mathbf{F} = q\mathbf{E} + q(\mathbf{v} \times \mathbf{B})$$

5. (a) **Idea** The given problem is the application of torque about a point. Here it has to be noted that angular displacement ( $\theta$ ) for both the doors are same.

For door A

$$FL = \frac{ML^2}{3} \alpha_1 \text{ [where } L \text{ is length of door]}$$

$$\alpha_1 = \frac{3F}{ML}$$

$$\theta_A = \frac{1}{2} \alpha_1$$

$$t_1^2 = \frac{1}{2} \left( \frac{3F}{ML} \right) (3)^2$$

For door B

$$F \frac{L}{2} = \frac{ML^2}{12} \alpha_2$$

$$\alpha_2 = \frac{6F}{ML}$$

$$\theta_B = \frac{1}{2} \left( \frac{6F}{ML} \right) (t_2^2)$$

For

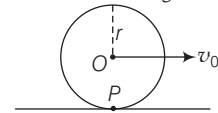
$$\theta_A = \theta_B,$$

$$\frac{1}{2} \left( \frac{3F}{ML} \right) (3)^2 = \frac{1}{2} \left( \frac{6F}{ML} \right) t_2^2$$

$$t_2^2 = \frac{3^2}{2} \Rightarrow t_2 = \frac{3}{\sqrt{2}} \approx 2 \text{ s.}$$

**TEST Edge** The question related to rotation are frequently asked in JEE Advanced. Usually concept of torque, angular momentum conservation are required to tackle such problems.

$\Rightarrow$  for example, a solid sphere rolls without slipping on a rough surface as shown in figure then angular momentum about point of contact with rough surface is given by  $L = \frac{7}{5} m v_0 r$



[mass of sphere is :  $m$ ]

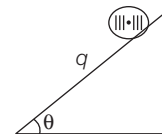
6. (d) **Idea** For a rolling body like disc, ring, cylinder etc acceleration along the inclined plane is given by

$$a = \frac{g \sin \theta}{1 + \frac{I}{mR^2}} \quad \dots(i)$$

where,  $I$  = moment of inertia of rolling body.

Given velocity at bottom is same so,

$$\text{or } V_1 = V_2$$



$$\Rightarrow 2a_1 s_1 = 2a_2 s_2$$

$$\Rightarrow 2a_1 \frac{h_1}{\sin \theta} = 2a_2 \frac{h_2}{\sin \theta} \Rightarrow \frac{h_1}{h_2} = \frac{a_2}{a_1}$$

$$\text{Now } a_1 = \frac{g \sin \theta}{1 + \frac{I_1}{m_1 R^2}} = \frac{g \sin \theta}{1 + \frac{2}{5}} = \frac{5}{7} g \sin \theta$$

$$a_2 = \frac{g \sin \theta}{1 + \frac{I_2}{m_2 R^2}} = \frac{g \sin \theta}{1 + \frac{1}{2}} = \frac{2}{3} g \sin \theta$$

$$\therefore \frac{h_1}{h_2} = \frac{14}{15}$$

**TEST Edge** Moment of inertia of some standard bodies about an axis passing through its centre of mass must be known because sometimes their direct application is asked.

$\Rightarrow$  The moment of inertia of sphere with cavity having mass  $M$  and inner and outer radius  $R_1$  and  $R_2$

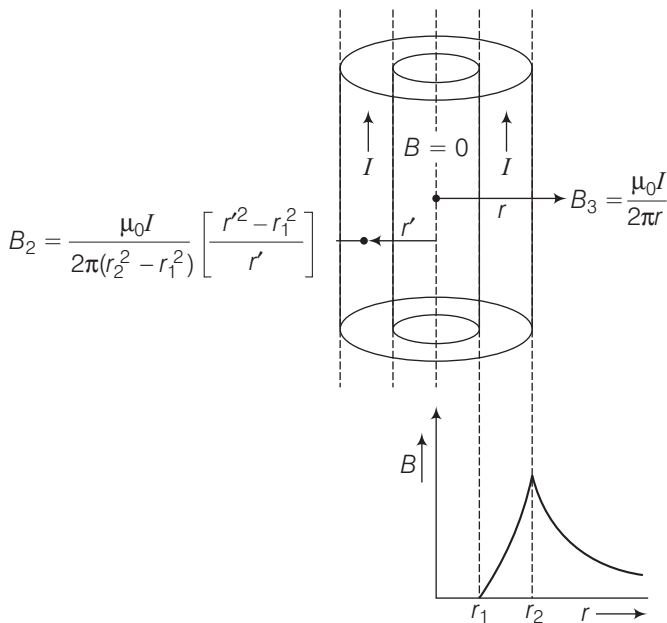
$$\text{respectively is given by } I = \frac{2M}{5} \left[ \frac{R_2^5 - R_1^5}{R_2^3 - R_1^3} \right]$$

7. (b) **Idea** Gravitation force is a central force so it acts between centres of two given masses.

Major part of gravitational force acting on the moon will be due to the earth and for the sun it will not be central because net force is directed towards centre of the earth.

**TEST Edge** At least one question is frequently asked in JEE Advance from gravitation in every year. Students are advised to focus more on application of concepts and graphs. Question from application of Kepler's law can also be asked in the examination.

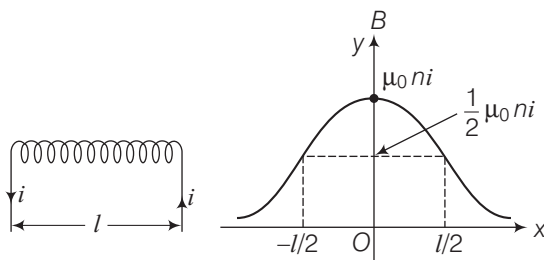
8. (c) **Idea** Here we have used Ampere's circuital law i.e.,  $\mathbf{B} \cdot d\mathbf{l} = \mu_0 I$  is being used, to find the relation between magnetic field and distance with the help of which we can draw the graph.



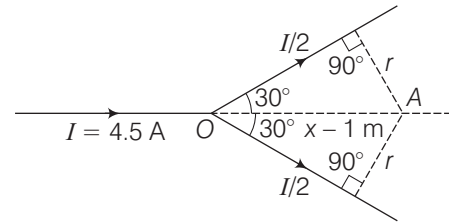
By applying Ampere's circuital's law inside the cavity, the magnetic field is zero and inside the wire magnetic field will be  $B_2 = \frac{\mu_0 I}{2\pi(r_2^2 - r_1^2)} \left[ \frac{r^2 - r_1^2}{r} \right]$  and on the surface and outside the conductor is  $B_3 = \frac{\mu_0 I}{2\pi r}$

**TEST Edge** A number of variation can be done in the shape and size of current carrying conductor and relation or graph between magnetic field. The plot between  $B$  and  $r$  can be sketched with the help of Ampere's circuital law.

The graph between variation of magnetic field  $B$  with distance  $r$  from the centre along the axis of solenoid is shown below



9. (d) **Idea** Here we have used the concept that due to an infinite long wire the magnetic field at a point which lies at a perpendicular distance  $r$  from the central line is given by  $B = \frac{\mu_0 I}{2\pi r}$  [ $I$ : current in the conductor] and its direction is given by right hand palm rule. However, if a point lies along the axis of current carrying wire then magnetic field due to wire at that point is zero.



The angle between the wires will not play any role in calculating the net magnetic field at A

Now,  $(\mathbf{B}_{\text{net}})_A = \frac{\mu_0 I/2}{2\pi r} \otimes + \frac{\mu_0 I/2}{2\pi r}$   
 $= 0$

[∵ Both have same magnitude but opposite direction]

**TEST Edge** A number of variation can be done by changing shape of wire and question can be asked in various ways for example

- Magnetic field at O is  $B = \frac{\mu_0 i}{4r} \otimes$
- Magnetic field at O is  $B = \frac{\mu_0 i}{4r} \otimes$
- Magnetic field at O is  $B = \frac{\mu_0 i}{4\pi r} [\sin \alpha - \sin \beta] \otimes$

Use some of cases with little variation. Sometimes case (3) is used as a standard result.

10. (a) **Idea** When a projectile is projected from earth its path or trajectory is conic.

Motion of a projectile projected from the surface of the earth will be a conic with focus at the point connecting centre of the earth.

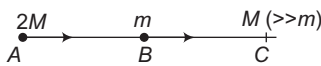
**TEST Edge** Question is based on equation of path of projectile can also be asked in JEE Advanced. So students are advised to focus to do more questions on its application and

The equation of trajectory is given by

$$y = x \tan \theta - \frac{gx^2}{2u^2 \cos^2 \theta}.$$

**11.(a,b,c)** **Idea** In case of simple harmonic motion angular frequency,  $\omega = \frac{2\pi}{T}$  [T is time period of SHM]

At  $t = 0$ , initial position of both particles is indicated below.



For  $\omega_B = 2\omega_A \Rightarrow \frac{1}{T_B} = \frac{2}{T_A} \Rightarrow T_A = 2T_B$

So, they can reach at extreme at same time

So for  $\omega_B = 2\omega_A$ , they will meet with zero speed.

For  $\omega_B > 2\omega_A$ ,  $T_A > 2T_B$

B will catch A before reaching extreme so they will meet and both will be moving with velocity in same direction.

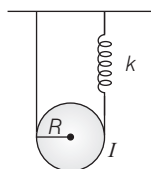
For  $\omega_B < 2\omega_A \Rightarrow T_B < 2T_A$

Now, it is clear that they will meet when A will be returning from the extreme. So, at the time of meet they will be moving in opposite direction.

**TEST Edge** Question can be twisted if there is a third particle C in second straight line parallel to the line in which A and B are executing SHM. If relation between their velocities is asked to determine then in such problem such problem then it is to be noted that velocity at extreme position is zero and at mean position, it is maximum.

Question based on SHM clubbed with moment of inertia can also be asked. For the situation as shown in figure and time period of SHM is

$$T = 2\pi \sqrt{\left(\frac{I}{r^2} + m\right) / (4k)}$$



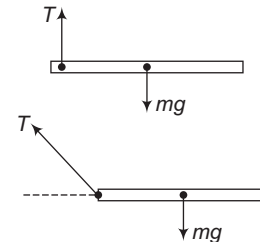
**12. (a,b,c)** **Idea** The relation  $\tau = I\alpha$  is applicable only if point about which torque is calculated lies in non-accelerating or inertial frame of reference.

The relation  $\tau = I\alpha$  is only applicable about an inertial axis or point because it is derived from  $F = ma$ . If axis or point is non-inertial then we have to apply pseudo force at COM of system corresponding to acceleration of axis to use  $\tau = I\alpha$ .

Here you must note that accelerated COM is exception for this concept. You can always apply  $\tau = I\alpha$  about COM.

For (i), point P will be inertial point as it will be at rest.

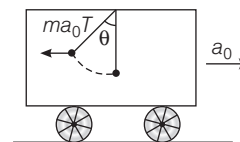
For (ii), point P will not be inertial point because according to diagram P will have acceleration  $\perp$  to string. See FBD given below.



For (i)  $\tau_P = I_P \alpha$   
 $mg \frac{L}{2} = \frac{mL^2}{3} \alpha \quad \left[ \alpha = \frac{3g}{2L} \right]$

**TEST Edge** Question based on pseudo force are frequently asked in JEE Advanced. So students are advised to understand the concept and its application.

$\Rightarrow$  For example, to calculate  $\theta$  in the situation shown in figure we have to use concept of pseudo force, here,  
 $\theta = \tan^{-1}\left(\frac{a_0}{g}\right) \Rightarrow a_0 = g \tan \theta$



**13. (b,c)** **Idea** This question is based on the concept of motional e.m.f. which is given by  $e = (\mathbf{v} \times \mathbf{B}) \cdot \mathbf{L}$

When circular coil expands radially in a region of magnetic field induced emf is developed.

Here magnetic field B is in a plane perpendicular to the plane of circular coil. As  $e = 0$ , magnetic field must be in the plane of circular coil.

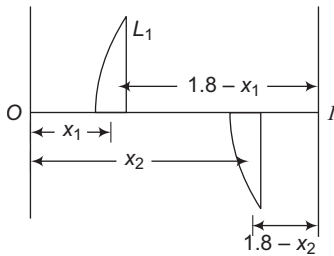
So that its component perpendicular to the plane of coil is zero.

Further, if the magnetic field has a component perpendicular to the plane of the coil, whose magnitude is decreasing suitably so that magnetic flux linked with coil stays constant then  $e = \frac{d\phi}{dt} = 0$ .

**TEST Edge** Question of many varieties are asked in which concept of magnetic flux, motional emf and inductance are involved. It is important to understand the basic concepts as problems related to these topic may need mathematical tools such as integration to tackle them

14. (c) **Idea** In the given situation if the magnification of first lens is  $m$ , then magnification of second lens is  $1/m$ .

Given that magnification at one half is 2. For  $L_1$ , object is close so that will be the point with magnification  $-2$  so other half will have  $m = -1/2$



For magnification  $m = \frac{v}{u}$

For  $L_1$ ,  $m = -2 = \frac{(1.8 - x_1)}{-x_1}$   $x_1 = 0.6 \text{ m}$

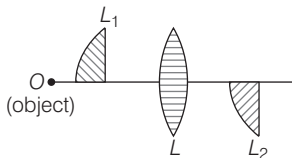
For  $L_2$ ,  $m = -\frac{1}{2} = \frac{1.8 - x_2}{-x_2}$   $x_2 = 1.2 \text{ m}$

$\therefore$  we know that

$$m = \frac{f}{f + u}$$

$$-2 = \frac{f}{f + 0.6} \Rightarrow f = 0.4 \text{ m}$$

**TEST Edge** Question can be twisted if there is another lens is placed in middle of two lens  $L_1$  and  $L_2$  and position of image is asked. Then we use mirror formulae and image formed by lens  $L_1$  will work as object for lens  $L$  and image formed by  $L$  will work as an object for  $L_2$ .

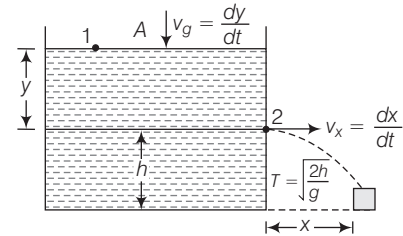


15. (a,d) **Idea** The problem is based on the fact that magnetic field produced by a moving charge particle is different for different frame of reference.

A is stationary and observes the current  $I$ . B observes the free electrons to be at rest, but the unbalanced positive charges in the conductor will appear to move in the direction opposite to that of  $v$ . Thus, A and B observed the same current and hence the same magnetic field.

**TEST Edge** Question may be asked in various form such as what prediction you can do for electric field. To tackle such problems, it must be kept in mind that charge at rest can produce only electric field whereas charge in motion can produce electric as well as magnetic field.

16. (1) **Idea** Here velocity of efflux at point 2 is given by  $v = \sqrt{2gy}$  and as condition is given in



question that block should move in such a way that stream always hits the block. So, velocity of block  $v_b = \frac{dx}{dt}$ . Also the velocity at point 1 will be rate of decrease in level of water i.e.,  $\frac{dy}{dt}$ .

Besides these concept we have to use equation of continuity.

Velocity of efflux,  $v = \sqrt{2gy}$

Range,  $x = \sqrt{2gy} \times \sqrt{\frac{2h}{g}}$

The velocity of the block must be  $\left(\frac{dx}{dt}\right)$

$$\therefore v_b = \frac{dx}{dt} = \sqrt{\frac{2h}{g}} \times \sqrt{2g} \times \frac{1}{2\sqrt{y}} \frac{dy}{dt}$$

$$v_b = \frac{\sqrt{h}}{\sqrt{y}} \cdot \frac{dy}{dt} \quad \dots(i)$$

Using equation of continuity

$$\frac{A dy}{dt} = a\sqrt{2gy} \quad \dots(ii)$$

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

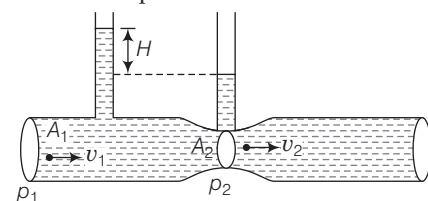
$$v_b = \sqrt{\frac{h}{y}} \times \frac{a}{A} \sqrt{2gy}$$

$$v_b = \sqrt{2gh} \times \frac{a}{A}$$

$$= 20 \times \frac{1}{20}$$

$$= 1 \text{ ms}^{-1}$$

**TEST Edge** The question is based on Archimede's principle, Bernoulli's theorem, equation of continuity are frequently asked in JEE Advanced, generally Bernoulli's theorem is clubbed with equation of continuity. While applying these theorem it is necessary to keep in mind that fluid must be incompressible and irrotational.

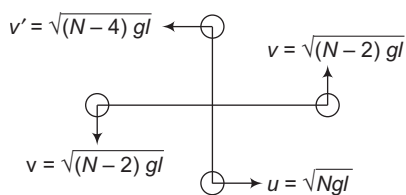




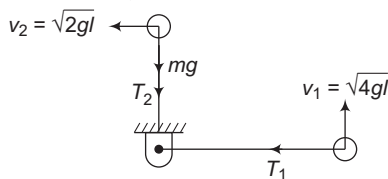
⇒ In the situation shown in figure by applying Bernoulli's equation and equation of continuity we can calculate  $v_1$  and  $v_2$ , here  $p_1 - p_2 = \rho g H$  and  $v_2 - v_1^2 = 2gH$ .

**17. (4)** **Idea** When rod is in horizontal direction centripetal force is provided by tension only but when rod is in vertical direction then centripetal force is provided by tension and weight of the particle. By drawing necessary FBD and applying Newton's law tension can easily be calculated.

For vertical circular motion, student should always remember that



For given  $u = \sqrt{6gl}$



At horizontal position,

$$T_1 = \frac{mv_1^2}{l} = 4mg \quad \dots(i)$$

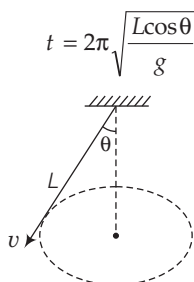
At highest point

$$T_2 + mg = \frac{mv_2^2}{l} = 2mg \Rightarrow T_2 = mg \quad \dots(ii)$$

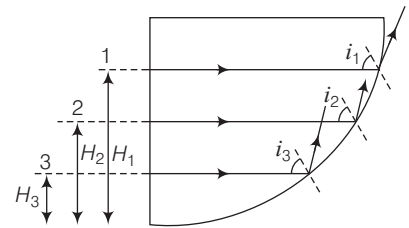
From above equation, we get

$$\frac{T_1}{T_2} = 4$$

**TEST Edge** The problems based on vertical circular motion, are important for JEE Advanced point of view. The standard result as given in question is very useful and question related to conical pendulum can also be solved using similar concepts, for e.g., the time period of conical pendulum to complete one circle as shown in figure is given by

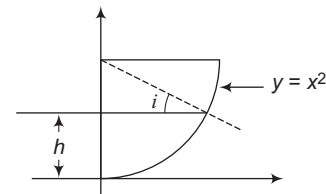


**18. (2)** **Idea** To understand the question



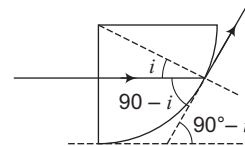
Consider the rays as shown in figure, for ray 1 with angle of incidence  $i_1$  ( $i_1 < \theta_c$ ) where ( $\theta_c$  is critical angle) the ray will get refracted, but  $H_1$  is not the minimum height. For ray 3 with angle of incidence  $i_3$  ( $i_3 > \theta_c$ ) the ray will get reflected (due to phenomenon of TIR), now for light ray 2 with angle of incidence  $i_2$  ( $i_2 = \theta_c$ ) the ray will just refracted (limiting ray) and correspondingly  $H_2$  will be minimum height so that light will just refracted.

For TIR at that point of incidence on curved surface. We can easily say that as  $h$  increases  $i$  decreases and for TIR at the point of incidence minimum value of  $i$  should be  $\theta_c$  and corresponding to that  $h$  will be minimum for refraction.



At just TIR by Snell's law,

$$3 \sin i = 1 \sin 90^\circ \Rightarrow \sin i = \frac{1}{3}$$



So, slope of tangent will be  $90^\circ - i$ .

$$\frac{dy}{dx} = \tan(90^\circ - i) = \cot i = \frac{2\sqrt{2}}{1}$$

At  $y = h$   $\frac{dy}{dx} = 2x$

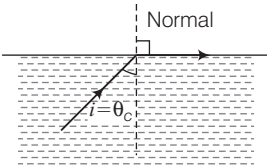
$$2x = 2\sqrt{2}$$

$$x = \sqrt{2} \text{ m}$$

$$y = h = (\sqrt{2})^2 = 2 \text{ m}$$

**TEST Edge** Questions based on total internal refraction are frequently asked in JEE Advanced and generally it is clubbed with one or more concept like Snell's law. Concept of limiting ray is also important in total internal refraction.

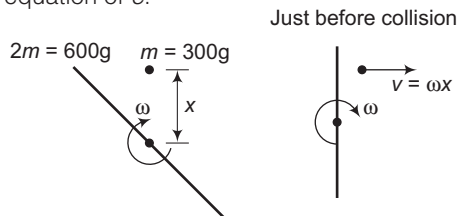
In the figure shown when light goes from denser to rarer medium with angle of incidence ( $i$ ) = critical angle ( $\theta_c$ ) then this ray is commonly known as limiting ray which is refracted making angle of  $90^\circ$  with the normal.



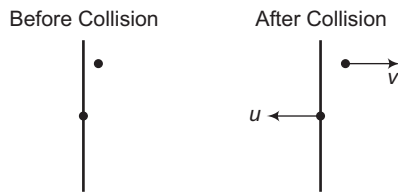
**19. (9)** **Idea** As no external forces are acting on the system so momentum will be conserved and as collision is elastic so coefficient of restitution ( $e$ ) = 1

It is the case of collision of rigid body with point mass. It can be done by

1. conservation of momentum
2. conservation of angular momentum
3. equation of  $e$ .



There is no external force so linear momentum will be conserved.



$$2m(0) + m(0) = -2mu + mv$$

$$v = 2u \quad \dots(i)$$

Conservation of angular momentum with respect to centre of rod.

$$L_i = L_f$$

$$\frac{2mL^2}{12} \times \omega + 0 = 0 + mvx$$

$$\frac{2\omega L^2}{12} = vx \quad \dots(ii)$$

**Equation of  $e$**

$$e = \frac{\text{Velocity of separation of point of contact}}{\text{Velocity of approach of point of contact}}$$

$$e = \frac{v + u}{\omega x} = 1$$

$$v + u = \omega x \quad \dots(iii)$$

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

$$3u = \omega x$$

$$\omega = \frac{3u}{x}$$

Putting values in Eq. (ii), we get

$$\frac{2\omega L^2}{12} = vx$$

$$\frac{2 \times 3u}{12x} \times L^2 = 2u x$$

$$x^2 = \frac{2 \times 3l^2}{24} = \frac{2l^2}{8} = \frac{l^2}{4}$$

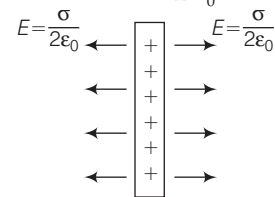
$$x^2 = \frac{90 \times 90}{4} = (45)^2$$

$$x = 45 \text{ cm} \Rightarrow \frac{x}{5} = \frac{45}{5} = 9 \text{ cm}$$

**TEST Edge** Questions related to work done by conservative and non-conservative forces are frequently asked in JEE Advanced. Usually these problems are clubbed with one or more concept like collision so, students are advised to understand the basic concepts of work, energy and power and focus more on their application besides theoretical aspects.

**20. (4)** **Idea** The electric field produced by thin charged sheet is given by

$$E = \frac{\sigma}{2\epsilon_0}$$



[ $\sigma$  = surface charge density]

$\therefore$  an external electric field is also present so we will use principle of superposition to find net electric field.

From the figure, it is clear that the plate is placed in an external electric field. Let the electric field due to plate is  $E$  and  $E_0$  be the external electric field.

$$E_0 + E = 12 \text{ V/m} \quad \dots(i)$$

$$E_0 - E = 8 \text{ V/m} \quad \dots(ii)$$

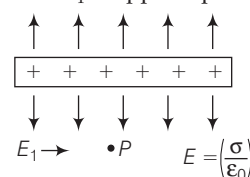
Solving Eqs. (i) and (ii), we get

$$E = 2 \text{ V/m}$$

$$\text{Now, electric field due to plate} = \frac{\sigma}{2E_0} = 2$$

$$s = 4e_0 \therefore n = 4$$

**TEST Edge** Question can be twisted if orientation of charged sheet is changed as shown in figure and an electric field  $E_1$  is applied parallel to the sheet.



In this situation value of electric field at point  $P$  is given by resultant of both electric field *i.e.*,

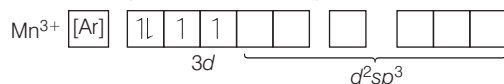
$$E_{net} = \sqrt{E_1^2 + \left(\frac{\sigma}{2\epsilon_0}\right)^2}$$

as angle between the electric field is  $90^\circ$ .

21. (c) **Idea** This problem is based on VBT and magnetic moment of coordination compound. Problem can be solved by using the concept of hybridisation according to VBT. Students are advised to solve this problem by following the given steps.

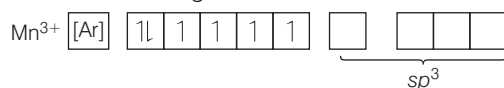
- Write the electronic configuration of metal ion and then count the number of unpaired electrons ( $n$ ).
- Then calculate magnetic moment ( $\mu$ ) using  $\mu = \sqrt{n(n+2)}$  BM where  $n$  = number of unpaired electrons(s).

The magnetic moment of  $[\text{Mn}(\text{CN})_6]^{3-}$  indicates that it is having two unpaired electrons, thus  $\text{Mn}^{3+}$  would have the following electronic configuration,



The hybridisation is likely to be  $d^2sp^3$  [ $\text{MnBr}_4$ ] $^{2-}$  is having the magnetic moment 5.9 MB. Hence, the number of unpaired electrons is 5.

$\therefore$  The electronic configuration of  $\text{Mn}^{2+}$  is

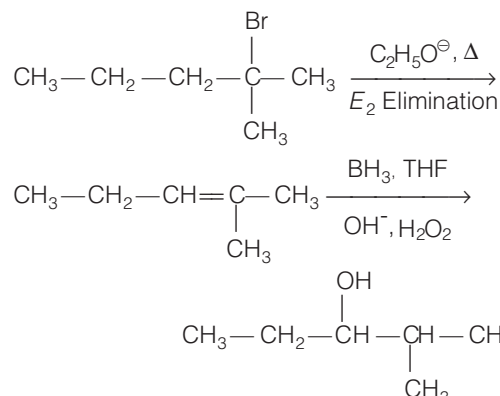


The hybridisation is likely to be  $sp^3$ .

**TEST Edge** In JEE Advanced, such types of problems are included to judge the knowledge of students regarding bonding in coordination compounds so students are advised to go through study of various theories such as VBT, CFT, etc. Questions related to the concept of splitting of  $d$  orbital in spherically symmetrical field of ligand are asked. Such as crystal field stabilization energy of  $[\text{Co}(\text{CN})_6]^{3+}$  has higher value than CFSE of  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ . This can be explained by using the concept of strength of ligand.

22. (d) **Idea** This problem is based on conceptual mixing of  $E_2$  reaction sytzeff rule and hydroboration oxidation reaction. The problem can be solved by following the given steps.

- Complete the organic conversion using the concept of  $E_2$  elimination and sytzeff rule according to which more substituted (alkylated) alkene will be more stable.
- Now perform the hydroboration oxidation reaction then select the correct choice.



**TEST Edge** In JEE Advanced, such type of problems are asked to judge the knowledge of students regarding reaction mechanism and stability of product. So students are suggested to understand the mechanism of chemical reaction and stability of product.

Similar type of questions including conceptual mixing of oxymercuration demuration, Hoffmann elimination and ozonolysis can also be asked.

23. (d) **Idea** This problem is based on the concept of % composition. For determination of copper sulphide while solving the problem students are advised to analyse the type of oxidation state of copper ion in copper sulphite.

Consider the any one ion of copper (cuprom or cupric) as  $x$  and another as  $(1.8-x)$  then calculate the % of  $\text{Cu}^{2+}$ .

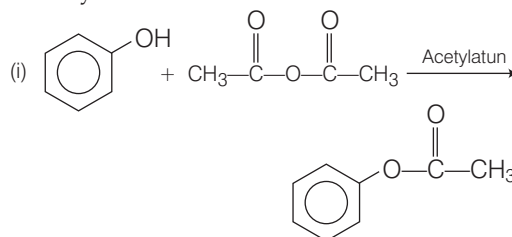
Let  $x \text{ Cu}^{2+}$  and  $(1.8-x) \text{ Cu}^+$  ions are present in the compound  $\text{Cu}_{1.8}\text{S}$ . Compound is electrically neutral.

$$\begin{aligned} (+2) \times x + (1.8-x) - 2 &= 0 \\ x &= 0.2 \end{aligned}$$

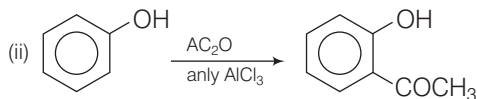
$$\% \text{ Cu}^{2+} = \frac{0.2}{1.8} \times 100 = 11.11\%$$

**TEST Edge** Similar concept based problems for  $\text{Fe}_2\text{O}_3$  may also be asked. Problems based on magnetic properties of solid, curies temperature, piezoelectricity may also be asked, so students are advised to go through these topics in depth.

24. (d) **Idea** While solving the problem students are advised to go through the chemical properties of phenol which includes Friedel Craft acylation.




In the absence of  $\text{AlCl}_3$ /any Lewis acid, acetylation does not take place at benzene ring.



**TEST Edge** Similar types of problems, including the concept of Friedel Craft alkylation, Friedel Craft acylation to different substrates, may be asked. Students must understand the concept of electrophilic substitution reaction to the benzene and derivatives of benzene. Similarly problems based on fries rearrangement, are also asked. Such as

What will be the product when *o*-methyl phenyl acetate is strongly heated?

*m*-acyl toluene.

**25. (b)**  **Idea** This problem is based on concept of Kohlrausch law and determination of conductivity of solution, using cell constant. While solving the problem student must write all the given parameters in the question, then required parameters and asked parameters also.

Student must follow these steps.

- Calculate total equivalent conductivity using Kohlrausch law and conductivity of solution.
- Then correlate the above two values to get the answer. Useful formula

$$\lambda = \frac{1000 \times K}{M}, K = G \times \sigma$$

where,  $\lambda$  = equivalent conductivity

$K$  = conductivity

$G$  = conductance

$\sigma$  = cell constant

$$\lambda_{(\text{Co}(\text{NH}_3)_4 \text{Cl}_2)\text{ClO}_4} = 50 + 70 = 120$$

$$\lambda_{[\text{Co}(\text{NH}_3)_4 \text{Cl}_2] \text{CO}_4} = \frac{1000 K}{M}$$

$$K = G\sigma = \frac{1}{33.5} \times 0.20$$

$$\lambda = 120 = \frac{1000 \times 0.20}{33.5 \times M}$$

$$\Rightarrow M = 49.75 \text{ m mol/L}$$

**TEST Edge** The related concepts such as  $K_{sp}$ , equivalent conductivity, normality may also be asked.


Students are suggested to keep in mind the following formula

$$\lambda_{\text{eq}} = \frac{K \times 1000}{N}$$

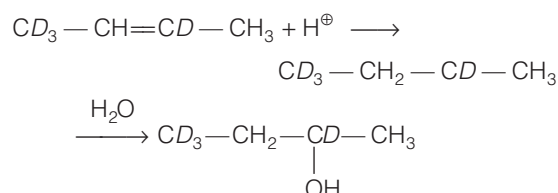
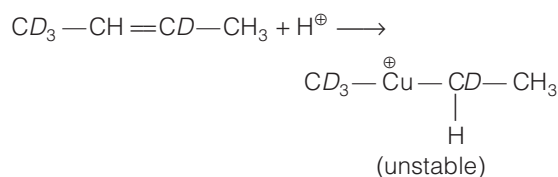
or

$$\frac{K \times 1000}{S}$$

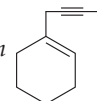
where,  $N$  = normality,  $S$  = solubility

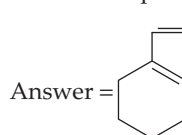
**26. (c)**  **Idea** This problem is based on the chemical properties of alkene and Markovnikov's addition reaction. The students are suggested to undergo electrophilic addition reaction.

Perform electrophilic addition reaction on alkene (butene) (keep in mind that the stability of carbocation reaction) must proceed through most stable carbocationic pathway, use sytzeff rule to product the correct product as




**TEST Edge** Similar problems including concept of electrophilic addition reaction on alkene, alkyne, such as reduction, oxidation, selective reduction including conditions when both alkene, alkyne are present can also asked. So student must be careful to answer these question e.g.,

What will be the product when  undergo reaction with  $\text{Pd}/\text{BaSO}_4$ ?



In depth study of selective reduction of organic hydrocarbon is suggestive.

**27. (d)**  **Idea** The problem is based on magnetic moment of transition metal ion. Problem includes the concept of magnetic moment of *d* and *f* block elements which can be calculated by using following formulae.

$$\mu = \sqrt{n(n+2)} \text{ BM (for } d \text{ block element)}$$

$$\mu = \sqrt{4s(s+1) + L(L+1)} \text{ (for } f \text{ block elements)}$$

where,  $n$  = number of unpaired electron

$s$  = sum of spin quantum number

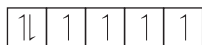
$L$  = sum of angular quantum number

Magnetic moment of any ions can be easily calculated by using the formula  $\mu = \sqrt{n(n+2)} \text{ BM}$

where,  $n$  = number of unpaired electrons.

$$\text{BM} = \text{Bohr magneton} = \frac{eh}{4\pi m_c}$$

For



$n = 4$

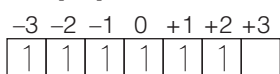
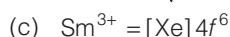
$\mu = \sqrt{4(4+2)} \text{ BM}$

$= \sqrt{24} \text{ BM} = 4.87 \text{ BM}$



$x = 0$

$\mu = \sqrt{0(0+2)} = 0 \text{ BM} = 0$



$S = G \times \frac{1}{2} = 3$

$L = 3$

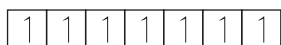
$\mu_m = \sqrt{4S(S+1) + L(L+1)}$

$= \sqrt{4 \times 3(3+1) + 3(3+1)}$

$= \sqrt{48 + 12}$

$= \sqrt{60} = 7.74$

$= \text{Eu}^{2+} = [\text{Xe}] 4f^7$



$= s = 7/2, L = 0$

$\mu_m = \sqrt{4 \times \frac{7}{2} \left( \frac{7}{2} + 1 \right) + 0(0+1)}$

$= \sqrt{7 \times \frac{9}{2}}$

$= \sqrt{63}$

$= 7.93$

Hence,  $\text{Eu}^{2+}$  has highest value of magnetic moment and correct choice is (a).

**TEST Edge** Similar problems including colour of transition metal elements, inner transition elements, variation of colour around different ligands in different coordination compound are also asked. So students are advised to study these topics and interrelate all these topics on the basis of numbers of electrons present in  $d$  subshell.

28. (c) **Idea** This problem is based on characteristic of amino acid and protein, while solving this problem students are advised to understand each statement very carefully. Mark the correct and incorrect statements, then answer.

Among 4 given choices all are correct, except  $S_4$  which is incorrect.

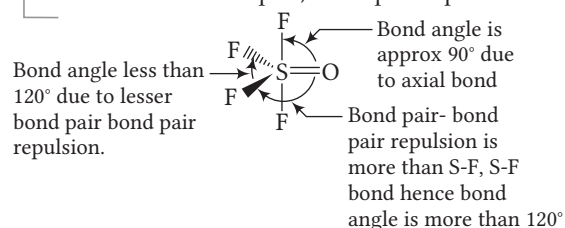
Fibrous protein is insoluble form of protein.

**TEST Edge** Problems, including the concept of isoelectric point determination, electrophoresis, test of amino acid, peptide side chain determination etc may be asked. So students must be very clear about these topics. e.g.,

Determine the isoelectric point of glutamic acid having pH of functional groups are 4.25, 9.67 and 2.19.

To get the answer add the two similar values then answer will be 3.22.

29. (b) **Idea** Problem is based on concept of hybridisation and bent rule, and can be solved by analysing the effect of bond pair, bond pair repulsion.



This is why correct order is  $Z > Y > X$

**TEST Edge** Similar problems including VSEPR theory, Bent's rule, Drago's rule etc may also be asked.

30. (d) **Idea** This problem can be answered by using the concept of hybridisation while solving this problem students are advised to determine the structure of each species using

$$H = \frac{V + M - C + A}{2}$$

where,  $V$  = valence electrons of central atom

$M$  = monoatomic member such as H, F, Cl, Br, I

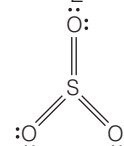
$C$  = number of positive charge

$A$  = number of negative charge

Then choose the correct answer, having similar structure

This problem includes hybridisation of different compounds,  $\text{SO}_3$  has triangular planar structure

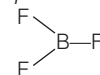
$$H = \frac{V + M - C + A}{2} = \frac{6}{2} = 3$$



Hybridisation =  $sp^2$

$\text{BF}_3$  has triangular planar structure  $H = \frac{3+3}{2} = 3$

Hybridisation =  $sp^2$



$\text{BH}_3$  has triangular planar structure  $H = \frac{3+3}{2} = 3$

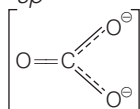
Hybridisation =  $sp^2$



$CO_3^{2-}$  has also triangular planar structure

$$H = \frac{4 + 2}{2} = 3$$

Hybridisation =  $sp^2$



Hence, correct choice is (d).

**TEST Edge** In JEE Advanced, the problems based on structure of inorganic compound and different type of hybridisation may be asked. Students are suggested to solve such problems by using VBT very carefully. Such as

*What will be the hybridisation and structure of permanganate ion?*

structure - tetrahedral

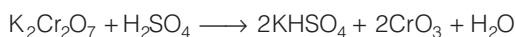
hybridisation -  $sd^3$

While answering through concept of VBT, 4s and 3d orbitals (having comparable energy) undergo  $sd^3$  hybridisation to produce  $4sd^3$  hybrid orbitals. All  $4sd^3$  hybrid orbitals are oriented in tetrahedral geometry.

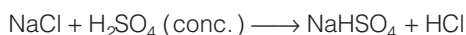
- 31. (a,b,d)** **Idea** This problem can be solved by using the knowledge of chemical properties of  $K_2Cr_2O_7$ . Students are advised to complete the chemical reaction(s) then analyse the nature of product(s) and then read the statements, provided to answer the question.

This problem includes the chemical properties of  $K_2Cr_2O_7$ .

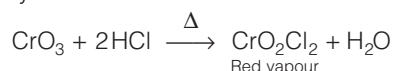
When  $K_2Cr_2O_7$  is treated with NaCl and  $H_2SO_4$  it first forms  $KHSO_4$  due to reaction between  $K_2Cr_2O_7$  and  $H_2SO_4$ .



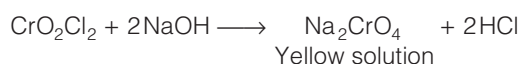
NaCl and  $H_2SO_4$  reacts with each other to produce  $NaHSO_4$  and HCl.



$CrO_3$  formed in first step reacts with HCl to produce chromyl chloride.



When this red vapour is passed through aqueous NaOH solution, it produces yellow solution of  $Na_2CrO_4$ .

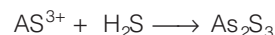


**TEST Edge** Similar problems, based on chemical properties of calcium hydroxide, sodium bicarbonates, magnesium sulphates are also asked. The students must be careful about product as well as byproducts

*What will be the nature of the oxide obtained on heating slaked lime with  $CO_2$ ?*

After solving the problem one will get answer that nature of oxide is neutral.

- 32. (a,b,c)** **Idea** Problem is based on charge of colloidal sol while solving this problem students are advised to complete the chemical reaction according to the question, then read all the statements and mark the correct answer.



It is a negatively charged sol because the sol  $As_2S_3$  is surrounded by negatively charge sulphide ion which is a common ion among both substrate  $H_2S$  and  $As^{3+}$ .

On adding  $BaCl_2$ ,  $As_2S_3$  flocculate on  $As_2S_3$ .

After flocculation the medium becomes acidic.

Concentrated  $HNO_3$  cannot coagulate this solution due to absence of positively charge cation.

Hence d is incorrect and correct option are (a), (b), (c).

**TEST Edge** Similar problems, including the concept of gold number, flocculation value order etc can also be asked. Then it is advisable to go through in depth in these topics.

*What will the correct order of flocculating value of  $Cl^- < SO_4^{2-} < PO_4^{3-}$ . When all these ions are flocculating positively charged sol?*

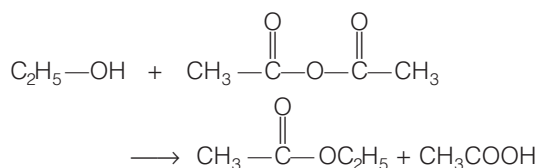
By using Hardy Schulze rule one can get the correct order as  $Cl^- < SO_4^{2-} < PO_4^{3-}$

- 33. (a,c)** **Idea** This problem includes the concept of analysis of solubility of lead and barium. While solving this problem, it is advised to use the concept of covalent character of molecule and Fajan's rule.

$CuSO_4$  and  $Ag_2SO_4$  are water soluble while the  $PbSO_4$  and  $BaSO_4$  and water insoluble.

**TEST Edge** The conceptual mixing of Fajan's rule and stability of carbonates, polarising capacity etc can also be asked.

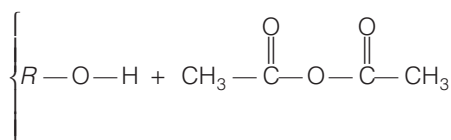
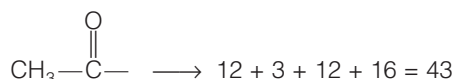
- 34. (a,b,c)** **Idea** This problem is based on the process of acetylation reaction, esterification reaction and molecular mass determination, while solving this problem students are advised to find molecular mass of reactants and products, then answer the question.



Formation of ester so it is called esterification.

addition of acetyl ( $\text{CH}_3\text{—}\overset{\text{O}}{\parallel}\text{C—}$ ) group is called acetylation.

During this reaction mol. mass is increased by 42.



Acetyl group replace one hydrogen of alcohol so  $(43 - 1) = 42$

During esterification Cleavage of O—H in alcohol occurs.

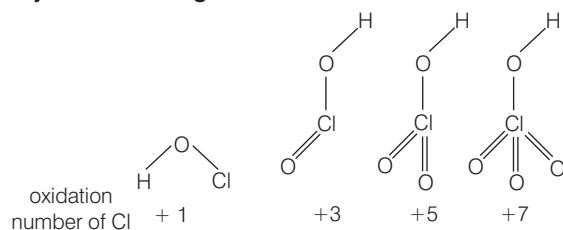
**TEST Edge** Similar questions based on the concept of peptide bond formation and amino acid formation can also be asked. Such as

*What will be the difference in molecular mass of Ala—Gly when the Ala and Gly undergo peptide bond formation?*

Ans is 18

35. (c,d) **Idea** This problem includes the concept of various properties of oxy acids of halogen. While solving the problem, students are advised to write the structural formulae of each oxy acid then write their oxidation number under each structure. Then read the choices given in option and answer accordingly.

**Oxy acids of halogen**



- Thermal stability increases As oxidation number increases
- Acidic strength increases.
- Basic strength decreases.
- Cl—O bond distance increases.

**TEST Edge** Similar problems including similar concept for oxy acids of phosphorous are also asked so students are advised to go through study of properties of oxy acids of phosphorous along with oxyacid acids of S and N, such as

*What will be the oxidation state difference between Caro's acid and Marshall's acid?*

Answer will be 0.

36. (5) **Idea** This problem is based on concept of ideal gas equation and specific heat capacity of gases. While solving this problem, students must write the ideal gas equation  $pV = nRT$  to determine  $\frac{dV}{dT}$ .

Put the value of  $\frac{dV}{dT}$  in equation

$$C = C_V + p\left(\frac{dV}{dT}\right)$$

$$\left(\frac{5}{2}R\right)T = k \cdot V \quad pV = RT$$

$$pV = RT \quad Rk \cdot dV = RdT$$

$$p = R\left(\frac{T}{V}\right) \quad \frac{dV}{dT} = \frac{1}{k}$$

$$C = C_V + p\left(\frac{dV}{dT}\right)$$

$$C = C_V + Rk \cdot \frac{1}{k} = C_V + R$$

$$C = \frac{3}{2}R + R = \frac{5}{2}R$$

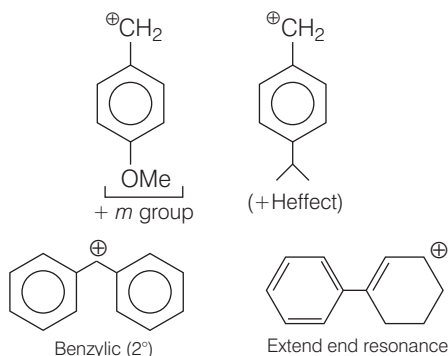
$$2C = 2 \times \frac{5}{2}R = 5R$$

**TEST Edge** Problems incorporating the concept of specific heat capacity and enthalpy change can also be asked, so students are advised to learn the formula related to thermodynamic parameter calculation such as

$$\Delta s = 2.303 n C_V \log\left(\frac{T_2}{T_1}\right) + 2.303 n R \log\left(\frac{V_2}{V_1}\right)$$

$\Delta s$  = entropy change during mixing of ideal gases. Be careful during adiabatic expansion of gas because during adiabatic expansion of ideal gas  $\Delta s = 0$ .

37. (4) **Idea** This problem is based on the stability of carbocation and it can be solved by using the concept of resonance, hyperconjugation, inductive effect etc.



**TEST Edge** Similar questions relating the concept of stability of carbanion, free radical etc can also be asked. Hence, proper study at these topics is suggestive.

38. (3) **Idea** This problem is based on concept of critical temperature. This can be solved by using formula  $T_c = \frac{8a}{27Rb}$

$$V_c = \frac{60}{0.80}$$

$$= 75 \text{ cm}^3 \text{ mol}^{-1}$$

$$b = \frac{V_c}{3} = 25 \text{ cm}^3 \text{ mol}^{-1}$$

$$= 0.025 \text{ L mol}^{-1}$$

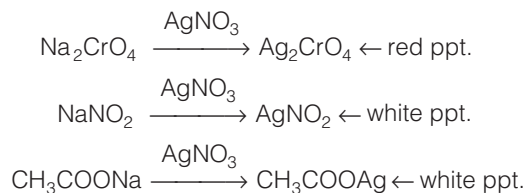
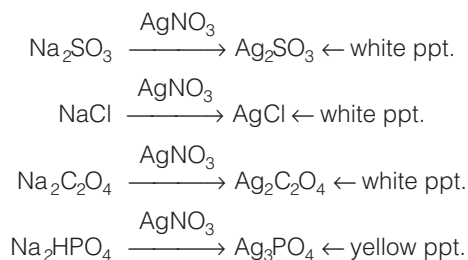
$$T_c = \frac{8a}{27Rb}$$

$$\frac{4 \times 10^5}{821} = \frac{8 \times a}{27 \times 0.0821 \times 0.025}$$

$$a = 3.375 \approx 3$$

**TEST Edge** Similar problem based on critical volume, enthalpy of sublimation of reaction can also be asked.

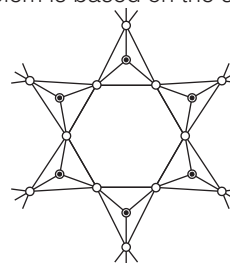
39. (5) **Idea** This problem is related to precipitation reaction, which is used to analyse the presence of chloride ion in reaction medium. The students are advised to complete all precipitation reactions and then count correct number of compound(s) which undergo precipitation.



**TEST Edge** In JEE Advanced, problems of similar concept, using different reagent and substrate can also be asked.

40. (3) **Idea** Question is based on concept of structure of 2D silicates. To solve this problem draw the correct structure, then count the corner per tetrahedron.

This problem is based on the structure of silicates.



$\Rightarrow$  2-D or sheet silicate

Number of corner shared per tetrahedron = 3.

**TEST Edge** Similar questions based on structure of cyclic, silicates, 3 dimensional silicates, can also be asked.

Students are suggested to undergo study of these topics and solve questions like

What is the negative charge present on basic unit of beryl?

By knowing molecular formula you will get 12 as answer.

41. (d) **Idea** We know that the point  $p(x_1, y_1)$  lies outside on or inside a circle
- $$s = x^2 + y^2 + 2gx + 2fy + c = 0$$
- according as  $s_1 = x_1^2 + y_1^2 + 2gx_1 + 2fy_1 + c \geq 0$  or  $< 0$ . Now find the radius the centre of given circle.

Since,  $P$  should always be at a constant distance from the point  $\left(\frac{3}{2}, 0\right)$  hence locus should be circle with

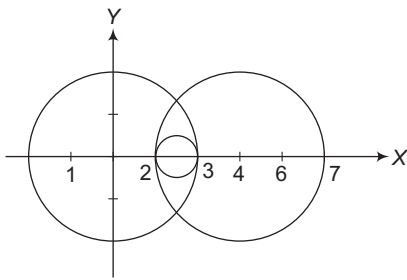
centre at the point  $\left(\frac{3}{2}, 0\right)$ .

$S_1: x^2 + y^2 = 4$  centre  $(0, 0)$ , radius = 2 units.

$S_2: x^2 + y^2 - 8x + 7 = 0$  centre  $(4, 0)$ , radius =  $\sqrt{4^2 + 0^2 - 7} = 3$  units

Since,  $P$  lies inside the two circles and its path has to enclose maximum area.





∴ Its maximum radius is  $\frac{1}{2}$ .  
 ∴ Required locus is  $\left(x - \frac{3}{2}\right)^2 + y^2 = \left(\frac{1}{2}\right)^2$   
 $x^2 + y^2 - 3x + 2 = 0$

**TEST Edge** Equation of circle in various forms, external and internal contact of circles related question are asked in JEE Advanced. To solve such type of questions students are advised to understand the basic concept of the circle. For e.g., find the equation of a circle through the inter section of  $x^2 + y^2 + 2x = 0$  and  $x - y = 0$  having minimum radius. To solve this type of question, use the concept of maximum/minimum and you will get the answer i.e.,  $x^2 + y^2 + x + y = 0$ .

42. (b) **Idea** To solve this problem, use the method of substitution and we know that

$$\int_a^b f(x) dx = \int_a^c f(x) dx + \int_c^b f(x) dx$$

and  $\int_0^{\pi/2} f(x) dx = \int_0^{\pi/2} f(t) dt.$

$$\int_0^\infty \frac{dx}{\left(x^2 + \frac{1}{x^2}\right) + a^2 - 2} = \int_0^\infty \frac{x^2 dx}{x^4 + (a^2 - 2)x^2 + 1}$$

$$\Rightarrow \int_0^\infty \frac{x^2 dx}{x^4 + kx^2 + 1} = \frac{1}{2} \int_0^\infty \frac{(x^2 + 1) + (x^2 - 1)}{x^4 + kx^2 + 1} dx$$

Let  $a^2 - 2 = k \geq 0$

$$\Rightarrow \frac{1}{2} \int_0^\infty \frac{1 + \frac{1}{x^2}}{x^2 + \frac{1}{x^2} + k} dx + \frac{1}{2} \int_0^\infty \frac{1 - \frac{1}{x^2}}{x^2 + \frac{1}{x^2} + k} dx$$

$\Rightarrow I_1 + I_2$

Let  $x - \frac{1}{x} = t$

$$\left(1 + \frac{1}{x^2}\right) dx = dt$$

$$I_1 = \frac{1}{2} \int_0^\infty \frac{1 + \frac{1}{x^2}}{x^2 + \frac{1}{x^2} + k} dx$$

$$I_1 = \frac{1}{2} \int_0^\infty \frac{1 + \frac{1}{x^2}}{\left(x - \frac{1}{x}\right)^2 + k + 2}$$

$$= \frac{1}{2} \int_{-\infty}^\infty \frac{dt}{t^2 + (\sqrt{k+2})^2}$$

$$I_2 = \frac{1}{2} \int_0^\infty \frac{1 - \frac{1}{x^2}}{x^2 + \frac{1}{x^2} + k}$$

Let  $x + \frac{1}{x} = t \Rightarrow \left(1 - \frac{1}{x^2}\right) dx = dt$

$$= \frac{1}{2} \int_0^\infty \frac{\left(1 - \frac{1}{x^2}\right) dx}{\left(x + \frac{1}{x}\right)^2 + k - 2}$$

$$= \frac{1}{2} \int_{-\infty}^\infty \frac{dt}{t^2 + (\sqrt{k-2})^2}$$

$$I_1 = \frac{\pi}{2a} \quad \text{and} \quad I_2 = 0$$

as  $I = \frac{\pi}{2a} = \frac{\pi}{5050}$

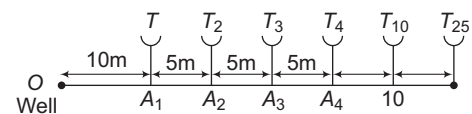
$\Rightarrow a = 2525$

**TEST Edge** In JEE Advanced, properties of definite integration, integration of implicit function and explicit function related question are asked.

To solve these type of questions, students are advised to understand the concept of definite integration. If  $m$  and  $M$  are global minima and global maxima of  $f(x)$  in  $[a, b]$  i.e.,  $m \leq f(x) \leq M$  for  $a \leq x \leq b$ , then  $m(b-a) \leq \int_a^b f(x) dx \leq M(b-a)$

43. (d) **Idea** This problem based on the concept of AP. To solve this use the basic properties of AP and then find the sum of given terms such we know that  $S_n = \frac{n}{2} [2a + (n-1)d]$

Given that 25 trees are planted in st. line 5m apart to each other.



(i) Distance covered by gardener for water to first tree

$$D_1 = OA_1 = 10 \text{ m}$$

(ii) Distance covered by gardener for water to second tree

$$O_2 = OA_1 + OA_2$$

$\Rightarrow 10 + 15 = 25 \text{ m}$

(iii) Distance for water in third tree

$$O_3 = OA_2 + OA_3 = 15 + 20 = 35 \text{ m}$$


Similarly, next distance for fourth = 45 m

Hence, total distance covered to water all the trees

$$10 + 25 + 35 + 45 + \dots \dots \text{to 25 terms}$$

$$\begin{aligned}
 & 10 + [25 + 35 + 45 + \dots 24 \text{ terms}] \\
 \Rightarrow & 10 + \frac{24}{2} [2(25) + (24 - 1)10] \\
 & \qquad \qquad \qquad [\text{from } S_n = \frac{n}{2} [2A + (n - 1)d]] \\
 \Rightarrow & 10 + 12 [50 + 230] \\
 \Rightarrow & 10 + 12 [280] \\
 \Rightarrow & 3370 \text{ m}
 \end{aligned}$$

**TEST Edge** Generally in JEE Advanced,  $n$ th terms of an AP and geometrical application related questions are asked. To solve such type of questions, students are advised to understand the concept of AP. For e.g., If the roots of the equation  $x^3 - 12x^2 + 39x - 28 = 0$  are in AP, then find the common difference of this AP. To solve this type of problem, students should use the concept of properties of AP.

44. (b)  **Idea** To solve this problem students are suggested to use the concept of modulus function such as  $|f(x) + g(x)| = |f(x)| + |g(x)|$

Solution of equation

$$\begin{aligned}
 & \left| \frac{x+1}{x} \right| + |x+1| = \frac{(x+1)^2}{|x|} \\
 \text{Let } \frac{x+1}{x} &= f(x) \text{ and } g(x) = x+1 \\
 \text{Now, } f(x) + g(x) &= \frac{x+1}{x} + (x+1) \\
 &= \frac{(x+1) + x(x+1)}{x} \\
 \Rightarrow &= \frac{(x+1)(x+1)}{x}
 \end{aligned}$$


$$\text{So, } |f(x) + g(x)| = |f(x)| + |g(x)|$$

$$\therefore f(x) \cdot g(x) \geq 0$$

$$\therefore \frac{(x+1)^2}{x} \geq 0 \text{ So, } x > 0 \text{ or } x = 1$$

So, required solution is  $(0, \infty) \cup \{-1\}$

**TEST Edge** Domain and range of absolute valued functions, logarithmic functions and exponential function based questions are asked in JEE Advanced. To solve such types of questions, students are advised to understand the basic concept of these functions for e.g., find the domain of function  $f(x) = \log(-2 + 3x - x^2)$ . To solve this follow the concept of logarithmic function as we know that  $f(x) = \log_a x$  is defined when  $f(x) > 0$  or  $x > 0$  and  $a > 0$ , we will get the answer i.e.,  $x \in (1, 2)$ .

45. (c)  **Idea** The number of selection of  $n$  different things taken  $r$  at a time is  ${}^n C_r$  and the number of arrangements of  $n$  different things taken  $r$  at a time when each things may be repeated any number of time is  $n^r$ .

If a team is awarded 1 point for a win and 0 point for a loss.

Then team scores must be 0, 1, 2, ..., 39

Let the teams be  $P_1, P_2, \dots, P_{40}$  and also let  $P_i$  loose to  $P_j$  for  $i < j$ . There are 40! such orders.

$$\text{Numbers of games} = {}^{40}C_2 = \frac{40 \times 39}{2} = 780$$


Number of outcomes =  $2^{780}$

$$\therefore \text{Probability} = \frac{40!}{2^{780}}$$

**TEST Edge** Generally in JEE Advanced partition of a sample space odds in favoured odd against an event related questions are asked to solve these type of questions student are advised to understand the concept of events in probability. Such as if  $E_1, E_2, E_3$  are events associated with a random experiment, then

$$\begin{aligned}
 P(E_1 \cup E_2 \cup E_3) &= P(E_1) + P(E_2) - P(E_1 \cap E_2) \\
 &\quad - P(E_2 \cap E_3) - P(E_1 \cap E_3) + P(E_1 \cap E_2 \cap E_3)
 \end{aligned}$$

If  $E_1, E_2, E_3$  are mutually exclusive events then  $P(E_1 \cup E_2 \cup E_3) = P(E_1) + P(E_2) + P(E_3)$

46. (a)  **Idea** In this question, students should use the concept of parabola and quadratic equation we know that if  $ax^2 + bx + c = 0$  has equal roots then  $b^2 - 4ac = 0$

Given that parabola

$$y = (a-b)x^2 + (b-c)x + (c-a)$$

touches the  $x$ -axis.

Hence, solving the above equation and  $y = 0$

$$(x\text{-axis}) \Rightarrow (a-b)x^2 + (b-c)x + (c-a) = 0$$

Since,  $x$ -axis is a tangent.

$\therefore$  Above equation will have equal roots

$$\text{i.e., } D = 0$$

$$\Rightarrow (b-c)^2 - 4(a-b)(c-a) = 0$$

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

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

$$\Rightarrow (-2)a + b + c = 0$$

On comparing with  $ax + by + c = 0$ , we get  $x = -2$  and  $y = 1$


i.e.,  $ax + by + c = 0$  always passes through  $(-2, 1)$

**TEST Edge** Intersection of line and parabola condition of tangency related questions are asked to solve such type of questions, students are advised to understand the concept of parabola.

If the line  $y - \sqrt{3}x + 3 = 0$  cuts the parabola  $y^2 = x + 2$  at  $A$  and  $B$ , then  $PA - PB$  is equal to [where  $P = (\sqrt{3}, 0)$ ].

To solve this problem, students should use the concept of intersection of line and parabola and will

$$\text{get the answer i.e., } \frac{4(2+\sqrt{3})}{3}.$$

**47. (b)**  **Idea** To solve this problem, first of all find the point of intersection of given lines. Then get the direction ratios of plane. Now you will get the required equation of plane.

Let the point intersection be  $P$ .

$$\frac{x-1}{3} = \frac{y-2}{1} = \frac{z-3}{2} = \lambda \quad (\text{say})$$

$$\Rightarrow x = 3\lambda + 1, y = \lambda + 2, z = 2\lambda + 3$$

$$\therefore P(3\lambda + 1, \lambda + 2, 2\lambda + 3)$$

$P$  also satisfies 2nd equation

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

$$3\lambda - 2 = \frac{\lambda + 1}{2} = \frac{2\lambda + 1}{3}$$

$$\Rightarrow 6\lambda - 4 = \lambda + 1$$

$$\Rightarrow 5\lambda = 5$$

$$\Rightarrow \lambda = 1$$

Here, the point of intersection is  $P(4, 3, 5)$ .

For a plane to be at shortest distance from  $O(0, 0, 0)$ ,  $OP \perp$  plane.

Direction ratio of  $OP$  are  $4 - 0, 3 - 0, 5 - 0$

$$i.e., \quad 4, 3, 5$$

Equation of required plane

$$4(x - 4) + 3(y - 3) + 5(z - 5) = 0$$

$$4x + 3y + 5z - 16 - 9 - 25 = 0$$


$$4x + 3y + 5z = 50$$

**TEST Edge** Equation of a plane through a given line, angle between a line and plane and a line lie in a plane related questions are asked in JEE Advanced. To solve such type of questions students are advised to understand the concept of line and plane.

Find the equation of perpendicular from  $(3, -1, 11)$  to the line  $\frac{x}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ .

To solve this problem students should use the concept of a line and plane, and will get the answer

$$i.e., \quad \frac{x-3}{1} = \frac{y+1}{-6} = \frac{z-11}{4}$$

**48. (b)**  **Idea** This problem involved the concept of argument/amplitude of a complex number. To solve this problem, also use the concept of geometry of complex number.

We are given that

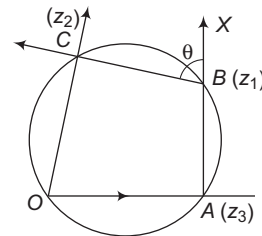
$$\frac{2}{z_1} = \frac{1}{z_2} + \frac{1}{z_3}$$

$$\frac{1}{z_1} - \frac{1}{z_2} = \frac{1}{z_3} - \frac{1}{z_1}$$

$$\Rightarrow \frac{z_2 - z_1}{z_1 z_2} = \frac{z_1 - z_3}{z_3 z_1}$$

$$\Rightarrow \frac{z_2 - z_1}{z_1 - z_3} = \frac{z_2 - 0}{z_3 - 0}$$

$$\Rightarrow \arg\left(\frac{z_2 - z_1}{z_1 - z_3}\right) = \arg\left(\frac{z_2 - 0}{z_3 - 0}\right)$$



$$\Rightarrow \angle COA = \theta \text{ and } \angle XBC = \theta$$


$$\Rightarrow \angle ABC = \pi - \theta$$

Since,  $\angle ABC + \angle COA = \pi$

$\therefore OABC$  is a cyclic quadrilateral.

Hence,  $O, A, B, C$  lie on a circle passing through origin.

**TEST Edge** Generally in JEE (Advanced) principal value of argument, properties of argument of complex number and concept of rotation based questions are asked. To solve such type of question students are advised to understand the concept of complex number. For e.g.,  $\arg(z_1 \bar{z}_2) = \arg(z_1) - \arg(z_2)$

**49. (c)**  **Idea** To solve this questions, students should use the concept of modules function apply the concept of greatest integer function, such as if  $y = f(x) = [x]$  is a greatest integer function if  $n \leq x < n + 1$  then  $[x] = n$

$$f(x) = \sin^{23} x - \cos^{22} x \Rightarrow f(x) \leq 1$$

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

$$|x| \geq 0$$

$$\Rightarrow \tan^{-1} |x| \geq 0$$

$$\text{Thus } g(x) \geq 1$$

$$\Rightarrow [g(x)] = 1, 2, \dots f(x) = [g(x)]$$

holds only when  $f(x) = 1$  and  $[g(x)] = 1$

$$\Rightarrow \left[1 + \frac{1}{2} \tan^{-1} |x|\right] = 1$$

$$\Rightarrow 1 + \left[\frac{1}{2} \tan^{-1} |x|\right] = 1$$

$$\left[\frac{1}{2} \tan^{-1} x\right] = 0$$

$$\Rightarrow -\tan 2 < x < \tan 2$$


$$\therefore x = \pi/2 \text{ if } x \in [0, 2\pi]$$

Number of real values of  $x$  in  $[-10\pi, 20\pi]$  satisfying the given equation is 15.

**TEST Edge** Generally in JEE Advanced rational function, fraction part and domain, range of the function related questions are asked.

To solve these type of questions students are advised to understand the concept of function and also acquainted yourself with the concept of domain and range of these function for e.g., the period of the functions

$\sin^n x, \cos^n x, \sec^n x, \operatorname{cosec}^n x$  is  $\pi$  (if  $n$  is an even) and  $2\pi$  (if  $n$  is odd)

50. (d)  **Idea** To solve this problem students should use the concept of AP. Then apply the concept of principal or general value of trigonometric functions.

It is given that  $3^{2 \sin 2x - 1}, 14, 3^{4 - 2 \sin 2x}$  are in AP.

So from  $2b = a + c$

$$\Rightarrow 28 = 3^{2 \sin 2x - 1} + 3^{4 - 2 \sin 2x}$$

$$28 = \frac{9^{\sin 2x}}{3} + \frac{81}{9^{\sin 2x}}$$

Let  $9^{\sin 2x} = t$

$$\Rightarrow \frac{t}{3} + \frac{81}{t} = 28$$

$$t^2 + 243 = 84t$$

$$t^2 - 84t + 243 = 0$$

$$t^2 - 81t - 3t + 243 = 0$$

$$\Rightarrow (t - 81)(t - 3) = 0$$

$$9^{\sin 2x} = 81 \text{ or } 9^{\sin 2x} = 3$$

$$9^{\sin 2x} = 9^2$$

or  $9^{\sin 2x} = 9^{1/2}$

So,  $\sin 2x = 2, \sin 2x = \frac{1}{2}$

(not possible)  $2x = \frac{\pi}{6}$

Now  $x = \frac{\pi}{12}$

Now, fifth term of AP =  $T_5$

$$T_5 = A + (5 - 1)d$$

$$\Rightarrow A = 3^{2 \sin 2x - 1}, d = 14 - 3^{2 \sin 2x - 1}$$

$$\Rightarrow T_5 = 3^{2 \sin 2x - 1} + 4(14 - 3^{2 \sin 2x - 1})$$

Now,  $\sin 2x = \frac{1}{2}$


$$\text{So, } T_5 = 3^{2\left(\frac{1}{2}\right) - 1} + 4\left(14 - 3^{2\left(\frac{1}{2}\right) - 1}\right)$$

$$= 3^{1-1} + 4[14 - 3^{1-1}]$$

$$= 1 + 4[14 - 1] = 1 + 4 \times 13$$

$$= 53$$

**TEST Edge** Sum of  $n$  terms of an AP and properties of AP, application of AP related questions are asked. To solve such type of questions students are advised to understand the concept of AP and also acquainted yourself with the principal/general value of trigonometric function. Such as if sum of  $n$  terms of any sequence is quadratic equation (expression) in  $n$  (i.e.,  $S_n = ax^2 + bx + c$ ), then the sequences is AP.

51. (b,d)  **Idea** To solve this question, students should apply the concept of continuity and differentiability of the function then use the Rolle's theorem.

Let us assume that

$$f(x) = \frac{ax^4}{4} + \frac{bx^3}{3} + \frac{cx^2}{2} + dx,$$

which is continuous and differentiable.

On substituting  $x = 0$ , we get

$$f(0) = 0$$

On substituting  $x = -1$ , we get

$$f(-1) = \frac{a}{4} - \frac{b}{3} + \frac{c}{2} - d$$

$$= \frac{1}{4}(a + 2c) - \frac{1}{3}(b + 3d) = 0$$

$$\therefore f(0) = f(-1)$$


Hence, according to Rolle's theorem, there exists at least one root of  $f(x) = 0$  in the interval  $(-1, 0)$ .

$\therefore$  Options (b) and (d) are correct.

**TEST Edge** Generally in JEE (Advanced) Application of quadratic equation, continuity and differentiability based questions are asked to solve these type of questions. Students are advised to understand the concept of quadratic equation and continuity of the function.

What values of  $m \in \mathbb{R}$ , both roots of the equation  $x^2 - 6mx + 9m^2 - 2m + 2 = 0$  exceed 3?

To solve this question student should use the concept of quadratic equation and will get the answer i.e.,  $m \in (1, \infty)$ .

52. (b,d)  **Idea** We know that for the general equation of second degree  
i.e.,  $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$   
if  $h^2 = ab$  then given conic is a parabola.

Equation of the given conic is

$y^2 + 2ax + 2by + c = 0$ . On comparing with the general equation of second degree i.e.,

$$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0, \text{ we get}$$

$$a = 0, h = 0, b = 1$$

$$g = a, f = b, c = c$$

$$\Delta = \begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c \end{vmatrix} = \begin{vmatrix} 0 & 0 & a \\ 0 & 1 & b \\ a & b & c \end{vmatrix} = -a^2$$

$\therefore \Delta \neq 0$

Also,  $h^2 - ab = 0 - 0 = 0$

$\therefore$  Then, given conic is a parabola.

Now,  $y^2 + 2ax + 2by + c = 0$

$$(y + b)^2 - b^2 = c - 2ax$$


$$\Rightarrow (y + b)^2 = -2a \left( x - \frac{b^2}{2a} + \frac{c}{2a} \right)$$

$\therefore$  Length of latus rectum is  $2a$ .

**TEST Edge** Recognition of conics, centre of conics, position of a point with respect to the parabola based question are asked. To solve these type of question students are advised to understand the concept of conic and also acquainted yourself with the concept of parabola.

Find the position of point  $(1, 4)$  with respect to the parabola  $y^2 + 9 - 6y = 5x$ .

To solve this problem, students should apply the concept of position of point with respect to parabola and will get the answer i.e., given point lies inside the curve.

**53. (c,d)**  **Idea** We know that if  $a_1, a_2, a_3, a_n, \dots$  are in GP then  $\frac{a_2}{a_1} = \frac{a_3}{a_2}$ . To solve this problem student should use the concept of GP.

Given relation is  $a_n = \frac{a_{n-1}^2}{a_{n-2}}$

$$\Rightarrow \frac{a_n}{a_{n-1}} = \frac{a_{n-1}}{a_{n-2}}$$

$\Rightarrow a_1, a_2, a_3, a_4, \dots$  are in GP

also  $a_1 = 2$

Let  $a_2 = x$

$$\frac{a_2}{a_1} = \frac{a_3}{a_2} \Rightarrow \frac{x}{2} = \frac{a_3}{x}$$

$$\Rightarrow a_3 = \frac{x^2}{2}$$

i.e., we have a GP as follow us

$$2, x, \frac{x^2}{2}, \frac{x^3}{4}, \frac{x^4}{8}, \dots$$

Given that  $\frac{x^4}{8} \leq 162$

$$\Rightarrow x^4 \leq 1296$$

$$\Rightarrow x \leq 6$$

Also  $x, \frac{x^4}{8}$  are positive inters.

$$\Rightarrow x \text{ must be even so as } \frac{x^4}{8} \text{ is integer.}$$

$\therefore$  Possible values of  $n$  are 4 and 6.


( $x \neq 2$  as all terms are distinct)

$\therefore$  Possible values of  $a_5 = \frac{x^4}{8}$  is  $\frac{4^4}{8}, \frac{6^4}{8}$

$$\Rightarrow \frac{4 \times 4 \times 4 \times 4}{8}, \frac{6 \times 6 \times 6 \times 6}{8}$$

$$32, 162$$

**TEST Edge** Generally in JEE Advanced, properties of GP and their application based questions are asked. To solve such type of question students are advised to understand the concept of GP such as  $(2m + 1)$  number in GP can be written as  $(m \in N)$  i.e.,  $\frac{a}{r^m}, \frac{a}{r^{m-1}}, \dots, \frac{a}{r}, ar, \dots, ar^{m-1}, ar^m$ .

**54. (a,b)**  **Idea** To solve this problem, students should use the concept of trigonometric function then apply the concept of AP

$$\cos(A - C) \cos B + \cos 2B = 0$$

$$\cos(A - C) \cos [180^\circ - (A + C)] + 1 - 2 \sin^2 B = 0$$

$$- \cos(A - C) \cos(A + C) + 1 - 2 \sin^2 B = 0$$

$$- \cos^2 A - \sin^2 C + 1 - 2 \sin^2 B = 0$$

$$-(1 - \sin^2 A) + \sin^2 C + 1 - 2 \sin^2 B = 0$$

$$\sin^2 A + \sin^2 C = 2 \sin^2 B$$

we know  $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} = k$  (say)

$$\therefore \sin A = ak, \sin B = bk, \sin C = ck$$

$$a^2 k^2 + c^2 k^2 = 2b^2 k^2$$


$$\Rightarrow a^2 + c^2 = 2b^2$$

$$\Rightarrow a^2, b^2, c^2 \text{ are in AP.}$$

**TEST Edge** Generally in JEE Advanced, properties of AP and GP and trigonometric functions based questions are asked. To solve such type of questions, students are advised to understand the concept of sequence and series and trigonometric function.

The sum  $S_n$  of the first  $n$  terms of GP is

$$S_n = \begin{cases} \frac{a(r^n - 1)}{r - 1} & \text{if } r \neq 1 \\ na & \text{if } r = 1 \end{cases}$$

**55. (a,b)**  **Idea** We know that if  $\mathbf{a}$  is a unit vector then  $|\mathbf{a}| = 1, \mathbf{a} \cdot \mathbf{b} = |\mathbf{a}| |\mathbf{b}| \cos \theta$ . To solve this problem, student should apply the concept of dot product of vectors.

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

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

Given,  $\mathbf{b} - 2\mathbf{c} = \lambda \mathbf{a}$


Taking dot product with  $\mathbf{a}, \mathbf{b}$  and  $\mathbf{c}$ , we get

$$\mathbf{a} \cdot \mathbf{b} - 2\mathbf{a} \cdot \mathbf{c} = \lambda |\mathbf{a}|^2$$

$$\begin{aligned} \mathbf{a} \cdot \mathbf{b} - \frac{1}{2} &= \lambda && \dots(\text{ii}) \\ \Rightarrow \mathbf{a} \cdot \mathbf{b} &= \lambda + \frac{1}{2} \\ \text{By } \mathbf{b} \cdot \mathbf{c} - 2|\mathbf{c}|^2 &= \lambda \mathbf{a} \cdot \mathbf{c} \\ \mathbf{b} \cdot \mathbf{c} - 2 &= \lambda \frac{1}{4} && \dots(\text{iii}) \\ \mathbf{b} \cdot \mathbf{c} &= 2 + \lambda \frac{1}{4} \\ (\mathbf{b} - 2\mathbf{c}) \cdot \mathbf{b} &= \lambda \mathbf{a} \cdot \mathbf{b} \\ |\mathbf{b}|^2 - 2\mathbf{b} \cdot \mathbf{c} &= \lambda \left( \lambda + \frac{1}{2} \right) [\because |\mathbf{b}| = 4] && \dots(\text{iv}) \\ 16 - 2 \left( 2 + \frac{\lambda}{4} \right) &= \lambda \left( \lambda + \frac{1}{2} \right) \quad [\text{from Eqs. (ii), (iii), (iv)}] \\ 16 - 4 - \frac{\lambda}{2} &= \lambda^2 + \frac{1}{2}\lambda \\ \lambda^2 + \lambda - 12 &= 0 \\ (\lambda + 4)(\lambda - 3) &= 0 \\ \lambda &= -4, +3 \end{aligned}$$

**TEST Edge** Generally in JEE Advanced, cross product and dot product of vectors and their geometrical application based questions are asked. To solve such type of questions students are advised to understand the concept of product of two vectors.

Let  $\mathbf{r}$  be a unit vector satisfying  $\mathbf{r} \times \mathbf{a} = \mathbf{b}$ , where  $|\mathbf{a}| = \sqrt{3}$  and  $|\mathbf{b}| = \sqrt{2}$ , then find the relation between  $\mathbf{a}$ ,  $\mathbf{b}$  and  $\mathbf{r}$ . To solve this problem, student should apply the concept of dot and cross product of vectors and will get the answer i.e.,  $\mathbf{r} = \frac{1}{3}(\mathbf{a} \times \mathbf{b} \pm \mathbf{a})$ .

**56. (4)**  **Idea** To solve it use the concept of increasing function and maximum/minimum value of a function.

Domain of  $f(x)$  is  $[-1, 1]$

$$\begin{aligned} f(x) &= \sin^{-1} x + 2 \tan^{-1} x + x^2 + 4x + 1 \\ f'(x) &= \frac{1}{\sqrt{1-x^2}} + \frac{2}{1+x^2} + 2x + 4 \\ &= \frac{1}{\sqrt{1-x^2}} + \frac{2}{1+x^2} + 2(x+2) \end{aligned}$$

$$\forall x \in [-1, 1], f'(x) > 0$$

$\therefore f(x)$  is increasing function.

$\therefore p =$  minimum value of  $f(x)$

$$\begin{aligned} &= \sin^{-1}(-1) + 2 \tan^{-1}(-1) + (-1)^2 + 4(-1) + 1 \\ &= -\frac{\pi}{2} + 2 \left( -\frac{\pi}{4} \right) - 2 \\ &= -\frac{\pi}{2} - \frac{\pi}{2} - 2 \\ &= -\pi - 2 \end{aligned}$$


$$\begin{aligned} \text{and } q &= \text{maximum value of } f(x) \\ &= \sin^{-1}(1) + 2 \tan^{-1}(1) + 1 + 4 + 1 \\ &= \frac{\pi}{2} + 2 \left( \frac{\pi}{4} \right) + 6 \\ &= \pi + 6 \end{aligned}$$

$\therefore$  So, range of  $f(x)$  is  $[-\pi - 2, \pi + 6]$

$$\therefore p + q = \pi + 6 - \pi - 2 = 4$$

**TEST Edge** Range and domain of algebraic, and exponential function related questions are asked. To solve such type of questions students are advised to understand the concept of range and domain of the function. The domain of definition of the function  $f(x) = \sqrt{\log_{(|x|-1)}(x^2 + 4x + 4)}$

To solve it use the concept of greatest integer function, and will get the answer i.e.,  $(-\infty, -3] \cup (-2, -1) \cup (2, \infty)$ .

**57. (7)**  **Idea** To solve this problem, students first find the equation of plane passing through the line of intersection. Now use the condition of rotation of plane.

Equation of plane passing through their line of intersection is

$$\begin{aligned} (4x + 7y + 4z + 81) + \lambda(5x + 3y + 10z - 25) &= 0 \\ \Rightarrow (4 + 5\lambda)x + (7 + 3\lambda)y + (4 + 10\lambda)z &+ 81 - 25\lambda = 0 \end{aligned}$$

$$\text{Plane (i) is } \perp \text{ to } 4x + 7y + 4z + 81 = 0 \quad \dots(\text{i})$$

$$\therefore 4(4 + 5\lambda) + 7(7 + 3\lambda) + 4(4 + 10\lambda) = 0$$

$$\therefore \lambda = 1$$

Hence, equation of plane is

$$-x + 4y - 6z + 106 = 0$$

Distance from origin  $(0, 0, 0)$  is

$$\begin{aligned} \frac{106}{\sqrt{1+16+36}} &= \frac{106}{\sqrt{53}} \\ &= \frac{106 \times \sqrt{53}}{53} \end{aligned}$$

$$\therefore \left[ \frac{K}{2} \right] = \left[ \frac{\sqrt{53}(2)}{2} \right] = [\sqrt{53}] = 7$$

**TEST Edge** Equation of plane in various form and distance from a point to the plane related questions are asked to solve such type of questions. Students are advised to understand the concept of plane.

Find the distance of the point  $(2, -1, 3)$  from the plane  $x - 2y + 3z - 3 = 0$  measured parallel to the line  $\frac{x}{1} = \frac{y}{2} = \frac{z-1}{3}$ .

To solve this problem use the concept of plane and line and will get the answer i.e.,  $\frac{5\sqrt{14}}{3}$  unit.

58. (1) **Idea**

$\because \int_a^b f(x) dx = \int_a^c f(x) dx + \int_c^b f(x) dx$   
 and  $\int_0^\pi f(x) dx = \int_0^\pi f(t) dt$  use these properties  
 of definite integration to solve the problem.

Putting  $t = \frac{1}{v}$  in first integration then  $dt = -\frac{1}{v^2} dv$

$$\Rightarrow \int_e^{\cot x} \frac{\frac{1}{v} \left(-\frac{1}{v^2}\right) dv}{1 + \frac{1}{v^2}} + \int_{1/e}^{\cot x} \frac{dt}{t(1+t^2)}$$

$$- \int_e^{\cot x} \frac{dv}{v(1+v^2)} + \int_{1/e}^{\cot x} \frac{dt}{t(1+t^2)}$$

$$- \int_e^{\cot x} \frac{dv}{v(1+v^2)} + \int_{1/e}^{\cot x} \frac{dv}{v(1+v^2)}$$

$$\int_{\cot x}^e \frac{dv}{v(1+v^2)} + \int_{1/e}^{\cot x} \frac{dv}{v(1+v^2)}$$

$$\Rightarrow \int_{1/e}^e \frac{dv}{v(1+v^2)}$$

$$\Rightarrow \int_{1/e}^e \left( \frac{1}{v} - \frac{v}{1+v^2} \right) dv$$

(by using partial fraction)

$$\Rightarrow \left[ \ln v - \frac{1}{2} \ln(1+v^2) \right]_{1/e}^e$$

$$\Rightarrow 2 - \frac{1}{2} \ln e^2$$

$$\Rightarrow 2 - 1 = 1$$

**TEST Edge** Generally in JEE (Advanced) definite integration of different type of functions related question are asked to solved these type of question. Students are advised to understand the concept of definite integration.

Such as if  $g$  is continuous on  $[a, b]$  and  $f_1(x)$  and  $f_2(x)$  are differentiable functions whose value lie in  $[a, b]$ , then

$$\frac{d}{dx} \int_{f_1(x)}^{f_2(x)} g(t) dt = g(f_2(x)) f_2'(x) - g(f_1(x)) f_1'(x).$$

59. (7) **Idea** To solve this problem find the tangent of the given hyperbola, then use the concept of quadratic equation such as  $ax^2 + bx + c = 0$  has roots  $\alpha$  and  $\beta$  then  $\alpha\beta = \frac{c}{a}$ .

Given hyperbola is  $3x^2 - 2y^2 = 6$  or  $\frac{x^2}{2} - \frac{y^2}{3} = 1$

Tangent from the point  $(\alpha, \beta)$

$$y = mx \pm \sqrt{a^2 m^2 - b^2}$$

or  $(y - mx)^2 = a^2 m^2 - b^2$

or  $(\beta - m\alpha)^2 = 2m^2 - 3$

$$\Rightarrow m^2 (\alpha^2 - 2) - 2\alpha\beta m + \beta^2 + 3 = 0$$

$$m_1 m_2 = \frac{\beta^2 + 3}{\alpha^2 - 2} = 2 = \tan \theta \tan \phi$$

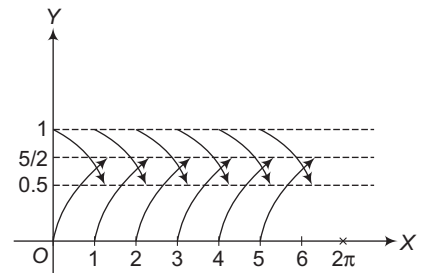
$$\therefore \beta^2 + 3 = 2\alpha^2 - 4$$

$$\Rightarrow 7 = 2\alpha^2 - \beta^2$$

**TEST Edge** Normal to hyperbola, position of a point with respect to the hyperbola related question are asked. To solve such type of question students are advised to understand the concept of hyperbola. Such as the straight line  $y = mx + c$  is a tangent to the curve then  $c^2 = a^2 m^2 - b^2$ .

60. (6) **Idea** To solve this problem, draw the graph of  $y = \sin\{x\}$  and  $y = \cos\{x\}$ , and get the points of intersections.

The graph of  $y = \sin\{x\}$  and  $y = \cos\{x\}$  are shown below



Points of intersection are

$$x = 1, 1 + \frac{\pi}{4}, 2 + \frac{\pi}{4}, 3 + \frac{\pi}{4}, 4 + \frac{\pi}{4}, 5 + \frac{\pi}{4}$$

i.e., numbers of solutions are 6.

**TEST Edge** Generally in JEE (Advanced) greatest integer function, rational function, absolute value function related questions are asked.

If  $f(x) = \log_{[x-1]} \frac{|x|}{x}$  where  $[ \cdot ]$  denotes greatest integer function then find the domain of  $f(x)$ ?

To solve this problem, use the concept of range and domain and will get the answer i.e.,  $[3, \infty)$ .