| Advanced Problem Package | Colligative Properties of Solutions |
|---|---|

## SINGLE CORRECT ANSWER TYPE

**Each of the following Question has 4 choices A, B, C & D, out of which ONLY ONE Choice is Correct.**

**1.** An azeotropic solution of two liquids has boiling point lower than either of them when it:
**(A)** Shows negative deviation from the Raoult's law
**(B)** Shows no deviation from the Raoult's law
**(C)** Shows positive deviation from the Raoult's law
**(D)** Is saturated

**2.** Which of the following 0.1 M aqueous solutions will have the lowest freezing point?
**(A)** $K_2SO_4$ **(B)** NaCl **(C)** Glucose **(D)** Urea

**3.** When mercury (II) iodide is added is added to an aqueous solution of potassium iodide, the:
**(A)** Freezing point is lowered **(B)** Freezing point is raised
**(C)** Freezing point does not change **(D)** Boiling point does not change

**4.** The vapour pressure of a solution of 5 g of non-electrolyte in 100 g of water at a particular temperature is $2985\,N/m^2$. The vapour pressure of water is $3000\,N/m^2$. The molecular mass of the solute is:
**(A)** 60 **(B)** 120 **(C)** 180 **(D)** 380

**5.** Increasing in temperature of an aqueous solution will cause:
**(A)** Decrease in molality **(B)** Decrease in molarity
**(C)** Decrease in mole fraction **(D)** Decrease in % W/W

**6.** A 0.2 molal aqueous solution of a weak acid (HX) is 20% ionised. The freezing point of the solution is:
**(A)** $-0.45°C$ **(B)** $0.90°C$ **(C)** $-0.31°C$ **(D)** $-0.53°C$

**7.** During depression of freezing point in a solution, the following are in equilibrium:
**(A)** Liquid solvent, solid solvent **(B)** Liquid solvent, solid solute
**(C)** Liquid solute, solid solute **(D)** Liquid solute, solid solvent

**8.** 0.004 M $Na_2SO_4$ is isotonic with 0.01 M glucose. Degree of dissociation of $Na_2SO_4$ is:
**(A)** 75% **(B)** 50% **(C)** 25% **(D)** 85%

**9.** The van't Hoff factor of 0.1 M $Ba(NO_3)_2$ solution is 2.74. The degree of dissociation is:
**(A)** 91.3% **(B)** 87% **(C)** 100% **(D)** 74%

**10.** When 20 g of naphthoic acid $(C_{11}H_8O_2)$ is dissolved in 50 g of benzene ($K_f = 1.72\,K\,kg,\,mol^{-1}$), a freezing point depression of 2K is observed. The van't Hoff factor (i) is:
**(A)** 0.5 **(B)** 1 **(C)** 2 **(D)** 3

**11.** 0.5 M aqueous solution of glucose is isotonic with:
**(A)** $0.5\,M$ KCl solution **(B)** $0.5\,M$ $CaCl_2$ solution
**(C)** $0.5\,M$ urea solution **(D)** $1M$ solution of sucrose

**12.** The degree of ionization ($\alpha$) of a weak electrolyte $A_xB_y$ is related to van't Hoff factor by expression:

**(A)** $\alpha = \frac{i-1}{x+y+1}$ **(B)** $\alpha = \frac{i-1}{x+y-1}$ **(C)** $\alpha = \frac{x+y-1}{i-1}$ **(D)** $\alpha = \frac{x+y+1}{i-1}$

**13.** The relationship between osmotic pressure at 273 K when 10 g of glucose $(P_1)$; 10 g of urea $(P_2)$ and 10 g of sucrose($P_3$) are dissolved in 250 mL of water is:

**(A)** $P_1 > P_2 > P_3$ **(B)** $P_3 > P_1 > P_2$ **(C)** $P_2 > P_1 > P_3$ **(D)** $P_2 > P_3 > P_1$

**14.** When acetone and Chloroform are mixed together, H-bonding takes place between them. Such a liquid pair shows:

**(A)** +ve deviation from Raoult's law **(B)** −ve deviation from Raoult's law

**(C)** No deviation from Raoult's law **(D)** Slight increase in volume

**15.** Compound $PdCl_4 \cdot 6H_2O$ is a hydrated complex. 1 molal aqueous solution of it has freezing point 269.28 k. Assuming 100% ionization of complex, calculate the molecular formula of the complex ($k_f$ for water $= 1.86$ k kg $mol^{-1}$):

**(A)** $[Pd(H_2O)_6]Cl_4$ **(B)** $[Pd(H_2O)_4Cl_2]Cl_2 \cdot H_2O$

**(C)** $[Pd(H_2O)_3Cl_3]Cl \cdot 3H_2O$ **(D)** $[Pd(H_2O)_2Cl_4] \cdot 4H_2O$

**16.** The mass of glucose that should be dissolved in 100 g of water and in order to produce same lowering of vapour pressures as is produced by 1 g of urea (mol. mass = 60) on 50 g of water is

**(A)** 1g **(B)** 2g **(C)** 6g **(D)** 12g

**17.** 50 g of antifreeze (ethylene glycol) is added to 200 g water. What amount of ice will separate out at $-9.3°C$? $(K_f = 1.86)$

**(A)** 42 mg **(B)** 42 g **(C)** 38.71 g **(D)** 38.71 mg

**18.** Which of the following graphs represent the behaviour of ideal binary liquid mixture?

**(A)** Plot of $1/P_{Total}$ against $y_A$ is linear **(B)** Plot of $1/P_{Total}$ against $y_B$ is non-linear

**(C)** Plot of $P_{Total}$ against $y_A$ is linear **(D)** Plot of $P_{Total}$ against $y_B$ is linear

(Here, $y_A$ and $y_B$ are the mole fraction of components A and B in vapour).

**19.** Which of the following solution will have the lowest freezing point depression?

**(A)** 0.2 M urea and 0.2 M glucose **(B)** 0.1 M $Al_2(SO_4)_3$ and 0.1 M $Na_2SO_4$

**(C)** 0.1 M $KNO_3$ and 0.2 M $Ba(NO_3)_2$ **(D)** 0.1 M $Ca(NO_3)_2$ and 0.1 M $Ba(NO_3)_2$

**20.** Mixture of volatile components A and B has total vapour pressure (in torr): $P = 254 - 119X_A$

Where, $X_A$ is mole fraction of A in mixture, Hence, $P_A^0$ and $P_B^0$ are (in torr) :

**(A)** 254, 119 **(B)** 119, 254 **(C)** 135, 254 **(D)** 154, 119

**21.** A compound $MX_2$ has observed and normal molar masses 65.6 and 164 respectively. Calculate the apparent degree of ionization of $MX_2$ :

**(A)** 75% **(B)** 85% **(C)** 65% **(D)** 25%

**22.** Total vapour pressure of mixture of 1 mol A ($P_A^0 = 150$ torr) and 2 mol B ($P_B^0 = 240$ torr) is 200 torr. In this case :

**(A)** There is positive deviation from Raoult's law

**(B)** There is negative deviation from the Raoult's law

**(C)** There is no deviation from Raoult's law

**(D)** Molecular masses of A and B are also required from calculating the deviation

**23.** If liquids A and B form an ideal solution:

**(A)** The free energy of mixing is zero **(B)** The free energy as well as entropy of mixing are zero

**(C)** Enthalpy of mixing is zero **(D)** The entropy of mixing is zero

**24.** Which statement about the composition of vapour over an ideal 1 : 1 molar mixture of benzene and toluene is correct? Assume the temperature is constant at 25°C.

**Vapour pressure data (25°C):**

Benzene 75 mm Hg

Toluene 22 mm Hg

**(A)** The vapour will contain higher percentage of benzene

**(B)** The vapour will contain higher percentage of toluene

**(C)** The vapour will contain equal amount of benzene and toluene

**(D)** Not enough information is given to make a prediction

**25.** A solution containing 0.1 g of a non-volatile organic substance P(molecular mass 100) in 100 g of benzene raises the boiling point of benzene by $0.2°C$, while a solution containing 0.1 g of another non-volatile substance Q in the same amount of benzene raises the boiling point of benzene by $0.4°C$. What is the ratio of molecular masses of P and Q?

**(A)** 1:2 **(B)** 2:1 **(C)** 1:4 **(D)** 4:1

**26.** Consider 0.1 M solution of two solutes X and Y. The solute X behaves as an univalent electrolyte while the solute Y dimerises in solution. Which of the following statements are correct regarding these solutions?

**1.** The boiling point of solution of X will be higher than that of Y

**2.** The osmotic pressure of solution of Y will be lower than that of X

**3** The freezing point of the solution of X will be lower than that of Y

**4.** The relative lowering of vapour pressure of both the solutions will be the same

Select the correct answer from the codes given below:

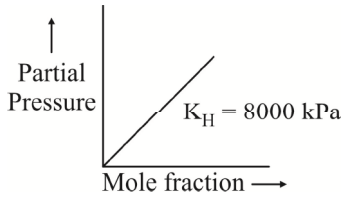
**(A)** 1, 2, 3 **(B)** 2, 3, 4 **(C)** 1, 2, 4 **(D)** 1, 3, 4

**27.** At 300 K, solubility of a gas in a liquid was measured at different partial pressure.

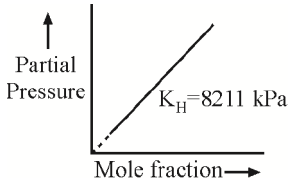
| **Mole fraction of Gas** | 0.010 | 0.015 | 0.020 |
|---|---|---|---|
| **Partial pressure of Gas (kPa)** | 82 | 122 | 166 |

Which of the following graph is correct in accordance with the Henry's law?

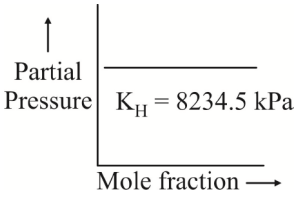
**(A)**



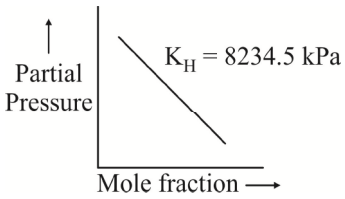

**(B)**



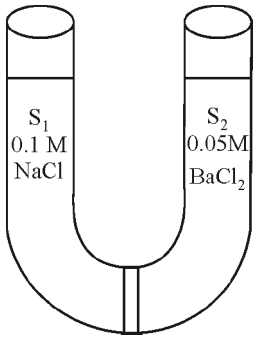

**(C)**




**(D)**



**28.** Two solutions $S_1$ and $S_2$ containing 0.1 M NaCl(aq) and 0.05 M $BaCl_2$ (aq) are separated by semipermeable membrane. Which among the following statement(s) is/are correct? (Assume complete dissociation of both the electrolytes).




**(A)** $S_1$ and $S_2$ are isotonic

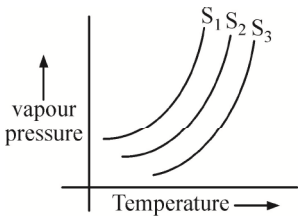
**(B)** $S_1$ is hypertonic while $S_2$ is hypotonic

**(C)** $S_1$ is hypotonic while $S_2$ is hypertonic

**(D)** Osmosis will take place from $S_1$ to $S_2$

**29.** The vapour pressure of three aqueous solutions $S_1$, $S_2$ and $S_3$ of same solute at different concentration are plotted against temperature in Kelvin.

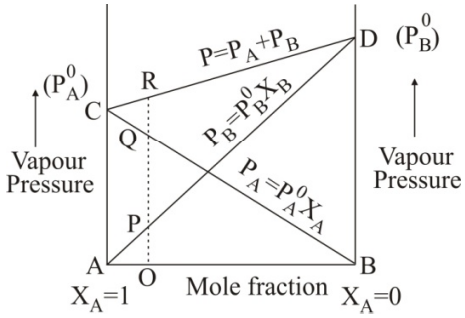
The concentrations of these solution will be in the order :




**(A)** $S_1 = S_2 = S_3$ **(B)** $S_1 < S_2 < S_3$

**(C)** $S_3 < S_2 < S_1$ **(D)** $S_1 < S_3 < S_2$

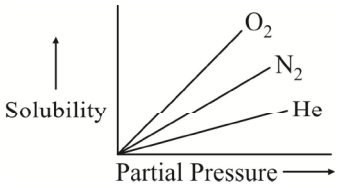
**30.** Two volatile liquids A and B form ideal solution. Considering the following vapour-pressure composition graph




OR will be equal to :

**(A)** $OP + OQ$ **(B)** $OP + PR$ **(C)** $OQ + QR$ **(D)** $OQ + PQ$

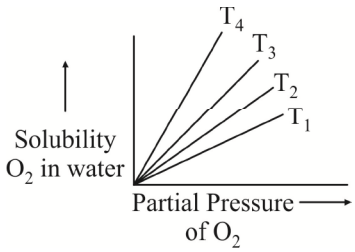
**31.** Molar solubility of helium, nitrogen and oxygen are plotted against partial pressure of the gas at constant temperature. Henry's law constant for these gases will lie in following sequence?




**(A)** $O_2 > N_2 > He$ **(B)** $O_2 < N_2 < He$

**(C)** $O_2 = N_2 = He$ **(D)** $O_2 > N_2 < He$

**32.** Solubility of oxygen gas in water follows Henry's law. When the solubility is plotted against partial pressure at a definite temperature we get following plots. Which of the following sequence of temperatures is correct?




**(A)** $T_1 = T_2 = T_3 = T_4$ **(B)** $T_1 > T_2 > T_3 > T_4$

**(C)** $T_1 < T_2 < T_3 < T_4$ **(D)** $T_1 > T_2 < T_3 > T_4$

## Paragraph for Questions 33 - 36

The colligative properties of electrolytes require a slightly different approach that the one used for the colligative properties of non-electrolytes. The electrolytes dissociate into ions in a solution. It is the number of solute particles that determines the colligative properties of a solution. The electrolyte solutions, therefore, show abnormal colligative properties. To account for this effect we define a quantity called the van't Hoff factor, given by

$$i = \frac{\text{Actual number of particles in solution after dissociation}}{\text{Number of formula units initially dissolved in solution}}$$

i = 1 (for non-electrolytes);
i > 1 (for electrolytes, undergoing dissociation)
i < 1(for solutes, undergoing association).

**33.** Benzoic acid undergoes dimerisation in benzene solution. The van't Hoff factor 'i' is related to the degree of association $'\alpha'$ of the acid as:

**(A)** $i = 1 - \alpha$ **(B)** $i = 1 + \alpha$ **(C)** $i = 1 - \frac{\alpha}{2}$ **(D)** $i = 1 + \frac{\alpha}{2}$

**34.** A substance trimerises when dissolved in a solvent A. the van't Hoff factor 'i' for the solution is:

**(A)** 1 **(B)** $1/3$ **(C)** 3 **(D)** Unpredictable

**35.** For a solution of non-electrolyte in water, the van't Hoff factor is:

**(A)** Always equal to 0 **(B)** $\leq 1$
**(C)** Always equal to 1 **(D)** $> 1 \text{ but } < 2$

**36.** 0.1 M $K_4\left[Fe(CN)_6\right]$ is 60% ionized. What will be its van't Hoff factor?

**(A)** 1.4 **(B)** 2.4 **(C)** 3.4 **(D)** 4.4

## Paragraph for Questions 37 - 40

The boiling point elevation and the freezing point depression of solutions have a number of practical applications. Ethylene glycol $(CH_2OH \cdot CH_2OH)$ is used in automobile radiators as an antifreeze because it lowers the freezing point of the coolant. The same substance also helps to prevent the radiator coolant from boiling away by elevating the boiling point. Ethylene glycol has low vapour pressure. We can also use glycerol as antifreeze. For boiling point elevation to occur, the solute must be non-volatile, but no such restriction applies to freezing point depression. For example, methanol $(CH_3OH)$, a fairly volatile liquid that boils only at 65°C is sometimes used as antifreeze in automobile radiators.

**37.** Which of the following is a better reagent for depression in freezing point but not for elevation in boiling point?

**(A)** $CH_3OH$ **(B)** $\begin{matrix} CH_2OH \\ | \\ CH_2OH \end{matrix}$ **(C)** $\begin{matrix} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \end{matrix}$ **(D)** $C_6H_{12}O_6$

**38.** 124 g each of the two reagents glycol and glycerol are added in 5 kg water of the radiators in the two cars. Which of the following statements is wrong?

**(A)** Both will act as antifreeze
**(B)** Glycol will be better
**(C)** Glycerol is better because its molar mass is greater than glycol
**(D)** Glycol is more volatile than glycerol

**39.** 620 g glycol is added to 4 kg water in the radiator of a car. What amount of ice will separate out at –6°C ? $K_f = 1.86\,K\,kg\,mol^{-1}$ :

**(A)** 800 g **(B)** 900 g **(C)** 600 g **(D)** 1000 g

**40.** If cost of glycerol, glycol and methanol are same, then the sequence of economy to use these compounds as antifreeze will be:

**(A)** glycerol > glycol > methanol **(B)** methanol > glycol > glycerol

**(C)** methanol = glycol = glycerol **(D)** methanol > glycol < glycerol

## MULTIPLE CORRECT ANSWERS TYPE

**Each of the following Question has 4 choices A, B, C & D, out of which ONE or MORE Choices may be Correct:**

**41.** For accurate measurement of molecular mass of solute using colligative properties:

**(A)** Solution must be very dilute **(B)** Solute should not dissociate or associate

**(C)** Solute should be non-volatile **(D)** Solute and solvent should react with each other

**42.** Which of the following statements is/are correct about azeotropic mixture?

**(A)** Azeotropic mixture are non-ideal solutions

**(B)** The components of azeotropic mixture cannot be separated by fractional distillation

**(C)** Azeotropes obey Raoult's law

**(D)** Solutions with positive deviation from Raoult's law, forms minimum boiling azeotrope

**43.** Solution of two liquids A and B showing negative deviation from Raoult's law, will show :

**(A)** $\Delta H_{mix} < 0$ **(B)** $\Delta V_{mix} < 0$ **(C)** $P < P_A^0 X_A + P_B^0 X_B$ **(D)** $\Delta S_{mix} < 0$

**44.** Which of the following solutions exhibit positive deviation from Raoult's law?

**(A)** $H_2O + C_2H_5OH$ **(B)** $C_6H_6 + C_2H_5OH$

**(C)** $H_2O + HCl$ **(D)** $CHCl_3 + (CH_3)_2\,CO$

## MATRIX MATCH TYPE

**Given question contains statements given in two columns, which have to be matched. Statements in Column 1 are labelled as (A), (B), (C) & (D) whereas statements in Column 2 are labelled as p, q, r, s & t. More than one choice from Column 2 can be matched with Column 1.**

**45.** Match the Column-1 with Column-2 :

| Column-1 | | Column-2 | |
|---|---|---|---|
| **(A)** | Elevation in boiling point | **(p)** | Used in molecular mass determination of Polymers |
| **(B)** | Depression in freezing point | **(q)** | Proportional to the molality of solution |
| **(C)** | Osmotic pressure | **(r)** | Colligative property |
| **(D)** | Vapour pressure of a liquid | **(s)** | Depends on the intermolecular force |

## Numerical Value Type Questions

**The Answer to the following questions can be positive or negative integers of 1/2/3 digits, 0 and decimal numerical value.**

**46.** The vapour pressure of pure benzene at a certain temperature is $640\,mm\,Hg$. A non-volatile, non-electrolyte solid weighing 2.175 g is added to 39.0 g of benzene (to form an ideal solution). The vapour pressure of the solution is $600\,mm\,Hg$. What is the molecular weight of the solid substance ?

**47.** The vapour pressure of pure water at 37°C is 47.1 torr. What is the vapour pressure in torr of an aqueous solution at 37°C containing 20 g of glucose dissolved in 500 gm of water.

**48.** The vapour pressure of ethyl alcohol at 25°C is 59.2 torr. The vapour pressure of a solution of urea in ethyl alcohol is 51.3 torr. What is the molality of the solution?

**49.** An aqueous solution containing 1g of urea boils at 100.25°C. The aqueous solution containing 3g of glucose in the same volume will boil at (Molecular mass of urea and glucose are 60 and 180 respectively)_____°C.

**50.** A solution of sucrose (Molar mass = 342 g/mol) is prepared by dissolving $68.4\,g$ of it per litre of the solution, what is its osmotic pressure in atm ? $(R = 0.082\,lit.atm/mol-K)$ at $273K$

**51.** A solution has a $1:4$ mole ratio of pentane to hexane. The vapour pressure of the pure hydrocarbons at 20°C are $440\,mm\,Hg$ for pentane and $120\,mm\,Hg$ for hexane. The mole fraction of pentane in the vapour phase would be :

**52.** The boiling point elevation constant for benzene is 2.57°C/m. The boiling point of benzene is 80.1°C. Determine the boiling point of a solution formed when 5.0 gm of $C_{14}H_{12}$ is dissolved in 15 gm of benzene.

**53.** What mass of sugar, $C_{12}H_{22}O_{11}(M_0 = 342)$ must be dissolved in 4.0 kg of $H_2O$ to yield a solution that will freeze at $-3.72°C$. $(\text{Take } K_f = 1.86°C/m)$

**54.** The values of observed and calculated molecular weights of silver nitrate are 92.64 and 170 respectively. The percent dissociation of silver nitrate is_____.

**55.** Henry's constant of oxygen is $1.4\times10^{-3}\,mol\,L^{-1}\,atm^{-1}$ at 298 K. How much of oxygen (in mg) is dissolved in 100 mL at $298K$ when the partial pressure of oxygen is 0.5 atm ?

| Advanced Problem Package | Electrochemistry |
|---|---|

## SINGLE CORRECT ANSWER TYPE

**Each of the following Question has 4 choices A, B, C & D, out of which ONLY ONE Choice is Correct.**

**1.** The standard reduction potential values of $Cr^{3+}|Cr^{2+}$ and $Cr^{3+}|Cr$ half cells are –0.41 V and –0.74V respectively. The standard electrode potential of $Cr^{2+}|Cr$ half-cell is :

**(A)** +1.81 V . **(B)** –1.81V **(C)** +0.9 V. **(D)** – 0.9 V.

**2.** Beryllium occurs naturally in the form of beryl. The metal is produced from its ore by electrolysis after the ore has been converted to the oxide and then to the chloride. How many grams of Be(s) is deposited from a $BeCl_2$ solution by a current of 5.0 A that flows for 1.0 h? (Atomic weight: Be = 9)

**(A)** 0.840 **(B)** 1.68 **(C)** 1.42 **(D)** 1.08

**3.** The element indium is to be obtained by electrolysis of a molten halide of the element. Passage of a current of 3.20 A for a period of 40.0 min results in formation of 3.05 g of In. What is the oxidation state of indium in the halide melt? (Atomic weight : In = 114.8)

**(A)** 1 **(B)** 2 **(C)** 3 **(D)** 4

**4.** How may grams of Cr are deposited in the electrolysis of solution of $Cr(NO_3)_3$ in the same time that it takes to deposit 0.54 g of Ag in a silver coulometer arranged in series with the $Cr(NO_3)_3$ cell? (Atomic weight : Cr = 52.0; Ag = 108)

**(A)** 0.0866 **(B)** 0.0288 **(C)** 0.173 g **(D)** 0.220

**5.** When a solution of $AgNO_3$ (1 M) is electrolyzed using platinum anode and copper cathode. What are the reaction occurring at two electrodes?

Given : $E^o_{Cu^{2+}|Cu} = +0.34$ volt; $E^o_{O_2,H^+|H_2O} = +1.23$ volt; $E^o_{H^+|H_2} = +0.0$ volt;

$E^o_{Ag^+|Ag} = +0.8$volt

**(A)** $Cu \rightarrow Cu^{2+} + 2e^-$ at anode; $Ag^+ + e^- \longrightarrow Ag$ at cathode

**(B)** $H_2O \longrightarrow \frac{1}{2}O_2 + 2H^+ + 2e^-$ at anode; $Cu^{2+} + 2e^- \longrightarrow Cu$ at cathode

**(C)** $H_2O \longrightarrow \frac{1}{2}O_2 + 2H^+ + 2e^-$ at anode; $Ag^+ + e^- \longrightarrow Ag$ at cathode

**(D)** $e^- + 2H^+ + NO_3^- \rightarrow NO_2 + H_2O$ at anode; $Ag^+ + e^- \longrightarrow Ag$ at cathode

**6.** The E° at 25° C for the following reaction at the indicated concentrations is 1.50 V. Calculate the $\Delta G$ in kJ at 25° C for the given reaction: $Cr(s) + 3Ag^+(aq, 0.1M) \longrightarrow 3Ag(s) + Cr^{3+}(aq, 0.1M)$

**(A)** −140.94 **(B)** −295 **(C)** −212 **(D)** −422.96 kJ

**7.** Copper reduces $HNO_3$ into $NO_2$ depending upon concentration of $HNO_3$ in solution. Assuming $[Cu(NO_3)_2] = 0.1M$ and $P_{NO_2} = 10^{-3}$ bar, at which concentration of $HNO_3$, thermodynamic tendency for reduction of $HNO_3$ into $NO_2$ by copper is feasible?[Given $E^o_{Cu^{2+}|Cu} = +0.34$ volt, $E^o_{HNO_3|NO_2} = +0.79$ volt]

**(A)** $2.71\times10^{-5}$ M **(B)** $2.82\times10^{-6}$ M **(C)** $2\times10^{-7}$ M **(D)** $2.71\times10^{-8}$ M

**8.** Molar conductivity of a solution of an electrolyte $AB_3$ is 150 $Scm^2\ mol^{-1}$. If it ionisesas : $AB_3 \longrightarrow A^{3+} + 3B^-$, its equivalent conductivity will be :

**(A)** 150 (in $Scm^2\ eq^{-1}$) **(B)** 75 (in $Scm^2\ eq^{-1}$)

**(C)** 50 (in $Scm^2\ eq^{-1}$) **(D)** 80 (in $Scm^2\ eq^{-1}$)

**9.** A galvanic cell is composed of two hydrogen electrodes, of which cathode is a standard hydrogen electrode. In which of the following solutions, should the other electrode be immersed to get maximum e.m.f. ?

**(A)** 0.1 M HCl **(B)** 0.1 M $H_2SO_4$

**(C)** 0.1 M $HCO_2H$ **(D)** 0.01 M HCOOH

**10.** The EMF of the following cell is 0.265 V at 25ºC and 0.2595 V at 35ºC.

$$Pt(H_2)/HCl(aq) \| AgCl/Ag.$$

The heat of reaction taking place at 25ºC is

**(A)** – 90.8 kJ **(B)** – 80.8 kJ

**(C)** –82.76 kJ **(D)** –41.38 kJ

**11.** The electrolytic conductivity of a saturated solution of AgCl in water at 25ºC is $1.26\times10^{-6}\Omega^{-1}$ $cm^{-1}$greater than that for the water used. Calculate the solubility of AgCl in water if the molar ionic conductivities of $Ag^+$ and $Cl^- = 53.9\Omega^{-1}$ $cm^{-2}\,mol^{-1}$, and $72.1\Omega^{-1}cm^2mol^{-1}$ respectively.

**(A)** $0.95\times10^{-5}$ g/L **(B)** $1\times10^{-5}$mol/L

**(C)** $0.95\times10^{-2}$mol/L **(D)** $0.95\times10^{-2}$ g/L

**12.** Molar conductivities of AgCl, $BaSO_4$, $AlPO_4$ and $Ba_3(PO_4)_2$ are 200, 300, 500 and 700 S $cm^2\ mol^{-1}$. Which of the following solution has greater conducting ability?

**(A)** $Ba_3(PO_4)_2$ **(B)** $AlPO_4$ **(C)** $BaSO_4$ **(D)** AgCl

**13.** The molar conductivity of a weak acid (HA) at infinite dilution is 275 S $cm^2\ mol^{-1}$ and that of 0.1 M solution of HA is 5.5 S $cm^2\ mol^{-1}$ at 25ºC. What is the dissociation constant of HA at the given temperature?

**(A)** $1\times10^{-4}$ **(B)** $4.08\times10^{-4}$

**(C)** $4.08\times10^{-5}$ **(D)** $1\times10^{-5}$

**14.** Which of the following is(are) correct for a lead acid battery supplying electrical energy?

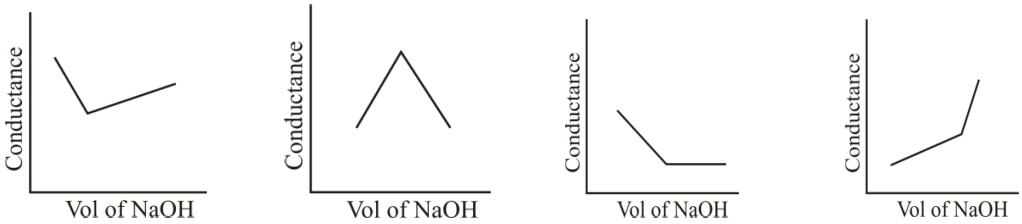
**(A)** $PbSO_4$ is formed at one electrode only

**(B)** $Pb + H_2SO_4 \rightarrow PbSO_4 + H_2$

**(C)** Weight of electrolyte decreases

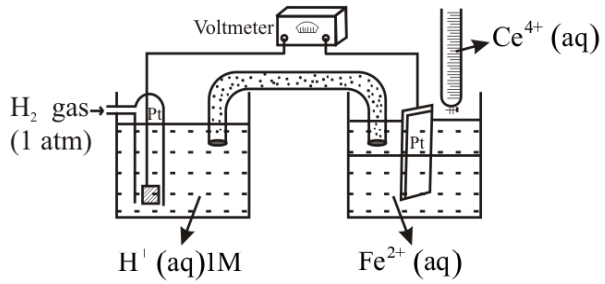
**(D)** $PbO_2$ accepts electrons only

**15.** $HNO_3$ (aq) is titrated with NaOH(aq) conductometrically, graphical representation of the titration is :




**(A)** **(B)** **(C)** **(D)**

**Paragraph for Questions16- 18**




The given electrochemical cell setup has standard hydrogen electrode as anode and $Fe^{3+}/Fe^{2+}$ half-cell as cathode. $Ce^{4+}$ (cerric) ion is added from the burette to beaker containing $Fe^{2+}$ ion, when following reaction occurs.

$$Fe^{2+}(aq) + Ce^{4+}(aq) \rightleftarrows Fe^{3+}(aq) + Ce^{3+}(aq)$$

With the addition of $Ce^{4+}$ ion, the half – cell potential changes, and is measured directly by the voltmeter. Given; $E^{o}_{Ce^{4+}/Ce^{3+}} = 1.64V$, $E^{o}_{Fe^{2+}/Fe^{3+}} = -0.80V$. The concentration of $Fe^{2+}$ solution is 0.1 M and its volume is 600 ml. The concentration of $Ce^{4+}$ solution added from burette is 0.1 M.

**16.** The potential of the cell after 1/3rd of the ferrous ion has been titrated will be :

**(A)** 1.64 V **(B)** 0.782 V **(C)** 1.522 V **(D)** 0.682 V

**17.** The potential of the cell at equivalence point in the titration of $Ce^{4+}$ and $Fe^{2+}$, will be :

**(A)** 1.22 V **(B)** 0.42 V **(C)** 1.64 V **(D)** 0.8 V

**18.** The equilibrium constant for the reaction in cathode half-cell is :

**(A)** $10^{1.68/0.059}$ **(B)** $10^{0.84/0.059}$ **(C)** $10^{1.64/0.059}$ **(D)** $10^{0.8/0.059}$

## MULTIPLE CORRECT ANSWERS TYPE

**Each of the following Question has 4 choices A, B, C & D, out of which ONE or MORE Choices may be Correct:**

**19.** If $Sn^{+2} + 2e^- \rightarrow Sn;\ E^o = -0.14V$

$Sn^{+4} + 2e^- \rightarrow Sn^{+2};\ E^o = -0.13V$

Then :

**(A)** $Sn^{+2}$ is unstable and disproportionates to $Sn^{+4}$ and Sn

**(B)** $Sn^{+2}$ is stable and disproportionation reaction is not spontaneous

**(C)** $Sn^{+4}$ is easily reduced to Sn in aqueous solution

**(D)** $Sn^{+4} + Sn \rightarrow 2Sn^{+2}$ is spontaneous

**20.**

| Electrolyte | KCl | $KNO_3$ | HCl | NaOAc | NaCl |
|---|---|---|---|---|---|
| $\Lambda_m^{\infty}\left(Scm^2mol^{-1}\right)$ | 149.9 | 145 | 426.2 | 91 | 126.5 |

Which of the following is/are correct?

**(A)** $\Lambda^{\infty}_{HOAc}$ is 517.2 **(B)** $\Lambda^{\infty}_{HNO_3}$ is 450

**(C)** $\Lambda^{\infty}_{AcOH}$ is 390.7 **(D)** $\Lambda^{\infty}_{HNO_3}$ is 421.3

**21.** Perdisulphuric acid ($H_2S_2O_8$) can be prepared by electrolytic oxidation of $H_2SO_4$ as :

$$2H_2SO_4 \rightarrow H_2S_2O_8 + 2H^+ + 2e^-$$

Which of the following statement(s) is(are) correct for this electrolysis?

**(A)** Oxygen and hydrogen gases are formed as other products at anode and cathode respectively.

**(B)** Concentrated $H_2SO_4$ solution can be used during this electrolysis to get $H_2S_2O_8$.

**(C)** Equivalents of $H_2S_2O_8$ formed is the difference between equivalents of $H_2$ and $O_2$ formed.

**(D)** Equivalents of $H_2S_2O_8$ formed is the sum of equivalents of $H_2$ and $O_2$ formed.

**22.** Which of the following cell reaction is spontaneous?

**(A)** $Pt \mid H_2(1\ atm) \mid HCl(0.01M) \parallel H_2SO_4(0.01M) \mid H_2(1\ atm) \mid Pt$

**(B)** $Pt \mid H_2(1\ atm) \mid HCl(0.1M) \parallel HCl(0.1M) \mid H_2(0.1\ atm) \mid Pt$

**(C)** $Ag \mid AgNO_3(0.01M) \parallel AgCl(saturated) \mid Ag \quad (K_{sp}\ of\ AgCl = 1\times10^{-10})$

**(D)** $Ag \mid AgBr(saturated) \parallel AgCl(saturated) \mid Ag \quad (K_{sp}\ of\ AgCl = 1\times10^{-10})$

$\left(K_{sp}\ of\ AgBr = 1\times10^{-13}\right)$

**23.** Which of the following represents correct relation(s)?

**(A)** $\Delta G = -nFE$ under non-standard conditions

**(B)** $\Delta G = -RT\ln K_{eq}$

**(C)** $\Delta G = \Delta G^o + RT\ln Q$

**(D)** $E^o_{Cl^-/AgCl/Ag} = E^o_{Ag^+/Ag} + \frac{RT}{F}\ln K_{Sp}(AgCl)$

**24.** When an aqueous solution of NaCl is electrolysed using Pt electrodes, the correct statement(s) is(are) :

**(A)** $H_2O$ is reduced at cathode to liberate $H_2$ gas

**(B)** $Na^+$ reduced at cathode.

**(C)** $Cl^-$ is oxidized at anode to liberate $Cl_2$ gas

**(D)** There is no change in pH of solution.

**25.** Which of the following is true about the given cell, Ag | Saturated AgCl || Saturated $Ag_2CrO_4$|Ag?

$\left(K_{sp}\ AgCl = 10^{-10}M^2\right) \quad \left(K_{sp}\ Ag_2CrO_4 = 3.2\times10^{-11}M^3\right)$

**(A)** It is an electrolyte concentration cell

**(B)** It is a non-spontaneous concentration cell.

**(C)** The net reaction is $Ag^+_c \longrightarrow Ag^+_A$

**(D)** The EMF of cell is 0.0944V

**26.** Consider the cell : $Ag \mid AgCl \mid KCl(0.1M) \mid Hg_2Cl_2 \mid Hg$, the cell potential :

**(A)** increases on increasing concentration of $Cl^-$ ions

**(B)** decreases on decreasing concentration of $Cl^-$ ions

**(C)** is independent of concentration of $Cl^-$ ions

**(D)** is independent of amounts of AgCl and $Hg_2Cl_2$

**27.** From the solution of an electrolyte, one mole of electron will deposit at cathode :

**(A)** 63.5g of Cu **(B)** 12 g of Mg **(C)** 11.5 g of Na **(D)** 9.0g of Al.

**28.** An aqueous solution containing 1M $NiSO_4$ and 1M $S_2O_8^{2-}$ is electrolysed using palladium electrodes at 25°C.

$Ni^{2+} + 2e^- \rightarrow Ni \quad E^\circ = -0.25V$

$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O \quad E^\circ = 1.23V$

$Pd^{2+} + 2e^- \rightarrow Pd \quad E^\circ = 0.92V$

$S_2O_8^{2-} + 2e^- \rightarrow 2SO_4^{2-} \quad E^\circ = 2.0V$

pH of solution is assumed as 7.

Select the correct statement(s) on the basis of above given information (Ignore over-voltage)

**(A)** Anode reaction : $Pd \rightarrow Pd^{2+} + 2e^-$ **(B)** Anode reaction : $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$

**(C)** Cathode reaction : $Ni^{2+} + 2e^- \rightarrow Ni$ **(D)** Cathode reaction : $2H^+ + 2e^- \rightarrow H_2$

**29.** Standard electrode potential data are useful for understanding the suitability of an oxidant in a redox reaction. Some half-cell reactions and their standard potential are given below:

$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l) \quad E^\circ = 1.5\ V$

$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l) \quad E^\circ = 1.38\ V$

$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq) \quad E^\circ = 0.77\ V$

$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq) \quad E^\circ = 1.40\ V$

Identify the correct statement(s) regarding the quantitative estimation of aqueous ferrous nitrate insolution.

**(A)** $MnO_4^-$ can be used in aqueous $H_2SO_4$ **(B)** $Cr_2O_7^{2-}$ can be used in aqueous $H_2SO_4$

**(C)** $MnO_4^-$ can be used in aqueous HCl **(D)** $Cr_2O_7^{2-}$ can be used in aqueous HCl

**30.** For the given half-cell, Ag | AgCl | $Cl^-$ (M)

The reaction is : $Ag(s) \rightarrow Ag^+(aq) + e^- - (i)$

$$Ag^+(aq) + Cl^-(aq) \rightleftharpoons AgCl(s) - (ii)$$

$$Ag(s) + Cl^-(aq) \rightarrow AgCl(s) + e^- - (iii)$$

Which of the following is(are) true about this half cell?

**(A)** $E^\circ$ of reaction (i) and $E^\circ$ of reaction (iii) are same

**(B)** E of reaction (ii) is zero

**(C)** E of reaction (i) is same as E of reaction (iii)

**(D)** Moles of AgCl precipitated is same as moles of Ag used

**31.** Which of the following statement(s) is/are correct with respect to given standard electrode potentials?

$E^\circ_{Cu^{2+}/Cu} = 0.34V$, $E^\circ_{Sn^{2+}/Sn} = -0.136V$ and $E^\circ_{H^+/H_2} = 0.0V$.

**(A)** $Cu^{2+}$ ions can be reduced by $H_2(g)$ **(B)** $Sn^{2+}$ ions can be reduced by $H_2(g)$

**(C)** Sn can be oxidized by $Cu^{2+}$ ions **(D)** Cu can be oxidized by $Sn^{2+}$ ions

**32.** Which of the following electrolytic arrangement(s) will produce oxygen at anode during electrolysis?

**(A)** Fused NaOH with inert electrodes **(B)** Dilute $H_2SO_4$ with Cu electrodes

**(C)** Dilute $H_2SO_4$ with Pt electrodes **(D)** Concentrated NaCl with Pt electrodes

**33.** Which of the following represents a redox half-cell?

**(A)** $Pt \mid Fe^{2+}(0.1M), Fe^{3+}(0.01M)$ **(B)** $Pt \mid H_2\ (1\ atm) \mid H^+\ (0.05M)$

**(C)** $Pt \mid Mn^{2+}(0.1M),\ MnO_4^-(0.1M), H^+(0.8M)$ **(D)** $Pt \mid Cr^{3+}(0.2M), Cr_2O_7^{2-}(0.1M), H^+(1.4M)$

**34.** Which of the following represents a feasible reaction?

**(A)** $F_2 + 2Br^- \longrightarrow Br_2 + 2F^-$ **(B)** $Cl_2 + 2Br^- \longrightarrow 2Cl^- + Br_2$

**(C)** $Br_2 + 2Cl^- \longrightarrow Cl_2 + 2Br^-$ **(D)** $Br_2 + 2I^- \longrightarrow I_2 + 2Br^-$

**35.** Which of the following is(are) true about lead storage battery?

**(A)** Concentration of $H_2SO_4$ decreases during discharging of lead storage battery.

**(B)** Amount of Pb increases during charging of lead storage battery.

**(C)** Lead storage battery in a car does not take ignition on a cold winter morning due to increase in viscosity of $H_2SO_4$.

**(D)** Moles of $PbSO_4$ formed during discharging is same as that of Pb used.

**36.** Which of the following represents a spontaneous electrolyte concentration cell?

**(A)** $Pt \mid H_2(0.1atm) \mid HCl(0.1M) \mid\mid H_2SO_4(0.05M) \mid H_2(0.05atm) \mid Pt$

**(B)** $Pt \mid H_2(0.1\ atm) \mid HCl(0.2M) \mid\mid H_2SO_4(0.1M) \mid H_2(0.2\ atm) \mid Pt$

**(C)** $Ag \mid \underset{K_{sp}=1\times10^{-13}}{AgBr} \mid Br^-(0.1M) \mid\mid Cl^-(0.1M) \mid \underset{K_{sp}=1\times10^{-10}}{AgCl} \mid Ag$

**(D)** $Zn \mid Zn^{2+}(0.2M) \mid\mid Zn^{2+}(0.1M) \mid Zn$

## MATRIX MATCH TYPE

**Each of the following question contains statements given in two columns, which have to be matched. Statements in Column 1 are labelled as (A), (B), (C) & (D) whereas statements in Column 2 are labeled as p, q, r, s & t. More than one choice from Column 2 can be matched with Column 1.**

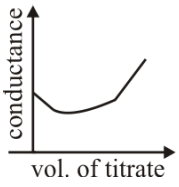
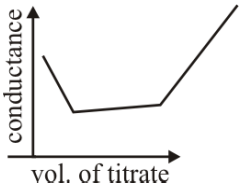
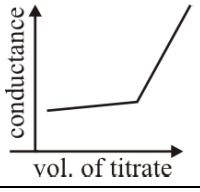
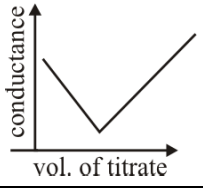
**37. MATCH THE FOLLOWING:**

| | **Column 1** | | **Column 2** |
|---|---|---|---|
| **(A)** | $Cu \mid Cu^{2+} \mid (c_1M) \mid\mid Cu^{2+}(c_2M) \mid Cu$ <br> $c_2 > c_1$ | **(p)** | Concentration cell |
| **(B)** | $Al \mid Al^{3+} \mid\mid Zn^{2+} \mid Zn$ | **(q)** | Gas-gas ion electrode |
| **(C)** | $Pt \mid O_2(P_1atm) \mid OH^-(cM) \mid\mid OH^-(cM) \mid O_2(P_2atm) \mid Pt$ <br> $P_1 > P_2$ | **(r)** | pH measurement |
| **(D)** | $Mg \mid Mg^{2+} \mid\mid H^+ \mid H_2 \mid Pt$ | **(s)** | Galvanic cell |

**38. MATCH THE FOLLOWING:**

| | **Column 1** | | **Column 2** |
|---|---|---|---|
| **(A)** | Electrolysis of aqueous $CuSO_4$ using Cu electrodes | **(p)** | Density of $H_2SO_4$ increases |
| **(B)** | Electrolysis of dil. $H_2SO_4$ using Pt electrodes | **(q)** | Molarity of solution remains same. |
| **(C)** | Electrolysis of aqueous NaF using Pt electrodes | **(r)** | $H_2$ is liberated at cathode. |
| **(D)** | Recharging of lead storage battery | **(s)** | Positive electrode is anode and negative electrode is cathode |
| | | **(t)** | $O_2$ is liberated at anode. |

**39.** Match the titrations of titrant and titrate in column1 with appropriate conductometric titration curves in column 2 and select the correct answer among the code given below the columns.

| | **Column 1** | | **Column 2** |
|---|---|---|---|
| **(1)** | Titration of HCl v/s NaOH | **(p)** |   |
| **(2)** | Titration of $CH_3CO_2H$ v/s NaOH | **(q)** |   |
| **(3)** | Titration of (HCl+$CH_3CO_2H$) v/s NaOH | **(r)** |   |
| **(4)** | Titration of $AgNO_3$ v/s KCl | **(s)** |   |

**Codes :**

| | **P** | **Q** | **R** | **S** | | **P** | **Q** | **R** | **S** |
|---|---|---|---|---|---|---|---|---|---|
| **(A)** | 4 | 1 | 2 | 3 | **(B)** | 4 | 2 | 1 | 3 |
| **(C)** | 4 | 3 | 2 | 1 | **(D)** | 4 | 3 | 1 | 2 |

## Numerical Value Type Questions

**The Answer to the following questions can be positive or negative integers of 1/2/3 digits, 0 and decimal numerical value.**

**40.** The EMF of the cell $M|M^{n+}(0.02M)||\ H^+\ (1M)|H_2(g)(1\ atm)|Pt$ at 25ºC is 0.81V. The valency of the metal if the standard oxidation potential of the metal is 0.76V, is_____.

**41.** Consider the cell, $Ag\,|\,AgBr\,|\,Br^-\,||\,Cl^-\,|\,AgCl\,|\,Ag$ at 25ºC. The $K_{sp}$ of AgBr and AgCl are $5\times10^{-13}$ and $1\times10^{-10}$. The concentration ratio of $\frac{[Cl^-]}{[Br^-]}$ ions when the emf of the cell is 0.118V, will be_____.

**42.** The electrolysis of a metal salt was carried out by passing a current of 4 amp for 45 minutes. It resulted in the deposition of 2.977 g metal. If atomic mass of the metal is 106.4 g $mol^{-1}$, then calculate the charge on metal cation.

**43.** The emf of the given cell $Pt\,|\,H_2\,(g)\,|\,Buffer\,||$ Normal std. calomel electrode is 0.68 V at 25ºC, when barometric pressure is 760 mm. What is the pH of the buffer solution?

$E^0$ calomel = 0.28 V. (Take $\frac{2.303RT}{F}=0.06$)

**44.** The conductivity of a saturated solution of $CaF_2$ at 18ºC was found to be $5.2\times10^{-5}$ S $cm^{-1}$ and the conductivity of water used for making the solution was $2\times10^{-6}$ S $cm^{-1}$. The molar ionic conductivities at infinite dilution of $Ca^{2+}$ and $F^-$ ions are 120 & 65 S $cm^2$ $mol^{-1}$ respectively. The solubility product of $CaF_2$is $4x\times10^{-12}M^3$. The value of x is _____.

**45.** When 0.5 L of 16 M $SnSO_4$ is electrolysed for a period of 100 minutes using a current of 96.5 A and inert electrodes, the final concentration of $Sn^{2+}$ in the solution will be _____.

($E^o\ Sn^{2+}/Sn = -0.14$ V, $E^o\ Sn^{2+}/Sn^{4+}$ = -0.13 V, $E^oOH^-/O_2=-0.4V$, $E^0so_4{}^{2-}/s_2o_8{}^{2-}=-2.0V$).

**46.** In the Hall-Heroult process, molten $Al_2O_3$ is electrolysed using 9650 A current for a period of 100 s. How many Al cans can be made from the Al produced if each can uses 10 g?

**47.** Aluminium displaces hydrogen from dilute HCl whereas silver does not. The EMF of a cell prepared by combining $Al/Al^{3+}$ and $Ag/Ag^+$ is 2.46 V. The reduction potential of silver electrode is +0.80 V. The reduction potential of aluminium electrode is _____.

**48.** A 100 W, 110 V lamp is connected in series with an electrolytic cell containing $CdSO_4$ solution. What mass of Cd will be deposited by the current flowing for 10 hours ? (Use : $A_{Cd}=112\,gm/mole$)

**49.** During the electrolysis of water, a total volume of $33.6\,mL$ of hydrogen and oxygen gas was collected at STP. Find the amount of electricity in coulomb that passed during electrolysis.

**50.** The standard reduction potentials of $Cu^{2+}/Cu$ and $Cu^{2+}/Cu^+$ are $0.337\,V$ and $0.153\,V$ respectively. The standard electrode potential of $Cu^+/Cu$ half-cell is :

| Advanced Problem Package | Solid State |
|---|---|

## SINGLE CORRECT ANSWER TYPE

**Each of the following Question has 4 choices A, B, C & D, out of which ONLY ONE Choice is Correct.**

**1.** There are three cubic unit cells A, B and C. A is FCC and all of its tetrahedral voids are also occupied. B is also FCC and all of its octahedral voids are also occupied. C is simple cubic and all of its cubic voids are also occupied. If voids in all unit cells are occupied by the spheres exactly at their limiting radius, then the order of packing efficiency would be :

**(A)** A < B < C **(B)** C < A < B **(C)** C < B < A **(D)** A < C < B

**2.** If 'a' stands for the edge length of the cubic systems: simple cubic, body centered cubic and face centred cubic, then the ratio of radii of the spheres in these systems will be respectively :

**(A)** $\frac{a}{2}:\frac{a\sqrt{3}}{2}:\frac{a\sqrt{2}}{2}$ **(B)** $a:\sqrt{3}a:\sqrt{2}a$ **(C)** $\frac{a}{2}:\frac{a\sqrt{3}}{4}:\frac{a}{2\sqrt{2}}$ **(D)** $\frac{a}{2}:\sqrt{3}\,a:\frac{a}{\sqrt{2}}$

**3.** First three nearest neighbour distance for body centered cubic lattice are :

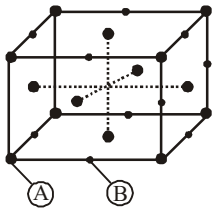
**(A)** $\sqrt{2}a, a, \sqrt{3}a$ **(B)** $\frac{a}{\sqrt{2}}, a\sqrt{3}, a$ **(C)** $\frac{\sqrt{3}a}{2}, a, \sqrt{2}a$ **(D)** $\frac{\sqrt{3}a}{2}, a, \sqrt{3}a$

**4.** At very low temperature oxygen ($O_2$) freezes and forms a crystal. Which term best describes the formed solid :

**(A)** Covalent network crystal **(B)** Molecular crystal

**(C)** Metallic crystal **(D)** Ionic crystal

**5.** For solid with following structure, The coordination number of the point B is :



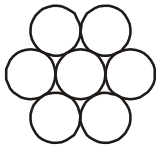

**(A)** 3

**(B)** 4

**(C)** 5

**(D)** 6

**6.** In FCC crystal, which of the following shaded planes contains the following type of arrangement of atoms :



**(A)**  **(B)**  **(C)**  **(D)** 

**7.** Distance between tetrahedral void and octahedral void in the FCC lattice will be (a = edge length of unit cell)

**(A)** $\frac{\sqrt{3}a}{4}$ **(B)** $\sqrt{3}a$ **(C)** $\frac{\sqrt{3}a}{2}$ **(D)** $\frac{\sqrt{3}a}{3}$

**8.** A non-stoichiometric compound $Cu_{1.8}$ S is formed due to incorporation of $Cu^{2+}$ ions in the lattice of cuprous sulphide. What percentage of $Cu^{2+}$ ions out of the total copper content is present in the compound:

**(A)** 88.88 **(B)** 11.11 **(C)** 99.8 **(D)** 89.8

**9.** CsBr has BCC structure with edge length 4.3 Å. The shortest inter ionic distance in between $Cs^{+1}$ and $Br^{-}$ in Å is :

**(A)** 3.72 **(B)** 1.86 **(C)** 7.44 **(D)** 4.3

**10.** When NaCl is doped with $1 \times 10^{-4}$ mole of $SrCl_2$, the no. of cation vacancies produced are :

**(A)** $6.023 \times 10^{18}$ **(B)** $6.023 \times 10^{19}$ **(C)** $6.023 \times 10^{20}$ **(D)** $3.011 \times 10^{20}$

**11.** A mineral having formula AB crystallizes in CCP lattice with 'A' atoms occupying the lattice points. Pick out the correct statement from the following :

**(A)** 100% occupancy of tetrahedral voids by B, co-ordination no. of B = 4

**(B)** 100% occupancy of octahedral voids by B, co-ordination no. of B = 4

**(C)** 50% occupancy of tetrahedral voids by B, co-ordination no. of A = 4

**(D)** 100% occupancy of octahedral voids by B, co-ordination no. of A = 4

**12.** Zinc oxide which is white when cold, becomes yellow when heated. It is due to the development of :

**(A)** Frenkel defect **(B)** Metal excess defect

**(C)** Schottky defect **(D)** Metal deficiency defect

**13.** A metal crystallizes into two crystal unit cells like face centered cubic (FCC) and body centre cubic (BCC) at different temperatures. Ratio of densities of FCC and BCC crystals will be (Assuming same edge length) :

**(A)** 1.09 **(B)** 1.21 **(C)** 1.25 **(D)** 1.3

**14.** In a face centred cubic packed structure of mixed oxide, the lattice is made up of oxide ions, $1/5^{th}$ of tetrahedral voids are occupied by divalent ions ($X^{2+}$), while ½ of the octahedral voids occupied by trivalent ($Y^{3+}$) ions, then the formula of the oxide is :

**(A)** $XY_2O_4$ **(B)** $X_2YO_4$ **(C)** $X_4Y_5O_{10}$ **(D)** $X_5Y_4O_{10}$

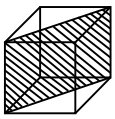
**15.** A crystal is made of particles X, Y and Z. X forms cubic close packing. Y occupies all the octahedral voids of X and Z occupies all the tetrahedral voids of X. If all the particles along one body diagonal of unit cell are removed then the formula of the crystal would be :

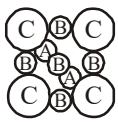
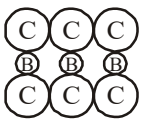
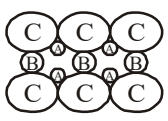
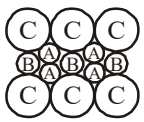
**(A)** $XYZ_2$ **(B)** $X_2YZ_2$ **(C)** $X_8Y_4Z_5$ **(D)** $X_5Y_4Z_8$

**16.** A certain solid mixed oxide crystallizing in the cubic system contains cations $M_1$ and $M_2$ and the oxide ion $O^{2-}$. Each $M_1$ ion is surrounded by 12 equidistant nearest neighbour oxide ions. If the oxide ions occupy face centers of cubic unit cell, where are the $M_1$ ions situated?

**(A)** At the center of the unit cell **(B)** At the corners of the cube

**(C)** At the edge centers **(D)** Occupying half the number of edge centres

**17.**  In a hypothetical solid C atoms are found to form cubic close packed lattice, A atoms occupy all tetrahedral voids B atoms occupy all octahedral voids. A and B atoms are of appropriate size, so that there is no distortion in CCP lattice of C atoms. Now if a plane as shown in the following figure is cut, then the cross section of this plane will look like.

**(A)**  **(B)**  **(C)**  **(D)** 

**18.** What is the distance between two nearest tetrahedral voids in FCC, given the edge length is 'a'

**(A)** $a/2$ **(B)** $\sqrt{3}/2a$ **(C)** $\sqrt{2}a$ **(D)** $a/\sqrt{2}$

**19.** Which of the following expressions is correct for a CsCl unit cell with lattice parameter, a?

**(A)** $r_{Cs^+} + r_{Cl^-} = 2a$ **(B)** $r_{Cs^+} + r_{Cl^-} = \frac{a}{\sqrt{2}}$ **(C)** $r_{Cs^+} + r_{Cl^-} = \frac{\sqrt{3}a}{2}$ **(D)** $r_{Cs^+} + r_{Cl^-} = \frac{3a}{2}$

**Paragraph for Questions 20 - 22**

Packing referes to the arrangement of constituent units in such a way that the forces of attraction among the constituent particles is maximum and the constituents occupy the maximum available space and the remaining is the void space. Different voids are present in close packing viz trigonal, tetrahedral, octahedral and cubic void. In three dimensions there are hexagonal close packing and cubic close pacing. HCP has AB AB AB …….... layer arrangement and CCP has ABC ABC ABC …… layer arrangement of constituent spheres.

**20.** The volume of HCP unit cell is (r is radius of constituent spheres) :

**(A)** $24\sqrt{2}\,r^3$ **(B)** $16\sqrt{2}\,r^3$ **(C)** $12\sqrt{2}\,r^3$ **(D)** $\frac{64}{3\sqrt{3}}r^3$

**21.** Which of the following is not common between HCP and CCP arrangements?

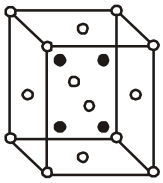
**(A)** Both have same packing efficiency
**(B)** Both have same coordination number
**(C)** Both contain octahedral voids
**(D)** Both contain same number of tetrahedral voids per unit cell

**22.** Distance between two adjacent most closely packed layers in CCP will be equal to (r = radius of atom)

**(A)** $\sqrt{2}\,r$ **(B)** $\sqrt{\frac{2}{3}}\,r$ **(C)** $2\sqrt{\frac{2}{3}}\,r$ **(D)** $2\sqrt{\frac{3}{2}}\,r$

**For Questions 23 - 25**

Answer the following questions for the given unit cell :



○ ⟶ A (corner and face centre)
● ⟶ B (tetrahedral void)

**23.** If the molar mass of AB is 100g $mol^{-1}$ and 'a' is edge length then the density of the crystal will be :

**(A)** $\frac{4N_A}{a^3 \times 100}$ **(B)** $\frac{4 \times 100}{a^3 N_A}$ **(C)** $\frac{2N_A}{a^3 100}$ **(D)** $\frac{2 \times 100}{a^3 N_A}$

**24.** The given unit cell belongs to :

**(A)** CsCl type **(B)** TiCl type **(C)** Rock salt type **(D)** Zinc blende type

**25.** The coordination number of 'B' will be :

**(A)** 8 **(B)** 6 **(C)** 4 **(D)** 12

**Paragraph for Questions 26 - 28**

A site in a closest-packed lattice can be generated by placing four spheres of radius R at alternate corners of a cube, such that the spheres are in contact.

**26.** The site created is :

**(A)** Octahedral **(B)** Spherical **(C)** Tetrahedral **(D)** Square planar

**27.** The length of body diagonal of this cube is:

**(A)** Greater than 3R **(B)** Less than $\sqrt{2}$ R **(C)** Equal to $\sqrt{6}$ R **(D)** Greater than $\sqrt{6}$ R

**28.** The radius of tetrahedral hole is :

**(A)** $\frac{\sqrt{3}}{2}R$ **(B)** $\left(\sqrt{\frac{3}{2}}-1\right)R$ **(C)** $\sqrt{3}$ R **(D)** $\left(\frac{\sqrt{3}-1}{2}\right)R$

## MULTIPLE CORRECT ANSWERS TYPE

**Each of the following Question has 4 choices A, B, C & D, out of which ONE or MORE Choices may be Correct:**

**29.** If the three interaxial angles of the unit cell are all equal in magnitude, the crystal cannot belong to the :

**(A)** monoclinic system **(B)** cubic system
**(C)** hexagonal system **(D)** triclinic system

**30.** The two types of holes which occur in any close-packed structure are :

**(A)** tetrahedral, octahedral **(B)** trigonal, octahedral
**(C)** trigonal, tetrahedral **(D)** octahedral, cubic

**31.** Which of the following statements are correct ?

**(A)** The co-ordination number of each type of ions in CsCl crystals is 8
**(B)** A metal which crystallizes in bcc structure has co-ordination number of 12
**(C)** The edge length of a unit cell in NaCl is 552 pm. $\left(r_{Na^+} = 95\text{ pm}, r_{C\ell^-} = 181\text{ pm}\right)$
**(D)** A unit cell of an ionic crystal shares some of its ions with other unit cells.

**32.** Which of the following statements are false :

**(A)** The radius of a metal atom is taken as half of the nearest metal-metal distance in a metallic crystal
**(B)** One tetrahedral void per atom is present in hcp structure
**(C)** In the fluorite structure ($CaF_2$), the $Ca^{2+}$ ions are located at the lattice points and the fluoride ions fill all the tetrahedral holes in the ccp crystal.
**(D)** In the antifluorite structure ($Li_2O$, $Rb_2S$) the cations are located at the lattice points and anions fill the tetrahedral holes in the ccp structure.

**33.** In the unit cell of NaCl, which of the following statements are correct ?

**(A)** $Na^+$ ions have six $Cl^-$ ions in its nearest neighbourhood
**(B)** $Cl^-$ ions have six $Na^+$ ions in its nearest neighbourhood
**(C)** Second nearest neighbour of $Na^+$ ion are twelve $Na^+$ ions
**(D)** NaCl has 68% of occupied space

**34.** The correct statement(s) regarding defects in solids is(are)

**(A)** Schottky defect is usually favoured by a very small difference in the sizes of cation and anion
**(B)** Frenkel defect increases exponentially with temperature
**(C)** Trapping of an electron in the lattice leads to the formation of F-center
**(D)** Solids with F – centre act as semi – conductors

**35.** Which of the following is expected in case of crystal exhibiting schottky defect ?

**(A)** Crystal has intrinsic semi conduction **(B)** Density of crystal is less than expected
**(C)** Stoichiometry remains same **(D)** Crystal exhibit colour

**36.** Select the correct statements if NaCl is doped by $CaCl_2$, then the formed solid solution results in :

**(A)** Substitutional cation vacancy **(B)** Frenkel's defect

**(C)** Schottky defect **(D)** Decrease of density

**37.** Select the correct statement (s) :

**(A)** Schottky defect is shown by CsCl

**(B)** Frenkel defect is shown by ZnS

**(C)** Hexagonal close packing (HCP) and Cubic close packing (CCP) structure has same coordination no.12

**(D)** At high pressure, the co-ordination number increases.

**38.** In which of the following crystalline systems $\alpha = \beta = \gamma$ is followed

**(A)** Cubic **(B)** Tetragonal **(C)** Orthorhombic **(D)** Rhombohedral

**39.** In diamond, the lattice is FCC with C atoms occupying lattice points as well as some of the void positions and resemble zinc blend structure. Which of the following statements are correct about the diamond structure?

**(A)** In the lattice half of the tetrahedral positions are vacant

**(B)** Packing efficiency of the crystal is 74 %

**(C)** In the lattice, all octahedral positions are vacant

**(D)** Coordination number of carbon atoms is 4

## MATRIX MATCH TYPE

**Each of the following question contains statements given in two columns, which have to be matched. Statements in Set 1 are labelled as (A), (B), (C) & (D) whereas statements in Column 2 are labeled as p, q, r, s & t. More than one choice from Set 2 can be matched with Set 1.**

**40.** **MATCH THE FOLLOWING :**

| | **Set – I(Type of ionic crystal)** | | **Set – II(Related information)** |
|---|---|---|---|
| **(1)** | NaCl type of crystal | **(P)** | Coordination number of cation = 8 |
| **(2)** | CsCl type of crystal | **(Q)** | Coordination number of anion = 4 |
| **(3)** | ZnS type of crystal | **(R)** | $r_c + r_a = a/2$ (lattice parameter) |
| **(4)** | $CaF_2$ type of crystal | **(S)** | Anions occupy CCP position |

($r_c$ and $r_a$ are radius of cation and anion respectively)

**(A)** 1 – R, 2 – P, 3 – Q, 4 – S **(B)** 1 – R, 2 – S, 3 – P, 4 – Q

**(C)** 1 – R, S 2 – P, S 3 –Q, S 4 –P, Q **(D)** 1 – S, 2 – P, 3 – Q, 4 – R

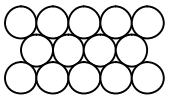
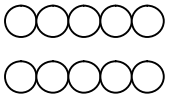
**41.** **MATCH THE FOLLOWING :**

| | **Set – I** | | **Set – II** |
|---|---|---|---|
| **(1)** | Cubic | **(P)** | All angles are equal |
| **(2)** | Ortho rhombic | **(Q)** | Only two sides have equal length |
| **(3)** | Monoclinic | **(R)** | Have maximum elements of symmetry |
| **(4)** | Hexagonal | **(S)** | Contain two bravais lattice |

**(A)** 1 – P, R 2 – P, 3 – S, 4 – Q **(B)** 1 – R, 2 – P, 3 – Q, 4 – S

**(C)** 1 – P, 2 – R, 3 – Q, 4 – S **(D)** 1 – P, 2 – Q, 3 – R, 4 – S

**42. MATCH THE FOLLOWING :**

| | **Set – I** | | **Set – II (Possible arrangement of atoms in different planes)** |
|---|---|---|---|
| **(1)** | Simple cubic | **(P)** |  |
| **(2)** | Body centred cubic | **(Q)** |  |
| **(3)** | Face centred cubic | **(R)** |  |
| **(4)** | Hexagonal close packing | **(S)** |  |

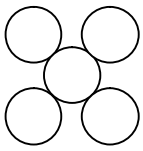
**(A)** 1 – Q, 2 – R, 3 – P,R,S 4 – P **(B)** 1 – Q, 2 – P, 3 – S, 4 – R

**(C)** 1 – P, 2 – R, 3 – Q, 4 – S **(D)** 1 – R, 2 – S, 3 – P, 4 – Q

## Numerical Value Type Questions

**The Answer to the following questions can be positive or negative integers of 1/2/3 digits, 0 and decimal numerical value.**

**43.** One the metallic crystal is cubic system with arrangement of atoms over face of the cubic unit cell is :



Find the rank of unit cell.

**44.** The nearest distance between two atoms of a cubic metallic crystal is $\frac{\sqrt{3}a}{2}$. Find the effective no. of atoms per unit cell of that crystal ?

**45.**

**46.** One of metallic crystal follow cubic system with atoms present at corners and face centred positions. Find the ratio of no. of tetrahedral voids to that of octahedral voids per unit cell in the crystal.

**47.** In F.C.C system, body diagonal length is x and the nearest distance between octahedral void and a tetrahedral void is y. Find the value of x/y.

**48.** How many effective $Na^+$ ions are present in a unit cell of the Rock salt (NaCl) if ions along one of the axis joining opposite faces are removed ?

**49.** A spinel is an important class of oxides consisting of two types of metal ions with oxide ions arranged in CCP layers. The normal spinel has $\frac{1}{8}$th of the tetrahedral void occupied by one type of metal and one half of the octahedral voids occupied by another type of metal ions such a spinel is formed by $Zn^{2+}$, $Al^{3+}$ and $O^{2-}$ with $Zn^{2+}$ in tetrahedral void. Then the simplest formula of that spinel is $Zn_xAl_yO_z$ then x + y + z is _____.

**50.** Analysis shows that nickel oxide has formula $Ni_{0.98}O_{1.00}$, the percentage occupation by $Ni^{3+}$of cationic sites is x%. Then 'x' is _____.

**51.** The number of octahedral faces that are present in a truncated octahedron is _____.

**52.** If an atom crystallizes in ABC packing, then the distance between two layers of 'A' is 'X' nm. The edge length of unit cell formed by A is $\sqrt{3}$nm. What is the value of X? (In nearest integer)

**53.** A compound AB has Rock salt structure with A : B = 1 : 1. The formula weight of AB is 6.023 y amu and the closest distance between A and B is $y^{1/3}$ nm. The observed density of the lattice in kg/$m^3$ is_____.

**54.** An alloy of metals A, B and C is found to have 'A' constituting CCP lattice. If 'B' atoms occupy the edge-centres and 'C' is present at body-centre then the total number of atoms present in a formula unit of the alloy is_____.

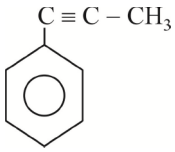
| Advanced Problem Package | IOC & Hydrocarbons |
|---|---|

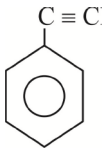
## SINGLE CORRECT ANSWER TYPE

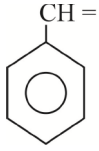
**Each of the following Question has 4 choices A, B, C & D, out of which ONLY ONE Choice is Correct.**

**1.** $C_6H_5-CH=CH_2 \xrightarrow{Br_2} A \xrightarrow[NaNH_2]{3.0\ eqv.} B \xrightarrow{CH_3I} C$ Compound 'C' in the sequence is :

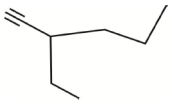
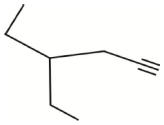
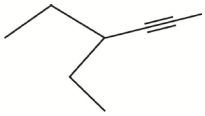

**(A)**


**(B)**


**(C)**


**(D)**

**2.** Which alkyne will give 3-ethylhexane on catalytic hydrogenation?

**(A)**  **(B)**  **(C)**  **(D)** All of these

**3.** Which of the following statements best explain the greater acidity of terminal alkynes $(RC\equiv CH)$ compared with monosubstituted alkenes $(RCH=CH_2)$

**(A)** The sp-hybridized carbon atoms of the alkynes are less electronegative than the $sp^2$-hybridized carbons of the alkene.

**(B)** The two $\pi$-bonds of the alkyne are better able to stabilize the negative charge of the anion by resonance.

**(C)** The sp-hybridized carbons of the alkyne are more electronegative than the $sp^2$-hybridized carbon of the alkene.

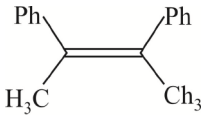
**(D)** The question is incorrect as alkenes are more acidic than alkynes.

**4.** In the given reaction trans-2-butene $\xrightarrow{Br_2/CCl_4} X$. (X) will be :

**(A)** meso-2, 3-dibromobutane **(B)** d-2, 3-dibromo butane

**(C)** 1 : 1 mixture of (±) 2, 3-dibromo butane **(D)** 2 : 1 mixture of (±) 2, 3-dibromo butane

**5.** $CHCl_3 + CH_3NH_2 \xrightarrow{OH^-} CH_3NC$.

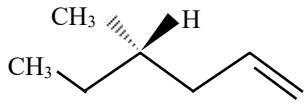
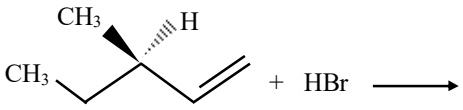
The intermediate of this reaction is treated with the compound 

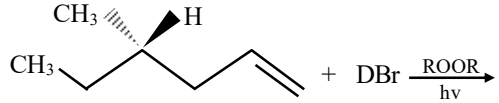
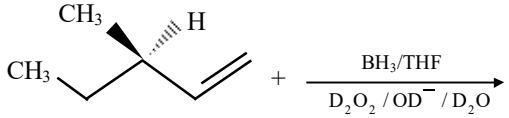
The reaction will be:

**(A)** Electrophilic addition reaction **(B)** Free radial addition reaction

**(C)** Nucleophilic addition reaction **(D)** Electrophilic aromatic substitution

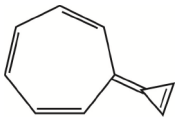
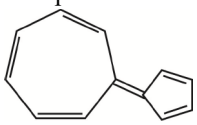
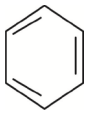
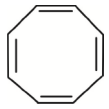
**6.** Which of the following reactions result in creation of a pair of diastereomers (neglect regioselectivity)?

**(I)**  **(II)** 

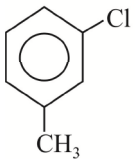
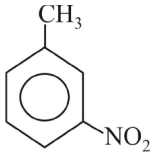
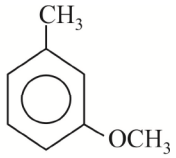
**(III)**  **(IV)** 

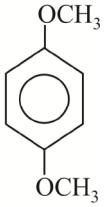
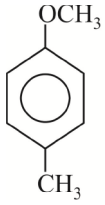
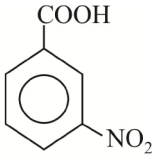
**(A)** I only **(B)** I & III **(C)** I, II & III **(D)** I, III & IV

**7.** Which of the following is aromatic & polar?

**(A)**  **(B)**  **(C)**  **(D)** 

**8.** The compounds which give only one product on mono-nitration.

**(A)**  &  **(B)**  & 

**(C)**  &  **(D)**  & 

**9.** Which of the following statements concerning a meso compound is false?

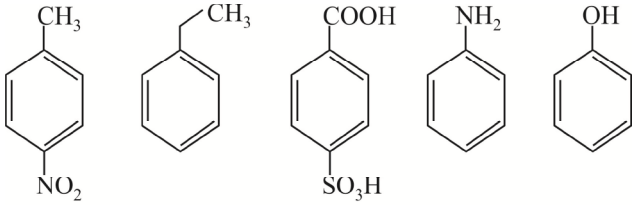
**(A)** There is no chiral centre in the molecule

**(B)** There is at least one element of symmetry in the molecule

**(C)** There is internal compensation for optical inactivity

**(D)** It cannot have non-superimposable mirror image

**10.** Which will easily undergo a Friedel–Crafts alkylation reaction?



(1) (2) (3) (4) (5)

**(A)** 1, 2, 4 **(B)** 1, 3 **(C)** 2 **(D)** 1, 2

**11.** A sample of 2-chlorobutane has $[\alpha] = 11.55^{\circ}$. The specific rotation of (+)-2-chlorobutane is 23.1°. Which is correct option?

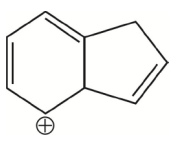
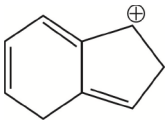
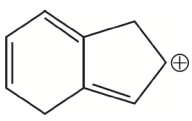
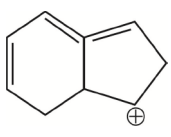
**(A)** The dextro form is 65%

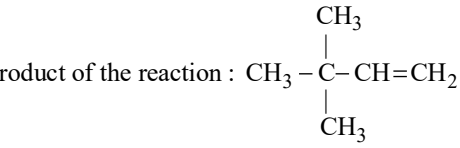
**(B)** The leavo form is 25%

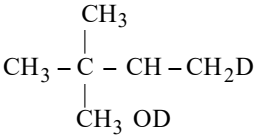
**(C)** Enantiomeric excess is 50% of (+)2-chlorobutane

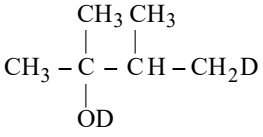
**(D)** Both (B) and (C)

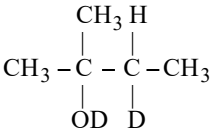
**12.** Which carbocation is most stabilized ?

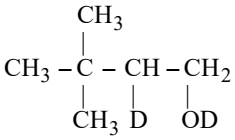
**(A)**  **(B)**  **(C)**  **(D)** 

**13.** The major product of the reaction :  would be :

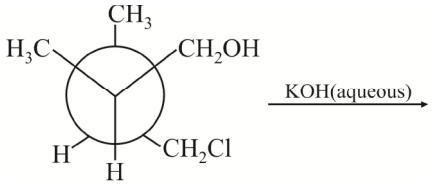
**(A)** 

**(B)** 

**(C)** 

**(D)** 

**14.** Find out the correct statement about the product in the following reaction:

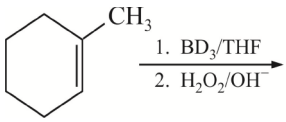


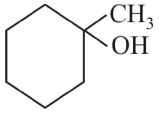
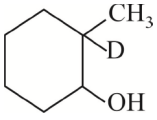
**(A)** product obtained is a mixture of optically active compounds

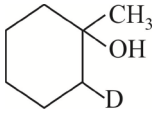
**(B)** product obtained is an optically active compound

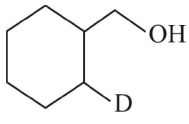
**(C)** product obtained is optically inactive due to plane of symmetry

**(D)** product obtained is inactive due to 2 – fold alternating axis of symmetry

**15.**  Act A is:

**(A)**  **(B)** 

**(C)** 

**(D)** 

**16.** $X \xrightarrow[(2)\,H_2O/H^+]{(1)\ O_3} CH_3-CH_2-COOH + HOOC-CH_2-CH_2-COOH + HCOOH$ . X is :

**(A)** $CH_3-CH_2-C\equiv C-(CH_2)_2-C\equiv CH$

**(B)** $CH_3-C\equiv C-(CH_2)_3-C\equiv CH$

**(C)** $CH_3-CH_2-C\equiv C-CH_2-C\equiv CH$

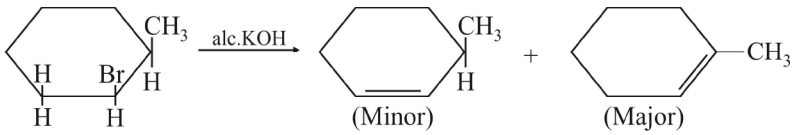
**(D)** $HC\equiv C-(CH_2)_4-C\equiv CH$

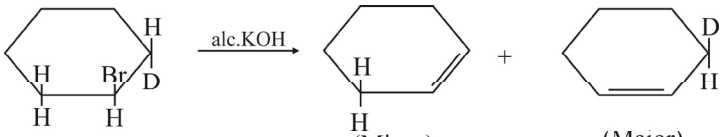
## MULTIPLE CORRECT ANSWERS TYPE

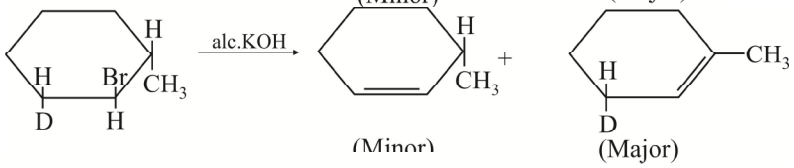
**Each of the following Question has 4 choices A, B, C & D, out of which ONE or MORE Choices may be Correct:**

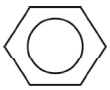
**17.** Which of the following are correct:

**(A)** $Me_3C-Cl \xrightarrow{C_2H_5OH} Me_3C-O-C_2H_5\,(Major) + Me_2C=CH_2\,(Minor)$

**(B)** 


**(C)** 


**(D)** 


**18.**  $+ CH_3CH_2COCl \xrightarrow[AlCl_3]{\text{anhydrous}} (X) \xrightarrow[HCl]{Zn-Hg} (Y)$. The product (Y) can be obtained by

**(A)** $C_6H_6 + \triangle \xrightarrow[AlCl_3]{\text{anhydrous}} ?$ **(B)** $C_6H_6 + CH_3CH_2CH_2Cl \xrightarrow[\text{anhydrous}]{AlCl_3}$

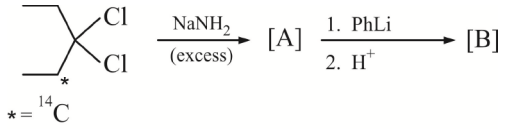
**(C)** $CH_3CH_2CH_2Cl + PhMgCl \longrightarrow$ **(D)** $(n\text{-}Pr)_2CuLi + PhCl \longrightarrow$

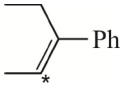
**19.** $CH_3-C\equiv CH \xrightarrow[2.CH_3Br]{1.NaNH_2} (A) \xrightarrow{Na/ND_3(l)} (B) \xrightarrow{H_2/Pt} (C)$

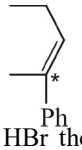
**(A)** (C) is meso-2, 3-dideutero butane **(B)** (C) is rac-2, 3-dideutero butane

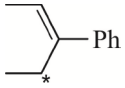
**(C)** (C) is d-2, 3-dideutero butane only **(D)** (B) is trans-2, 3-dideutero but-2-ene only

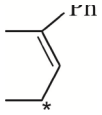
**20.** What are the possible structures of product [B] in the following sequence of reactions?




**(A)** 


**(B)** 


**(C)** 

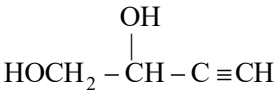

**(D)** 

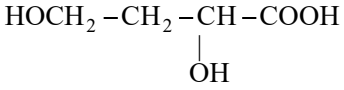

**21.** When $CH_2=CH-Br$ is reacted with HBr then the product formed is A and when $CH_2=CH-COOH$ is treated with HBr then the product is formed is C. Hence, here:

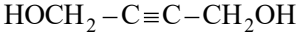
**(A)** A is $\begin{matrix} CH_2-CH_2 \\ | \quad\quad | \\ Br \quad\quad Br \end{matrix}$ **(B)** A is $CH_3-CH\begin{matrix} Br \\ Br \end{matrix}$

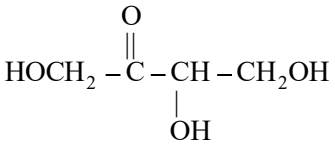
**(C)** C is $\begin{matrix} CH_3-CH-COOH \\ \quad\quad | \\ \quad\quad Br \end{matrix}$ **(D)** C is $\begin{matrix} CH_2-CH_2-COOH \\ | \\ Br \end{matrix}$

**22.** One mole of an unknown organic compound (A) when treated with excess of $CH_3MgBr$ liberates three moles of $CH_4$ gas. When reduced with HI and red phosphorus, compound (A) gives n- butane. The possible structure(s) of A is(are):

**(A)** 

**(B)** 

**(C)** 

**(D)** 

**23.** Which of the following carbide(s) on hydrolysis give methane as one of the products?

**(A)** beryllium carbide **(B)** boron carbide

**(C)** magnesium carbide **(D)** aluminium carbide

**24.** Which statement is/are true about resonance?

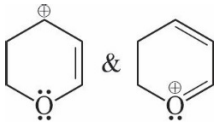
**(A)** It decreases the energy of system

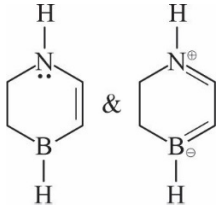
**(B)** The hybridization of atoms do not change due to resonance

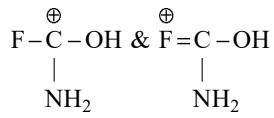
**(C)** Resonance hybrid is more stable than any resonating structure

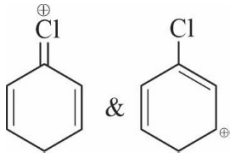
**(D)** Resonating structures can not be isolated at any temperature

**25.** In which of the following pairs of compounds, will second structure have more contribution to resonance hybrid than first ?

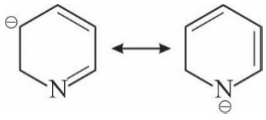
**(A)** 

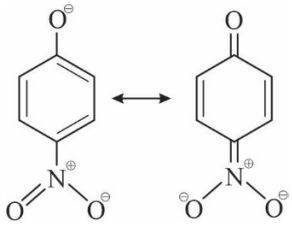
**(B)** 

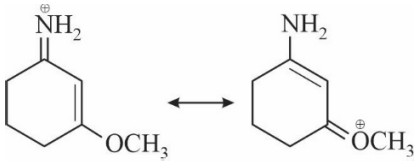
**(C)** 

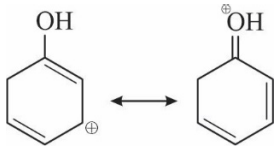
**(D)** 

**26.** In which of the following pairs of resonating structures first resonating structure is more stable than second ?

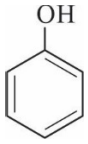
**(A)** 

**(B)** 

**(C)** 

**(D)** 

**27.** In which of the following compounds delocalization of electrons and shifting of electron in the same direction?

**(A)** 

**(B)** $CH_3 - NH - NO_2$

**(C)** $CH_2 = CH - CH = CH - NO_2$

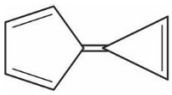
**(D)** $H_2N - \overset{H}{\underset{|}{C}} = CH_2$

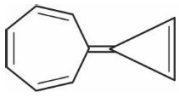
**28.** Which of the following groups cannot participate in resonance with benzene :

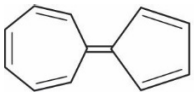
**(A)** $-COOH$ **(B)** $-COO^{\ominus}$ **(C)** $-\overset{\oplus}{N}H_3$ **(D)** $-COCl$

**29.** Which of the following is/are correct :

**(A)**  is antiaromatic

**(B)**  is aromatic

**(C)**  is aromatic

**(D)**  is aromatic

**30.** Which of the hybrid species are correct ?

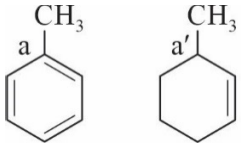
**(A)** $\overset{\delta-}{CH_2} - \overset{\delta+}{CH} - O - CH_3$

**(B)** $\overset{\delta+}{CH_2} - CH - CH - \overset{\delta-}{O}$

**(C)** $CH_3 - \overset{O^{\delta-}}{\overset{\|}{C}} - \overset{\delta+}{N}H_2$

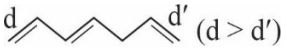
**(D)** $\overset{\delta+}{CH_2} - CH - CH - \overset{\delta-}{CH_2}$

**31.** The correct orders for bond length are :

**(A)**  $(a' > a)$

**(B)** $CH_3 - \overset{b}{\underset{b'}{C}} - NH_2 \quad (b' \equiv b)$ with $\oplus NH_2$

**(C)** $CH_3 - \overset{c}{\underset{c'}{C}} - ONa \quad (c > c')$ with O

**(D)**  $(d > d')$

**32.** Which of the following statement is/are correct?

**(A)** Contributing structures contributes to the resonance hybrid is directly proportional of their energies

**(B)** Equivalent contributing structures make the resonance very important

**(C)** Contributing structures represent hypothetical molecules having no real existence

**(D)** Contributing structures are less stable than the resonance hybrid

**33.** Which of the following compounds will show tautomerism ?

**(A)** 2, 2-Dimethylpropanal

**(B)** 2,2-Dimethyl-1 nitropropane

**(C)** Acetyl Acetone

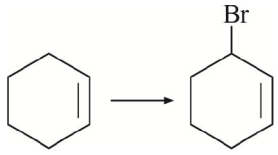
**(D)** Benzophenene

**34.** Which of the following is correct regarding stability of the following pair of species ?

**(A)** $CH_2=\overset{+}{N}=\overset{-}{N} \;>\; \overset{-}{C}H_2-\overset{+}{N}\equiv N$ **(B)** $CH_2=CH-\overset{+}{C}H-\overset{-}{O} \;>\; \overset{-}{C}H_2-CH=CH-\overset{+}{O}$

**(C)** $CH_3-\overset{O}{\overset{\|}{C}}-\overset{-}{O} > CH_3-CH_2-\overset{-}{O}$ **(D)** Pent-2-ene > 2-methylbut-2-en

**35.** Which reagent will you use for the following reaction ?



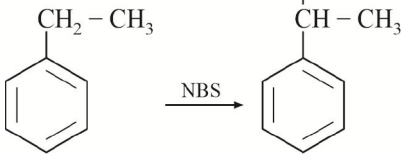
**(A)** NBS **(B)** $Br_2/Fe$ **(C)** $Br_2/h\nu$ **(D)** $Br_2/\Delta$

**36.** Which amongs the following reaction is/are correctly matched for major product ?

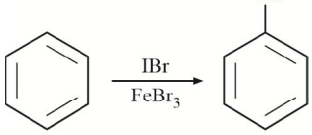
**(A)** $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_3 \xrightarrow[UV\ light]{Br_2} CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{Br}{|}}{C}}-CH_2-CH_3$

**(B)** $CH_3-CH=CH_2 \xrightarrow[UV\ light]{Br_2} \overset{\overset{Br}{|}}{CH_2}-CH=CH_2$

**(C)**

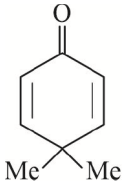



**(D)**

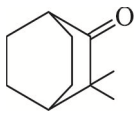



**37.** Which of the following do not show tautomerism ?

**(A)**

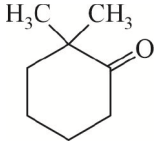



**(B)**




**(C)** $C_2H_5-\overset{O}{\overset{\|}{C}}-C_6H_5$

**(D)**




**38.** Which of the following catalysts is/are used for partial reduction of alkyne ?

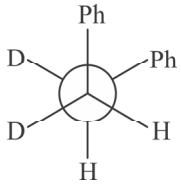
**(A)** $Na/NH_3(\ell)$ **(B)** $Ni_2B$ or P-2 catalyst

**(C)** Lindlar catalyst **(D)** Rossenmund catalyst

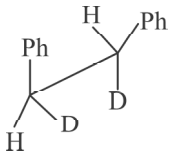
**39.** The end product of following reaction is/are :

$$Ph-C\equiv C-Ph \xrightarrow[(1)]{H_2/Pd\,BaSO_4/Quinoline} \xrightarrow[(2)]{D_2/Ni}$$

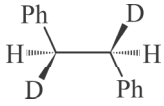
**(A)** $Ph-CH_2-CD_2-Ph$ **(B)**




**(C)**

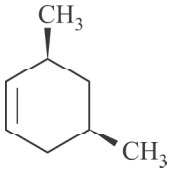



**(D)**

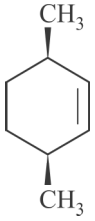



**40.** Which of the following give only meso compound on catalytic reduction ?

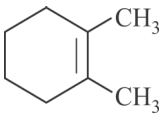
**(A)**



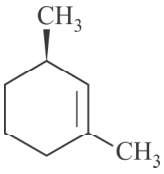

**(B)**




**(C)**

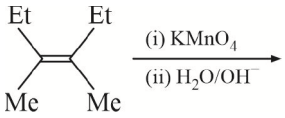



**(D)**

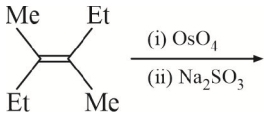



**41.** Which of the following involve syn addition ?

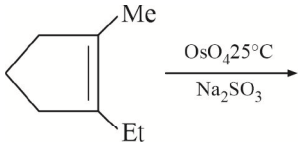
**(A)**



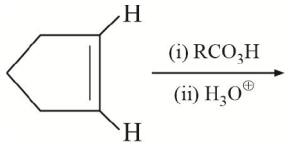

**(B)**



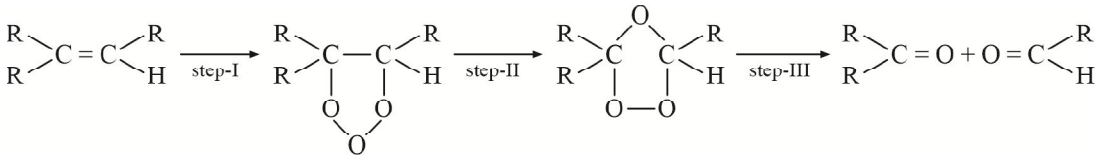

**(C)**




**(D)**




**42.** Mechanism of reductive ozonolysis is given below for an alkene.




Which is correct for the above mechanism ?

**(A)** Ozone act as electrophile and as well as nucleophile in this reaction

**(B)** First step of this reaction is an electrophile addition

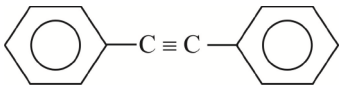
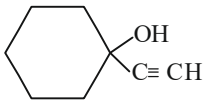
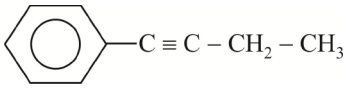
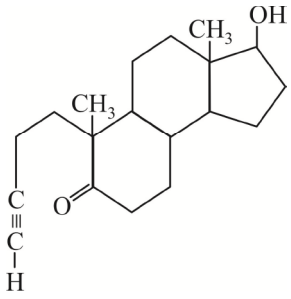
**(C)** Ozonide is formed in the step-II

**(D)** When ozonide is cleaved in the presence of reducing agent such as Zn or $Me_2S$ the products will be aldehydes and / or ketones

## MATRIX MATCH TYPE

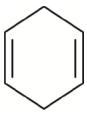
**Each of the following question contains statements given in two columns, which have to be matched. Statements in Column 1 are labelled as (A), (B), (C) & (D) whereas statements in Column 2 are labeled as p, q, r, s & t. More than one choice from Column 2 can be matched with Column 1.**

**43. Match the following:**

| | **Column 1** | | **Column 2** |
|---|---|---|---|
| **(A)** |  | **(p)** | Reacts with Lindlar catalyst ($H_2$ / Pd – $CaCO_3$) |
| **(B)** |  | **(q)** | Trans alkene will form, when reacts with (Na/liq. $NH_3$) |
| **(C)** |  | **(r)** | Reacts with ammonical $AgNO_3$ |
| **(D)** |  | **(s)** | Double bond equivalent is greater than two |

**44. Match the following:**

What would be the products of ozonolysis of the compounds in column 1

| | **Column 1** | | **Column 2** |
|---|---|---|---|
| **(A)** |  | **(p)** | Formaldehyde |
| **(B)** | $CH_2 = CH - CH = CH - CH_3$ | **(q)** | Glyoxal |
| **(C)** | $CH_3 - HC = CH - CH = CH_2$ | **(r)** | Propane-1, 3-dial |
| **(D)** | $CH_3 - CH = CH_2$ | **(s)** | Acetaldehyde |

**45.** **Match the following:**

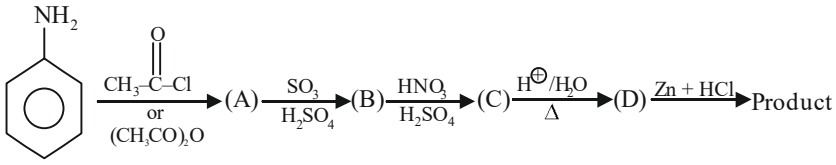
| | **Column 1** | | **Column 2** |
|---|---|---|---|
| **(A)** | Acid-catalysed hydration of alkenes | **(p)** | Markovnikov hydration |
| **(B)** | Oxymercuration demercuration of alkenes | **(q)** | Anti Markovnikov hydration |
| **(C)** | Hydroboration-oxidation of alkenes | **(r)** | Stereo selective |
| **(D)** | Dehydration of alcohols to alkenes | **(s)** | Regioselective |

## Numerical Value Type

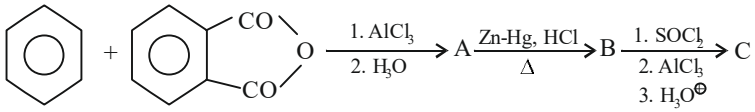
**The Answer to the following questions are positive integers of 1/2/3 digits and zero**

**46.** $\underset{(A)}{C_{12}H_{16}} \xrightarrow{\text{hot and conc. } KMnO_4} 2CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + 2HOOC-\overset{O}{\overset{\|}{C}}-COOH$

Number of C=C bond in organic compound (A) is _____.

**47.** 

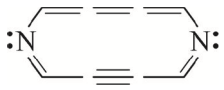

If the molecular weight of product (P) is M, then the value of $\frac{M}{27}$ is:

**48.** 


What is the molecular weight of product (C) ?

**49.** One equivalent of 1-bromo-3-chloro cyclobutane reacts with two equivalents of sodium in dry ether to form organic product [R]. Find out number of carbon-carbon bonds in the product [R].

**50.** Given compound possess a close loop of delocalizable x $\pi$ electrons. What is value of x?



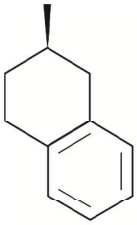

**51.** Find out number of delocalizable pi electrons in major product of the following reaction.

$$CH_3-C\equiv C-CH_3 + CH_2N_2 \xrightarrow{h\nu} \text{Major product}$$

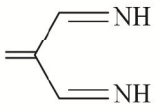
**52.** Molecule of $C_{13}H_{28}$ with the shortest possible parent carbon chain contains x carbon atoms. Numerical value of x is _____.

**53.** How many meso isomers are possible for 1, 2, 3, 4, 5, 6-hexachloro cyclohexane ?

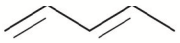
**54.** Geometrical isomerism is possible in how many of the following molecules/compounds ?



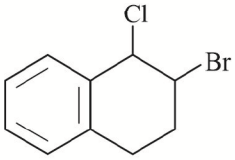
**(1)**



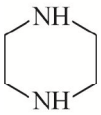

**(2)**



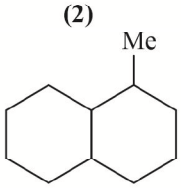
**(3)**




**(4)**

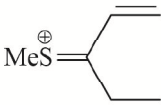



**(5)**

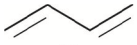



**(6)**

**(7)**




**(8)**



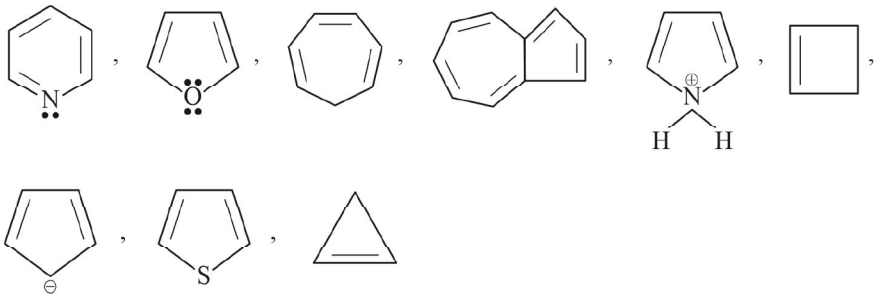
**(9)**

**(10)**

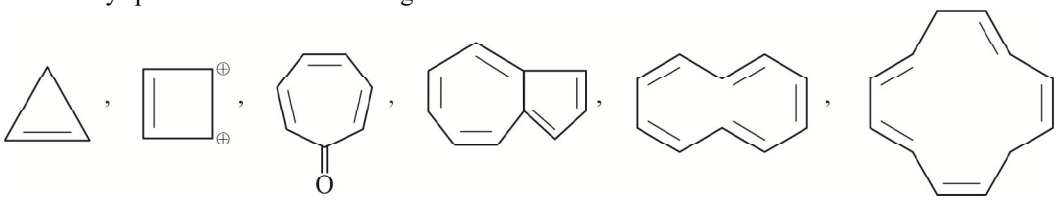
**55.** How many monocarboxylic acids (including stereoisomers) would give Methylcyclopropane on sodalime decarboxylation ?

**56.** Two stereoisomers (cis and trans) of 3, 4-Dibromocyclopentane-1, 1-dicarboxylic acid undergo decarboxylation, find out the total number of products formed.

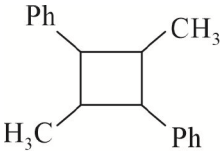
**57.** How many species out of the following are aromatic ?




**58.** How many species out of the following are aromatic ?



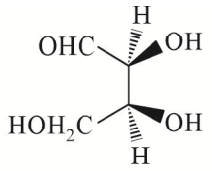

**59.** Sum of total number of optically active and optically inactive isomers of following compound.

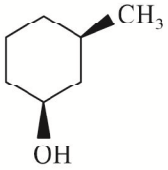


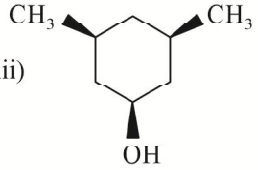
**60.** The total number of isomers for the alkyne with molecular formula $C_3HDClBr$ is:

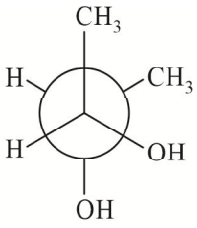
**61.** How many position isomers of dibromonaphthalene is possible if each ring of naphthalene has one halogen ?

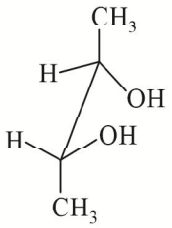
**62.** Number of meso compounds from the following is :

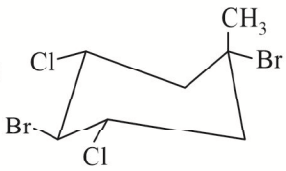
(i) 

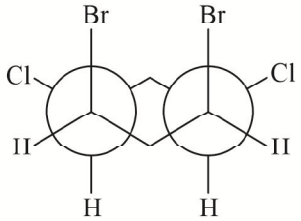

(ii) 

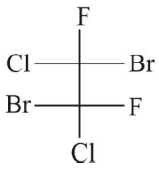

(iii) 


(iv) 


(v) 

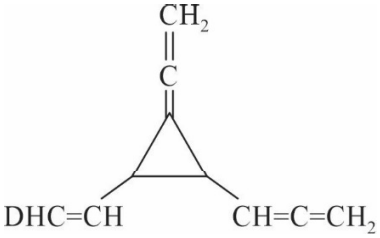

(vi) 


(vii) 


(viii) 


**63.** The total number of structural isomers with molecular formula $C_3H_7N$ which can show geometrical isomerism is:

**64.** Total number of stereo isomers corresponding to structure

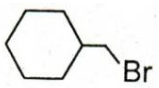
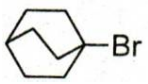
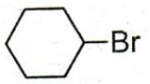
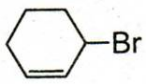


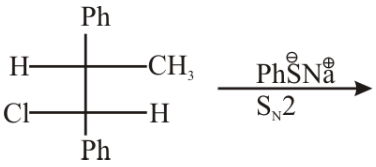
| Advanced Problem Package | Organic Halides & Organic Concepts |
|---|---|

## SINGLE CORRECT ANSWER TYPE

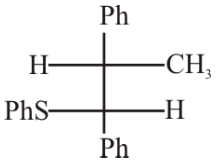
**Each of the following Question has 4 choices A, B, C & D, out of which ONLY ONE Choice is Correct.**

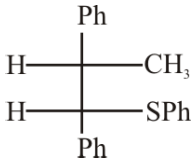
**1.** The compound, that undergoes $S_N1$ reaction most rapidly is:

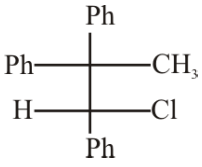
**(A)**  **(B)**  **(C)**  **(D)** 

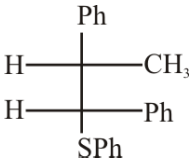
**2.** 

Principal organic product of the reaction will be :

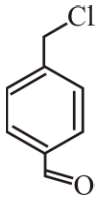
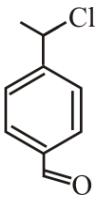
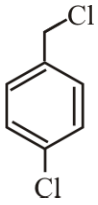
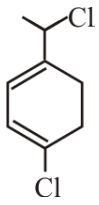

**(A)**


**(B)**

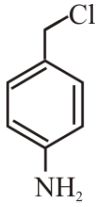
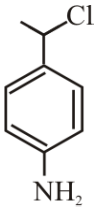
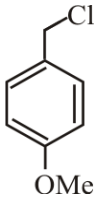
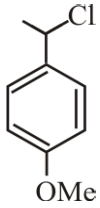

**(C)**

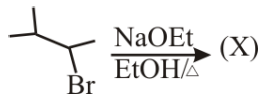

**(D)**

**3.** Which of the following benzyl halide would undergo $S_N2$ reaction faster?

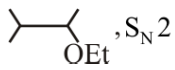
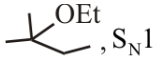
**(A)**  **(B)**  **(C)**  **(D)** 

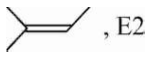
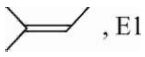
**4.** Which of the following benzyl halide would undergo $S_N1$ reaction faster ?

**(A)**  **(B)**  **(C)**  **(D)** 

**5.** 

The major product (X) and major reaction pathway is :

**(A)**  **(B)** 

**(C)**  **(D)** 

**6.** **(I)** $MeI + OH^- \longrightarrow MeOH + I^-$ **(II)** $MeI + NH_3 \longrightarrow Me\overset{\oplus}{N}H_3 + I^-$

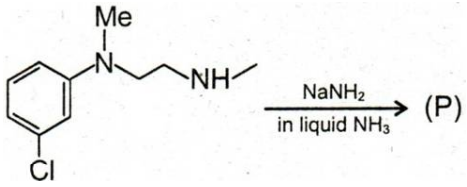
**(III)** $Me_2\overset{\oplus}{S}Me + OH^- \longrightarrow MeOH + Me_2S$ **(IV)** $Me_2\overset{\oplus}{S}Me + NH_3 \longrightarrow Me\overset{\oplus}{N}H_3 + Me_2S$

In which of the above $S_N2$ reactions, rate of the reaction increases on increasing the polarity of the solvent?

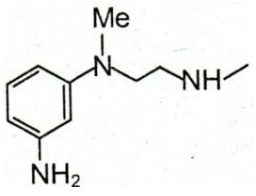
**(A)** (I) **(B)** (II)

**(C)** (III) **(D)** (IV)

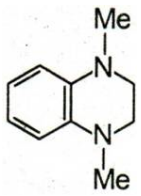
**7.** The product (P) of the given sequence of reaction,



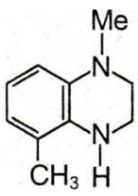

would be :



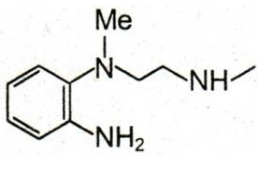

**(A)**



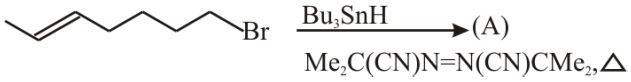

**(B)**




**(C)**




**(D)**

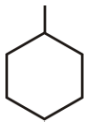
**8.** 


In the given reaction, the major product (A) would be :

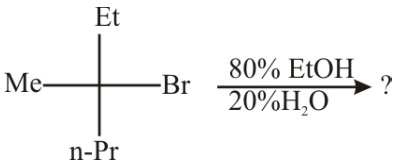
**(A)**

**(B)**

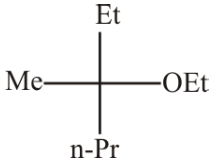
**(C)**



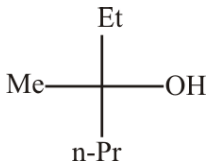
**(D)**

**9.** 

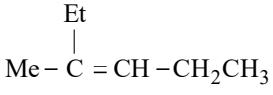

The major product of the above reaction is :



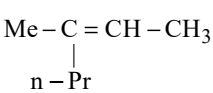

**(A)**




**(B)**

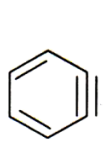



**(C)**

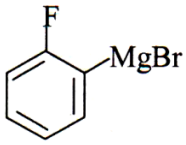



**(D)**

**10.** Treatment of o-bromofluorobenzene with one equivalent of Mg in presence of ether, generates

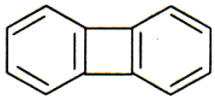


**(A)**



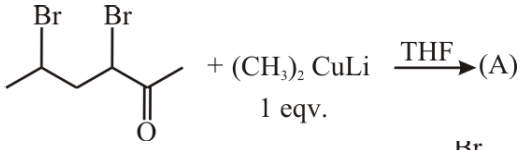

**(B)**

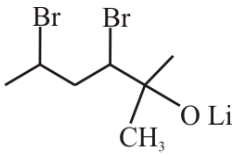

**(C)**



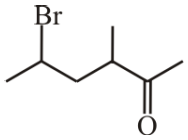
**(D)**

**11.** The major product of the given reaction is :

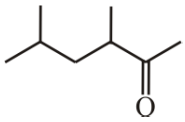


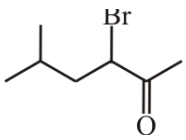

**(A)**



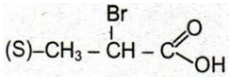

**(B)**



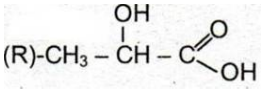

**(C)**



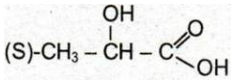

**(D)**

**12.** The nucleophilic substitution of 

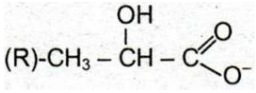
with dilute $OH^-$ followed by acidification gives



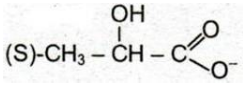

**(A)**



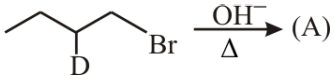

**(B)**



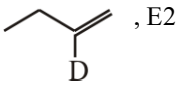

**(C)**




**(D)**

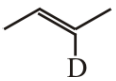
**13.** 


The major product of the reaction and major pathway followed is :



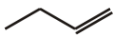

, E2

**(A)**




, E1

**(B)**



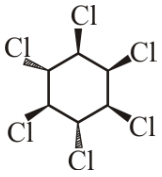
, E2

**(C)**

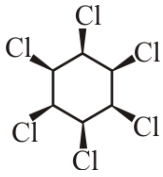
, E1

**(D)**

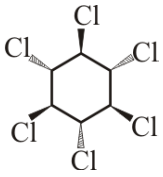
**14.** Which of the following hexachlorocyclohexane is the least reactive in an $E_2$ reaction?



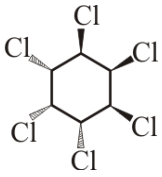

**(A)**




**(B)**

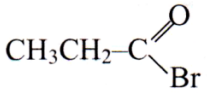



**(C)**

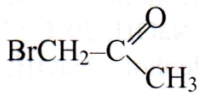



**(D)**

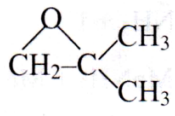
**15.** $CH_2 = C = O \xrightarrow{Br_2} \xrightarrow{CH_3MgBr} (X)$ . The structure of compound (X) would be :



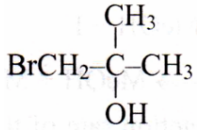

**(A)**




**(B)**

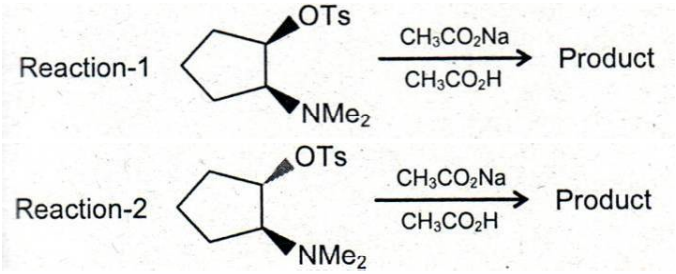


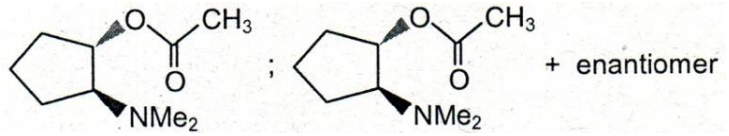

**(C)**

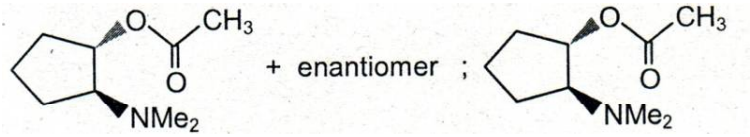


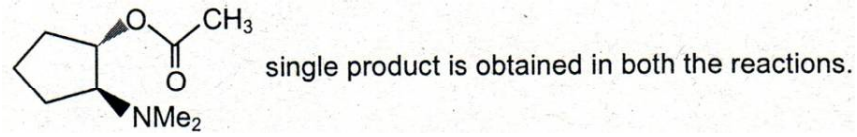

**(D)**

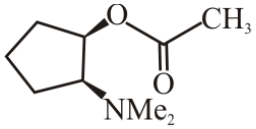
**16.** Identify products of the given reactions :




**(A)** 


**(B)** 

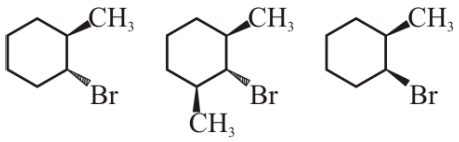

**(C)** 


**(D)** 

Single product is obtained in both the reactions.

**17.** The decreasing order of reactivity of following compounds in an E2 reaction is :

**(A)** 2 > 3 > 1
**(B)** 1 > 3 > 2
**(C)** 2 > 1> 3
**(D)** 3 > 1 > 2

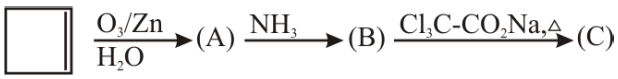


1 2 3

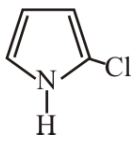
**18.** 

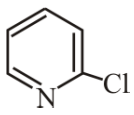

To get the required alkene, the most suitable base is

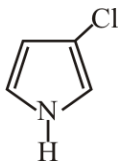
**(A)** NaOEt/EtOH **(B)** NaOMe/MeOH
**(C)** t-BuOK/t-BuOH **(D)** NaOPr/PrOH

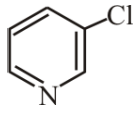
**19.** 


The product (C) would be :

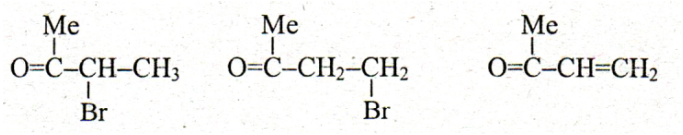
**(A)** 

**(B)** 

**(C)** 

**(D)** 

**20.** Both the following compounds (a) and (b) undergo base induced elimination of HBr to form the same product (c).



(a) (b) (c)

Which of the following statement is true?

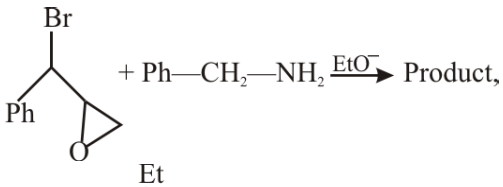
**(A)** (a) reacts faster than (b) **(B)** (b) reacts faster than (a)

**(C)** (a) and (b) react at the same rate **(D)** Cannot be predicted

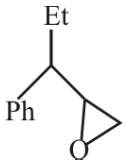
**21.** In an experiment starting with optically pure radioactive 2-iodopentane, the rate of racemization was found to be 1.80 times the rate of loss of radioactivity of the substrate. The % of reaction that proceeded by $S_N2$ mechanism is:

**(A)** 10% **(B)** 20% **(C)** 40% **(D)** 80%

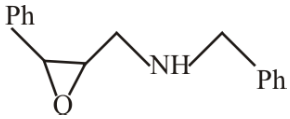
**22.**



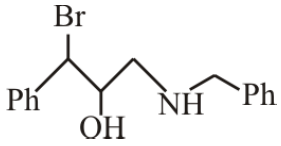
**(A)**



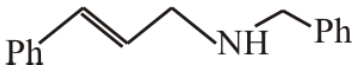
**(B)**



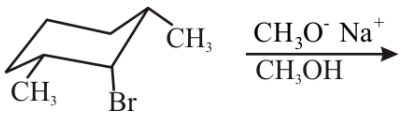
**(C)**



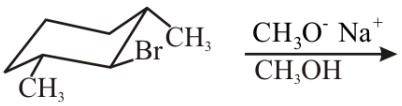
**(D)**



**23.**



(P)



(Q)

Which of the following is correct statement about compounds (P) and (Q)?

**(A)** Compound (P) undergoes reaction faster than compound (Q)

**(B)** Compound (P) undergoes reaction slower than compound (Q)

**(C)** Compound (P) undergoes reaction at the same rate as that of compound (Q)

**(D)** Can not be commented about their rate of reaction

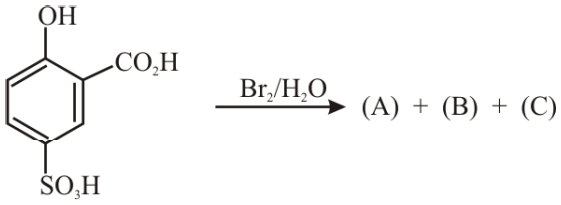
**24.** Which of the following is not true about given reaction?

**(A)** It is an example of electrophilic aromatic substitution reaction

**(B)** The electrophile is free $Br^+$

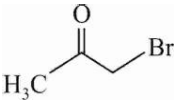
**(C)** It leads to tribromination

**(D)** If (A) is 2, 4, 6-tribromophenol, then (B) and (C) are $CO_2$ and $SO_3$ gases



**25.** 

Which of the following is correct about the given reaction sequence?

**(A)** (A) is 

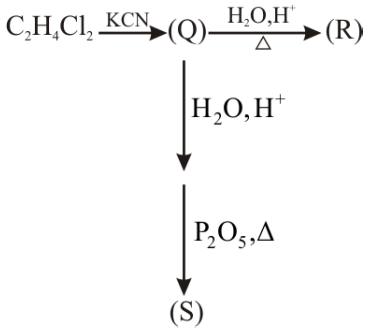
**(B)** Conversion of (A) to (B) take place via $S_N1$ pathway

**(C)** Reduction of (B) with $LiAlH_4$ gives 2- ketopentan-1-amine

**(D)** Acidic hydrolysis of (B) followed by heating gives original compound

## MULTIPLE CORRECT ANSWERS TYPE

**Each of the following Question has 4 choices A, B, C & D, out of which ONE or MORE Choices may be Correct:**

**26.** (P) : 

**(A)** If (P) is a vicinal dihalide, (S) is a cyclic anhydride

**(B)** If (P) is a geminal dihalide , (S) is a cyclic anhydride

**(C)** If (P) is a vicinal dihalide, (R) is a butane-1, 4-dioic acid

**(D)** If (P) is a geminal dihalide, (R) is a propanoic acid

**27.** Which of the following statement(s) is(are) correct?

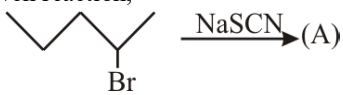
**(A)** $S_N1$ reaction of alkyl halides are catalysed by $Ag^+$ ion.

**(B)** $\alpha$ - Halo ketones undergo reaction by $S_N2$ mechanism but not by $S_N1$ mechanism.

**(C)** Hydrolysis of t- BuF is faster in acidic solution than in pure $H_2O$.

**(D)** $S_N2$ reactions never involve rearrangement.

**28.** In the given reaction,



Which of the following statement (s) is/are not true about (A)?

**(A)** With $S_N1$ pathway, the attack takes place through N.

**(B)** With $S_N1$ pathway, the attack takes place through S.

**(C)** With $S_N2$ pathway, the attack takes place through N.

**(D)** With $S_N2$ pathway, the attack takes place through S.

**29.** The rate law for the substitution reaction of 2-bromobutane and $OH^-$ in 75% ethanol and 25% $H_2O$ at 30ºC is Rate = $3.2\times10^{-5}$[2-bromobutane][$OH^-$] + $1.5\times10^{-6}$ [2-bromobutane].

Which of the following is/are true statement(s) when the concentration of $OH^-$ is 1.0 M?

**(A)** % of reaction occurring by $S_N1$ mechanism is 4.4%

**(B)** % of reaction occurring by $S_N1$ mechanism is 44%

**(C)** % of inversion product is 97.8%

**(D)** % of racemization in the reaction is 44%

**30.** Select the correct addition products among the following reactions.

**(A)** $CH_2=CHCH_3+HCl(aq.)\longrightarrow CH_3CH(Cl)CH_3$

**(B)** $CH_2=CHCH_3+HBr(aq.)\longrightarrow CH_3CH(Br)CH_3$

**(C)** $CH_2=CHCH_3+HBr\xrightarrow{Peroxide}CH_3CH_2CH_2Br$

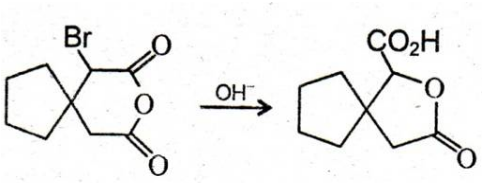
**(D)** $CH_2=CHCH_3+HI\xrightarrow{Peroxide}CH_3CH(I)CH_3$

**31.** Which of the following reagent(s) can be used to distinguish between $CH_2=CH-CH_2Cl$ and $CH_3CH_2CH_2Cl$?

**(A)** Sodium fusion; $HNO_3$ + $AgNO_3$ **(B)** Tollen's reagent

**(C)** $AgNO_3$ + $C_2H_5OH$ **(D)** Cold aq. $KMnO_4$

**32.**

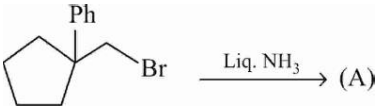


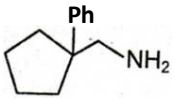

The given reaction involves:

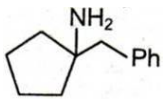
**(A)** Nucleophilic substitution at acyl carbon. **(B)** Nucleophilic substitution at alkyl carbon.

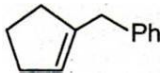
**(C)** Elimination **(D)** Ring contraction

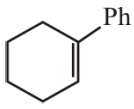
**33.** The product of the given solvolysis reaction would be :




**(A)** 


**(B)** 


**(C)** 


**(D)** 


**34.** (A) : $CH_3O-CH=CH-CH_2Br$ (B) : $CH_2=\overset{\overset{OCH_3}{|}}{C}-CH_2Br$

Which of the following is/are true about compounds (A) and (B)?

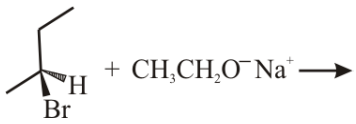
**(A)** Solvolysis of compound (A) is faster than compound (B)

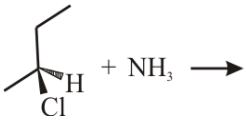
**(B)** $S_N2$ reaction of compound (A) is faster than compound (B)

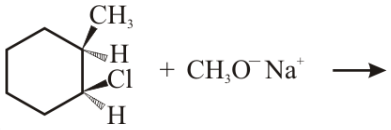
**(C)** $S_N2$ reaction of compound (B) is faster than compound (A)

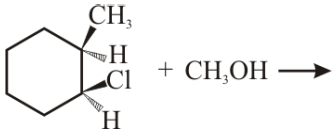
**(D)** Compound (A) undergoes rearrangement under $S_N1$ as well as $S_N2$ conditions

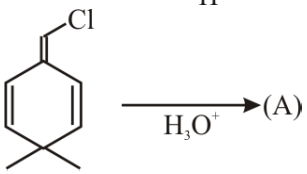
**35.** In which of the following reactions, inversion of configuration is mainly taking place?

**(A)** 

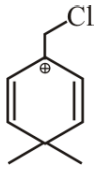
**(B)** 

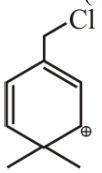
**(C)** 

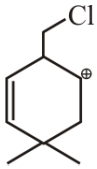
**(D)** 

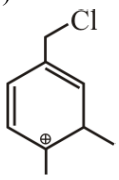
**36.** 

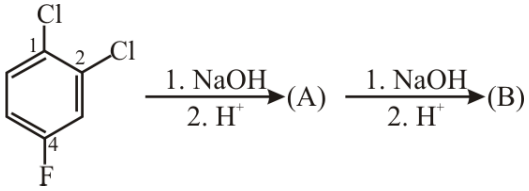
Which of the following is(are) intermediate(s) formed during the formation of product (A)?

**(A)** 

**(B)** 

**(C)** 

**(D)** 

**37.** 

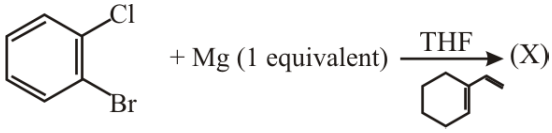
Which of the following is correct about the given reaction?

**(A)** During formation of (A), Cl at 1 is displaced by OH

**(B)** During formation of (A), F at 4 is displaced by OH

**(C)** During formation of (B), Cl at 2 is displaced by OH

**(D)** During formation of (B), F at 4 is displaced by OH

**38.** 

Which of the following is/are true about the reaction leading to formation of (X)?

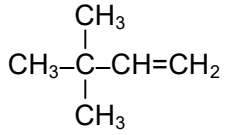
**(A)** Aryl bromide is more reactive than aryl chloride towards Grignard formation

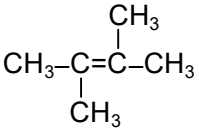
**(B)** The intermediate formed in the reaction is benzyne

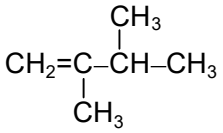
**(C)** The product formed has three six membered rings

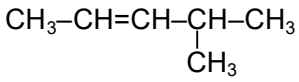
**(D)** (X) is formed via Diels – Alder reaction

**39.** When 2-iodo-3, 3-dimethylbutane is treated with $AgNO_3$ in ethanol/ethoxide, elimination reaction takes place. Identify all the products formed in the reaction.

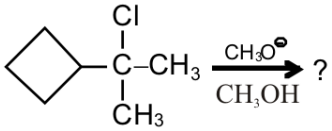
**(A)** 

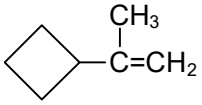
**(B)** 

**(C)** 

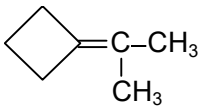
**(D)** 

**40.** Which of the following compound(s) is(are) formed in the given reaction?

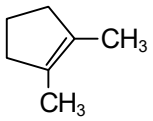




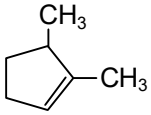
**(A)**



**(B)**

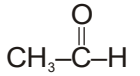
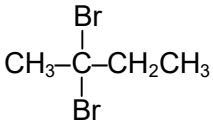
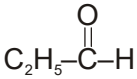
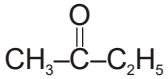


**(C)**



**(D)**

**41.** Which of the following compound(s) will give iodoform test on warming with $I_2$/NaOH?

**(A)**  **(B)**  **(C)**  **(D)** 

**42.** Ethyl alcohol, on treatment with bleaching powder gives chloroform. Which of the following is/are the function(s) of bleaching powder?

**(A)** Chlorinating agent **(B)** Oxidising agent

**(C)** Hydrolysing agent **(D)** None of these

**43.** Which of the following reaction products (major) is(are) incorrect?

**(A)** $(CH_3)_2CHCl + Ag - CN \longrightarrow (CH_3)_2CH - CN + AgCl$

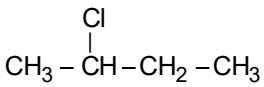
**(B)** $CH_3 - Cl + Na^+CN^- \longrightarrow CH_3{-}NC + NaCl$

(C) $(CH_3)_2CHCl + Ag - NO_2 \longrightarrow (CH_3)_2CH{-}NO_2 + AgCl$

**(D)** $CH_3 - Cl + NaNO_2 \longrightarrow CH_3{-}NO_2 + NaCl$

**44.** Which of the following compound(s) would result in the formation of isobutene on treatment / warming with alcoholic KOH?

**(A)** $(CH_3)_3C - Cl$ **(B)** $(CH_3)_2CH - CH_2Cl$

**(C)** $CH_3(CH_2)_2 - CH_2Cl$ **(D)** 

**45.** In the reaction, $R{-}COOAg + X_2 \rightarrow R - X + AgX + CO_2$ the best yield of R–X is obtained when :

**(A)** R– is 3° alkyl group **(B)** $X_2$ is bromine

**(C)** R– is 1° alkyl group **(D)** $X_2$ is iodine

**46.** In which of the following reactions, meta isomer is the major product?

**(A)** o-chlorotoluene + $NaNH_2$ in $NH_3(l)$ **(B)** o-chloroanisole + $NaNH_2$ in $NH_3$ ($l$)

**(C)** m-chlorotoluene + $NaNH_2$ in $NH_3(l)$ **(D)** m-chloroanisole + $NaNH_2$ in $NH_3$ ($l$)

**47.** Which of the following reaction will give chloroethene?

**(A)** Thermal decomposition of ethylene dichloride at 600 – 650ºC.

**(B)** Acetylene is passed into dilute hydrochloric acid at 65ºC in the presence of mercuric ions as catalyst.

**(C)** Ethylene dichloride is heated in presence of 1 equivalent of alc. KOH.

**(D)** Ethane is heated in presence of chlorine at 400ºC.

**48.** The reaction of isopropyl bromide with silver nitrite gives :

(A) 1–nitropropane **(B)** propane **(C)** 2–nitropropane **(D)** 2–nitritopropane

**49.** Which of the following is(are) correct statement(s)?

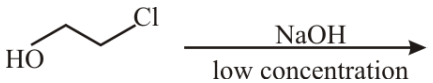
**(A)** Rate of reaction of $Me_3C-Br+H_2O$ is greater than that of $Me_3C-Cl+H_2O$

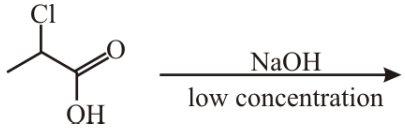
**(B)** Rate of reaction of $Me_3C-Cl+H_2O$ is greater than that of $Me_3C-Cl+CH_3OH$

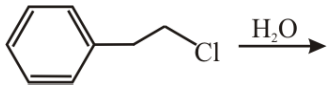
**(C)** Rate of reaction of $Et_3C-Cl+H_2O$ is equal to that of $Me_3C-Cl+H_2O$

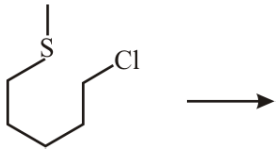
**(D)** Rate of reaction of $Me_3C-Cl+CH_3SH$ is greater than that of $Me_3C-Cl+CH_3OH$

**50.** Which of the following reaction involves neighbouring group participation?

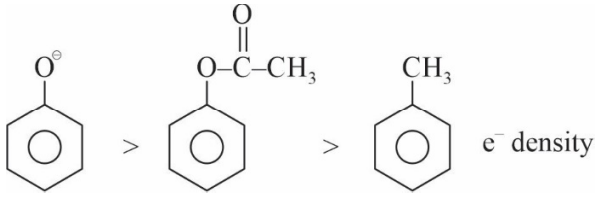
**(A)** 

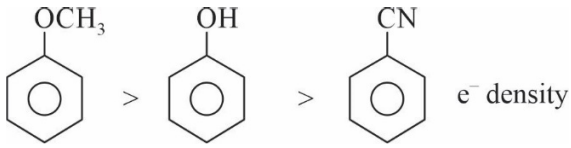

**(B)** 

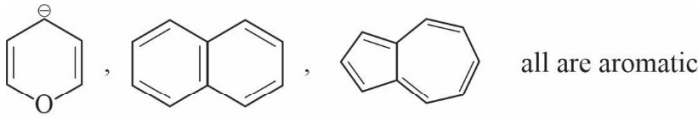

**(C)** 

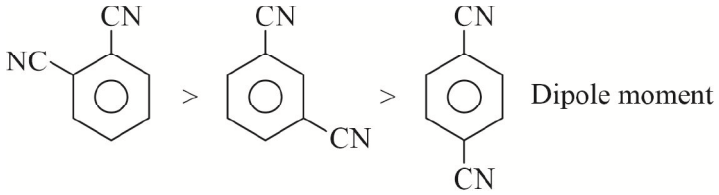

**(D)** 


**51.** Which of the following is/are correct statement :

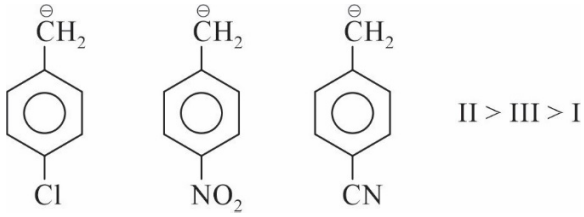
**(A)** 


**(B)** 

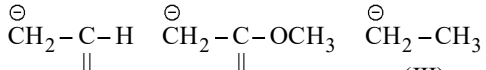

**(C)** 


**(D)** 

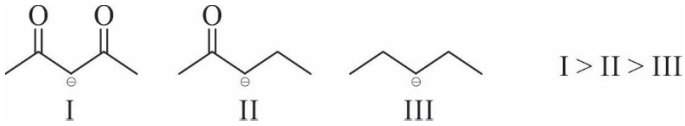
**52.** Which of the following stability order of anions is/are correct :

**(A)** 

(I) (II) (III) II > III > I

**(B)** 

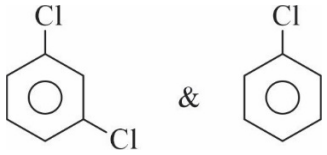
(I) (II) (III) I > II > III

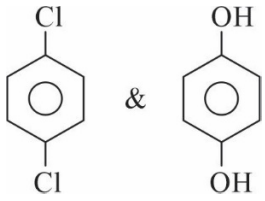
**(C)** 

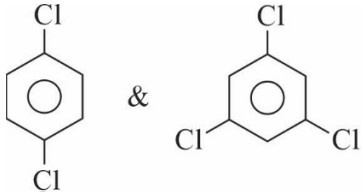
I II III I > II > III

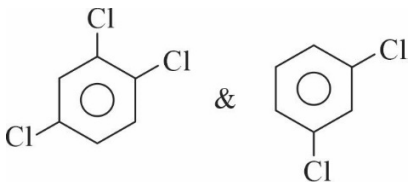
**(D)** $\overset{\ominus}{C}H_3 > \overset{\ominus}{C}D_3$

**53.** Which of the following pairs have same dipole moment

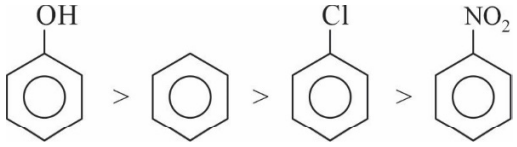
**(A)** 

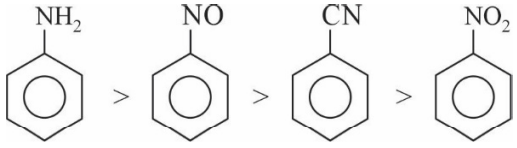

**(B)** 

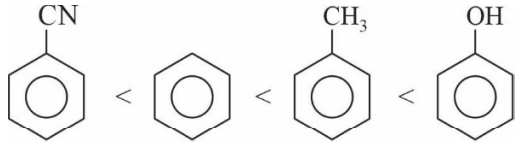

**(C)** 

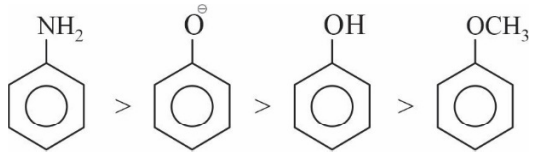

**(D)** 


**54.** Which is/are the correct order of electron density in aromatic ring?

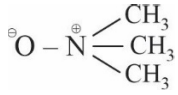
**(A)** 


**(B)** 

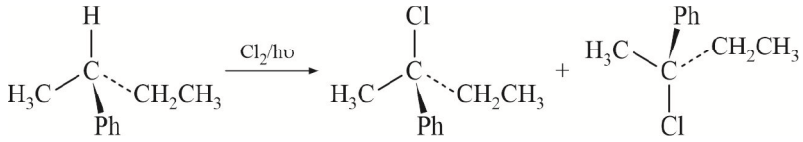
**(C)** 

**(D)** 

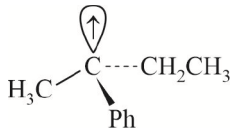
**55.** In which cases delocalization of charge is possible ?

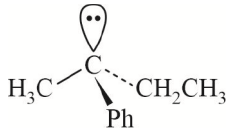
**(A)**  **(B)**  **(C)**  **(D)** 

**56.** Observe the following reaction and given products.

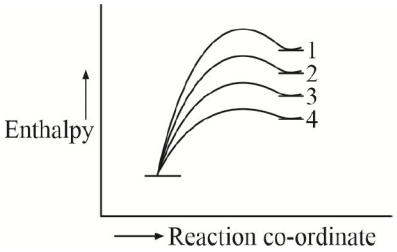


In this reaction the structures of reaction intermediate should be :

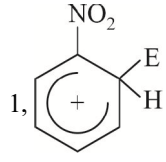
**(A)**  **(B)** 

**(C)**  **(D)** 

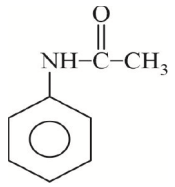
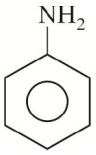
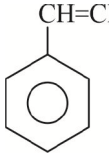
**57.**



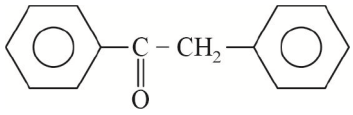
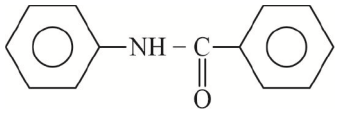

Out of the followings which one is/are correct :

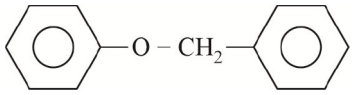
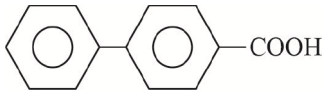
**(A)**  **(B)**  **(C)**  **(D)** 

**58.** Friedel craft acylation is/are not observed in :

**(A)**  **(B)**  **(C)**  **(D)** 

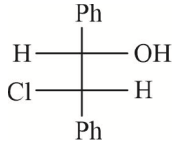
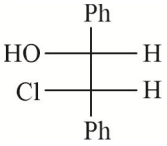
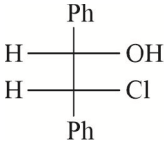
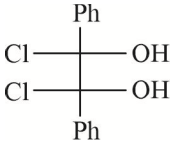
**59.** In which of following electrophilic aromatic substitution reaction takes place on left hand side phenyl ring ?

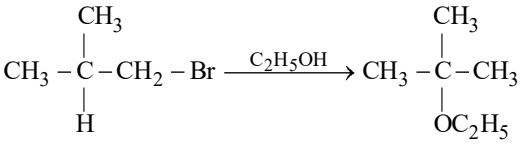
**(A)**  **(B)** 

**(C)**  **(D)** 

**60.** $Ph-C\equiv C-Ph \xrightarrow{Na/NH_3} A \xrightarrow{HOCl/H^+} B$

B is/are :

**(A)**  **(B)**  **(C)**  **(D)** 

**61.** 

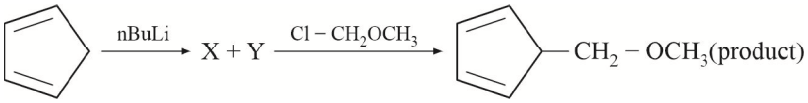
What is correct about the given reaction ?

**(A)** It is unimolecular nucleophilic substitution reaction

**(B)** Major product obtained by rearranged carbocation

**(C)** It is two step process

**(D)** Rate of reaction depends on the concentration of alkyl halide and nucleophile

**62.** 

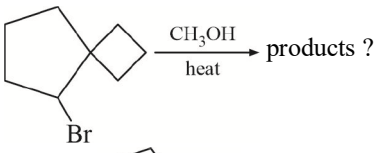
In the above reaction which of the following are correct ?

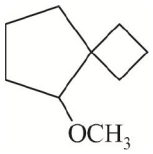
**(A)** step-1 is an acid-base reaction

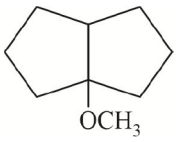
**(B)** step-2 is an $S_N2$ reaction

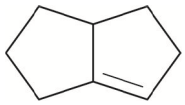
**(C)** X = n-Butane ; Y = aromatic salt

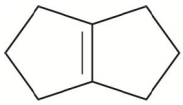
**(D)** the nucleophile in 2nd reaction is : $Bu^{\ominus}$

**63.** 


**(A)** 

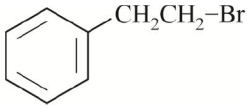

**(B)** 


**(C)** 

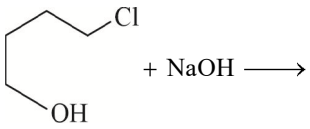
**(D)** 

**64.** Which of the following will give major product by $S_N2$ ?

**(A)** $CH_3CH_2SNa + CH_3CH_2Cl \longrightarrow$

**(B)** 

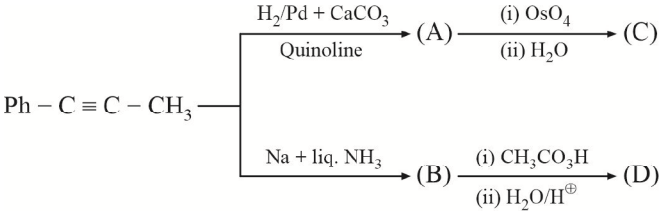
$+ NaCN \xrightarrow{\text{acetone}}$

**(C)** 

$+ NaOH \longrightarrow$

**(D)** $CH_3(CH_2)_8CH_2Cl + NaI \xrightarrow{\text{acetone}}$

**65.** Consider the following reaction sequence and choose the correct options.




**(A)** (A) and (B) are diastereomer's of each other

**(B)** Upon catalytic hydrogenation (A) and (B) gives same product

**(C)** Product (C) and (D) are identical

**(D)** Product (C) and (D) can be separated by fractional distillation

**66.** Two optically active acyclic compounds X and Y (molecular formula $C_5H_9Br$) give following reactions :

$$X \xrightarrow{H_2(1\text{ mole})} W\,(\text{achiral})$$

$$Y \xrightarrow{H_2(1\text{ mole})} S\,(\text{chiral})$$

Which of the following is/are correct ?

**(A)** $W = CH_3 - CH_2 - \underset{\displaystyle Br}{\underset{|}{CH}} - CH_2 - CH_3$

**(B)** $Y = CH_3 - \underset{\displaystyle Br}{\underset{|}{CH}} - CH_2 - CH = CH_2$

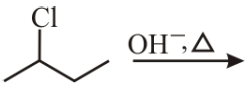
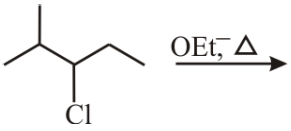
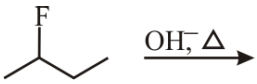
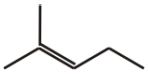
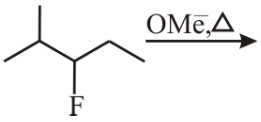
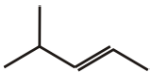
**(C)** $X = CH_3 - CH_2 - \underset{\displaystyle Br}{\underset{|}{C}} = CH - CH_3$

**(D)** $S = CH_3 - \underset{\displaystyle Br}{\underset{|}{CH}} - CH_2 - CH_2 - CH_3$

## MATRIX MATCH TYPE

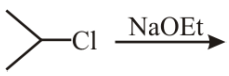
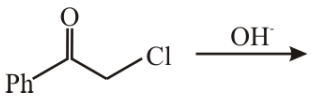
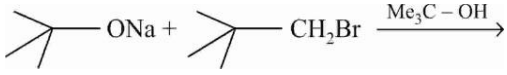
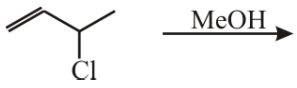
**Each of the following question contains statements given in two columns, which have to be matched. Statements in Column 1 are labelled as (A), (B), (C) & (D) whereas statements in Column 2 are labeled as p, q, r, s & t. More than one choice from Column 2 can be matched with Column 1.**

**67.** Match the following reaction in list I with appropriate products in list II and select the correct answer using the code given below the lists.

| | List I | | List II |
|---|---|---|---|
| **(P)** |   | **1.** |  |
| **(Q)** |   | **2.** |  |
| **(R)** |   | **3.** |  |
| **(S)** |   | **4.** |  |

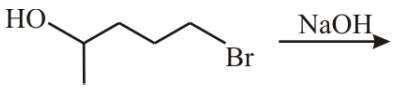
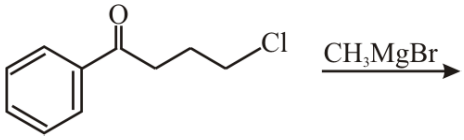
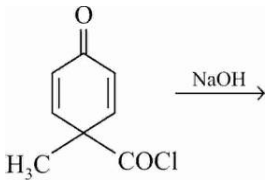
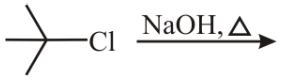
| | P | Q | R | S | | P | Q | R | S |
|---|---|---|---|---|---|---|---|---|---|
| **(A)** | 2 | 4 | 1 | 3 | **(B)** | 2 | 3 | 1 | 4 |
| **(C)** | 1 | 4 | 2 | 3 | **(D)** | 1 | 3 | 2 | 4 |

**68.** Match the following reaction in list –I with appropriate reaction in list – II and select the correct answer using the code given below the lists:

| | List I | | List II |
|---|---|---|---|
| **(P)** |   | **1.** | $S_N2$ |
| **(Q)** |   | **2.** | E2 |
| **(R)** |   | **3.** | $S_N1$ |
| **(S)** |   | **4.** | E1 |

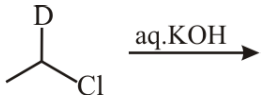
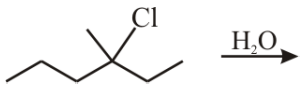
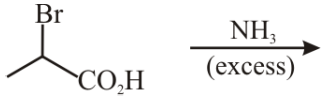
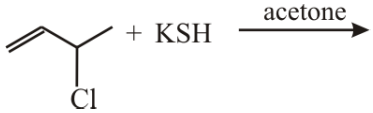
| | P | Q | R | S | | P | Q | R | S |
|---|---|---|---|---|---|---|---|---|---|
| **(A)** | 2 | 1 | 4 | 3 | **(B)** | 2 | 1 | 3 | 4 |
| **(C)** | 1 | 3 | 2 | 4 | **(D)** | 1 | 3 | 4 | 2 |

**69.** Match the following reaction in list –I with appropriate comment in list – II and select the correct answer using the code given below the lists:

| | List I | | List II |
|---|---|---|---|
| **(P)** |   | **1.** | Nucleophilic substitution |
| **(Q)** |   | **2.** | Nucleophilic acyl substitution |
| **(R)** |   | **3.** | Elimination |
| **(S)** |   | **4.** | Nucleophilic addition |

| | P | Q | R | S | | P | Q | R | S |
|---|---|---|---|---|---|---|---|---|---|
| **(A)** | 1 | 4 | 3 | 2 | **(B)** | 3 | 4 | 2 | 1 |
| **(C)** | 1 | 4 | 2 | 3 | **(D)** | 2 | 4 | 1 | 3 |

**70.** **MATCH THE FOLLOWING:**

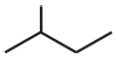
| | Column I | | Column II |
|---|---|---|---|
| **(P)** |   | **(A)** | Inversion |
| **(Q)** |   | **(B)** | Racemization |
| **(R)** |   | **(C)** | Retention |
| **(S)** |   | **(D)** | Mixture of inversion and an optically inactive product |
| | | **(E)** | $S_N2$ |

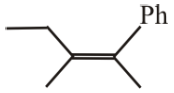
**71. MATCH THE FOLLOWING:**

| | Column I | | Column II |
|---|---|---|---|
| **(P)** | C – X is broken in RDS | **(A)** | E1cB |
| **(Q)** | Rate of reaction increases to a small extent by the presence of an electron withdrawing group at β-position. | **(B)** | $S_N1$ |
| **(R)** | $\frac{k_H}{k_D}=1$ | **(C)** | $S_N2$ |
| **(S)** | Product formation increases by a large extent by the presence of an electron withdrawing group at β-position. | **(D)** | E2 |
| | | **(E)** | No Kinetic isotope effect |

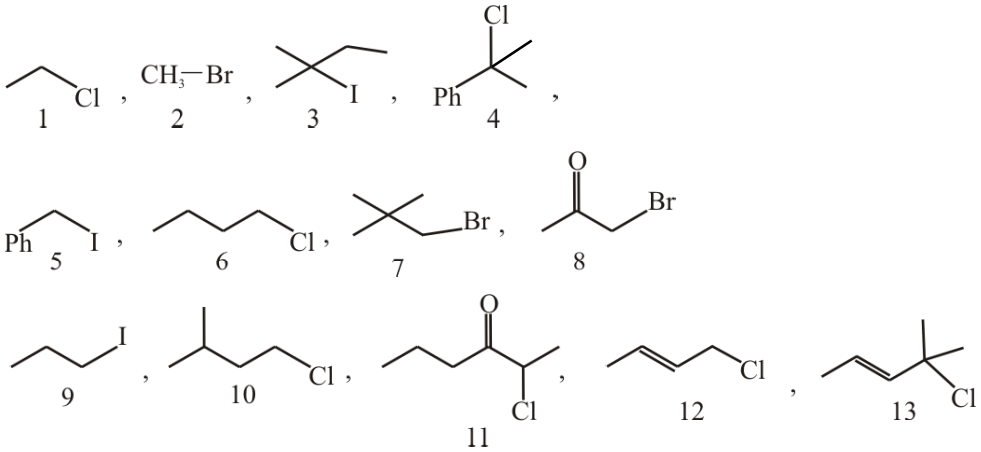
## Numerical Value Type

**The Answer to the following questions are positive integers of 1/2/3 digits and zero**

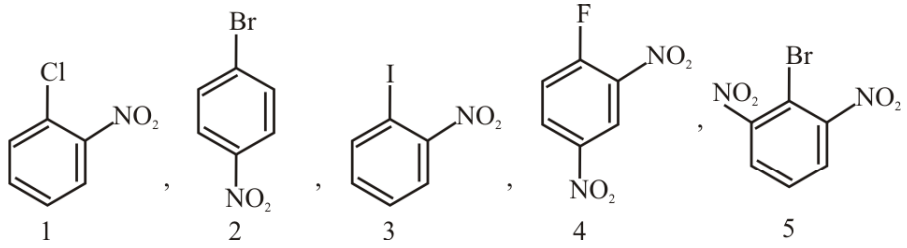
**72.** The number of optically active compounds formed on monochlorination of  will be _____.

**73.** How many alkyl chlorides can be used for the preparation of given alkene  ?

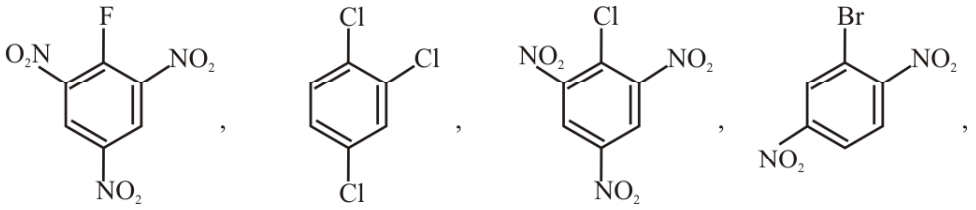
**74.** How many of the following alkyl halides can undergo reaction by $S_N2$ mechanism under suitable conditions?



**75.** Which of the following aryl halides will undergo reaction by bimolecular $S_NAr$ pathway at the fastest rate?



1, 2, 3, 4, 5



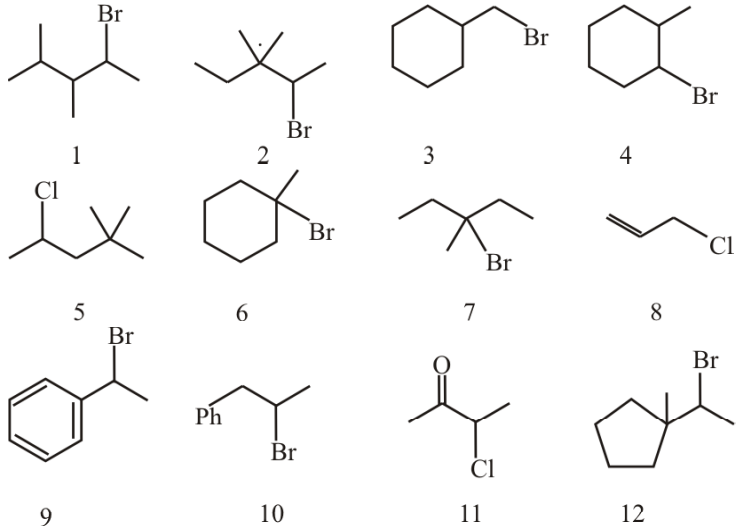
6, 7, 8, 9

**76.** How many optically active bromides are possible with molecular formula $C_5H_{11}Br$ ?

**77.** $\underset{\text{Allyl diazomethane}}{CH_2 = CH - CH_2 - CHN_2} \xrightarrow{\text{Light}} (A)$

The molecular weight of the compound (A) is 'xy'.
The sum of x and y is _____.

**78.** How many of the following alkyl halides form a substitution product in an $S_N1$ reaction that is different from that formed in an $S_N2$ reaction?

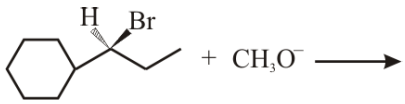
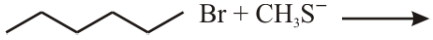
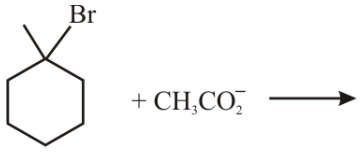
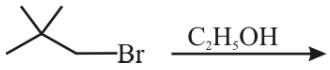
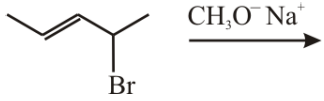
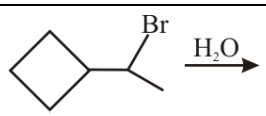
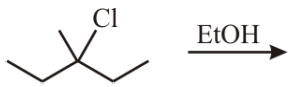
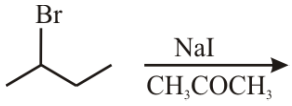
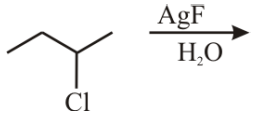
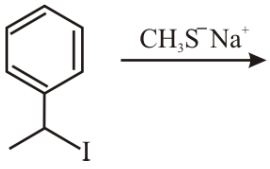


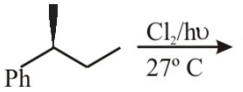
1, 2, 3, 4

5, 6, 7, 8

9, 10, 11, 12

**79.** In how many of the following reactions, the rate of reaction increases by increasing the concentration of nucleophile?

| | | | |
|---|---|---|---|
| **1.** |   | **2.** |   |
| **3.** |   | **4.** |   |
| **5.** |   | **6.** |   |
| **7.** |   | **8.** |   |
| **9.** |   | **10.** |   |

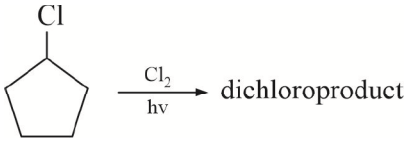
**80.** In the given reaction,   'm' products. What is the value of 'm'?

**81.**   . In the given reaction, the degree of unsaturation in product (A) is ____.

**82.** $CH_3COCH_3$ is treated with $I_2$ and NaOH to form yellow precipitate of iodoform. Find out sum of stoichiometric coefficients of all reactants of balanced reaction of acetone with $I_2$ and NaOH to form iodoform.

**83.** An ester $C_4H_8O_2$ on reaction with excess of $CH_3MgBr$ in dry ether followed by acidification produce alcohol $C_3H_8O$ as sole organic product. Find out number of carbon atoms in principal chain of ester $C_4H_8O_2$.

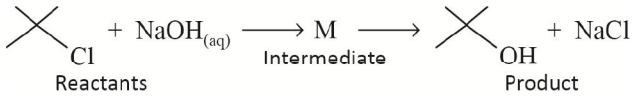
**84.** Identify total number of theoretically possible dichloro products formed in following reaction.




**85.** Total number of position isomers of tetrachlorocyclobutane which can show geometrical isomerism are :

**86.** How many butyl bromide can be converted into Grignard reagent followed by their reaction with acid to form n-Butane.

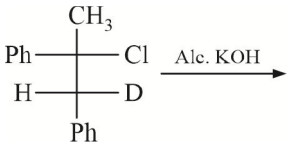
**87.** Consider the following reaction sequence.



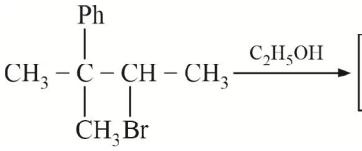

How many hyperconjugative structures are possible for intermediate M of above reaction ?

**88.** $CH_3-\underset{\underset{O}{\|}}{C}-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow[\text{(excess)}]{PhMgBr} \xrightarrow{H_2O}$ Number of product (X) $\xrightarrow{\text{Fractional distillation}}$ Number of fractions (Y)

Report your answer as XY.

**89.** 

Total number of possible alkenes are :

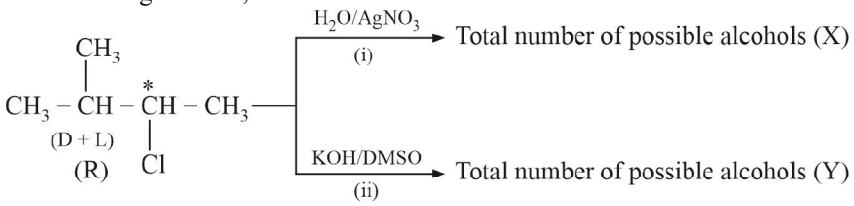
**90.** 

X [Number of substitution products including stereoisomers (all possible)]

Y [Number of elimination products including stereoisomers (all possible)]

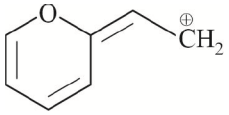
Report your answer as X|Y

**91.** Consider the following reaction,

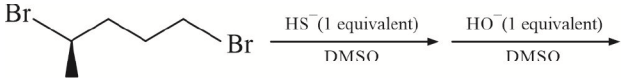



Report your answer as X|Y

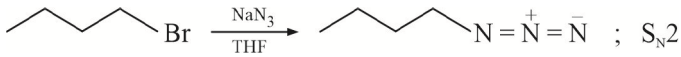
**92.** How many p-electrons are involved in resonance in the given structure ?

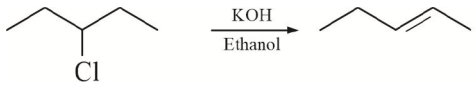


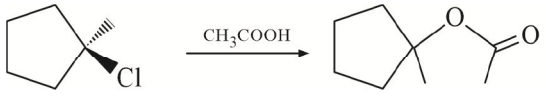

**93.** What is percent of sulphur in major product of the following reaction?

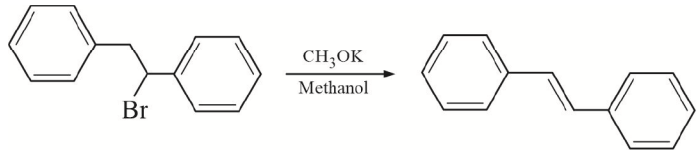



**94.** How many of the following reactions are correctly matched with reaction mechanism ?

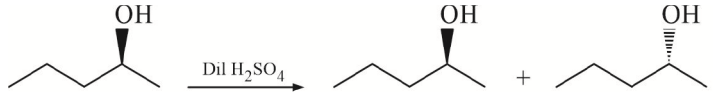
1. 


2. 


3. 

4. 

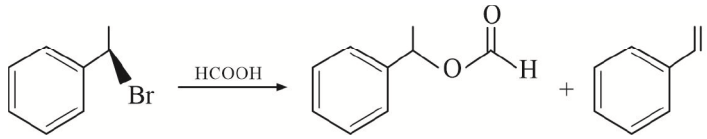
; E2

5. 

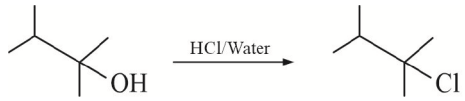
; $S_N1$

6. 

; E1CB

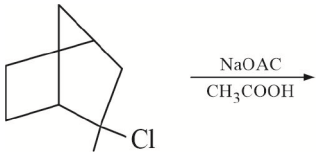
7. 

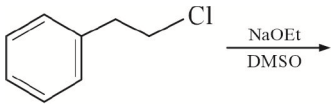
; E1

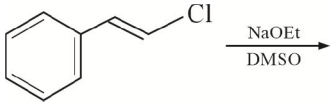
8. 

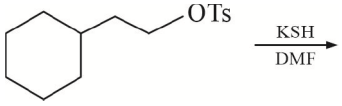
; $S_N1$

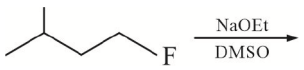
**95.** How many of the following reactions are most likely to proceed through $S_N1$ pathway?

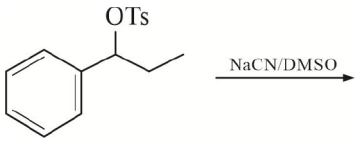
1. 

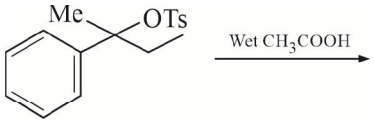

2. 

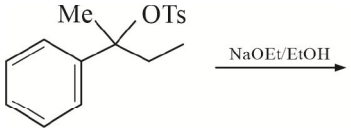

3. 

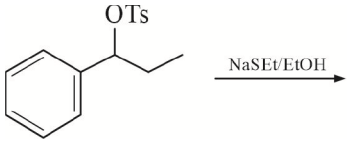

4. 

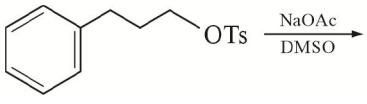

5. 


6. 

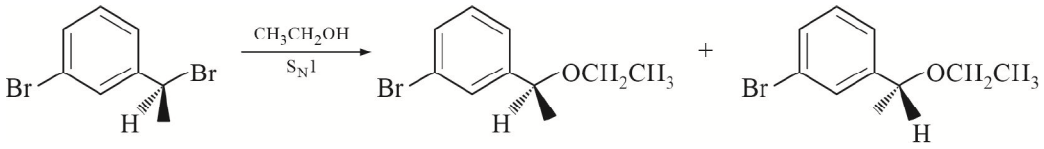

7. 

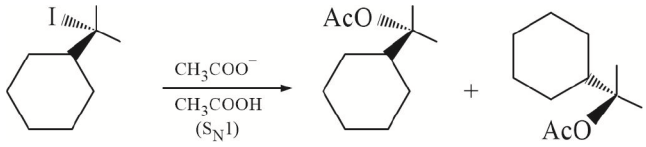

8. 

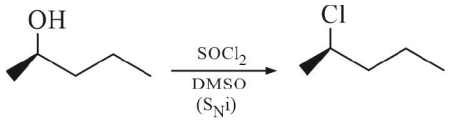

9. 

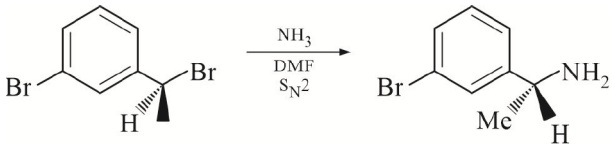

10. 

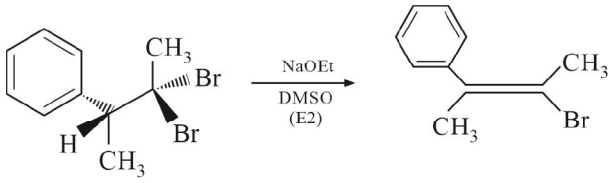
**96.** How many of the following reactions are correctly labelled with respect to reaction mechanism and stereochemistry of product wherever possible?

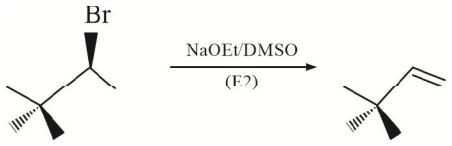
1. 

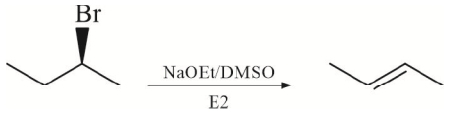

2. 

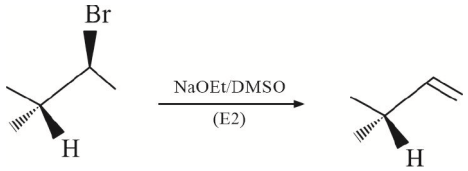

3. 


4. 

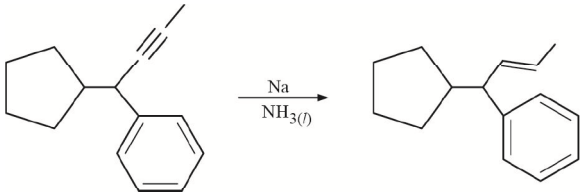

5. 

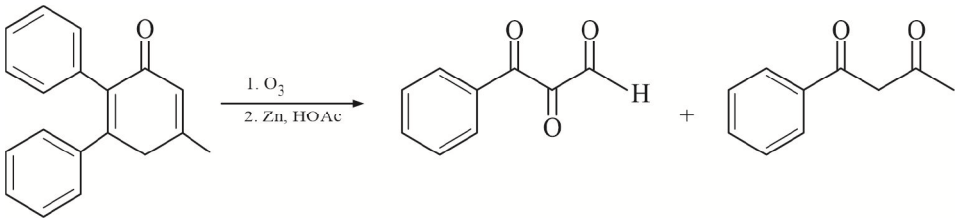

6. 

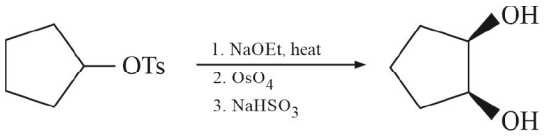

7. 

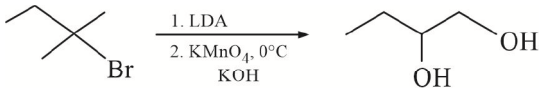

8. 

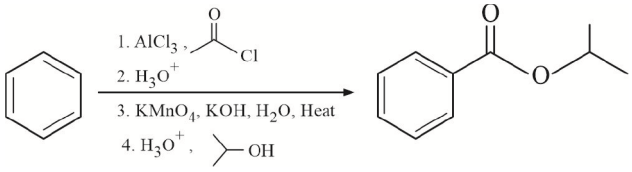
**97.** How many of the following reactions are correctly represented ?

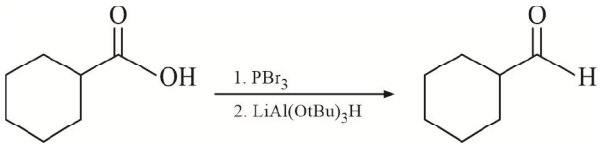
1. 

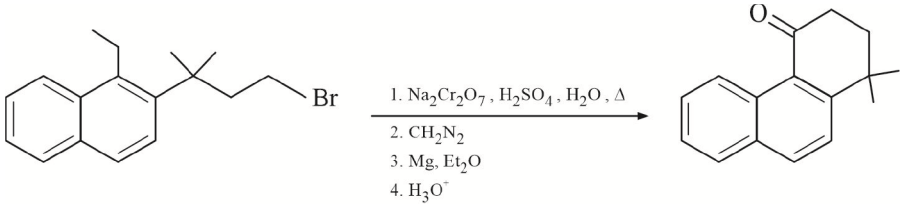

2. 

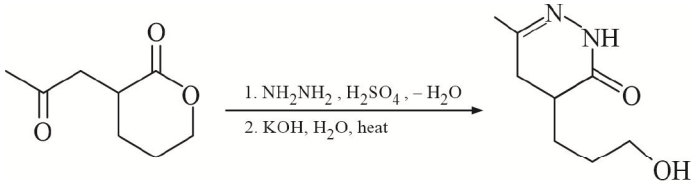

3. 


4. 

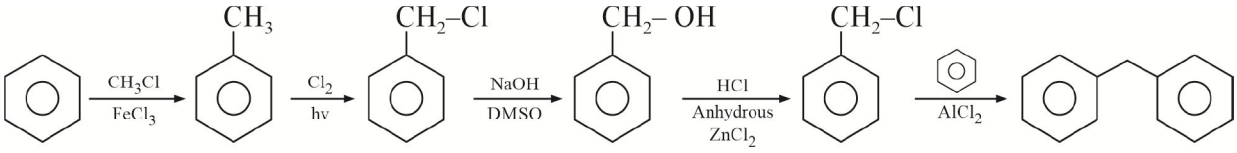

5. 


6. 


7. 


8. 

**98.** In the following sequence of reactions, number of Nucleophilic substitution is :

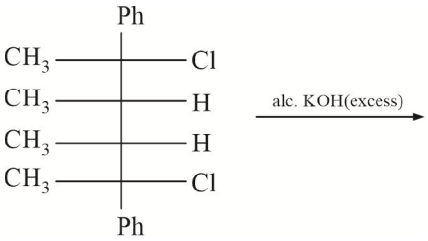



**99.** Rearrangement of carbon skeleton of substrate is possible in which of the following reactions?

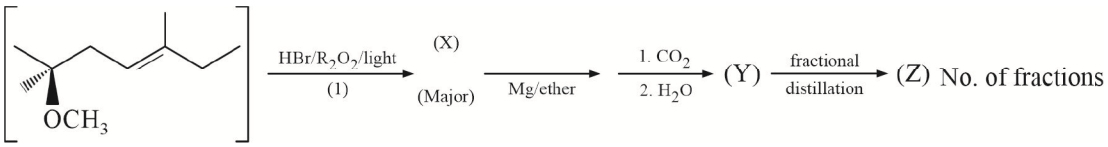
EAS (Electrophilic aromatic substitution), electrophilic addition on alkenes, free radical substitution of alkanes,

$S_N1$, $S_N2$, E1, E2, E1cB, $S_N2Ar$

**100.** Find the number of products (including stereoisomers) formed in the following reaction (consider only major product).

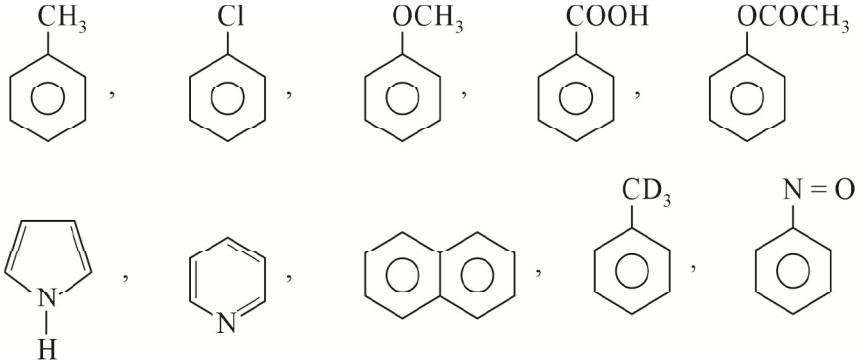



**101.**

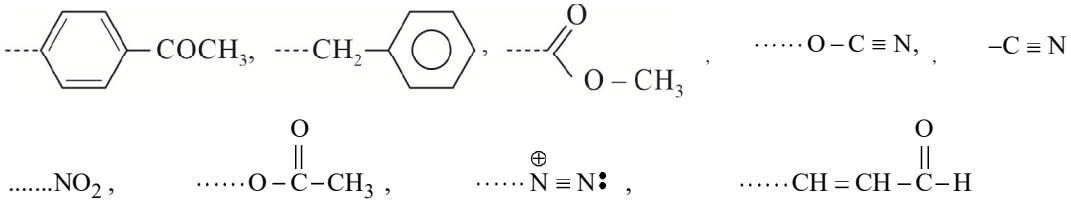



Find the value of (Z).

**102.** How many compounds are more reactive than benzene towards Nitration?



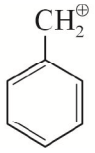
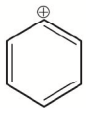

**103.** How many of the following groups exert –M effect?

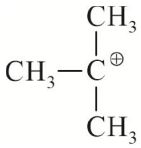


**104.** $CH_2=CH-CH_2-C\equiv C-CH=CH-\overset{\overset{\cdot\cdot}{\cdot\,O\,\cdot}}{\underset{\|}{C}}-H$

The maximum number of $\pi-$ electron pairs in direct conjugation with each other is :

**105.** Number of carbocations which are more stable than $CH=CH-\overset{\oplus}{C}H_2$ from the following is:

(i)  (ii)  (iii)  (iv)  (v)  (vi) 

(vii)  (viii) $CH_3-\overset{\oplus}{C}H-CH_3$ (ix) $O=CH-\overset{\oplus}{C}H_2$

**106.** How many compounds are more reactive than ethene towards electrophilic addition?

$CH_3-CH=CH_2$ , $H-\overset{\overset{O}{\|}}{C}-CH=CH_2$ , $Cl-CH=CH_2$ , $CH_3-O-CH=CH_2$ ,

(I) (II) (III) (IV)

$H-C\equiv C-H$ , $Ph-CH=CH_2$ , $CH_2=CH-CH=CH_2$

(V) (VI) (VII)

**107.** Calculate total number of alkene products when 3-chloro-3-methyl heptane react with alcoholic KOH and heat.