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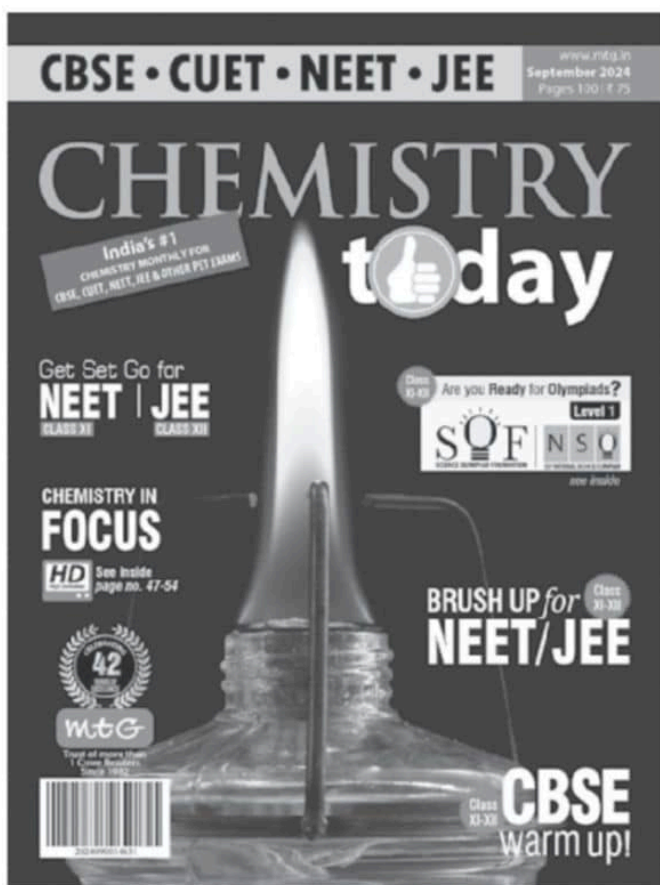
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CBSE
warm up!



CHEMISTRY today

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Managing Editor
Mahabir Singh

Editor
Anil Ahlawat

Corporate Office:

Plot 99, Sector 44 Institutional area, Gurugram -122 003 (HR).
Tel : 0124-6601200 e-mail : info@mtg.in website : www.mtg.in

Regd. Office:

406, Taj Apartment, Near Safdarjung Hospital, New Delhi - 110029.

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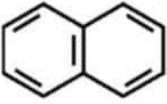
GET SET GO

NEET

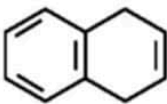
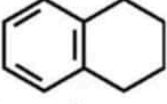
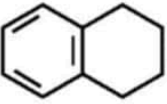
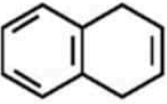
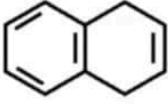
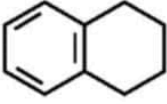


with exclusive and brainstorming questions

Practicing these questions helps to strengthen your concepts and give you extra edge in your NEET preparation

- Select the statement which is not true for the long form of the Periodic Table.
 - It reflects the sequence of filling the electrons in the order of the sub-energy shells s , p , d and f .
 - It helps to predict the stable valency states of the elements.
 - It reflects trends in physical and chemical properties of the elements.
 - It helps to predict relative ionicity of the bond between any two elements.
- 'A' $\xleftarrow[\text{C}_5\text{H}_{11}\text{OH}]{\text{Na in boiling}}$  $\xrightarrow[\text{C}_2\text{H}_5\text{OH}]{\text{Na in boiling}}$ 'B'

'A' and 'B' are

 - $A = B =$ 
 - $A = B =$ 
 - $A =$  , $B =$ 
 - $A =$  , $B =$ 

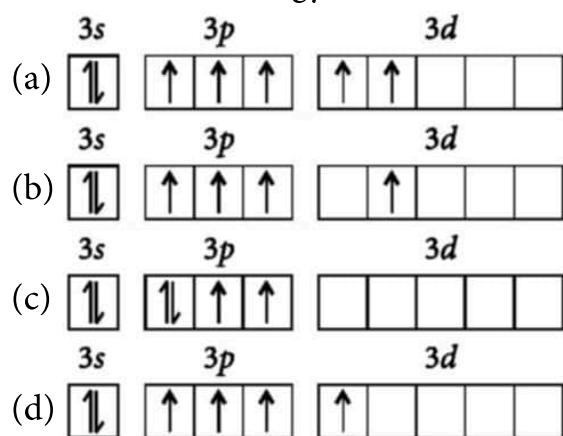
- In Dumas method of nitrogen estimation, nitrogen is
 - absorbed in KOH
 - collected in upper part of graduated tube
 - gets converted to ammonium sulphate
 - all of these.
- The major product obtained from E2-elimination of 3-bromo-2-fluoropentane is
 - $\text{CH}_3-\text{CH}=\text{CH}-\overset{\text{F}}{\text{C}}-\text{CH}_3$
 - $\text{CH}_3\text{CH}_2-\overset{\text{Br}}{\text{C}}-\text{CH}=\text{CH}_2$
 - $\text{CH}_3\text{CH}_2\text{CH}=\overset{\text{F}}{\text{C}}-\text{CH}_3$
 - $\text{CH}_3-\text{CH}_2-\overset{\text{Br}}{\text{C}}=\text{CH}-\text{CH}_3$
- What will be the value of pH of 0.01 mol dm^{-3} CH_3COOH ($K_a = 1.74 \times 10^{-5}$)?
 - 3.4
 - 3.6
 - 3.9
 - 3.0
- The average charge on each O atom and average bond order of I-O bond in IO_6^{5-} are

- (a) -1 and 1.67 (b) $-5/6$ and 1.67
 (c) $-5/6$ and 1.33 (d) $-5/6$ and 1.167

7. Which of the following statements is correct in relation to the halogenation of alkane?

- (a) The reactivity of chlorine is less than bromine towards alkanes.
 (b) For photochemical chlorination of methane, $\text{Cl}\cdot$ is formed in slowest step.
 (c) Free radicals are pyramidal intermediate, stabilised by hyperconjugation and resonance.
 (d) Bromine has much higher regioselectivity than chlorine in abstracting 3° hydrogen.

8. Which of the following electronic configurations has maximum energy?



9. Conversion of oxygen into ozone is non-spontaneous at

- (a) all temperatures (b) high temperature
 (c) room temperature (d) low temperature.

10. The group having triangular planar structures is

- (a) NCl_3 , BCl_3 , SO_3 (b) CO_3^{2-} , NO_3^- , SO_3
 (c) NH_3 , SO_3 , CO_3^{2-} (d) BF_3 , NF_3 , CO_3^{2-}

11. Which one of the following groups represent a collection of isoelectronic species?

(At. no. Cs = 55, Br = 35)

- (a) N^{3-} , F^- , Na^+ (b) Be , Al^{3+} , Cl^-
 (c) Ca^{2+} , Cs^+ , Br (d) Na^+ , Ca^{2+} , Mg^{2+}

12. 0.701 g of silver salt of a dibasic acid on ignition yielded 0.497 g of metallic silver. Molecular weight of the acid is ($\text{Ag} = 108$)

- (a) 90.7 (b) 304.7
 (c) 88.7 (d) 197.7

13. Which of the following statements are correct concerning redox properties?

- (i) A metal M for which E° for the half cell reaction $M^{n+} + ne^- \rightleftharpoons M$ is highly negative will be a good reducing agent.

(ii) The oxidising power of the halogens decreases from chlorine to iodine.

(iii) The reducing power of hydrogen halides increases from hydrogen chlorides to hydrogen iodide.

(iv) Higher the reduction potential, more is the reducing power.

- (a) (i), (ii) and (iii) (b) (i), (ii) and (iv)
 (c) (i) and (iii) (d) (ii), (iii) and (iv)


14. The statements that are true for silicates among the following are

- Each silicon atom has four Si—O bonds arranged tetrahedrally.
- Because of the availability of d -orbitals in Si, water molecules can coordinate with Si and bring about hydrolysis readily.
- Si—O bonds are strong; hence silica is inert having high melting point.
- Each oxygen atom in SiO_2 is shared by 4 silicon atoms in the tetrahedra.

- (a) 1, 2, 4 (b) 1, 3, 4
 (c) 1, 3 (d) all of these

15. The standard molar heat of formation of ethane, CO_2 and water (l) respectively are -21.0 , -94.1 and -68.3 kcal. The standard molar heat of combustion of ethane will be

- (a) -372 kcal (b) -340 kcal
 (c) 162 kcal (d) 183.5 kcal



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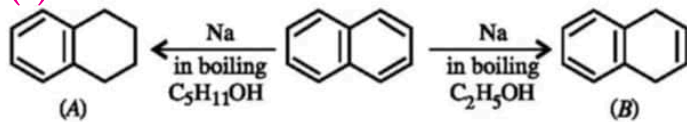
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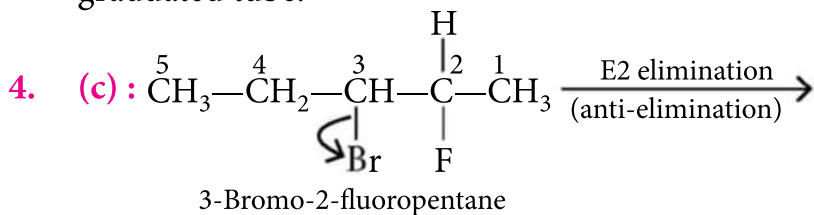
SOLUTIONS

1. (d)

2. (c):



3. (b): Mixture of gases produced in this method, collected over on aqueous solution of KOH which absorbs CO_2 and N_2 , is collected in upper part of graduated tube.



5. (a): Given, $K_a = 1.74 \times 10^{-5}$
 Concentration of CH_3COOH (C) = 0.01 mol dm^{-3}
 $[\text{H}^+] = \sqrt{K_a \cdot C} = \sqrt{1.74 \times 10^{-5} \times 0.01} = 4.17 \times 10^{-4}$
 $\text{pH} = -\log [\text{H}^+] = -\log (4.17 \times 10^{-4}) = 3.4$

6. (d) 7. (d)

8. (a): The order of increasing energy of the sub-atomic orbitals is $s < p < d < f$. The energy in excited state is more than that in the ground state. In option (a), two electrons are in excited state therefore, it has maximum energy.

9. (a): $3\text{O}_{2(g)} \rightleftharpoons 2\text{O}_{3(g)}$; $\Delta H = +ve$; $\Delta S = -ve$
 Equation, $\Delta G = \Delta H - T\Delta S = +ve - (-ve)$
 $\Delta G = +ve$
 \therefore Non-spontaneous at all temperatures.

10. (b): CO_3^{2-} , NO_3^- , SO_3 : sp^2 hybridised

11. (a)

12. (a): $\text{Ag}_2\text{A} \longrightarrow 2\text{Ag}$
 $\frac{0.701 \text{ g}}{2 M_{\text{Ag}}} = \frac{0.497 \text{ g}}{M_{\text{acid salt}}}$
 Gram equivalents of $\text{Ag}_2\text{A} = \text{Gram equivalents of Ag}$

$$\frac{0.701 \times 2}{2 M_{\text{Ag}} + M_{\text{acid salt}}} = \frac{0.497}{108}$$

$$M_{\text{acid salt}} = \frac{0.701 \times 2}{0.497} M_{\text{Ag}} - 2 M_{\text{Ag}}$$

$$= 2 M_{\text{Ag}} \left(\frac{0.701 - 0.497}{0.497} \right)$$

$$M_{\text{acid salt}} = 88.7$$

$$\therefore M_{\text{acid}} = 88.7 + 2 = 90.7$$

13. (a): (i) $M^{n+} + ne^- \rightleftharpoons M$, E° is highly negative
 This means that oxidation potential of M is very positive. Thus, M is good reducing agent.

(ii) The standard reduction potential decreases from chlorine to iodine and the oxidising power also decreases.

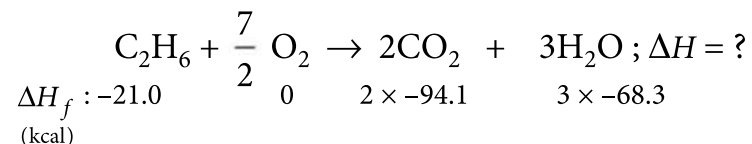
(iii) The ease of oxidation increases from F^- to I^- and thus reducing power of hydrogen halides also increases from hydrogen chloride to hydrogen iodide.

$\text{H}^+\text{I}^- \rightarrow \text{I}_2$ (E_{ox} is highest)

(iv) Lower the reduction potential, more is the reducing power.

14. (c): Silicates are very inert and are not easily hydrolysed (statement 2 is wrong). Each oxygen atom in SiO_2 is shared by 2 silicon atoms (not four). So statement 4 is wrong.

15. (a): Combustion of ethane



$$\begin{aligned} \Delta H_{\text{Reaction}} &= \sum \Delta H_f(\text{Products}) - \sum \Delta H_f(\text{Reactants}) \\ &= 2(-94.1) + 3(-68.3) - (-21.0) \\ &= -372.1 \text{ kcal} \end{aligned}$$



ANSWERS AUGUST 2024

The 3 sets of trio are (ARD, RDA, RAD),
 (CIS, SIC, ISC), (OLM, MOL, LOM)

ETARD
 MORDANT
 RADIUM
 CISOID
 MASSICOT
 FISCHER
 HOLMIUM
 MOLE
 COULOMB

Winners : Kaushikkumar Kevadiya, Sachin

NEET / JEE

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Unit 4 ▶ States of Matter (Gases and Liquids) ▶ Thermodynamics

STATES OF MATTER (GASES AND LIQUIDS)

INTRODUCTION

Matter exists mainly in three states, solid, liquid and gas. The fourth, plasma state, is the ionic state of atoms existing at very high temperature found only in the interior of stars. The fifth state is Bose-Einstein condensate. It is a state matter of dilute gas of bosons cooled to temperature very close to absolute zero (near zero Kelvin).

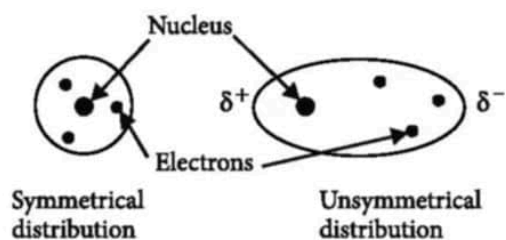
The three states or phases are interconvertible. A substance can exist simultaneously in all the three states at a particular temperature and pressure. The temperature at which all the phases co-exist is called triple point. For example, water exists in three phases simultaneously at 0.0098°C and 4.58 mm Hg pressure. The point at which three phases of a component exist together can be represented as,



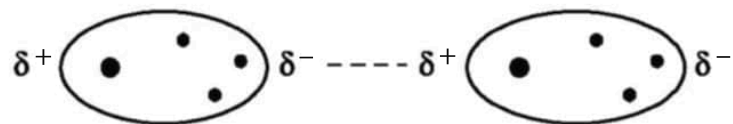
Solids	Liquids	Gases
<ul style="list-style-type: none"> • Possess definite shape, mass and volume. • Molecules are closely packed with strong intermolecular forces of attraction. • Possess least compressibility and thermal expansion. • Solids have high density. 	<ul style="list-style-type: none"> • Possess definite mass and volume but shape depends upon shape of container. • Molecules are less closely packed with comparatively weaker forces of attraction. • Possess slightly higher compressibility and thermal expansion. • Liquids have high density but lower than that of solids. 	<ul style="list-style-type: none"> • Possess definite mass but no definite shape and volume. • Molecules are sufficiently apart with almost negligible forces of attraction. • Possess high compressibility and thermal expansion. • Gases have very low density.

INTERMOLECULAR FORCES

- These are the forces of attraction and repulsion that exist between molecules of a compound. These cause the compound to exist in a certain state of matter – solid, liquid or gas and affect the melting and boiling points of compounds as well as the solubilities of one substance in another. Attractive intermolecular forces are also called van der Waals' forces. These are weak forces. Different types of intermolecular forces are the following:
 - **London forces or dispersion forces** : The London force is the weakest intermolecular force. It is a temporary attractive force that results when the electrons in two adjacent atoms occupy positions that make the atoms to form temporary dipoles. This force is sometimes called as dipole-induced dipole attraction. Because of the constant motion of the electrons, an atom or a molecule can develop a temporary (instantaneous) dipole when its electron are distributed unsymmetrical about the nucleus.



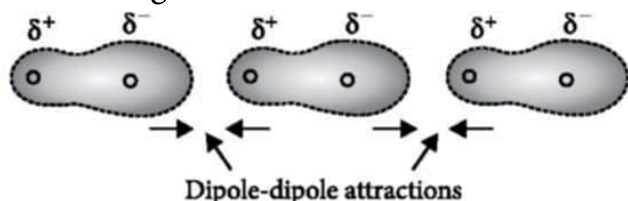
A second atom or molecule, in turn, can be distorted by the appearance of the dipole in the first atom or molecule (because electrons repel one another) which leads to an electrostatic attraction between the two atoms or molecules.



London or dispersion forces increase with:

- increase in number of electrons in molecules
- increase in molecular size
- increase in molecular weight.

- **Dipole-dipole forces** : This is the second strongest van der Waals' force. These forces exist between polar molecules where the positive end of one molecule attracts the negative end of another molecule.

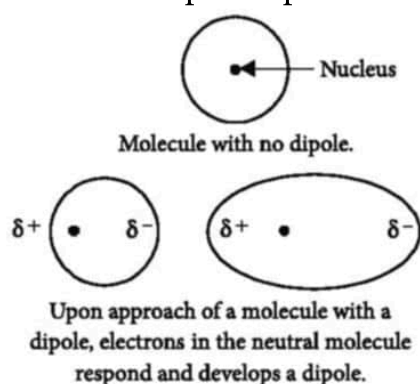


Dipole-dipole forces are characteristically weaker than ion-dipole forces.

These forces increase with:

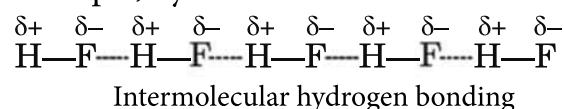
- increase in molecular size of molecule
- increase in molecular weight of molecule
- increase in polarity of molecule.

- **Dipole-induced dipole forces** : These forces operate between the polar molecules having permanent dipole and the molecules having no permanent dipole. A dipole-induced dipole attraction is a weak attraction that results when a polar molecule induces a dipole in an atom or in a non-polar molecule by disturbing the arrangement of electrons in the non-polar species.

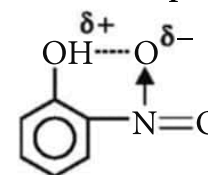


- **Hydrogen bonding** : It is the electrostatic force of attraction between hydrogen atom and highly electronegative atom (N, O, and F atoms) of another molecule. It is represented by dotted line. It is of two types :

- **Intermolecular hydrogen bonding** : It is the force of attraction that exists between H-atom and highly electronegative atom between several molecules of the same substance. For example, hydrofluoric acid.



- **Intramolecular hydrogen bonding** : It is the force of attraction that exists between H-atom and highly electronegative atom within the same molecule, for example, *o*-nitrophenol.



Intramolecular H-bonding

THERMAL ENERGY

Thermal energy is the energy of a body arising from motion of its atoms or molecules. It is directly proportional to the temperature of the substance. It keeps the molecules apart from each other.

- **For gaseous state** : Forces of attraction \ll Thermal energy
- **For liquid state** : Forces of attraction $>$ Thermal energy
- **For solid state** : Forces of attraction \gg Thermal energy

THE GASEOUS STATE

This is the simplest state of matter. Simplicity of gases is due to the fact that the forces of interaction between their molecules are negligible.

The Gas Laws

Boyle's Law

- This law states that, "volume of a given mass of a gas is inversely proportional to its pressure, keeping the temperature constant", *i.e.*,

$$V \propto \frac{1}{P} \text{ at constant temperature.}$$

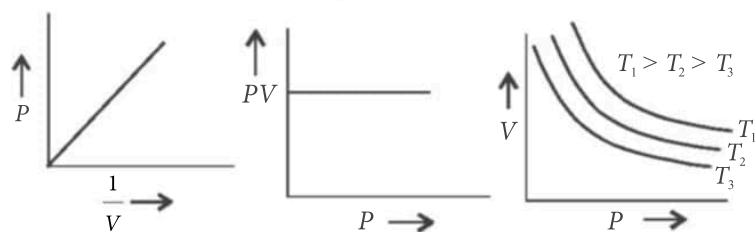
$$\text{or } PV = \text{constant}$$

- Thus if P_1 and V_1 are initial state of pressure and volume of gas and keeping the temperature

constant, if pressure is changed to P_2 , then volume will change to V_2 , so according to Boyle's law,

$$P_1 V_1 = P_2 V_2$$

(Initial state) (Final state)



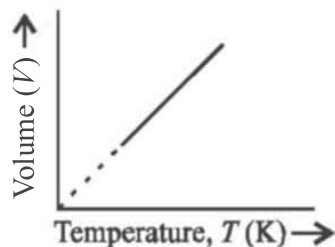
Charles' Law

This law states that, "at constant pressure the volume of a given mass of a gas increases or decreases by $1/273$ of its volume at 0°C for every rise or fall of one degree in temperature".

$$V_t = V_0 + \frac{V_0}{273} \times t \quad (\text{at constant pressure})$$

$$= V_0 \left[1 + \frac{t}{273} \right],$$

$$V_t = V_0 \left[\frac{273 + t}{273} \right]$$



Gay-Lussac's Law

This law states that pressure of a given mass of a gas is directly proportional to absolute temperature at constant volume.

$$P \propto T; \frac{P}{T} = \text{constant}$$

Avogadro's law

Equal volume of all gases under similar conditions of temperature and pressure contain equal number of molecules. $V \propto n$ (at constant temperature and pressure), where n = number of moles.

Ideal Gas Equation

- A gas which obeys the ideal gas equation, $PV = nRT$ under all conditions of temperature and pressure is called an ideal gas.
- R (gas constant) is independent of the nature of gas and depends only on the amount of gas taken. Hence, R is called '**universal gas constant**'.

- Combined gas law: $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

- Relationship between molar mass and density:

$$\frac{dT}{P} = \frac{M}{R}; \frac{dT}{P} = \text{constant}; \frac{d_1 T_1}{p_1} = \frac{d_2 T_2}{p_2}$$

Dalton's Law of Partial Pressure

The law states that "when a mixture of two or more non-reacting gases are enclosed in a container then the total pressure exerted by the gaseous mixture is equal to sum of partial pressures of the individual gases".

$$P_{\text{Total}} = p_A + p_B + p_C + \dots$$

Partial pressure = Total pressure \times Mole fraction.

Graham's Law of Diffusion

- The law states that "under similar conditions of temperature and pressure, the rates of diffusion of gases are inversely proportional to the square root of their densities".

$$r_{\text{diffusion}} \propto \sqrt{\frac{1}{d}}; \frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}}; \frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

- Where r_1 and r_2 are the rates of diffusion and d_1 and d_2 are the densities of gases 1 and 2 respectively.
- Molecular mass (M) = $2 \times$ vapour density (d)

KINETIC MOLECULAR THEORY OF GASES

It was so called as it assumes the gas to be made up of large number of molecules which were in ceaseless motion.

Postulates of Kinetic Theory of Gases

- Every gas is composed of large number of extremely small particles called molecules. All the molecules of a particular gas are identical in mass and size and differ in these from gas to gas.
- Molecules of a gas are extremely small in size and separated by large distances from each other, so that the actual volume of the molecule is negligible as compared to the total volume of gas.
- There are no forces of attraction or repulsion between the molecules of the gas, even gravitational force on molecules is also supposed to be negligible.
- Molecules of a gas are in a state of ceaseless motion. They collide with one another as well as with walls of the container. Molecular collisions are perfectly elastic, so that there is no net loss of energy.
- The pressure exerted by a gas is due to the bombardment of the molecules on the walls of the container.
- Since different molecules move with different velocities, they have different kinetic energies. However, the average kinetic energy of the molecules of a gas is directly proportional to the absolute temperature of the gas.

Kinetic Gas Equation and Kinetic Energy

- **Kinetic gas equation :** $PV = \frac{1}{3}mnC_{rms}^2$
 where, P = Pressure of the gas
 V = Volume of the gas
 m = Mass of a gas molecule
 n = Number of gas molecules
 C_{rms} = Root mean square velocity for 1 mole of the gas,
- For 1 mole of the gas, $PV = RT$ and $n = N_0$ where N_0 = Avogadro's number

$$PV = \frac{1}{3}mnC_{rms}^2 \quad \text{or} \quad \frac{2}{3} \times \frac{1}{2}mN_0C_{rms}^2 = RT$$

$$\text{Now} = \frac{1}{2}mN_0C_{rms}^2 = \text{kinetic energy per mole}$$

$$\therefore \frac{2}{3}K.E. = RT \quad \text{or} \quad K.E. = \frac{3}{2}RT$$

- Average *K.E.* per molecule

$$= \frac{\text{Average } K.E. \text{ per mole}}{\text{Avogadro's number}} = \frac{\frac{3}{2}RT}{N_0} = \frac{3}{2}kT$$

where, $k = \frac{R}{N_0}$, and k is called Boltzmann constant. Its numerical value is 1.38×10^{-16} erg K^{-1} molecule $^{-1}$.

- **Different Types of Molecular Velocities**

Most probable velocity (C_{mp})	Velocity possessed by maximum number of molecule.	$C_{mp} = \sqrt{\frac{2RT}{M}}$
Average velocity (C_{av})	Mean of different velocities possessed by the molecules of a gas.	$C_{av} = \frac{C_1 + C_2 + \dots + C_n}{n}$ $= \sqrt{\frac{8RT}{\pi M}}$
Root mean square velocity (C_{rms})	Square root of the mean of squares of the velocities possessed by all the molecules present.	$C_{rms} = \sqrt{\frac{C_1^2 + C_2^2 + \dots + C_n^2}{N}}$ $= \sqrt{\frac{3RT}{M}}$

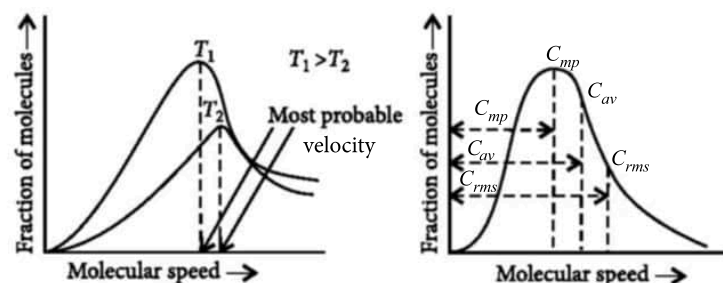
- Relation between C_{mp} , C_{av} , C_{rms}

$$C_{mp} : C_{av} : C_{rms} = \sqrt{\frac{2RT}{M}} : \sqrt{\frac{8RT}{\pi M}} : \sqrt{\frac{3RT}{M}}$$

$$= 1 : 1.128 : 1.224$$

- $C_{av} = 0.9213 \times C_{rms}$, $C_{mp} = 0.8165 \times C_{rms}$

Maxwell's Distribution of Molecular Speeds



Behaviour of Real Gases (Deviation from Ideal Gas Behaviour)

- Real gases do not obey ideal gas equation under all conditions. They nearly obey ideal gas equation at higher temperatures and very low pressures. However, they show deviations from ideality at low temperatures and high pressures.
- The deviation from ideal gas behaviour can also be expressed by compressibility factor, Z .

van der Waals' Equation for Real Gases

- van der Waals' gave modified form of ideal gas equation applicable to real gases.

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT, \text{ For one mole of a gas}$$

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT, \text{ For } n \text{ moles of a gas}$$

- where ' a ' and ' b ' are constants known as van der Waals' constant. The equation is based on two corrections in the ideal gas equation, *viz.*, volume correction and pressure correction.

Liquefaction of Gases

- The phenomenon of converting a gas into liquid is known as liquefaction. The liquefaction of a gas takes place when the intermolecular forces of attraction become so high that it exists in the liquid.

- Critical temperature (T_c) = $\frac{8a}{27br}$

- Critical pressure (P_c) = $\frac{a}{27br}$

- Critical volume (V_c) = $3b$

- Relation between three critical constants:

$$P_c V_c = \frac{3}{8}RT_c \quad \text{or} \quad \frac{P_c V_c}{RT_c} = \frac{3}{8}$$

THE LIQUID STATE

- It is intermediate between the gas and solid state. In liquids the molecules are close enough, so that there are considerable intermolecular forces of attraction. Liquids have definite volume like solids but no definite shape. Liquids possess fluidity like gases but incompressibility like solids.
- **Vapour pressure** : It is the pressure exerted by vapours of the liquids present above the liquid in equilibrium with the liquid at that temperature.
 - Vapour pressure of a liquid depends upon the nature of liquid and temperature.
 - Vapour pressure is high for those liquids which have weaker intermolecular attractive forces, so that molecules can easily leave the liquid to vapour state.
- **Surface tension** : It is the force acting at right angle to the surface along one centimetre length of the surface of liquid at rest.
 - It may also be defined as the force required to rupture the surface of liquid along unit length.
- Surface tension of liquid decreases with increase of temperature and becomes zero at its critical temperature.
- It is expressed in J m^{-2} or N m^{-1} .
- **Viscosity** : It is the force per unit area required to maintain a velocity difference of unity between the two parallel layers in the liquid which are unit distance apart.
 - The force of attraction between two layers of liquid each having area of A , separated by a distance of dx and having velocity difference of dv is given as :

$$f \propto A \frac{dv}{dx} \Rightarrow f = \eta A \frac{dv}{dx}$$
 where, η = coefficient of viscosity $\eta = \frac{f}{A} \frac{dx}{dv}$
 - Viscosity of liquid decreases with increase of temperature whereas increases with decrease of temperature.
- The reciprocal of coefficient of viscosity is known as fluidity of the liquid, $\phi = 1/\eta$

THERMODYNAMICS

INTRODUCTION

Chemical thermodynamics or energetics deals with the study of different forms of energy and the quantitative relationship between them. Thermodynamics can predict the feasibility of a reaction under a set of conditions and also determine the extent to which a process would proceed. However, the rate and mechanism of a process cannot be predicted.

FUNDAMENTALS OF THERMODYNAMICS

- **System** : It is the part of universe under investigation where energy changes can be regulated and studied.
- **Surroundings** : Rest part of the universe which can interact with the system or can influence the properties of the system is called surroundings.

- **Boundary** : A real or imaginary surface that separates the system from the surroundings is known as **boundary**. A boundary can be rigid or non-rigid (movable), permeable or impermeable, adiabatic (non-conductor of heat) or diathermic (conductor of heat).

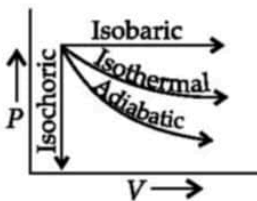
TYPES OF THE SYSTEM

- Open system** : An open system can exchange mass as well as energy with the surroundings.
Example : Water in an open vessel.
- Closed system** : A closed system can exchange only energy, not the mass with the surroundings.
Example : Water in a closed vessel.
- Isolated system** : An isolated system can exchange neither mass nor energy with the surroundings.
Example : Water in a closed insulated vessel.

Macroscopic Properties of a System				
Intensive Properties	Extensive Properties	State Functions	Path Functions	Thermodynamic Equilibrium
Independent of the quantity of matter present in the system <i>e.g.</i> , temperature, pressure, viscosity, surface tension, refractive index, etc.	Depend upon the quantity of matter present in the system <i>e.g.</i> , mass, volume, entropy, enthalpy, free energy, internal energy, etc.	Variables that depend only on the initial and final states of a system <i>e.g.</i> , pressure, volume, etc.	Variables whose values depend upon the path followed by the system on attaining that state. <i>e.g.</i> , work, heat, etc.	Macroscopic properties that do not undergo any change with time. <i>e.g.</i> , temperature, pressure, etc.

Types of Thermodynamic Processes

- **Isothermal process** : Temperature of the system remains constant ($\Delta T = 0$).
- **Isobaric process** : Pressure of the system remains constant ($\Delta P = 0$).
- **Isochoric process** : Volume of the system remains constant ($\Delta V = 0$).
- **Adiabatic process** : The system does not exchange heat with the surroundings (*i.e.*, $q = 0$).
- **Reversible process** : Direction may be reversed at any stage.
- **Irreversible process** : Proceeds only in one direction and cannot be reversed.
- **Cyclic process** : System returns to its original state after a number of steps. For such a process, $\Delta U = 0$ and $\Delta H = 0$.
- **Exothermic process** : Accompanied by the evolution of heat.
- **Endothermic process** : Accompanied by the absorption of heat.



Some Thermodynamic Quantities

- **Work (W)** : Work is a mode of energy transfer from or to the system to make some net changes in the state of the system. No work is being done when system is in equilibrium.

$$\text{Work} = \text{Force} \times \text{displacement} = F \times l$$
 - **Pressure-volume work** : It is the work done involved in expansion or compression of the gases against external pressure.

$$\text{Work} = \text{Pressure} \times \text{area} \times l = P_{\text{ext}} \times \Delta V$$
 where, Force = Pressure \times area;
 area \times l = volume and ΔV is change in volume *i.e.*, $\Delta V = (V_2 - V_1)$.
 - **Electrical work** : It is the work involved in reactions involving ions.

$$\text{Electrical work done} = \text{EMF} \times \text{Quantity of electricity}$$
- **Heat (q)** : Heat is a mode of energy transfer between system and surrounding because of difference in temperature between them. It is measured in terms of calories. SI unit of heat is joule.
- **Internal Energy (U)** : Sum of various forms of energy such as rotational, vibrational, translational, kinetic, coulombic, nuclear, etc. is known as internal energy.
 - It is a state function.
 - It is extensive property and depends only on temperature.

FIRST LAW OF THERMODYNAMICS

It is a law of conservation of energy which states that energy can neither be created nor destroyed, although it can be converted from one form to another. This obviously means that total energy of the universe remains constant.

Mathematically : ΔE or $\Delta U = q + W$ or $q = \Delta U - W$

Work done for isothermal reversible expansion

$$W = -2.303nRT \log \frac{V_2}{V_1} \quad \text{or} \quad W = -2.303nRT \log \frac{P_1}{P_2}$$

- **Free expansion** : Expansion of a gas in vacuum ($P_{\text{ex}} = 0$) is called free expansion. No work is done during free expansion of an ideal gas whether the process is reversible or irreversible. *i.e.*, $\Delta U = q - P_{\text{ex}} \Delta V$;
 At constant V , $\Delta U = q_V$
- For isothermal irreversible change
 $q = -W = P_{\text{ex}} (V_f - V_i)$
 For adiabatic processes, $q = 0$, thus, $\Delta U = W_{\text{adiabatic}}$;

$$\frac{dU}{dT} = C_v \Rightarrow dU = C_v dT$$

 Thus, $W_{\text{adiabatic}} = C_v dT = C_v (T_2 - T_1)$
 For isochoric process, $\Delta V = 0$, thus, $q = \Delta U$

ENTHALPY (H)

- Total heat content of the system at constant pressure is known as its enthalpy.
 - It is an extensive property. It is state function.
 - Its absolute value cannot be determined. Mathematically it is given as, $H = U + PV$
 If H_2 is the enthalpy in final state and H_1 in initial state, then

$$\Delta H = (H_2 - H_1) = \Delta U + P\Delta V$$
 For exothermic reaction (*i.e.*, heat released during the reaction), ΔH is negative *i.e.*, $\Delta H < 0$. Whereas for endothermic reaction (*i.e.*, heat absorbed during the reaction), ΔH is positive *i.e.*, $\Delta H > 0$.
 - According to first law of thermodynamics,
 $q = \Delta U - w$; where, w is the pressure-volume work done by the system; $w = -P\Delta V$
 At constant volume ($\Delta V = 0$) then, $w = 0$
 $\therefore q_V = \Delta U$
 At constant pressure, ($\Delta P = 0$) then,
 $w = -P\Delta V$; $q_P = \Delta U + P\Delta V$
 Comparing this equation with equation of enthalpy change, we get $q_P = \Delta H$

- **Relationship between ΔH and ΔU :**

- As $P\Delta V = \Delta n_g RT$
where, Δn_g = number of moles of gaseous products – number of moles of gaseous reactants.
 $\therefore \Delta H = \Delta U + \Delta n_g RT$ or $q_p = q_v + \Delta n_g RT$
- When $\Delta n_g = 0$, then $\Delta H = \Delta U$
- When $\Delta n_g > 0$, then $\Delta H > \Delta U$
- When $\Delta n_g < 0$, then $\Delta H < \Delta U$
- For a reaction involving only solids and liquids, $\Delta n_g = 0$, thus, $\Delta H = \Delta U$.

HEAT CAPACITY (C)

- Heat capacity is the amount of heat required to raise the temperature of a system by 1 K (or 1°C). In other words, heat given to a system is directly proportional to the change in temperature.

$$q \propto \Delta T \Rightarrow q = C \times \Delta T$$

$C = \frac{q}{\Delta T}$; where, q is the amount of heat supplied and ΔT is the increase in temperature.

Heat capacity at constant volume, $C_V = \left(\frac{dU}{dT} \right)_V$

Heat capacity at constant pressure, $C_P = \left(\frac{dH}{dT} \right)_P$

Specific heat capacity

- Specific heat capacity (or specific heat) is the quantity of heat required to raise the temperature of one gram of a substance through 1 K (or 1°C).

$$\text{Specific heat capacity} = \frac{\text{Heat capacity}}{\text{Mass}} = \frac{C}{m}$$

Molar heat capacity

- The molar heat capacity may be defined as the quantity of heat needed to raise the temperature of one mole of a substance by 1 K (or 1°C). Molar heat capacity is denoted by ' C_m ' and

$$C_m = \frac{C}{n} = \frac{q}{n\Delta T}$$

- Specific heat capacity \times molar mass = molar heat capacity.
- Units of molar heat capacity are $\text{J K}^{-1} \text{mol}^{-1}$.

Relationship between C_p and C_v

$$C_p - C_v = R$$

For n moles of a gas, $C_p - C_v = nR$; Thus, $C_p > C_v$

- Ratio of C_p and C_v is denoted by γ . Thus, $\gamma = \frac{C_p}{C_v}$.
- Value of γ is used to determine atomicity of a gas.

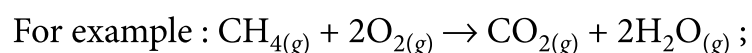
Nature of gas	C_v	$C_p = C_v + R$	$\gamma = C_p / C_v$
Monoatomic (He, Ne, Ar, etc.)	$\frac{3}{2}R$	$\frac{5}{2}R$	1.66
Diatomic (H_2 , C_2 , O_2 , N_2 , etc.)	$\frac{5}{2}R$	$\frac{7}{2}R$	1.40
Triatomic (CO_2 , H_2S , etc.)	$\frac{7}{2}R$	$\frac{9}{2}R$	1.28

DIFFERENT TYPES OF ENTHALPIES OF REACTION

- **Heat of formation** : It is the heat change (either evolved or absorbed) accompanying the formation of 1 mole of a substance from its elements under given condition of temperature and pressure. It is denoted by ΔH_f . Enthalpy of reaction can be calculated from standard heat of formation.

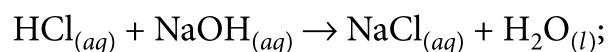
$$\Delta H_{\text{Reaction}}^{\circ} = \Delta G_{f(\text{Products})}^{\circ} - \Delta H_{f(\text{Reactants})}^{\circ}$$

- **Heat of combustion** : It is the amount of heat liberated when one mole of a substance is completely burnt or oxidized in air.



$$\Delta H_C = -890.4 \text{ kJ mol}^{-1}$$

- **Heat of neutralization** : It is the heat change associated with neutralization of one gram equivalent of an acid (or base) by one gram equivalent of a base (or acid) in dilute aqueous solution.

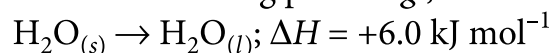


$$\Delta H = -57.1 \text{ kJ mol}^{-1}$$

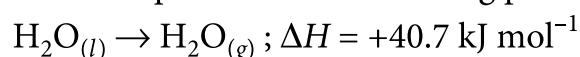
- **Heat of solution** : It is the enthalpy change when one mole of a substance is dissolved in such a large excess of solvent so that further dilution of solution produces no appreciable heat change.

- **Heat of hydration** : It is the enthalpy change when one mole of anhydrous salt combines with required number of moles of water to form specific hydrated salt.

- **Heat of fusion** : It is the enthalpy change when one mole of a solid substance changes into its liquid state at its melting point. *e.g.*,



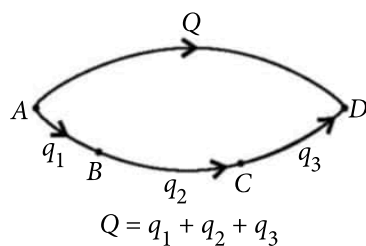
- **Heat of vaporization** : It is the heat required to convert one mole of a liquid substance completely into its vapour state, at its boiling point. *e.g.*,



- **Heat of sublimation** : It is the heat required to convert one mole of solid substance directly into its vapour state at a temperature below its melting point. *e.g.*, $I_{2(s)} \rightarrow I_{2(g)}$; $\Delta H = +62.4 \text{ kJ mol}^{-1}$
Sublimation is fusion and vaporization in one step, *i.e.*, $\Delta H_{\text{sublimation}} = \Delta H_{\text{fusion}} + \Delta H_{\text{vaporization}}$
- **Heat of ionization** : It is the heat change when one mole of an electrolyte completely dissociates into ions. *e.g.*, $\text{HCl}_{(g)} \rightarrow \text{H}^+ + \text{Cl}^-$; $\Delta H = -75.2 \text{ kJ mol}^{-1}$
- **Heat of atomization** : The enthalpy change required to convert one mole of an element from its normal state at 298 K and one atmosphere pressure into free atoms. $\text{H}_{2(g)} \rightarrow 2\text{H}_{\text{atoms}}$; $\Delta H = 433 \text{ kJ}$
- **Bond enthalpy** : The standard enthalpy of reaction is related to bond enthalpies of reactants and products in gas phase reaction as, $\Delta_r H^\circ = \sum \text{Bond enthalpies}_{(\text{reactants})} - \sum \text{Bond enthalpies}_{(\text{products})}$
- **Lattice enthalpy** : Lattice enthalpy of an ionic compounds is the enthalpy change which occurs when one mole of an ionic compound dissociated into its ions in gaseous state. It is calculated by using Born-Haber cycle.

Hess's Law of Constant Heat Summation

- It states that the total amount of heat change in a chemical reaction is same whether the reaction takes place in one step or in number of steps.



SPONTANEITY

A spontaneous process is an irreversible process and may only be reversed by some external energy. Entropy (S) is a measure of the degree of randomness or disorder of the system.

$$\Delta S_{\text{total}} = \Delta S_{\text{system}} + \Delta S_{\text{surrounding}}$$

GIBBS FREE ENERGY

It is denoted by G , and given mathematically as,

$$G = H - TS$$

where, H is the enthalpy, T is absolute temperature and S is entropy of the system.

$$\text{For initial state } G_1 = H_1 - TS_1$$

$$\text{For final state } G_2 = H_2 - TS_2$$

$$\therefore \Delta G = G_2 - G_1 = (H_2 - TS_2) - (H_1 - TS_1)$$

$$= (H_2 - H_1) - T(S_2 - S_1)$$

$$\Delta G = \Delta H - T\Delta S$$

- If electrical work is involved, then electrical work = nFE

where, n is number of electrons involved in cell reaction, F is Faraday and, E is EMF of the cell

$$-\Delta G = nFE \text{ or } \Delta G = -nFE$$

- If standard state is maintained *i.e.*, 298 K and 1 atm pressure during the reaction, then,

$$-\Delta G^\circ = nFE^\circ \text{ or } \Delta G^\circ = -nFE^\circ$$

where ΔG° is standard free energy change.

E° is standard EMF of the cell.

- **Standard free energy change and equilibrium constant** : $\Delta G^\circ = -RT \ln K$ or $\Delta G^\circ = -2.303 RT \log K$
- **Relation Between ΔH , ΔS , ΔG and Spontaneity of a Reaction**

S. No.	Sign of ΔH	Sign of ΔS	$\Delta G = \Delta H - T\Delta S$	Remarks
1.	-ve	+ve	Always -ve	Spontaneous at all temperatures
2.	+ve	-ve	Always +ve	Non-spontaneous at all temperatures
3.	+ve	+ve	+ve at low temperature, -ve at high temperature	Non-spontaneous at low temperature, spontaneous at high temperature
4.	-ve	-ve	-ve at low temperature, +ve at high temperature	Spontaneous at low temperature, non-spontaneous at high temperature

SECOND LAW OF THERMODYNAMICS

- All spontaneous processes are thermodynamically irreversible.
- The entropy of the universe is continuously increasing.
- Heat cannot be completely converted into an equivalent amount of work without producing permanent changes either in the system or its surroundings.

THIRD LAW OF THERMODYNAMICS

- The entropy of any pure crystalline substance approaches zero as the temperature approaches absolute zero.
- The statement is confined to pure crystalline solids because the entropy of solutions and super cooled liquids is not zero at 0 K.



WRAP it up!

MULTIPLE CHOICE QUESTIONS

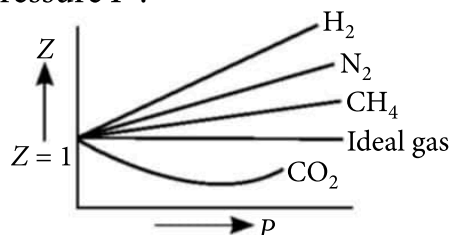
1. Under identical conditions of temperature, the density of a gas X, is three times that of gas Y, while molecular mass of gas Y is twice that of X. The ratio of pressures of X and Y will be

- (a) 6 (b) 1/6 (c) 2/3 (d) 3/2

2. The entropy change can be calculated by using the expression, $\Delta S = \frac{q_{\text{rev}}}{T}$. When water freezes in a glass beaker then what will happen?

- (a) $\Delta S(\text{system})$ decreases but $\Delta S(\text{surroundings})$ remains the same.
(b) $\Delta S(\text{system})$ increases but $\Delta S(\text{surroundings})$ decreases.
(c) $\Delta S(\text{system})$ decreases but $\Delta S(\text{surroundings})$ increases.
(d) $\Delta S(\text{system})$ and $\Delta S(\text{surroundings})$ both decrease.

3. Consider the graph between compressibility factor Z and pressure P :



The correct increasing order of ease of liquefaction of the gases shown in the above graph is

- (a) $\text{H}_2 < \text{N}_2 < \text{CH}_4 < \text{CO}_2$
(b) $\text{CO}_2 < \text{CH}_4 < \text{N}_2 < \text{H}_2$
(c) $\text{H}_2 < \text{CH}_4 < \text{N}_2 < \text{CO}_2$
(d) $\text{CH}_4 < \text{H}_2 < \text{N}_2 < \text{CO}_2$

4. The heat of combustion of benzene in a bomb calorimeter (*i.e.*, at constant volume) was found to be $3263.9 \text{ kJ mol}^{-1}$ at 25°C . The heat of combustion of benzene (in kJ mol^{-1}) at constant pressure is

- (a) -3263.9 (b) -3267.6
(c) -3260.2 (d) $+436.1$

5. The pressure exerted by 1 mol of CO_2 at 273 K is 34.98 atm. Assuming that volume occupied by CO_2 molecules is negligible, the value of van der Waals' constant for attraction of CO_2 gas is

- (a) $3.59 \text{ dm}^6 \text{ atm mol}^{-2}$ (b) $2.59 \text{ dm}^6 \text{ atm mol}^{-2}$
(c) $1.25 \text{ dm}^6 \text{ atm mol}^{-2}$ (d) $1.59 \text{ dm}^6 \text{ atm mol}^{-2}$

6. Which of the following represents enthalpy of formation of water?

- (a) $\text{H}_{2(\text{g})} + \frac{1}{2} \text{O}_{2(\text{g})} \longrightarrow \text{H}_2\text{O}_{(\text{g})}; \Delta H = -242 \text{ kJ}$
(b) $\text{H}_{2(\text{g})} + \frac{1}{2} \text{O}_{2(\text{g})} \longrightarrow \text{H}_2\text{O}_{(\text{l})}; \Delta H = -286 \text{ kJ}$
(c) $\text{H}_{2(\text{g})} + \frac{1}{2} \text{O}_{2(\text{g})} \longrightarrow \text{H}_2\text{O}_{(\text{l})}; \Delta H = 286 \text{ kJ}$
(d) $2\text{H}_{2(\text{g})} + \text{O}_{2(\text{g})} \longrightarrow 2\text{H}_2\text{O}_{(\text{l})}; \Delta H = -572 \text{ kJ}$

7. The average energy per molecule of a gas at a given temperature T , is given by

- (a) $\frac{3}{2}RT$ (b) $\sqrt{\frac{3RT}{M}}$
(c) $\sqrt{\frac{8(R/N_A)T}{\pi M}}$ (d) $\frac{3}{2}\left(\frac{R}{N_A}\right)T$

8. Two moles of an ideal monoatomic gas expands isothermally against a constant external pressure of 2 atm from an initial volume of 22.4 L to a state where its final pressure becomes equal to external pressure. If the initial temperature of gas is 273°C , then the entropy change of the system in the above process is

- (a) $R \ln 6$ (b) $R \ln 4$ (c) $R \ln 8$ (d) zero.

9. **Statement-1** : The pressure of a fixed amount of an ideal gas is proportional to its temperature.

Statement-2 : Frequency of collisions and their impact both increase in proportion to the square root of temperature.

- (a) Statements-1 and 2 are true and statement-2 is a correct explanation for statement-1.
(b) Statements-1 and 2 are true and statement-2 is not a correct explanation for statement-1.
(c) Statement-1 is true, statement-2 is false.
(d) Statement-1 is false, statement-2 is true.

10. The following data are available for the melting of KCl : $\Delta H_{\text{fus}} = 7.25 \text{ kJ mol}^{-1}$ and $\Delta S_{\text{fus}} = 0.007 \text{ kJ K}^{-1} \text{ mol}^{-1}$. The melting point of KCl (in K) is

- (a) 1035.7 (b) 762.7 (c) 897.5 (d) 1308.7

11. The total number of gas molecules in a room of capacity 25 m^3 at a temperature of 27°C and 1 atm pressure will be

- (a) 3.011×10^{23} (b) 6.119×10^{23}
 (c) 6.119×10^{26} (d) 3.011×10^{26}

12. For which of the following equations, will ΔH be equal to ΔU ?

- (a) $\text{H}_2(\text{g}) + 1/2\text{O}_2(\text{g}) \longrightarrow \text{H}_2\text{O}(\text{l})$
 (b) $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \longrightarrow 2\text{HI}(\text{g})$
 (c) $2\text{NO}_2(\text{g}) \longrightarrow \text{N}_2\text{O}_4(\text{g})$
 (d) $4\text{NO}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{N}_2\text{O}_5(\text{g})$

13. One litre of gas A at 2 atm pressure at 27 °C and two litres of gas B at 3 atm pressure at 127 °C are mixed in a 4 litre vessel. The temperature of the mixture is maintained at 327 °C. What is the total pressure of the gaseous mixture?

- (a) 3.93 atm (b) 3.25 atm
 (c) 4.25 atm (d) 6.25 atm

14. **Assertion:** A process is called adiabatic if the system does not exchange heat with the surroundings.

Reason: It does not involve increase or decrease in temperature of the system.

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
 (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) If assertion is true but reason is false.
 (d) If both assertion and reason are false.

15. Mark the correct statement for viscosity.

- (a) Greater the viscosity, more slowly the liquid flows.
 (b) Viscosity increases with increase in temperature.
 (c) Hydrogen bonding and van der Waals' forces decrease the viscosity.
 (d) SI unit of viscosity coefficient is N m^{-1} .

16. The specific heat of a gas at constant volume is 0.075 cal/g-K. Predict the atomicity of the gas. (Molar mass of gas is 40 g mol^{-1} .)

- (a) 1 (b) 2
 (c) 3 (d) None of these

17. Match gases under specified conditions listed in Column I with their properties/laws in Column II and select the correct option.

Column I		Column II	
A.	Hydrogen gas ($P = 200 \text{ atm}$, $T = 273 \text{ K}$)	p.	Compressibility factor $\neq 1$
B.	Hydrogen gas ($P \approx 0$, $T = 273 \text{ K}$)	q.	Attractive forces are dominant

C.	CO_2 ($P = 1 \text{ atm}$, $T = 273 \text{ K}$)	r.	$PV = nRT$
D.	Real gas with very large molar volume	s.	$P(V - nb) = nRT$

- (a) (A) \rightarrow (p, s); (B) \rightarrow (q); (C) \rightarrow (r); (D) \rightarrow (s)
 (b) (A) \rightarrow (q); (B) \rightarrow (p, s); (C) \rightarrow (p, q); (D) \rightarrow (r)
 (c) (A) \rightarrow (p, s); (B) \rightarrow (r); (C) \rightarrow (p, q); (D) \rightarrow (r)
 (d) (A) \rightarrow (p, q); (B) \rightarrow (s); (C) \rightarrow (p, s); (D) \rightarrow (s)

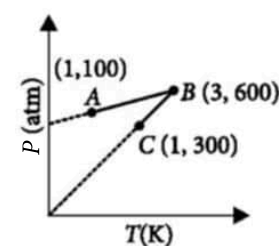
18. The standard heat of formation of $\text{CH}_4(\text{g})$, $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\text{g})$ are -76.2 , -398.8 and $-241.6 \text{ kJ mol}^{-1}$ respectively. The amount of heat evolved (in kJ) by burning 1 m^3 of methane measured under normal conditions is

- (a) 805 (b) 35973 (c) 22.4 (d) 3121

19. Capillary action of the liquid can be explained on the basis of its

- (a) resistance to flow
 (b) surface tension
 (c) heat of vapourisation
 (d) refractive index.

20. One mole of an ideal gas is subjected to a two step reversible process (A-B and B-C). The pressure at A and C is same. Mark the correct statement.



- (a) Work involved in the path AB is zero.
 (b) Volume of gas at A = volume of gas at B.
 (c) Volume of gas at C = $3 \times$ volume of gas at A.
 (d) Volume of gas at B is 25 litres.

NUMERICAL VALUE TYPE QUESTIONS

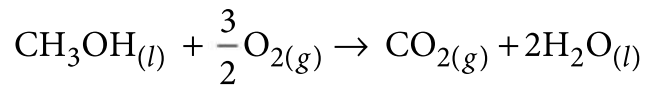
21. A 6 liter cylinder contained 280 g of N_2 gas at 27° C. Due to sudden leakage through the hole, all the gas escaped into atmosphere and the cylinder became empty. If the atmospheric pressure is 1.0 atmosphere, the work done by the gas is _____ kJ.

22. At 27 °C, 500 mL of helium diffuses in 30 minutes. What is the time (in hours) taken for 1000 mL of SO_2 to diffuse under the same experimental conditions?

23. A swimming pool contains $1 \times 10^5 \text{ L}$ of water, the energy required to raise the temperature of water from 20° C to 25° C in joules is _____ $\times 10^9$. The specific heat capacity of water is $4.184 \text{ J/}^\circ\text{C g}$.

24. A balloon of diameter 20 m weighs 100 kg. The payload is $x \times 10^3$ kg if it is filled with He at 1.1 atm and 27°C . The value of x is _____. Density of air is 1.2 kg m^{-3} ($R = 0.082\text{ dm}^3\text{ atm K}^{-1}\text{ mol}^{-1}$).

25. In a fuel cell methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is



At 298 K standard Gibbs energies of formation for $\text{CH}_3\text{OH}_{(l)}$, $\text{H}_2\text{O}_{(l)}$ and $\text{CO}_{2(g)}$ are -166.2 , -237.2 and $-394.4\text{ kJ mol}^{-1}$ respectively. If standard enthalpy of combustion of methanol is -726 kJ mol^{-1} , approximate efficiency of the fuel cell will be _____ %.

SOLUTIONS

1. (a): $pV = nRT$ or $p = \frac{w}{VM}RT$

$$\text{or, } p = \frac{\rho RT}{M}; p_X = \frac{\rho_X RT}{M_X}$$

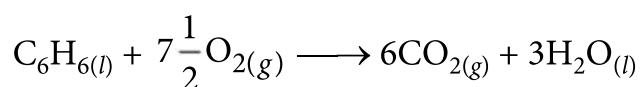
$$p_Y = \frac{\rho_Y RT}{2M_X}; 6p_Y = \frac{\rho_X RT}{M_X} \therefore 6p_Y = p_X$$

$$\frac{p_X}{p_Y} = 6$$

2. (c): When water freezes, the heat is transferred from system to the surroundings, thus entropy of system decreases but entropy of surroundings increases.

3. (a): When $Z < 1$ the gas is said to show $-ve$ deviation. This implies that gas is more compressible and attractive forces predominate. Due to which liquefaction of the gas become easy. When $Z > 1$ the gas is said to show $+ve$ deviation. This means gas is less compressible. As the value of Z increases in graph, ease of liquefaction decreases.

4. (b): The reaction is



In this reaction, O_2 is the only gaseous reactant and CO_2 is the only gaseous product.

$$\therefore \Delta n_g = n_p - n_r = 6 - 7\frac{1}{2} = -\frac{3}{2}$$

Given: ΔU (or q_v) = $-3263.9\text{ kJ mol}^{-1}$

$T = 25^\circ\text{C} = 298\text{ K}$

$$R = 8.314\text{ J K}^{-1}\text{ mol}^{-1} = \frac{8.314}{1000}\text{ kJ K}^{-1}\text{ mol}^{-1}$$

$$\therefore \Delta H \text{ (or } q_p) = \Delta U + \Delta n_g RT$$

$$= -3263.9 - \frac{3}{2} \times \frac{8.314}{1000} \times 298$$

$$= -3263.9 - 3.7 = -3267.6\text{ kJ mol}^{-1}$$

5. (a): $\left(P + \frac{a}{V^2}\right)(V - b) = RT$

As volume occupied by CO_2 molecules is negligible, $b = 0$

$$\therefore \left(P + \frac{a}{V^2}\right)V = RT \text{ or } V^2P - RTV + a = 0$$

$$V = \frac{+RT \pm \sqrt{R^2T^2 - 4Pa}}{2P}$$

Since, V is constant at given P and T , V can have only one value or discriminant = 0

$$\therefore R^2T^2 = 4Pa \text{ or } a = \frac{R^2T^2}{4P}$$

$$= \frac{(0.0821)^2 \times (273)^2}{4 \times 34.98} = 3.59\text{ dm}^6\text{ atm mol}^{-2}$$

6. (b): H_2 , O_2 and H_2O all are in their standard states and 1 mol of water is being produced.

7. (d): Average *K.E.* for 1 mol of gas = $\frac{3}{2}RT$

$$\text{Average } K.E. \text{ for 1 molecule} = \frac{3}{2} \frac{RT}{N_A}$$

8. (b): For initial state, $P_i \times 22.4 = 2 \times R \times 546$

$$\therefore P_i = 4\text{ atm}$$

Now, $P_i V_i = P_f V_f$ (\because Process is isothermal.)

$$4 \times 22.4 = 2 \times V_f \therefore V_f = 44.8\text{ L}$$

$$\therefore \Delta S_{\text{sys}} = nR \ln \left(\frac{V_f}{V_i} \right) = 2R \ln \left(\frac{44.8}{22.4} \right) = 2R \ln 2 = R \ln 4$$

9. (b): According to Gay - Lussac's law, at constant volume, the pressure of a given mass of a gas is directly proportional to the absolute temperature of the gas. $P \propto T$ or $P = KT$

10. (a): The entropy change at the melting point of a substance is given by

$$\Delta S_{\text{fus}} = \frac{\Delta H_{\text{fus}}}{T_{\text{melting}}}$$

$$\therefore T_{\text{melting}} = \frac{\Delta H_{\text{fus}}}{\Delta S_{\text{fus}}}$$

$$= \frac{7.25 \text{ kJ mol}^{-1}}{0.007 \text{ kJ K}^{-1} \text{ mol}^{-1}} = 1035.7 \text{ K}$$

Hence, the melting point of KCl is 1035.7 K

11. (c) : We know that, $PV = nRT$... (i)

Given : $P = 1 \text{ atm}$; $V = 25 \times 10^3 \text{ L}$; $T = 300 \text{ K}$

$R = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$

Putting these values in equation (i), we get

$$n = \frac{PV}{RT} = \frac{1 \times 25 \times 10^3}{0.082 \times 300} = 1016 \text{ mol}$$

Number of molecules = $n \times 6.023 \times 10^{23}$

$$= 1016 \times 6.023 \times 10^{23} = 6.119 \times 10^{26} \text{ molecules}$$

12. (b)

$$13. (b) : \frac{P_A V_A}{T_A} + \frac{P_B V_B}{T_B} = \frac{P_{\text{mix}} V_{\text{mix}}}{T_{\text{mix}}}$$

$$\frac{2 \times 1}{300} + \frac{3 \times 2}{400} = \frac{P_{\text{mix}} \times 4}{600} \Rightarrow \frac{8+18}{1200} = \frac{4P_{\text{mix}}}{600}$$

$$P_{\text{mix}} = \frac{26 \times 600}{4 \times 1200} = 3.25 \text{ atm}$$

14. (c) : It may involve increase or decrease in temperature of the system. Systems in which such process occur, are thermally insulated from the surroundings.

15. (a) : More viscous liquids flow slowly.
SI unit of viscosity coefficient is N s m^{-2} .

$$16. (a) : C_v = 0.075 \times 40 = 3 \text{ cal K}^{-1} \text{ mol}^{-1}$$

$$C_p - C_v = R$$

$$\Rightarrow C_p - 3 = 2 \Rightarrow C_p = 5 \text{ cal K}^{-1} \text{ mol}^{-1}$$

$$\gamma = \frac{C_p}{C_v} = \frac{5}{3} = 1.66$$

Thus, the gas is monoatomic.

17. (c) : (A) \rightarrow p, s, (B) \rightarrow r, (C) \rightarrow p, q, (D) \rightarrow r
(A) For H_2 gas, the value of a is negligible.

$$\therefore P(V - nb) = nRT$$

$$\text{or, } \frac{PV}{nRT} = Z = 1 + \frac{Pb}{RT}$$

Therefore compressibility factor of H_2 is always greater than 1.

(B) At extremely low pressure, real gas (H_2) behaves almost ideally, hence for H_2 gas at 0 atm, $PV = nRT$.

(C) For CO_2 at room temperature, van der Waals' force of attraction dominates.

Since P is 1 atm, Z will be less than 1.

$$(D) \left(P + \frac{an^2}{V^2} \right) (V - nb) = nRT$$

If V is very high, $PV = nRT$.

18. (b) : The combustion reaction for methane is
 $\text{CH}_4(g) + 2\text{O}_2(g) \longrightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(g)$; $\Delta H = ?$

$$\Delta H^\circ = \Delta H^\circ_{f(\text{products})} - \Delta H^\circ_{f(\text{reactants})}$$

$$= \Delta H^\circ_{f(\text{CO}_2)} + 2 \times \Delta H^\circ_{f(\text{H}_2\text{O})} - \Delta H^\circ_{f(\text{CH}_4)} - 2\Delta H^\circ_{f(\text{O}_2)}$$

$$= -398.8 - 2 \times 241.6 - (-76.2) - 2 \times 0$$

$$= -805.8 \text{ kJ mol}^{-1}$$

Heat evolved by burning 22.4 litre (1 mole) methane

$$= -805.8 \text{ kJ.}$$

So, heat evolved by burning 1000 litre (1 m^3) methane

$$= -\frac{805.8}{22.4} \times 1000 = -35973.2 \text{ kJ}$$

19. (b)

$$20. (c) : V_A = \frac{1 \times R \times 100}{1} = 100 \text{ R}$$

$$V_B = \frac{1 \times R \times 600}{3} = 200 \text{ R}; V_C = \frac{1 \times R \times 300}{1} = 300 \text{ R}$$

$V_B > V_A$, so expansion of gas takes place.

$$V_B = 200 \times 0.0821 = 16.42 \text{ L}$$

21. (-24.34) : $V_{\text{initial}} = 6 \text{ L}$, $T = 273 + 27 = 300 \text{ K}$

$$n = \frac{280}{28} = 10 \text{ mol, } p = 1 \text{ atm}; V_{\text{final}} = \frac{nRT}{P}$$

$$= \frac{10 \text{ mol} \times (0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1}) \times (300 \text{ K})}{1}$$

Chemistry bulletin



Impossible aerogel that reflects more visible light than it receives prompts scepticism

Material made from salmon sperm and gelatin touted as greener way to cool buildings

Researchers in China claim to have produced a photoluminescent aerogel with a visible light reflectance of 104%. When placed outside in the sun, they found that the material could cool surfaces by up to 16°C below ambient temperature. Moreover, the material is self-healing, recyclable, compostable, and environmentally friendly. However, other researchers have expressed scepticism about several aspects of the researchers' claims. They nevertheless believe the technology could have promising applications in paints.

$$= 246.3 \text{ L}$$

$$\Delta V = V_{\text{final}} - V_{\text{initial}} = 246.3 - 6.0 = 240.3 \text{ L}$$

$$w_{\text{exp}} = -p\Delta V = -1 \text{ atm} \times 240.3 \text{ L} = -240.3 \text{ L atm}$$

$$= -240.3 \times 101.3 \text{ J} \quad (\because 1 \text{ L atm} = 101.3 \text{ J})$$

$$= -24.342 \text{ kJ}$$

$$22. (4): \because \frac{r_1}{r_2} = \frac{V_1/t_1}{V_2/t_2} = \sqrt{\frac{M_2}{M_1}}$$

$$\frac{500 \text{ mL}}{0.5 \text{ h}} = \sqrt{\frac{M_{\text{SO}_2}}{M_{\text{He}}}} = \sqrt{\frac{64}{4}} = 4$$

$$t_2$$

Therefore, $t_2 = 4 \text{ h}$

23. (2): Heat supplied = Mass \times Specific heat capacity \times Rise in temperature = $m \times C_s \times \Delta T$

$$m = 1 \times 10^5 \text{ L} = 1 \times 10^5 \times 10^3$$

$$= 1 \times 10^8 \text{ g (density} = 1 \text{ g cm}^{-3}\text{)}$$

$$C_s = 4.184 \text{ J/}^\circ\text{C g}; \Delta T = 25 - 20 = 5^\circ$$

$$\therefore \text{Heat supplied} = 1 \times 10^8 \times 4.184 \times 5$$

$$= 2.092 \times 10^9 \text{ J} \approx 2.0 \times 10^9 \text{ J}$$

24. (4.3): Volume of balloon, $V = \frac{4}{3}\pi r^3$ ($r = 10 \text{ m}$)

$$\therefore V = \frac{4}{3} \times 3.14 \times (10)^3 = 4187 \text{ m}^3$$

$$\text{Mass of displaced air} = 4187 \text{ m}^3 \times 1.2 \text{ kg m}^{-3}$$

$$= 5024.4 \text{ kg}$$

$$\text{Moles of gas present, } n = \frac{pV}{RT} = \frac{1 \times 4187 \times 10^3}{0.082 \times 298}$$

$$= 170.2 \times 10^3 \text{ mol}$$

$$\text{Mass of He present} = 170.2 \times 10^3 \times 4$$

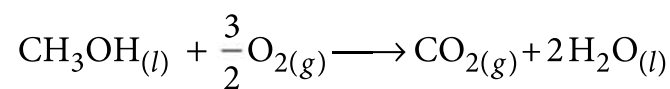
$$= 680.8 \times 10^3 \text{ g} = 680.8 \text{ kg}$$

$$\text{Mass of filled balloon} = 100 + 680.8 = 780.8 \text{ kg}$$

$$\text{Pay load} = \text{Mass of displaced air} - \text{Mass of balloon}$$

$$= 5024.4 - 780.8 = 4243.6 \text{ kg} \approx 4.3 \times 10^3 \text{ kg}$$

25. (97): For the given reaction,



$$\Delta G^\circ_{\text{reaction}} = \sum \Delta G^\circ_f(\text{products}) - \sum \Delta G^\circ_f(\text{reactants})$$

$$= [-394.4 + 2 \times (-237.2)] - (-166.2) = -702.6 \text{ kJ mol}^{-1}$$

$$\% \text{ Efficiency} = \frac{\Delta G}{\Delta H} \times 100 = \frac{-702.6}{-726} \times 100$$

$$= 96.77\% \approx 97\%$$



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CLASS-XI

CBSE

Warm-up!

Chapterwise practice questions for CBSE Exams as per the latest pattern and syllabus by CBSE for the academic session 2024-25.

Series-4

Chemical Bonding and Molecular Structure

General Instructions : Read the following instructions carefully and follow them :

- This question paper contains 33 questions. All questions are compulsory.
- This question paper is divided into five sections – Section A, B, C, D and E.
- Section A – questions number 1 to 16 are multiple choice type questions. Each question carries 1 mark.
- Section B – questions number 17 to 21 are very short answer type questions. Each question carries 2 marks.
- Section C – questions number 22 to 28 are short answer type questions. Each question carries 3 marks.
- Section D – questions number 29 and 30 are case-based questions. Each question carries 4 marks.
- Section E – questions number 31 to 33 are long answer type questions. Each question carries 5 marks.
- There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the sections except section A.
- Kindly note that there is a separate question paper for Visually Impaired candidates.
- Use of calculators is not allowed.

Time Allowed : 3 hours

Maximum Marks : 70

SECTION-A

Question No. 1 to 16 are multiple choice type questions, carrying 1 mark each.

- What formal charges are present in the molecule $C_6H_5C \equiv N - O$?
(a) N is -1 and C is $+1$
(b) N is $+1$ and C is -1
(c) O is -1 and C is $+1$
(d) O is -1 and N is $+1$
- The electronic configuration of metal M is $1s^2 2s^2 2p^6 3s^1$. The formula of its oxide will be
(a) MO (b) M_2O (c) M_2O_3 (d) MO_2
- Hybridisations of nitrogen in the ionic species NO_2^+ , NO_3^- and NH_4^+ respectively are
(a) sp^2 , sp^3 and sp^2 (b) sp , sp^2 and sp^3
(c) sp^2 , sp and sp^3 (d) sp^2 , sp^3 and sp^3 .
- Match column I with column II and select the correct answer by choosing an appropriate option.

Column I (Molecule/Ion)		Column II (Molecular geometry)	
A.	$HgCl_2$	(i)	Tetrahedral
B.	NH_4^+	(ii)	Trigonal bipyramidal
C.	SF_6	(iii)	Linear
D.	PCl_5	(iv)	Octahedral

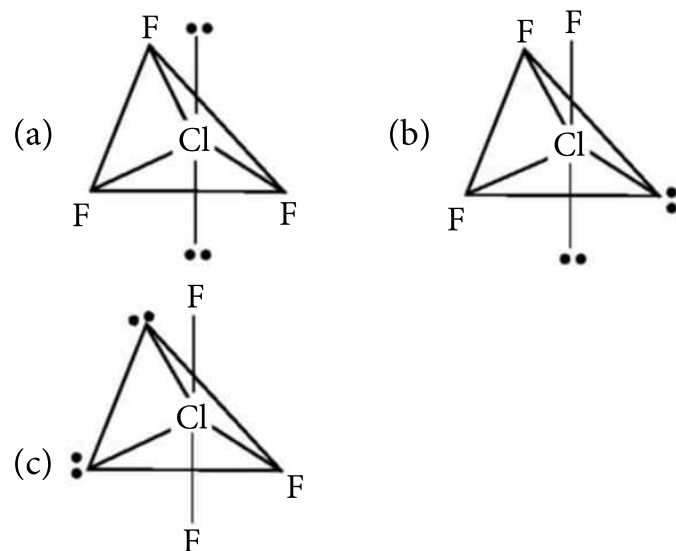
- A–(iv), B–(iii), C–(ii), D–(i)
 - A–(iii), B–(i), C–(iv), D–(ii)
 - A–(iii), B–(ii), C–(i), D–(iv)
 - A–(ii), B–(iii), C–(iv), D–(i)
- Which molecule has the largest dipole moment?
(a) HF (b) HCl
(c) HBr (d) HI
 - (I) 1,2-dihydroxybenzene
(II) 1,3-dihydroxybenzene
(III) 1,4-dihydroxybenzene
(IV) Hydroxybenzene.

The increasing order of boiling points of the given alcohols is

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

7. The correct arrangement of the species in the increasing order of the bond order between carbon and oxygen in them is
- (a) CO, CO₂, HCO₂⁻, CO₃²⁻
(b) CO₂, HCO₂⁻, CO, CO₃²⁻
(c) CO₃²⁻, HCO₂⁻, CO₂, CO
(d) CO, CO₃²⁻, CO₂, HCO₂⁻

8. Which of the following structures of ClF₃ is most stable ?



- (d) All the three structures are of equivalent stability.

9. Which of the following is a group of isoelectronic species?
- (a) O²⁻, F⁻, Na⁺, Mg²⁺ (b) O²⁺, Al³⁺, Si⁴⁺, Na
(c) F, Ne, O²⁻, B³⁺ (d) N³⁻, O²⁻, F⁻, Cl⁻

10. BCl₃ is a planar molecule whereas NCl₃ is pyramidal, because
- (a) B-Cl bond is more polar than N-Cl bond
(b) N-Cl bond is more covalent than B-Cl bond
(c) nitrogen atom is smaller than boron atoms
(d) BCl₃ has no lone pair but NCl₃ has a lone pair of electrons.

11. The bond order in NO is 2.5 while that in NO⁺ is 3. Which of the following statements is true for these two species?
- (a) Bond length in NO⁺ is greater than in NO.
(b) Bond length in NO is greater than in NO⁺.
(c) Bond length in NO⁺ is equal to that in NO.
(d) Bond length is unpredictable.

12. Which of the following order is correct?
- (a) AlCl₃ < MgCl₂ < NaCl : Polarising power
(b) CO > CO₂ > HCO₂⁻ > CO₃²⁻ : Bond length
(c) BeCl₂ < NF₃ < NH₃ : Dipole moment
(d) H₂S > NH₃ > SiH₄ > BF₃ : Bond angle.

For questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

13. **Assertion (A)** : LiCl is predominantly a covalent compound.

Reason (R) : Electronegativity difference between Li and Cl is too small.

14. **Assertion (A)** : Outermost shells of two elements X and Y have two and six electrons respectively. On combination, the expected formula will be X₂Y₆.

Reason (R) : Valency of an element depends on the number of electrons in outermost shell.

15. **Assertion (A)** : Polarising power of Ag⁺ is more than K⁺.

Reason (R) : Among two cations of similar size, the polarising power of cation with pseudo noble gas configuration is larger than cation with noble gas configuration.

16. **Assertion (A)** : O₂ molecule is paramagnetic.

Reason (R) : O₂ molecule has two unpaired electrons according to M.O.T.

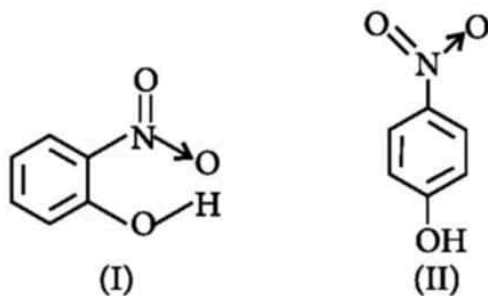
SECTION-B

17. How many σ and π-bonds are present in *m*-xylene and cumene?
18. Draw Lewis structures for the following :
(a) CO₃²⁻ (b) NH₄⁺
19. Out of MgO and NaCl, which has higher lattice energy and why?

OR

Out of σ and π bonds, which one is stronger bond and why?

20. Structure of molecules of two compounds are given below :



Which of the above two compounds will show higher boiling point?

21. Bond order in N_2^+ is less than that in N_2 whereas in O_2^+ it is more than O_2 . Why?

SECTION-C

22. Indicate the types of bonds present in NH_4NO_3 and state the mode of hybridisation of two N atoms.
23. Write any three points of difference between ionic and covalent compounds.
24. Give increasing order of bond orders for B_2 , F_2 and N_2^+ .
25. Explain why *o*-hydroxybenzaldehyde is a liquid at room temperature while *p*-hydroxybenzaldehyde is a high melting solid.
26. Discuss the hybridisation of carbon atoms in allene (C_3H_4) and show the *p*-orbital overlaps.
27. Bond angle in PH_4^+ is higher than that in PH_3 , why?
28. Predict the shape of the following species :
(any three)
- | | |
|--------------|--------------|
| (a) SF_4 | (b) BrF_5 |
| (c) NH_4^+ | (d) NH_2^- |

SECTION-D

The following questions are case-based questions. Read the case carefully and answer the questions that follow.

29. When an anion and cation approach each other, the electron cloud of anion is pulled towards the cation, this is known as polarisation. The ability of the cation to polarise the anion is called as polarising power of cation. Due to polarisation, sharing of electron occurs between two ions to some extent and bond shows some covalent character. Fajans suggested following factors on which polarisation depends : Size of cation/anion, charge on cation/anion and electronic configuration of cation.

Answer the following questions:

- (a) Which one has greater polarising power : $BeCl_2$ or $SrCl_2$?
- (b) Arrange the following in order of increasing covalent character : $LiCl$, $LiBr$, LiI
- (c) Which has greater solubility among the following?
 AlF_3 , $AlCl_3$, $AlBr_3$, AlI_3

OR

- (c) Why $FeCl_3$ has greater covalent character than $FeCl_2$?

30. Molecular orbitals are formed by overlap of atomic orbitals. The molecular orbital formed by additive effect of atomic orbitals is called bonding molecular orbital (BMO) and the molecular orbital formed by the subtractive effect of the orbitals is called antibonding molecular orbital (ABMO).

The molecular orbitals are filled with electrons according to the same rules as followed for filling of atomic orbitals. However, the order for filling is not the same for all molecules or their ions. Bond order is one of the most important parameters to compare the strength of the bonds.

Answer the following questions:

- (a) Explain why He_2 does not exist?
- (b) Compare the stability of O_2^+ and O_2 on the basis of molecule orbital theory.
- (c) Arrange the following in the decreasing order of the O–O bond length present in them, O_2 , KO_2 and $O_2[AsF_4]$.

OR

- (c) Out of B_2 , O_2 and N_2 which is/are diamagnetic?

SECTION-E

31. (a) The dipole moment of KCl is 3.336×10^{-29} coulomb metre which indicates that it is a highly polar molecule. The interatomic distance between K^+ and Cl^- in this molecule is 2.6×10^{-10} m. Calculate the dipole moment of KCl molecule if there were opposite charges of one fundamental unit located at each nucleus. Calculate percentage ionic character of KCl .
- (b) How is lattice energy related with stability of an ionic compound?

OR

- (a) Which out of NH_3 and NF_3 has higher dipole moment and why?

(b) Draw diagram showing the formation of a double bond between carbon atoms in C_2H_4 molecule.

32. Attempt any five of the following:

(a) The experimentally determined N-F bond length in NF_3 is greater than the sum of the single covalent radius of N and F. Explain.

(b) CH_4 , H_2O and NH_3 – all three have sp^3 hybridisation. Why are the bond angles different in three cases?

(c) Ethyl alcohol is a covalent compound, but it is completely miscible with water. Give reason.

(d) What is the shape of $[SnCl_3]^-$ ion?

(e) Which one has higher melting point, $BeCl_2$ or $MgCl_2$?

(f) Why does PCl_5 exist as $[PCl_4]^+[PCl_6]^-$ in the crystalline state?

(g) Write an example of intramolecular hydrogen bonding.

33. Give reason for the following:

(a) BF_3 has a zero dipole moment although the B-F bonds are polar.

(b) All carbon to oxygen bonds in CO_3^{2-} are equivalent.

OR

Draw the resonating structures of the following :

(a) Ozone molecule

(b) Nitrate ion

SOLUTIONS

1. (d) : For nitrogen, formal charge = $5 - \frac{1}{2}(8) = +1$

For oxygen, formal charge = $6 - 6 - \frac{1}{2}(2) = -1$.

2. (b) : $2M \rightarrow 2M^+ + 2e^-$
 $(1s^2 2s^2 2p^6 3s^1) \quad (1s^2 2s^2 2p^6)$

$O + 2e^- \rightarrow O^{2-}$
 $(1s^2 2s^2 2p^4) \quad (1s^2 2s^2 2p^6)$

Thus, M_2O .

3. (b) : Hybridisation of nitrogen in ionic species NO_2^+ , NO_3^- and NH_4^+ :

NO_2^+ : $H = \frac{1}{2}(5-1) = 2$ i.e. sp

NO_3^- : $H = \frac{1}{2}(5+1) = 3$ i.e. sp^2

NH_4^+ : $H = \frac{1}{2}(5+4-1) = 4$ i.e. sp^3

4. (b)

5. (a) : HF has largest dipole moment because electronegativity difference of both elements is high, so it is highly polar.

6. (c) : 1,4-dihydroxybenzene shows highest boiling point among given compounds due to intermolecular H-bonding.

7. (c) : Bond order = $\frac{\text{Bond order of each C—O bond}}{\text{Total no. of resonating structures}}$

$CO \rightarrow C \equiv O$ B.O. $\Rightarrow \frac{2+1}{1} = 3.0$

$CO_2 \rightarrow O=C=O$ B.O. $\Rightarrow \frac{2+2}{2} = 2.0$

$HCO_2^- \rightarrow H-C \begin{matrix} \nearrow \ddot{O}: \\ \searrow \ddot{O}: \end{matrix}$ B.O. $\Rightarrow \frac{2+1}{2} = 1.5$

$CO_3^{2-} \rightarrow \left[\begin{matrix} \text{:O:} \\ \parallel \\ \text{C} \\ \diagup \text{:O:} \quad \diagdown \text{:O:} \end{matrix} \right]^{2-}$ B.O. $\Rightarrow \frac{1+1+2}{3} = 1.33$

8. (c) : In this structure, there are four 90° repulsions between lone pair and bond pair.

($lp-lp = 0$, $lp-bp = 4$, $bp-bp = 2$)

9. (a) : $O^{2-} \Rightarrow 8+2 = 10$ $O^{2+} \Rightarrow 8-2 = 6$

$F^- \Rightarrow 9+1 = 10$ $Al^{3+} \Rightarrow 13-3 = 10$

$Na^+ \Rightarrow 11-1 = 10$ $Si^{4+} \Rightarrow 14-4 = 10$

$Mg^{2+} \Rightarrow 12-2 = 10$ $Na \Rightarrow 11$

$F \Rightarrow 9$, $Ne \Rightarrow 10$, $O^{2-} \Rightarrow 8+2 = 10$, $B^{3+} \Rightarrow 5-3 = 2$

$N^{3-} \Rightarrow 7+3 = 10$, $F^- \Rightarrow 9+1 = 10$, $Cl^- \Rightarrow 17+1 \Rightarrow 18$

10. (d) : BCl_3 : $\begin{matrix} 2s & 2p \\ \uparrow & \uparrow \uparrow \square \end{matrix}$ (Central B atom)

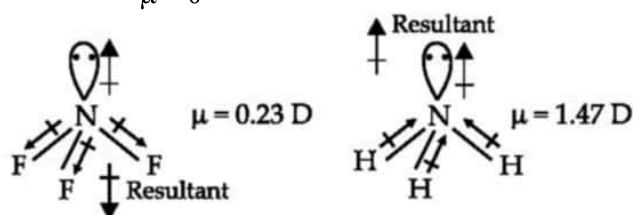
No lone pair of electrons is available in BCl_3 .

NCl_3 : $\begin{matrix} 2s & 2p \\ \uparrow \downarrow & \uparrow \uparrow \uparrow \square \end{matrix}$ (Central N atom)

One lone pair of electrons is available on N atom, it occupies a corner in the tetrahedral arrangement. Therefore, NCl_3 appears pyramidal in shape.

11. (b) : Higher the bond order, shorter will be the bond length. NO^+ has higher bond order than that of NO so, NO^+ has shorter bond length.

12. (c) : $Cl \leftarrow Be \rightarrow Cl$,
 $\mu = 0$



Correct order of dipole moment : $BeCl_2 < NF_3 < NH_3$

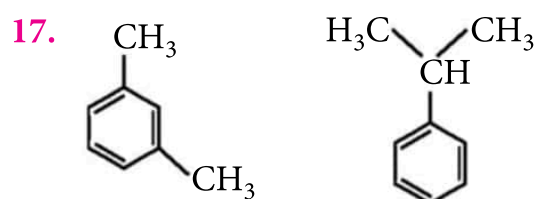
13. (c) : Electronegativity difference between Li and Cl is quite large. Covalent compound is formed due to high ionization energy of Li or small size of Li and greater polarising power.

14. (d) : Valency of X = 2 (as it can give two electrons)
Valency of Y = 8 - 6 = 2 (as it can gain two electrons)

$$\therefore \text{Formula} = X^{+2} Y^{-2} = XY.$$

15. (b)

16. (a) : O₂ is paramagnetic due to the presence of two unpaired electrons.



m-Xylene

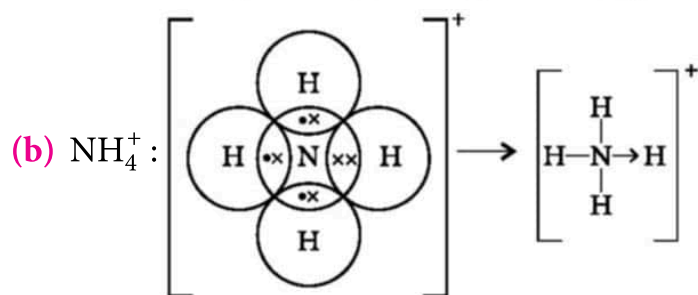
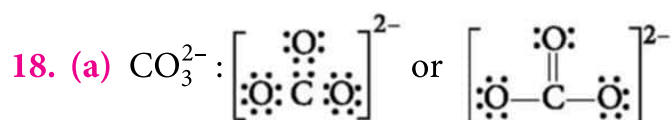
σ bonds = 18

π bonds = 3

Cumene

σ bonds = 21

π bonds = 3



19. MgO has higher lattice energy because both the ions (Mg²⁺ and O²⁻) carry two unit charges whereas in NaCl, each ion (Na⁺ or Cl⁻) carries one unit charge.

OR

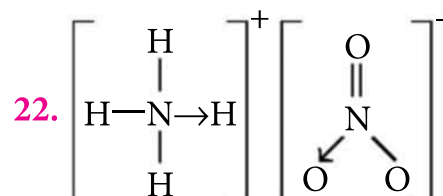
σ-bond is stronger than a π-bond. This is because σ-bond is formed by head-on overlapping of orbitals and therefore, overlapping is large. On the other hand π-bond is formed by the sidewise overlapping, which is small.

20. Compound II (*p*-Nitrophenol) has higher boiling point. Due to the intermolecular hydrogen bonding more energy needs to be supplied to vaporise the compound. Therefore, it has higher melting and boiling points. In compound I (*o*-Nitrophenol), the intramolecular hydrogen bond results in the cyclisation of the molecule and prevents their association. Consequently less energy needs to be supplied to vaporise the compounds.

21. N₂⁺ is formed by the removal of an electron from the bonding σ2p_z molecular orbital which causes the

reduction in the bond order in N₂⁺, thus it becomes 2.5 in N₂⁺ from 3 in N₂.

In case of O₂⁺ the electron is removed by antibonding orbital, which leads to increase in bond order.



NH₄⁺ ion contains three covalent bonds and one dative bond (formed by the donation of lone pair of electrons on N in NH₃ to H⁺ ion). NO₃⁻ ion contains covalent and dative bonds.

The bond between NH₄⁺ and NO₃⁻ is ionic.

N of NH₄⁺ ion is sp³ hybridised and the shape of NH₄⁺ ion is tetrahedral. N of NO₃⁻ ion is sp² hybridised and the shape of NO₃⁻ ion is planar.

23. Differences between ionic compound and covalent compound :

	Ionic compound	Covalent compound
1.	Ionic compounds are generally solid at room temperature, because of the strong electrostatic forces of attraction.	Covalent compounds are gases, liquids or soft solids under ordinary conditions.
2.	Freely soluble in water and in polar solvents. Insoluble in non-polar solvents.	Usually insoluble in water and in polar solvents. Soluble in non-polar solvents.
3.	Owing to strong electrostatic forces of attraction, ionic compounds possess high melting and boiling points.	Owing to weak intermolecular forces of attraction, covalent compounds have low melting and boiling points.

24. M.O. electronic configuration of B₂ :

$$KK\sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^1 = \pi 2p_y^1$$

$$\text{Bond order} = \frac{N_b - N_a}{2} ; \text{B.O.} = \frac{4 - 2}{2} = 1$$

M.O. electronic configuration of F₂ :

$$KK\sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^2$$

$$\text{B.O.} = \frac{1}{2}(8 - 6) = 1$$

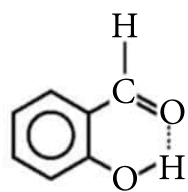
M.O. electronic configuration of N_2^+ :
 $KK \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^1$

$$B.O. = \frac{1}{2}(7 - 2) = 2.5$$

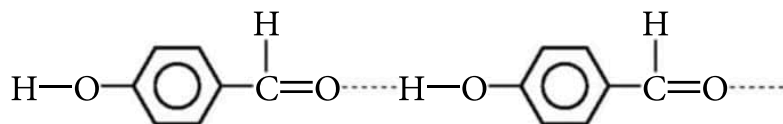
Thus, increasing order of bond orders :

$$B_2 = F_2 < N_2^+$$

25. In *o*-hydroxybenzaldehyde, there is intramolecular hydrogen bonding which further prevents association of the molecules. However, in *p*-hydroxybenzaldehyde, there is intermolecular hydrogen bonding and therefore, there is association among the molecules :



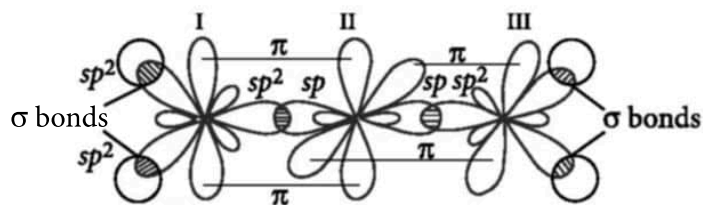
o-hydroxybenzaldehyde
(Intramolecular hydrogen bonding)



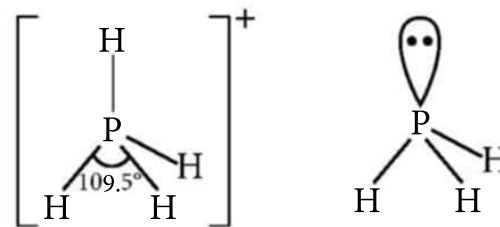
p-hydroxybenzaldehyde
(Intermolecular hydrogen bonding)

Thus, because of larger association, *p*-hydroxybenzaldehyde is a solid at room temperature but *o*-hydroxybenzaldehyde is a liquid because of less association.

26. Allene is $\overset{\text{I}}{\text{C}}\text{H}_2=\overset{\text{II}}{\text{C}}=\overset{\text{III}}{\text{C}}\text{H}_2$. Carbon atoms I and III are in sp^2 hybridised state while carbon II is in sp hybridised state. Two unhybridised orbitals of carbon II overlap sidewise with unhybridised orbital of each of carbon I and carbon III to form π -bonds besides it also forms a sigma bond with each of the carbon atoms using hybridised orbitals. Two hybridised orbitals of each of carbon I and III form sigma bonds with hydrogen atoms.



27. Both PH_4^+ and PH_3 involve sp^3 hybridisation of P atom. In PH_4^+ all the four orbitals are bonded, whereas in PH_3 there is a lone pair of electrons on P. In PH_4^+ , the H—P—H bond angle is tetrahedral angle of 109.5° . But in PH_3 , lone pair-bond pair repulsion is more than bond pair-bond pair repulsion so that bond angles become less than normal tetrahedral angle. The bond angle in PH_3 has found to be about 93.6° .



28. (a) SF_4 : Valence electrons = 6,

No. of single bonds = 4

$$ep = \frac{6+4}{2} = 5, bp = 4, lp = 5 - 4 = 1$$

Since it has 5 *ep*, the shape will be pentagonal bipyramidal with one position occupied by lone pair. Hence, its shape is see-saw.

(b) BrF_5 : Valence electrons = 7, single bonds = 5

$$ep = \frac{7+5}{2} = 6, bp = 5, lp = 6 - 5 = 1$$

Since it has 6 *ep*, its geometry will be octahedral with one position occupied by a lone pair. Hence, it has square pyramidal shape.

(c) NH_4^+ : Valence electrons = 5, single bonds = 4, unit positive charge = 1

$$ep = \frac{5+4-1}{2} = 4, bp = 4, lp = 4 - 4 = 0$$

It has tetrahedral shape.

(d) NH_2^- : Valence electrons = 5, single bonds = 2, unit negative charge = 1

$$ep = \frac{5+2+1}{2} = 4, bp = 2, lp = 4 - 2 = 2$$

It has tetrahedral geometry with two positions occupied by lone pairs. Its shape is bent or V-shape.

29. (a) Smaller the cation, greater is its polarising power. Therefore, Be^{2+} has greater polarising power than Sr^{2+} .

(b) Increasing order of the size of the anion is $\text{Cl}^- < \text{Br}^- < \text{I}^-$

Hence, LiCl is least covalent and LiI is most covalent and the order is : $\text{LiCl} < \text{LiBr} < \text{LiI}$.

(c) $\text{AlF}_3 > \text{AlCl}_3 > \text{AlBr}_3 > \text{AlI}_3$

As the size of the anion increases, it gets more and more easily polarised and hence covalent character of the molecule increases and solubility decreases.

OR

(c) Fe^{3+} ion has greater charge and smaller size than Fe^{2+} ion. Hence Fe^{3+} has a greater polarising power.

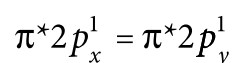
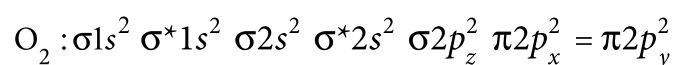
30. (a) In He_2 , total 4 electrons are present. Its M.O. electronic configuration is $\sigma 1s^2 \sigma^* 1s^2$. As $N_b = N_a$ the bond order is zero. Hence, He_2 does not exist.

(b) Stability of O_2^+ and O_2 :

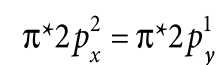
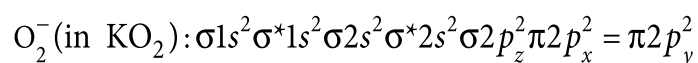
Species	Total electrons	Configuration	Bond order
O_2	16	(KK) $\sigma(2s)^2 \sigma^*(2s)^2$ $\sigma(2p_z)^2$ $\pi(2p_x)^2 = \pi(2p_y)^2$ $\pi^*(2p_x)^1 = \pi^*(2p_y)^1$	$\frac{(8-4)}{2} = 2.0$
O_2^+	15	(KK) $\sigma(2s)^2 \sigma^*(2s)^2$ $\sigma(2p_z)^2$ $(\pi(2p_x)^2 = \pi(2p_y)^2)$ $\pi^*(2p_x)^1$	$\frac{(8-3)}{2} = 2.5$

Greater the bond order, greater is stability. Hence, O_2^+ is more stable than O_2 .

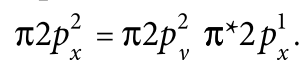
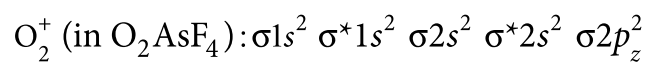
(c) Since bond strength \propto bond order, so we calculate the bond order in the given species.



$$\therefore \text{B.O.} = \frac{10-6}{2} = 2$$

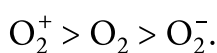


$$\therefore \text{B.O.} = \frac{10-7}{2} = 1.5$$



$$\therefore \text{B.O.} = \frac{10-5}{2} = 2.5$$

The B.O. of three species follows the order is



Bond length in decreasing order is $O_2^- > O_2 > O_2^+$.

OR

(c)

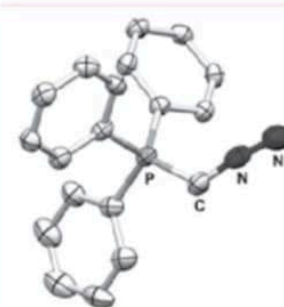
Molecule	Molecular orbital configuration	Bond order	Magnetic behaviour
B_2	$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2$ $\sigma^* 2s^2$ $(\pi 2p_x^1 = \pi 2p_y^1)$	$\frac{1}{2} (6-4)$ $= 1$	Paramagnetic

O_2	$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2$ $\sigma^* 2s^2 \sigma 2p_z^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$ $(\pi^* 2p_x^1 = \pi^* 2p_y^1)$	$\frac{1}{2} (10-6)$ $= 2$	Paramagnetic
N_2	$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2$ $\sigma^* 2s^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$ $\sigma 2p_z^2$	$\frac{1}{2} (10-4)$ $= 3$	Diamagnetic

Chemistry bulletin

Designer ylide transfers single carbon atoms

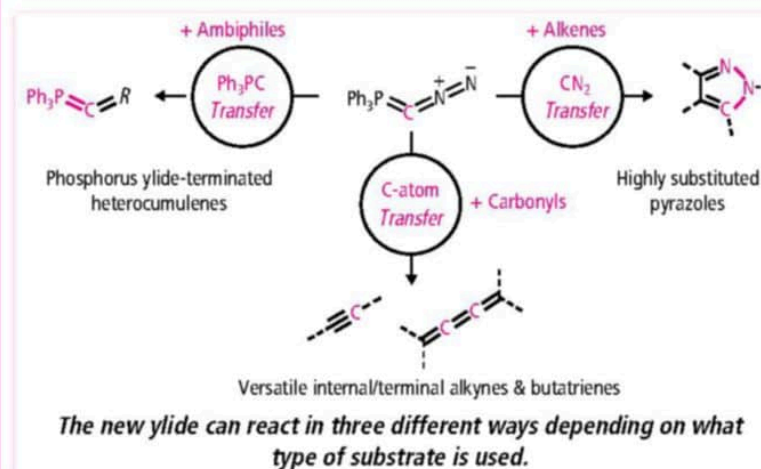
Researchers in Germany have designed an organic reagent capable of inserting a single carbon atom into existing molecules – one of three group transfer reactions supported by the new compound. The designer reagent is easy to make and could become a powerful addition to the skeletal editing toolbox.



This X-ray structure of the new ylide reagent reveals its cumulene-like structure with the carbon double-bonded to both a triphenylphosphine group and a diazo group.

Carbon atom insertions are important transformations in organic chemistry and homologations like the Wittig reaction are staples of undergraduate chemistry. These processes typically use a dipolar reagent called an ylide

which contains a (formally) negatively charged carbon atom attached to a (formally) positively charged heteroatom which is cleaved during the reaction. However, while this chemistry is well-established, many ylide reagents are synthesized using explosive azides and are unstable at room temperature, limiting both the practicality and scope of these techniques.



31. (a) For one unit charge, $q = 1.602 \times 10^{-19} \text{ C}$
 $\therefore \mu = 1.602 \times 10^{-19} \times 2.6 \times 10^{-10}$
 $= 4.1652 \times 10^{-29} \text{ coulomb metre}$

Dipole moment $\mu = q \times d$

$$\% \text{ ionic character} = \frac{\mu_{\text{observed}}}{\mu_{\text{ionic}}} \times 100$$

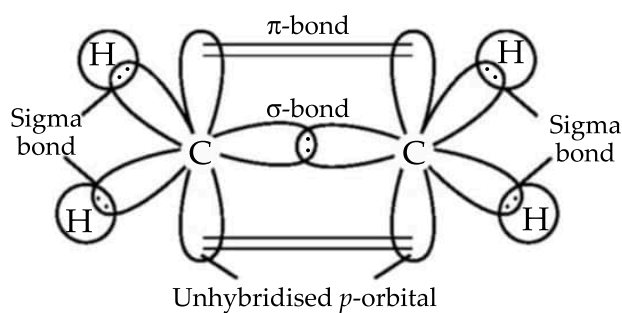
$$= \frac{3.336 \times 10^{-29}}{4.1652 \times 10^{-29}} \times 100 = 80.09 \%$$

(b) Stability is dependent on the magnitude of lattice energy. High negative value of lattice energy gives more stability to an ionic compound.

OR

(a) Both the molecules NH_3 and NF_3 have pyramidal shape with a lone pair of electrons on nitrogen atom. Although fluorine is more electronegative than nitrogen, the resultant dipole moment of NH_3 ($4.90 \times 10^{-30} \text{ C m}$) is greater than that of NF_3 ($0.8 \times 10^{-30} \text{ C m}$). This is because, in case of NH_3 the orbital dipole due to lone pair is in the same direction.

(b) C_2H_4 molecule :

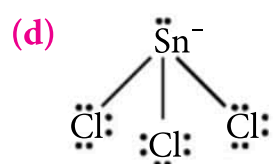


(Formation of ethylene molecule)

32. (a) Both N and F atoms are small in size and their electron density is high. Both N and F repel the bond pair and as a result N–F bond length is larger than the sum of the atomic radii of N and F atoms.

(b) All CH_4 , NH_3 and H_2O are sp^3 hybridised molecules but N in NH_3 has one and O in H_2O has two lone pairs of electrons. Lone pair – bond pair repulsion (lone pair effect) gives rise to contraction in bond angles. Hence, CH_4 has bond angle 109.5° , NH_3 has bond angle 107° and H_2O has bond angle 104.5° .

(c) The molecule of ethanol contains —OH groups and hence is capable of forming H-bonds with water.



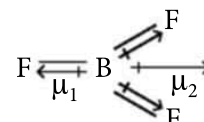
The shape of $[\text{SnCl}_3]^-$ ion is trigonal pyramidal.

(e) Due to the smaller size Be^{2+} ion, BeCl_2 is more covalent than MgCl_2 . Hence, MgCl_2 has higher melting point than BeCl_2 .

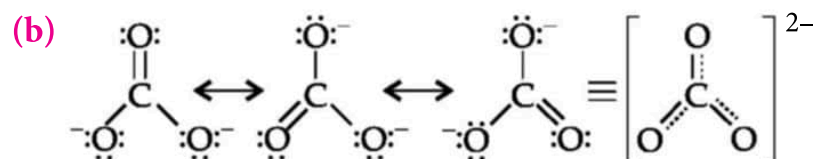
(f) PCl_5 has unsymmetrical structure because of different axial and equatorial bonds. Therefore, it is unstable and it changes to tetrahedral $[\text{PCl}_4]^+$ and octahedral $[\text{PCl}_6]^-$ ions, which have stable geometries.

(g) *o*-Nitrophenol has intramolecular hydrogen bonding.

33. (a) In case of BF_3 molecule,



μ_1 and μ_2 cancel each other, hence dipole moment becomes zero.

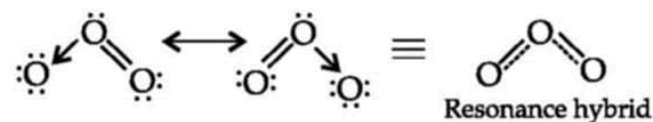


All the C–O bonds in CO_3^{2-} are equal because of resonance.

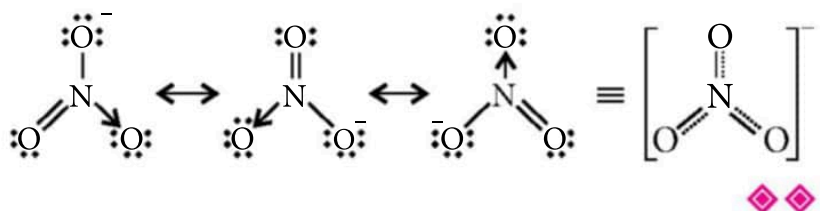
OR

Resonating structures :

(a) Ozone molecule :



(b) Nitrate ion :



CHEM CAPSULE

Teacher : Explaining the chemical properties of toluene

Me in my mind :

ALL WE NEED IS SOMEBODY  ON

Are you ready for Olympiads?

LEVEL 1 Exam on
18th Oct., 12th Nov. &
3rd Dec., 2024



CLASS XI

SYLLABUS*

Following the protocol of NEP (2020), NCF (2023), NCERT and CBSE guidelines, National and various State Boards for the convenience of schools and students, any change/reduction in the syllabi will be reflected in actual question papers.

Section – 1 : Physics : Units and Measurements, Mechanics, Properties of Matter, Heat and Thermodynamics, Oscillations, Waves.

Chemistry : Some Basic Concepts of Chemistry, Structure of Atom, Classification of Elements and Periodicity in Properties, Chemical Bonding and Molecular Structure, Thermodynamics, Equilibrium, Redox Reactions, Organic Chemistry - Some Basic Principles and Techniques, Hydrocarbons.

Section – 2 : Higher Order Thinking Questions - Syllabus as per Section – 1.

Section – 3 : Sets, Relations and Functions, Logarithms, Complex Numbers & Quadratic Equations, Linear Inequalities, Sequences and Series, Trigonometry, Straight Lines, Conic Sections, Permutations and Combinations, Binomial Theorem, Statistics, Limits and Derivatives, Probability, Introduction to 3-D Geometry.

Section – 3 : Diversity in the Living World, Structural Organisation in Plants and Animals, Cell : Structure and Functions, Plant Physiology, Human Physiology.

Total Questions : 50

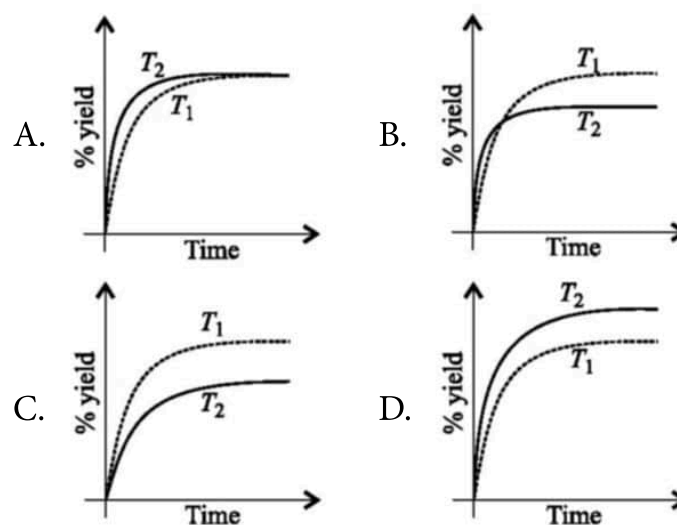
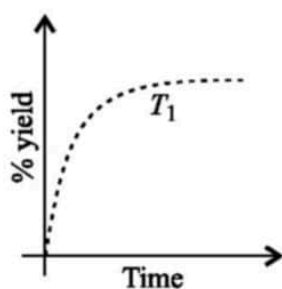
Time : 1 hr.

PATTERN & MARKING SCHEME			
Section	(1) Physics & Chemistry	(2) Achievers Section	(3) Mathematics or Biology
No. of Questions	25	5	20
Marks per Ques.	1	3	1

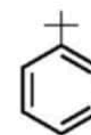
OR

Practice Questions

- The ionisation enthalpy of hydrogen atom is $1.312 \times 10^6 \text{ J mol}^{-1}$. The energy required to excite the electron in the atom from $n = 1$ to $n = 2$ is
A. $9.84 \times 10^5 \text{ J mol}^{-1}$ B. $8.51 \times 10^5 \text{ J mol}^{-1}$
C. $6.56 \times 10^5 \text{ J mol}^{-1}$ D. $7.56 \times 10^5 \text{ J mol}^{-1}$
- 20 mL of acetic acid reacts with 20 mL of ethyl alcohol to form ethyl acetate and water. The density of acid and alcohol are 1 g/mL and 0.7 g/mL respectively. The limiting reagent in this reaction is
A. Acetic acid B. Ethyl alcohol
C. Water D. Ester
- The % yield of ammonia as a function of time in the reaction $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$, $\Delta H < 0$ at (P, T_1) is given in the graph. If this reaction is conducted at (P, T_2) , with $T_2 > T_1$, the % yield of ammonia as a function of time is represented by



- Which of the following compounds would create electron density at *ortho* and *para* positions greater than the following compound?



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

- A. I only B. II and III only
C. III and IV only D. I, II and III only

5. Consider the following ionisation enthalpies of two elements 'A' and 'B':

Element	Ionisation enthalpy (kJ/mol)		
	1 st	2 nd	3 rd
A	899	1757	14847
B	737	1450	7731

Which of the following statements is correct?

- A. Both 'A' and 'B' belong to group-2 where 'A' comes below 'B'.
B. Both 'A' and 'B' belong to group-2 where 'B' comes below 'A'.
C. Both 'A' and 'B' belong to group-1 where 'B' comes below 'A'.
D. Both 'A' and 'B' belong to group-1 where 'A' comes below 'B'.
6. Oxidation number of bromine in sequence in Br_3O_8 is
A. +8, +6, +8 B. +6, +4, +6
C. 0, 0, 0 D. +8, +4, +8
7. The incorrect expression among the following is
A. In isothermal process, $w_{\text{reversible}} = -nRT \ln \frac{V_f}{V_i}$
B. $\ln K = \frac{\Delta H^\circ - T\Delta S^\circ}{RT}$
C. $K = e^{-\Delta G^\circ/RT}$ D. $\frac{\Delta G_{\text{system}}}{\Delta S_{\text{total}}} = -T$
8. One mole of a symmetrical alkene on ozonolysis gives two moles of an aldehyde having a molecular mass of 44 u. The alkene is
A. Ethene B. Propene
C. 1-Butene D. 2-Butene
9. Which of the following statements is not correct?
A. Hybridisation is the mixing of atomic orbitals and their simultaneous combination into molecular orbitals.
B. sp^2 hybrid orbitals are formed from two p -atomic orbitals and one s -atomic orbital.
C. dsp^2 hybrid orbitals are all at 90° to one another.
D. d^2sp^3 hybrid orbitals are directed towards the corners of a regular octahedron.
10. The correct order of second ionisation potential of carbon, nitrogen, oxygen and fluorine is
A. $C > N > O > F$ B. $O > N > F > C$
C. $O > F > N > C$ D. $F > O > N > C$

11. Which of the following solutions will have pH close to 1.0?

- A. 100 mL of (M/10) HCl + 100 mL of (M/10) NaOH
B. 55 mL of (M/10) HCl + 45 mL of (M/10) NaOH
C. 10 mL of (M/10) HCl + 90 mL of (M/10) NaOH
D. 75 mL of (M/5) HCl + 25 mL of (M/5) NaOH

12. The bond order in NO is 2.5 while that in NO^+ is 3. Which of the following statements is true for these two species?

- A. Bond length in NO^+ is greater than in NO.
B. Bond length in NO is greater than in NO^+ .
C. Bond length in NO^+ is equal to that in NO.
D. Bond length is unpredictable.

13. The heats of combustion of carbon and carbon monoxide are -393.5 and -283.5 kJ mol^{-1} respectively. The heat of formation (in kJ) of carbon monoxide per mole is
A. 110 B. 676.5 C. -676.5 D. -110

14. For the estimation of nitrogen, 1.4 g of an organic compound was digested by Kjeldahl method and the evolved ammonia was absorbed in 60 mL of M/10 sulphuric acid. The unreacted acid required 20 mL of M/10 sodium hydroxide for complete neutralization. The percentage of nitrogen in the compound is
A. 5% B. 6% C. 10% D. 3%.

15. In the reaction,



- A. 11.2 L $\text{H}_{2(g)}$ at STP is produced for every mole of $\text{HCl}_{(aq)}$ consumed
B. 6 L $\text{HCl}_{(aq)}$ is consumed for every 3 L of $\text{H}_{2(g)}$ produced
C. 33.6 L $\text{H}_{2(g)}$ is produced regardless of temperature and pressure for every mole of Al that reacts
D. 67.2 L $\text{H}_{2(g)}$ at STP is produced for every mole of Al that reacts.

ACHIEVERS SECTION

16. For a particular reversible reaction at temperature T , ΔH and ΔS were found to be both +ve. If T_e is the temperature at equilibrium, the reaction would be spontaneous when

- A. $T = T_e$ B. $T_e > T$
C. $T > T_e$ D. $T_e = 5T$

17. According to Bohr's theory E_n = total energy, K_n = kinetic energy, V_n = potential energy, r_n = radius of n^{th} orbit. Match the items of column I with values of column II and select the correct option.

Column I		Column II	
I.	$V_n/K_n = ?$	P	0
II.	If radius of n^{th} orbit inversely E_n^x , $x = ?$	Q	-1
III.	Angular momentum in lowest orbital	R	-2
IV.	$\frac{1}{r^n} \propto Z^y$, $y = ?$	S	1

- A. (I → Q), (II → S), (III → P), (IV → R)
 B. (I → R), (II → Q), (III → P), (IV → S)
 C. (I → P), (II → S), (III → Q), (IV → R)
 D. (I → P), (II → R), (III → S), (IV → Q)
18. When KMnO_4 acts as an oxidising agent and ultimately forms MnO_4^{2-} , MnO_2 , Mn_2O_3 and Mn^{2+} , then the number of electrons transferred in each case respectively are
- A. 4, 3, 1, 5 B. 1, 5, 3, 7
 C. 1, 3, 4, 5 D. 3, 5, 7, 1
19. Given below is the table showing shapes of some molecules having lone pairs of electrons. Fill

up the blanks left in it by selecting an appropriate option.

Molecule type	bp	lp	Shape	Example
AB_2E_2	2	<u>P</u>	Bent	H_2O
AB_3E_2	3	2	<u>Q</u>	ClF_3
AB_5E	5	<u>R</u>	<u>S</u>	BrF_5
AB_4E_2	4	2	<u>T</u>	<u>U</u>

- | | P | Q | R | S | T | U |
|----|--------------------|--------------------|--------------------|------------------|------------------|------------------------|
| A. | 2 Square pyramidal | 2 T-shaped | 2 T-shaped | Square planar | Square planar | H_2O_2 |
| B. | 4 T-shaped | 5 Square planar | 5 Square planar | Square pyramidal | Square pyramidal | SO_3 |
| C. | 2 T-shaped | 1 Square pyramidal | 1 Square pyramidal | Square planar | Square planar | XeF_4 |
| D. | 3 Square planar | 2 T-shaped | 2 T-shaped | Square pyramidal | Square pyramidal | BrCl_3 |
20. Of the isomeric hexanes, the isomers that give the minimum and maximum number of monochloro derivatives are respectively
- A. 3-methylpentane and 2,3-dimethylbutane
 B. 2,3-dimethylbutane and n -hexane
 C. 2,2-dimethylbutane and 2-methylpentane
 D. 2,3-dimethylbutane and 2-methylpentane.

Darken your choice with HB Pencil

1.	(A) (B) (C) (D)	5.	(A) (B) (C) (D)	9.	(A) (B) (C) (D)	13.	(A) (B) (C) (D)	17.	(A) (B) (C) (D)
2.	(A) (B) (C) (D)	6.	(A) (B) (C) (D)	10.	(A) (B) (C) (D)	14.	(A) (B) (C) (D)	18.	(A) (B) (C) (D)
3.	(A) (B) (C) (D)	7.	(A) (B) (C) (D)	11.	(A) (B) (C) (D)	15.	(A) (B) (C) (D)	19.	(A) (B) (C) (D)
4.	(A) (B) (C) (D)	8.	(A) (B) (C) (D)	12.	(A) (B) (C) (D)	16.	(A) (B) (C) (D)	20.	(A) (B) (C) (D)

SOLUTIONS

1. (A) : The ionisation enthalpy of H-atom is the energy absorbed when the electron in an atom gets excited from first shell (E_1) to infinity (*i.e.*, E_∞).

$$I.E. = E_\infty - E_1$$

$$1.312 \times 10^6 = 0 - E_1 \Rightarrow E_1 = -1.312 \times 10^6 \text{ J mol}^{-1}$$

$$E_2 = -\frac{1.312 \times 10^6}{(2)^2} = -\frac{1.312 \times 10^6}{4}$$

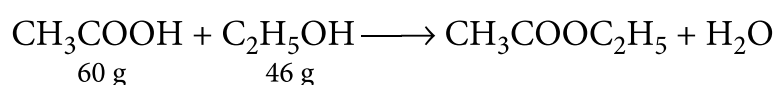
Energy of electron in second orbit, $n = 2$

∴ Energy required when an electron makes transition from $n = 1$ to $n = 2$,

$$\Delta E = E_2 - E_1 = -\frac{1.312 \times 10^6}{4} - (-1.312 \times 10^6)$$

$$= \frac{-1.312 \times 10^6 + 5.248 \times 10^6}{4} = 9.84 \times 10^5 \text{ J mol}^{-1}$$

2. (B): Mass of 20 mL of acetic acid = $20 \times 1 = 20$ g
 Mass of 20 mL of ethyl alcohol = $20 \times 0.7 = 14$ g



60 g of acetic acid \equiv 46 g of ethyl alcohol

20 g of acetic acid \equiv 15.3 g of ethyl alcohol

Therefore, ethyl alcohol is the limiting reagent.

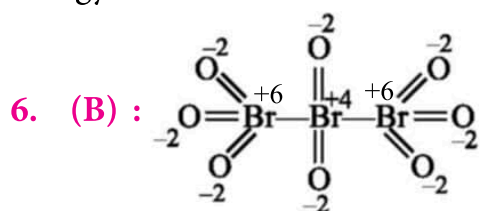
3. (B) : $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \xrightleftharpoons[\text{Endo}]{\text{Exo}} 2\text{NH}_3(\text{g}); \Delta H < 0$

Initially, with increase in temperature ($T_2 > T_1$), % yield increases.

Afterwards, equilibrium is reached and if the temperature is increased, *i.e.*, heat is supplied to the system, then according to Le Chatelier's principle, the equilibrium will shift in the backward direction, where the heat is absorbed. Hence, the % yield decreases.

4. (D) : $-\text{CH}_3$, $-\text{OH}$ and $-\text{NH}_2$ are electron donating groups so, they increase electron density at *ortho* and *para* positions.

5. (B) : As the third ionisation enthalpies of A and B are very high as compared to corresponding second ionisation enthalpies, thus, there must be two electrons in their valence shells. Hence, elements A and B belong to group-2. On going down the group, the atomic size increases, so force of attraction between valence electron and nucleus decreases. Hence, ionisation energy decreases. Thus, 'B' comes below 'A'.



Oxidation states of three bromines are +6, +4, +6.

7. (B) : $\Delta G^\circ = -RT \ln K$, $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$$\Delta H^\circ - T\Delta S^\circ = -RT \ln K \Rightarrow \ln K = -\left(\frac{\Delta H^\circ - T\Delta S^\circ}{RT}\right)$$

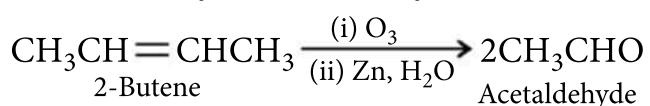
8. (D) : $R\text{CH}=\text{CHR} \xrightarrow[\text{(ii) Zn, H}_2\text{O}]{\text{(i) O}_3} 2R\text{CHO}$
(Symm. alkene)

Molecular mass of $R\text{CHO} = 44 \Rightarrow R + 12 + 1 + 16 = 44$

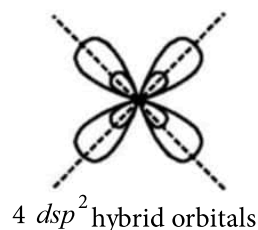
Molecular mass of $R = 44 - 29 = 15$

This is possible, only when R is $-\text{CH}_3$ group.

\therefore The aldehyde is CH_3CHO and the symmetrical alkene is $\text{CH}_3\text{CH}=\text{CHCH}_3$.



9. (C) : In dsp^2 hybrid orbitals, two adjacent orbitals are at 90° whereas opposite hybrid orbitals are at 180° .



10. (C) : As for IE_2 , in all the given cases *i.e.*, $\text{C}^+(1s^2 2s^2 2p^1)$, $\text{N}^+(1s^2 2s^2 2p^2)$, $\text{O}^+(1s^2 2s^2 2p^3)$, $\text{F}^+(1s^2 2s^2 2p^4)$, we have to remove an electron from $2p$ -orbital so, it must follow the order $\text{C} < \text{N} < \text{O} < \text{F}$, *i.e.*, according to decreasing size.

However, for O^+ the p -orbitals are half-filled and so, it is more stable. Thus, the correct order is $\text{O} > \text{F} > \text{N} > \text{C}$.

11. (D) : From the given data :

(A) will produce neutral solution.

(B) will produce acidic solution.

(C) will produce basic solution.

(D) will produce acidic solution.

making calculation of pH in case of (B) and (D) we find that in (D), the remaining solution contains 50 mL of

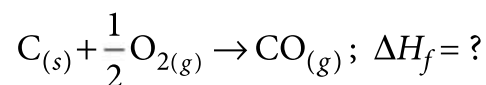
$$\frac{M}{5}\text{HCl} \text{ or } 100 \text{ mL of } \frac{M}{10}\text{HCl}$$

(Total solution = 100 mL)

$$\therefore \text{pH} = -\log [\text{H}^+] = -\log\left(\frac{1}{10}\right) = 1$$

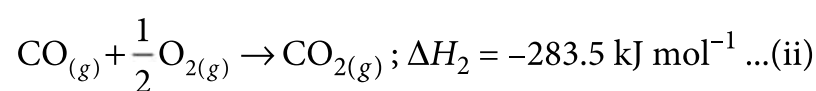
12. (B) : Higher the bond order, shorter will be the bond length. As NO^+ is having higher bond order than that of NO so, NO^+ has shorter bond length.

13. (D) : The required equation,



Given that, $\text{C}_{(s)} + \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)}$

$$\Delta H_1 = -393.5 \text{ kJ/mol}^{-1} \quad \dots(\text{i})$$



Subtracting eqn. (ii) from eqn. (i) will give the required equation.

$$\begin{aligned} \Delta H_f &= \Delta H_1 - \Delta H_2 = -393.5 - (-283.5) \\ &= -110 \text{ kJ mol}^{-1} \end{aligned}$$

14. (C) : Mass of organic compound = 1.4 g

$$\% \text{ of N} = \frac{1.4 \times \text{Meq. of acid consumed}}{\text{Mass of compound taken}}$$

Meq. of acid consumed

$$= \left(60 \times \frac{1}{10} \times 2 \right) - \left(20 \times \frac{1}{10} \times 1 \right) = 10 \quad [\text{Basicity of acid} = 2]$$

$$\% \text{ of N} = \frac{1.4 \times 10}{1.4} = 10\%$$

15. (A) : $2\text{Al}_{(s)} + 6\text{HCl}_{(aq)} \longrightarrow 2\text{Al}_{(aq)}^{3+} + 6\text{Cl}_{(aq)}^{-} + 3\text{H}_{2(g)}$

6 moles of HCl produced H_2 at STP = 3×22.4 L

\therefore 1 mole of HCl will produce H_2 at STP

$$= \frac{3 \times 22.4}{6} = 11.2 \text{ L}$$

16. (C) : According to Gibbs formula, $\Delta G = \Delta H - T\Delta S$. Since ΔH and ΔS , both are +ve, for $\Delta G < 0$, the value of $T > T_e$.

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$$\text{Potential energy } (V_n) = -\frac{1}{4\pi\epsilon_0} \frac{Ze^2}{r}$$

$$\text{Kinetic energy } (K_n) = \frac{1}{8\pi\epsilon_0} \frac{Ze^2}{r}$$

$$\text{Radius of } n^{\text{th}} \text{ orbit } (r_n) = \frac{n^2 h^2 \epsilon_0}{\pi m Z e^2}$$

$$\text{Potential energy } (E_n) = -\frac{me^4}{8\epsilon_0^2 h^2} \left(\frac{1}{n^2} \right)$$

$$\frac{V_n}{K_n} = \frac{-\frac{1}{4\pi\epsilon_0} \frac{Ze^2}{r}}{\frac{1}{8\pi\epsilon_0} \frac{Ze^2}{r}} = -2 \quad (\text{I} \rightarrow \text{R}); \quad E_n \propto \frac{1}{n^2} \propto \frac{1}{r_n}$$

$$r^n \rightarrow E_n^x \quad \therefore x = -1 \quad (\text{II} \rightarrow \text{Q})$$

l , the orbital quantum number, is connected to the total angular momentum of the electron. This quantum number is an integer less than n , and the total angular momentum of the electron can be calculated using :

Total angular momentum,

$$L = [l(l+1)]^{1/2} \frac{h}{2\pi} \quad (l = 0, 1, 2, \dots, n-1)$$

The lowest energy orbital in the hydrogen atom is the 1s orbital, which corresponds with $n = 1, l = 0$ and $m = 0$. Hence, total angular moment in lowest orbital = 0.

(III \rightarrow P)

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18. (C) : $\text{KMnO}_4 \xrightarrow{+7} \text{MnO}_4^{2-} \xrightarrow{+6}$

Electrons transferred = 1

$\text{KMnO}_4 \xrightarrow{+7} \text{MnO}_2 \xrightarrow{+4}$

Electrons transferred = 3

$\text{KMnO}_4 \xrightarrow{+7} \text{Mn}_2\text{O}_3 \xrightarrow{+3}$

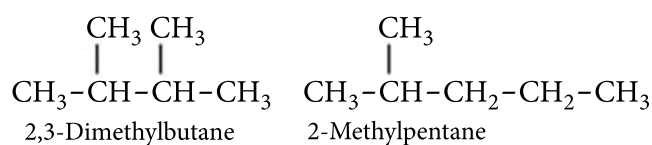
Electrons transferred = 4

$\text{KMnO}_4 \xrightarrow{+7} \text{Mn}^{2+} \xrightarrow{+2}$

Electrons transferred = 5

19. (C)

20. (D) : 2,3-dimethylbutane will give 2 monochlorinated compounds whereas 2-methylpentane will give 5 monochloro derivatives.



For other sections/subjects please refer to
Physics For You and Biology Today



Winners : Kaushikkumar Kevadiya, Naveen

SOLUTIONS TO AUGUST 2024 WORD GRID

G	N	I	T	I	O	E	C	P	P	R	U	H	K	R
Q	G	L	S	V	N	G	R	D	O	J	T	A	V	S
H	C	T	E	N	O	U	S	K	C	P	P	A	O	N
P	S	W	O	O	T	E	N	N	S	E	Q	I	Z	H
A	R	V	U	V	P	A	H	F	O	X	S	E	M	J
Q	G	L	S	O	M	I	J	E	B	A	N	U	S	B
O	I	G	N	C	O	R	R	U	T	D	I	J	U	K
N	F	B	L	A	C	E	E	I	O	B	S	E	H	C
I	Y	E	P	I	N	G	N	C	R	Q	Z	Y	L	R
R	E	R	N	B	A	E	X	E	I	N	N	G	A	S
O	R	O	Q	I	I	N	W	B	L	W	A	R	A	N
S	J	D	H	W	K	K	I	W	A	V	I	U	I	H
O	P	I	L	U	B	N	L	E	P	S	W	B	H	J
Y	D	A	B	R	E	W	A	K	A	R	V	B	I	R
J	P	Y	A	S	N	F	B	R	Q	G	L	S	V	W
I	J	X	N	E	S	N	F	B	L	R	L	I	W	N
B	E	W	T	E	B	W	E	P	S	I	L	O	N	C
G	N	I	T	I	L	L	R	H	U	H	J	I	Y	O

- Epsilon
- Isatin
- Erbium
- Etch
- Compton
- Dynel
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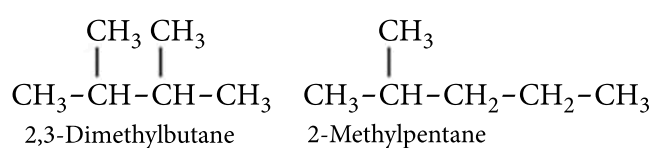
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Q	G	L	S	V	N	G	R	D	O	J	T	A	V	S
H	C	T	E	N	O	U	S	K	C	P	P	A	O	N
P	S	W	O	O	T	E	N	N	S	E	Q	I	Z	H
A	R	V	U	V	P	A	H	F	O	X	S	E	M	J
Q	G	L	S	O	M	I	J	E	B	A	N	U	S	B
O	I	G	N	C	O	R	R	U	T	D	I	J	U	K
N	F	B	L	A	C	E	E	I	O	B	S	E	H	C
I	Y	E	P	I	N	G	N	C	R	Q	Z	Y	L	R
R	E	R	N	B	A	E	X	E	I	N	N	G	A	S
O	R	O	Q	I	I	N	W	B	L	W	A	R	A	N
S	J	D	H	W	K	K	I	W	A	V	I	U	I	H
O	P	I	L	U	B	N	L	E	P	S	W	B	H	J
Y	D	A	B	R	E	W	A	K	A	R	V	B	I	R
J	P	Y	A	S	N	F	B	R	Q	G	L	S	V	W
I	J	X	N	E	S	N	F	B	L	R	L	I	W	N
B	E	W	T	E	B	W	E	P	S	I	L	O	N	C
G	N	I	T	I	L	L	R	H	U	H	J	I	Y	O

- Epsilon
- Isatin
- Erbium
- Etch
- Compton
- Dynel
- Rankine
- Grubbs

Are you ready for Olympiads?

LEVEL 1 Exam on

18th Oct., 12th Nov. &
3rd Dec., 2024



CLASS XII

SYLLABUS*

Following the protocol of NEP (2020), NCF (2023), NCERT and CBSE guidelines, National and various State Boards for the convenience of schools and students, any change/reduction in the syllabi will be reflected in actual question papers.

Section – 1 : Physics : Electricity and Magnetism, Electromagnetic Induction, Alternating current, Electromagnetic waves, Optics, Modern Physics, Semiconductor Electronics.

Chemistry : Solutions, Electrochemistry, Chemical Kinetics, The *d*- and *f*-Block Elements, Coordination Compounds, Haloalkanes and Haloarenes, Alcohols, Phenols and Ethers, Aldehydes, Ketones and Carboxylic Acids, Amines, Biomolecules.

Section – 2 : Higher Order Thinking Questions - Syllabus as per Section-1.

Section – 3 : Relations and Functions, Inverse Trigonometric Functions, Matrices and Determinants, Continuity and Differentiability, Application of Derivatives, Integrals, Application of Integrals, Differential Equations, Vector Algebra, Three Dimensional Geometry, Probability, Linear Programming.

OR

Section – 3 : Reproduction, Genetics and Evolution, Biology in Human Welfare, Biotechnology, Ecology.

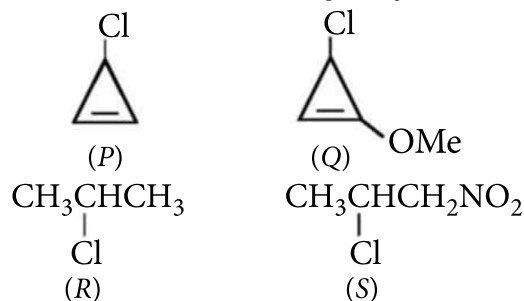
Total Questions : 50

Time : 1 hr.

PATTERN & MARKING SCHEME			
Section	(1) Physics & Chemistry	(2) Achievers Section	(3) Mathematics or Biology
No. of Questions	25	5	20
Marks per Ques.	1	3	1

Practice Questions

1. The decreasing order of reactivity of the following organic molecules towards AgNO_3 solution is

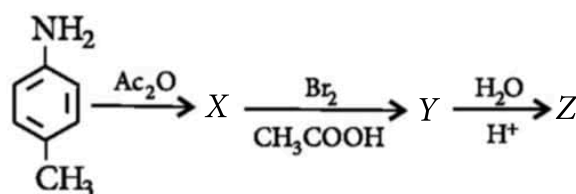


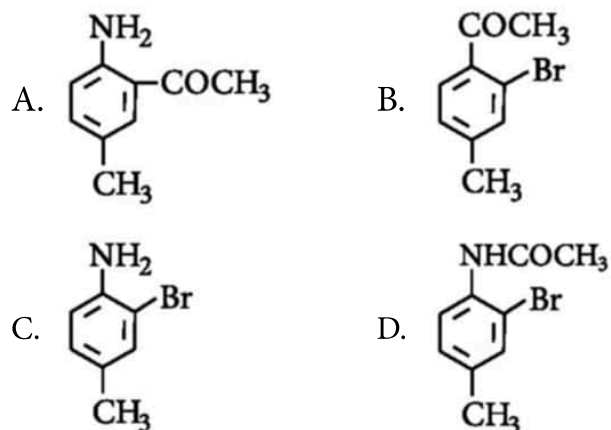
- A. (P) > (Q) > (S) > (R)
 B. (Q) > (P) > (R) > (S)
 C. (P) > (Q) > (R) > (S)
 D. (R) > (S) > (P) > (Q)
2. Which of the following liquid pairs shows a positive deviation from Raoult's law?
 A. Water - hydrochloric acid
 B. Benzene - acetone
 C. Water - nitric acid
 D. Benzene - chloroform
3. In tetrahedral permanganate ion π -bonding type between metal and oxygen is
 A. $p\pi-p\pi$ B. $d\pi-p\pi$ C. $d\pi-d\pi$ D. $d\pi-s$
4. RNA and DNA are chiral molecules, their chirality is due to
 A. Chiral bases

- B. Chiral phosphate ester units
 C. *D*-sugar component
 D. *L*-sugar component.

5. The electrolysis of a metal salt solution was carried out by passing a current of 4 amperes for 45 minutes. It results in deposition of 2.977 g of a metal. If atomic mass of the metal is 106.4 g mol^{-1} . Calculate the charge on the metal cation.
 A. +4 B. +3 C. +2 D. +1
6. The correct combination is
 A. $[\text{Ni}(\text{CN})_4]^{2-}$ – Tetrahedral;
 $[\text{Ni}(\text{CO})_4]$ – Paramagnetic
 B. $[\text{NiCl}_4]^{2-}$ – Paramagnetic;
 $[\text{Ni}(\text{CO})_4]$ – Tetrahedral
 C. $[\text{NiCl}_4]^{2-}$ – Diamagnetic;
 $[\text{Ni}(\text{CO})_4]$ – Square planar
 D. $[\text{NiCl}_4]^{2-}$ – Square planar;
 $[\text{Ni}(\text{CN})_4]^{2-}$ – Paramagnetic

7. The final product Z, obtained in this following reaction is



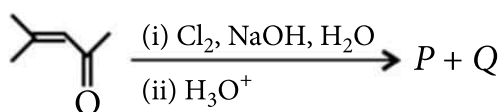


8. **Assertion :** F^- ion is a weak ligand and forms outer orbital complex.

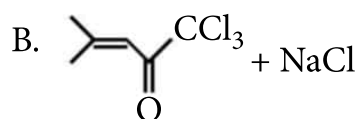
Reason : F^- ion cannot force the electrons of d_{z^2} and $d_{x^2 - y^2}$ orbitals of the inner shell to occupy d_{xy} , d_{yz} and d_{zx} orbitals of the same shell.

- A. If both assertion and reason are true and reason is the correct explanation of assertion.
 B. If both assertion and reason are true but reason is not the correct explanation of assertion.
 C. If assertion is true but reason is false.
 D. If both assertion and reason are false.

9. Major products, P and Q , of the following reaction are



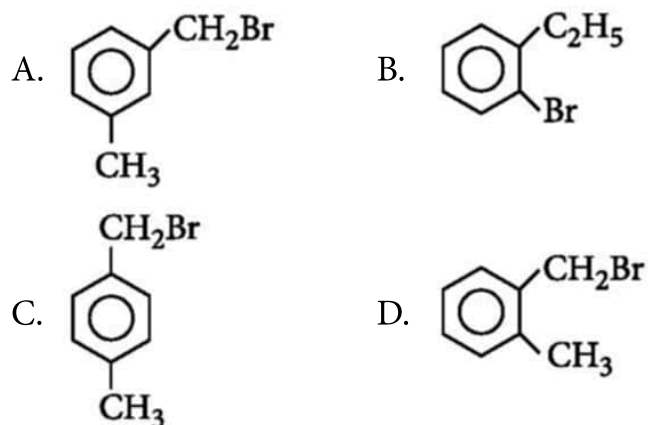
A. 3-Methylbut-2-enoic acid + CHCl_3



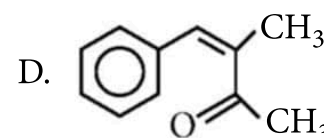
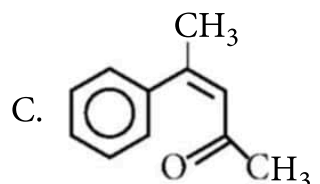
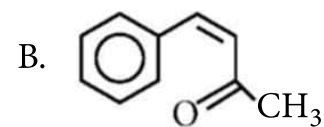
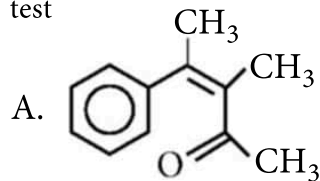
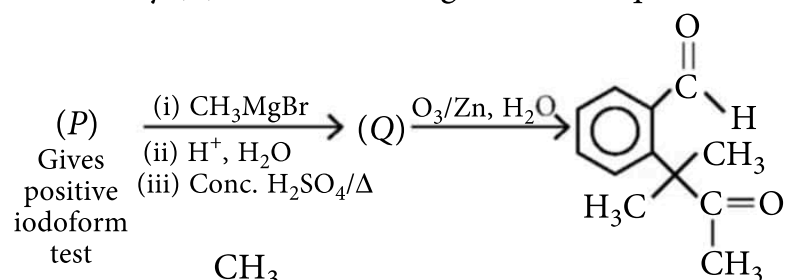
C.

D. 4-Hydroxy-4-methyl-2-pentanone + NaCl

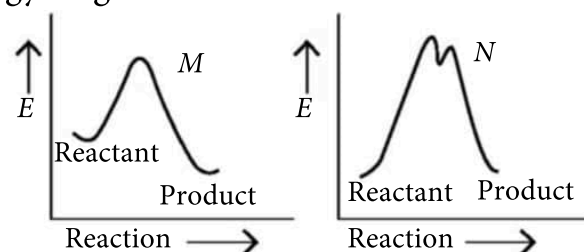
10. Compound (X), $\text{C}_8\text{H}_9\text{Br}$, gives yellow precipitate when warmed with alcoholic AgNO_3 . Oxidation of (X) gives an acid (Y), $\text{C}_8\text{H}_6\text{O}_4$. (Y) easily forms anhydride on heating. Identify the compound (X).



11. Identify (P) in the following reaction sequence,



12. The correct statement regarding the following energy diagrams is



- A. Reaction M is faster and less exothermic than reaction N
 B. Reaction M is slower and less exothermic than reaction N
 C. Reaction M is faster and more exothermic than reaction N
 D. Reaction M is slower and more exothermic than reaction N .

13. Which of the following syntheses gives 3-methyl-1-hexanol?

- A. 2-Bromohexane $\xrightarrow[\text{C}_2\text{H}_5\text{OC}_2\text{H}_5]{\text{Mg}} \xrightarrow[\text{(ii) H}_3\text{O}^+]{\text{(i) H}_2\text{C}=\text{O}}$
- B. 2-Bromopentane $\xrightarrow[\text{C}_2\text{H}_5\text{OC}_2\text{H}_5]{\text{Mg}} \xrightarrow[\text{(ii) H}_3\text{O}^+]{\text{(i) } \triangle \text{O}}$
- C. 3-Bromopentane $\xrightarrow[\text{C}_2\text{H}_5\text{OC}_2\text{H}_5]{\text{Mg}} \xrightarrow[\text{(ii) H}_3\text{O}^+]{\text{(i) CH}_3\text{CH}=\text{O}}$
- D. 1-Bromobutane $\xrightarrow[\text{C}_2\text{H}_5\text{OC}_2\text{H}_5]{\text{Mg}} \xrightarrow[\text{(ii) H}_3\text{O}^+]{\text{(i) CH}_3\text{COCH}_3}$

Quotable Quote

“Knowledge isn't free.
You have to pay attention.”

RICHARD P. FEYNMAN

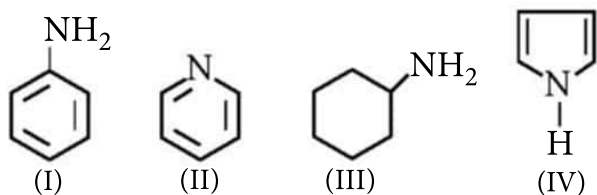
14. Match the catalyst given in column I with the process given in column II and select the correct option.

Column I (Catalyst)		Column II (Process)	
(P)	TiCl ₄	(i)	Ostwald's process
(Q)	Pt	(ii)	Ziegler-Natta polymerization
(R)	CuCl ₂	(iii)	Contact process
(S)	V ₂ O ₅	(iv)	Deacon's process

- A. (P) - (ii), (Q) - (iii), (R) - (iv), (S) - (i)
 B. (P) - (iii), (Q) - (i), (R) - (ii), (S) - (iv)
 C. (P) - (iii), (Q) - (ii), (R) - (iv), (S) - (i)
 D. (P) - (ii), (Q) - (i), (R) - (iv), (S) - (iii)
15. In both DNA and RNA, heterocyclic base and phosphate ester linkages are at
 A. C-5' and C-2' respectively of the sugar molecule
 B. C-2' and C-5' respectively of the sugar molecule
 C. C-1' and C-5' respectively of the sugar molecule
 D. C-5' and C-1' respectively of the sugar molecule.

ACHIEVERS SECTION

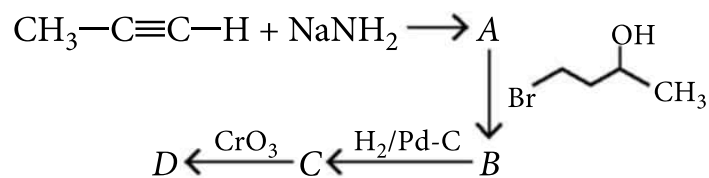
16. The decreasing order of basicity of the following amines is



- A. (I) > (III) > (IV) > (II)
 B. (II) > (III) > (IV) > (I)
 C. (III) > (I) > (II) > (IV)
 D. (III) > (II) > (I) > (IV)
17. The rate of first-order reaction is 0.04 mol L⁻¹ s⁻¹ at 10 seconds and 0.03 mol L⁻¹ s⁻¹ at 20 seconds after initiation of the reaction. The half-life period of the reaction is
 A. 44.1 s B. 54.1 s C. 24.1 s D. 34.1 s
18. Which one of the following statements is false?
 A. Raoult's law states that the vapour pressure of a component over a solution is proportional to its mole fraction.
 B. The osmotic pressure (π) of a solution is given by the equation ($\pi = MRT$), where M is the molarity of the solution.
 C. The correct order of osmotic pressure for 0.01 M aqueous solution of each compound is BaCl₂ > KCl > CH₃COOH > sucrose.

- D. Two sucrose solutions of same molality prepared in different solvents will have the same freezing point depression.

19. In the following sequence of reactions, the final product D is



- A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$
 B. $\text{H}_3\text{CCH}=\text{CHCH}(\text{OH})\text{CH}_2\text{CH}_2\text{CH}_3$
 C. $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_2\text{CH}_2\text{COOH}$
 D. $\text{H}_3\text{CCH}_2\text{CH}_2\text{CH}_2\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$

20. An aqueous solution of X is added slowly to an aqueous solution of Y as shown in list-I. The variation in conductivity of these reactions is given in list-II. Match list-I with list-II and select the correct answer using the code given below the lists :

List-I		List-II	
P.	(C ₂ H ₅) ₃ N + CH ₃ COOH (X) (Y)	1.	Conductivity decreases and then increases.
Q.	KI(0.1 M) + AgNO ₃ (0.01 M) (X) (Y)	2.	Conductivity decreases and then does not change much.
R.	CH ₃ COOH + KOH (X) (Y)	3.	Conductivity increases and then does not change much.
S.	NaOH + HI (X) (Y)	4.	Conductivity does not change much and then increases.

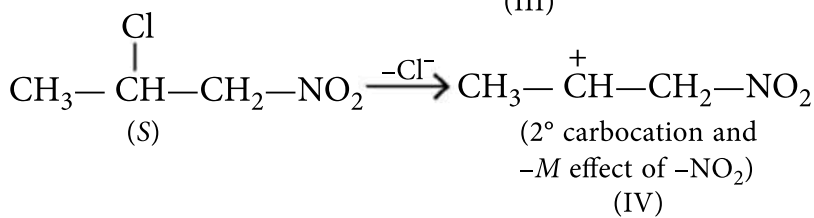
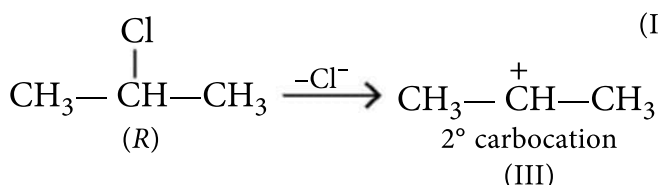
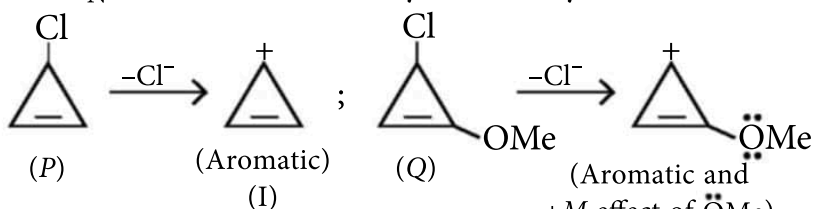
- A. P → 3; Q → 4; R → 2; S → 1
 B. P → 4; Q → 3; R → 2; S → 1
 C. P → 2; Q → 3; R → 4; S → 1
 D. P → 1; Q → 4; R → 3; S → 2

1. (A) (B) (C) (D)	5. (A) (B) (C) (D)	9. (A) (B) (C) (D)	13. (A) (B) (C) (D)	17. (A) (B) (C) (D)
2. (A) (B) (C) (D)	6. (A) (B) (C) (D)	10. (A) (B) (C) (D)	14. (A) (B) (C) (D)	18. (A) (B) (C) (D)
3. (A) (B) (C) (D)	7. (A) (B) (C) (D)	11. (A) (B) (C) (D)	15. (A) (B) (C) (D)	19. (A) (B) (C) (D)
4. (A) (B) (C) (D)	8. (A) (B) (C) (D)	12. (A) (B) (C) (D)	16. (A) (B) (C) (D)	20. (A) (B) (C) (D)

SOLUTIONS

1. (B): The given reaction is an example of S_N1 reaction.

For S_N1 reactions, reactivity \propto stability of carbocation.



Hence, stability order of carbocations : II > I > III > IV
Thus, reactivity order is : Q > P > R > S.

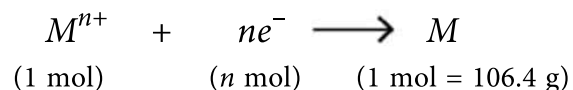
2. (B): Benzene-acetone pair will show positive deviation from Raoult's law, rest all will show negative deviation from Raoult's Law.

3. (B): In tetrahedral permanganate ion π -bonding takes place between $d\pi$ orbital of metal (here manganese) and $p\pi$ orbital of oxygen.

4. (C): The constituents of nucleic acids are nitrogenous bases, sugar and phosphate group. The sugar present in DNA is β -D-2-deoxyribose and the sugar present in RNA is β -D-ribose. Due to these β -D-sugar components, DNA and RNA molecules are chiral molecules.

5. (A): Let the charge on the metal ion be n^+ .

\therefore The reduction half-reaction would be



Quantity of electricity required for depositing 106.4 g of metal = $n \times 96500$ C

Quantity of electricity required for depositing 2.977 g of

$$\text{metal} = \frac{n \times 96500 \text{ C} \times 2.977 \text{ g}}{106.4 \text{ g}} = n \times 2700 \text{ C}$$

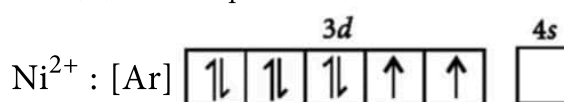
Quantity of electricity actually passed = $I \times t$
= $4 \text{ A} \times 45 \times 60 \text{ s} = 10800 \text{ C} = 10800 \text{ A s}$.

Now, $10800 \text{ C} = n \times 2700 \text{ C}$

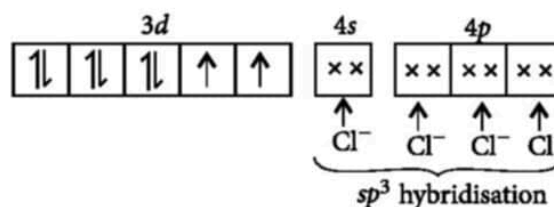
$$\therefore n = \frac{10800}{2700} = 4$$

Hence, charge on metal ion = + 4

6. (B): $[\text{NiCl}_4]^{2-}$: Oxidation state of Ni in $[\text{NiCl}_4]^{2-} = +2$

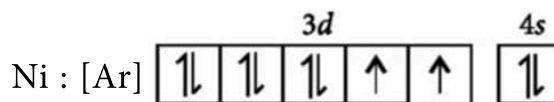


Cl^- being a weak field ligand does not lead to pairing of electrons.



Hence, the complex is tetrahedral and paramagnetic with two unpaired electrons.

$[\text{Ni}(\text{CO})_4]$: Oxidation state of Ni in $[\text{Ni}(\text{CO})_4]$ is zero.



WtG

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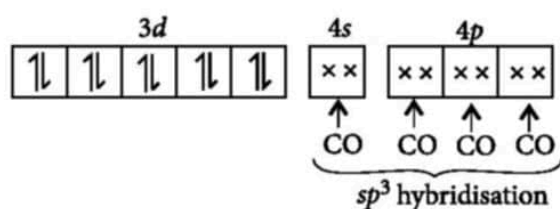


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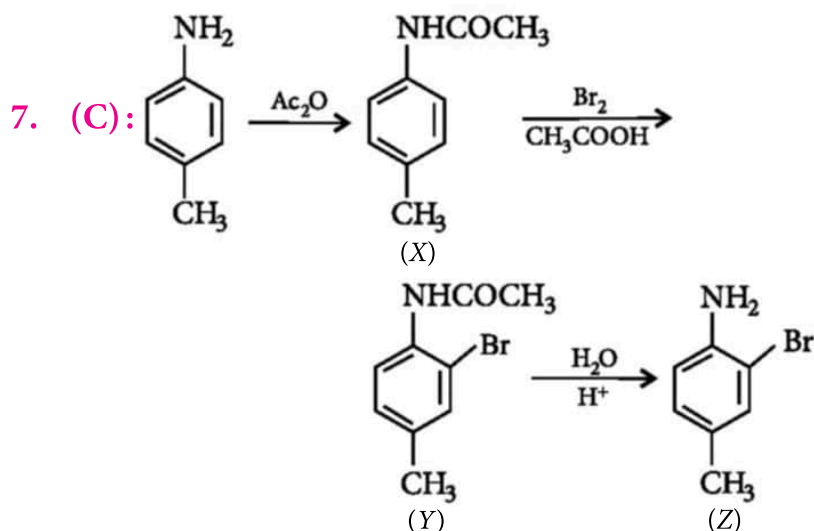


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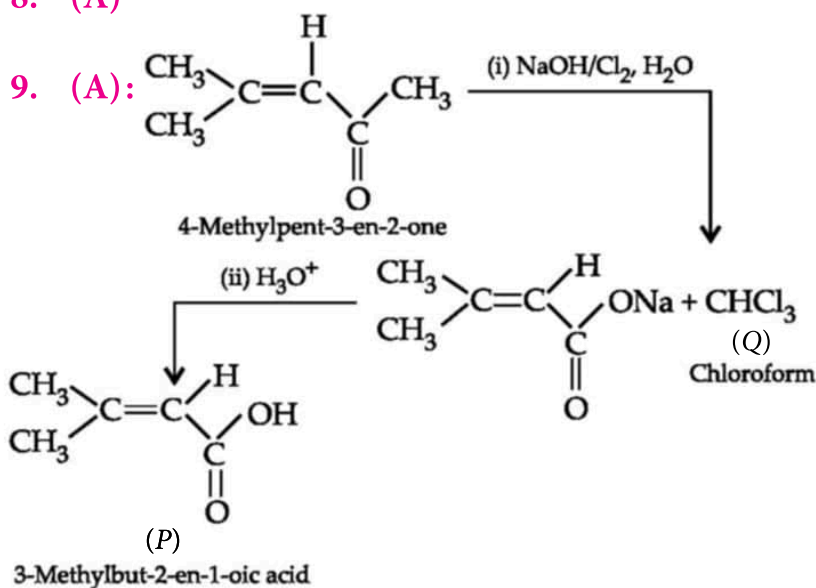
CO is a strong field ligand and leads to pairing of electrons.



Hence, the complex is tetrahedral and diamagnetic.

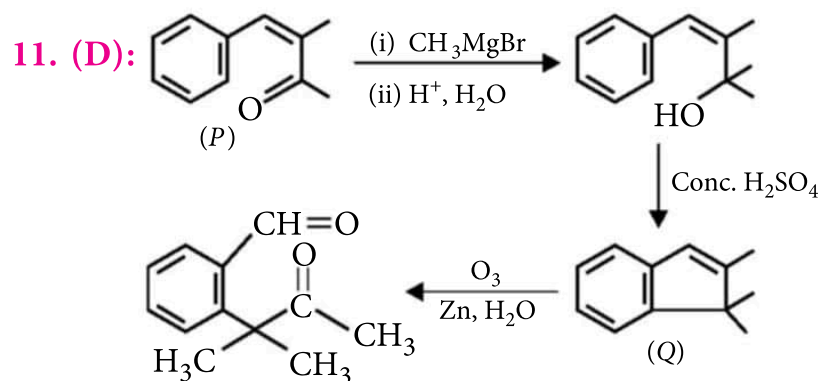
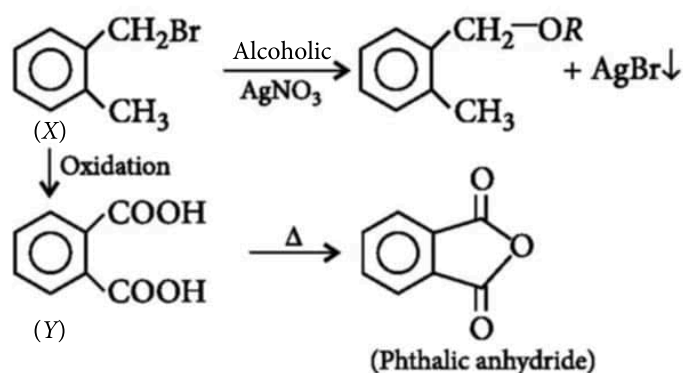


8. (A)

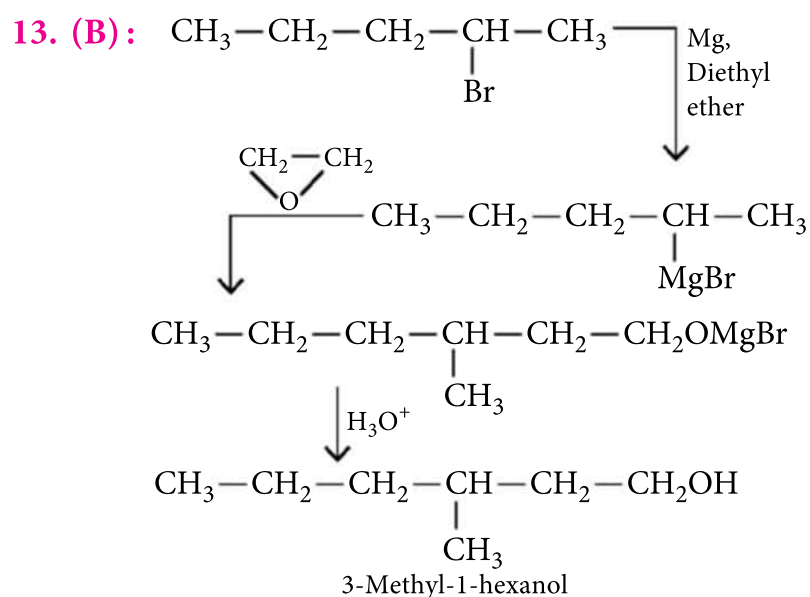


During the haloform reaction, carbon—carbon double bond remains intact.

10. (D): Since a yellowish precipitate is obtained, Br should be attached on the side chain. Moreover as the compound gives anhydride on heating, the two alkyl substituents must occupy adjacent position.



12. (C): Reaction M involves only one intermediate step, thus is a fast reaction. Moreover the energy of product is much less than reactant, thus it is exothermic in nature.



14. (D)

15. (C)

16. (D): Basic strength depends upon the availability of lone pairs of electrons. Involvement of lone pair of electrons in resonance, decreases the basic strength.

17. (C): Consider a first order reaction, $A \rightarrow \text{Products}$. The expression of rate for first order reaction for two different concentration at two different time can be written as,

$$k = \frac{2.303}{t_2 - t_1} \log \frac{[A]_1}{[A]_2}$$

$$\text{Hence, } k = \frac{2.303}{t_2 - t_1} \log \frac{(\text{Rate})_1}{(\text{Rate})_2} \quad (\because \text{Rate} \propto [A])$$

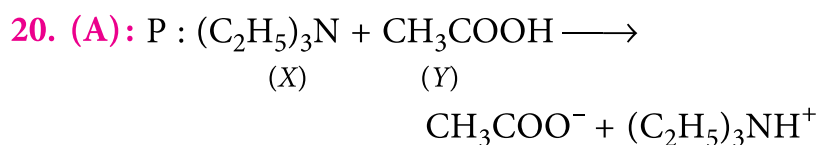
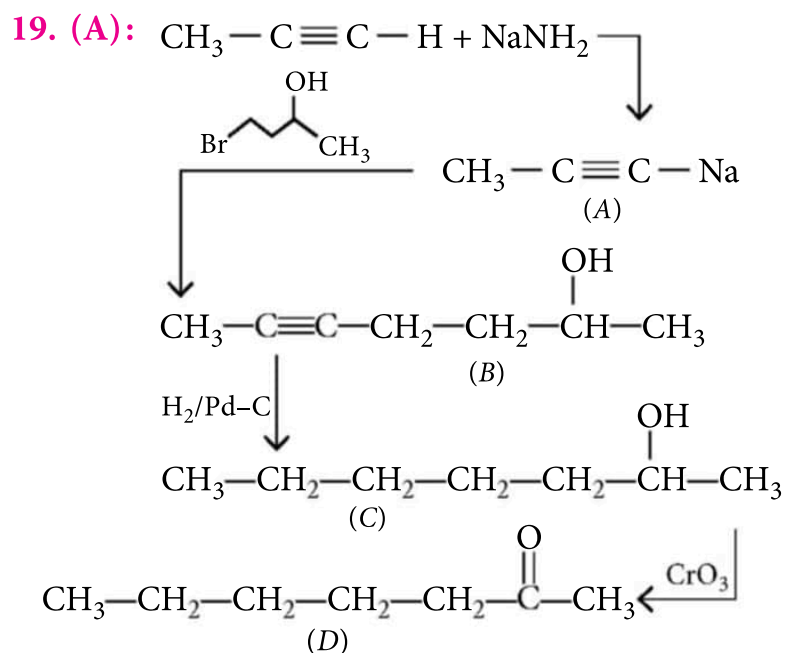
$$\therefore k = \frac{2.303}{(20 - 10)} \log \left(\frac{0.04}{0.03} \right) = 0.0287 \text{ sec}^{-1}$$

$$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{0.0287 \text{ sec}^{-1}} = 24.14 \text{ sec}$$

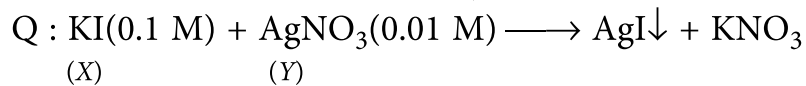
18. (D): The depression in freezing point depends upon the number of solute particles and the nature of solvent, it can be expressed as

$$\Delta T_f = K_f \times m$$

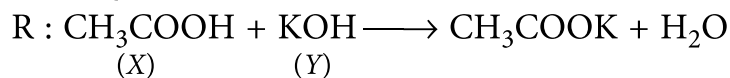
For different solvents, value of K_f is also different. So, for two different solvents the extent of depression may vary even if number of solute particles dissolved in them is same.



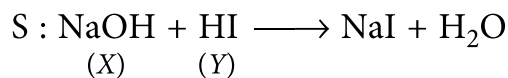
Initially conductivity increases due to ion formation after that it becomes practically constant because X alone cannot form ions. Hence, P \rightarrow 3



Number of ions in the solution remains constant until all the AgNO_3 precipitated as AgI . Thereafter conductance increases due to increase in number of ions. Q \rightarrow 4



Initially conductance decreases due to the decrease in the number of OH^- ions thereafter increases due to increase in H^+ ions but the increase is not much significant because of weak ionisation of CH_3COOH . Hence, R \rightarrow 2



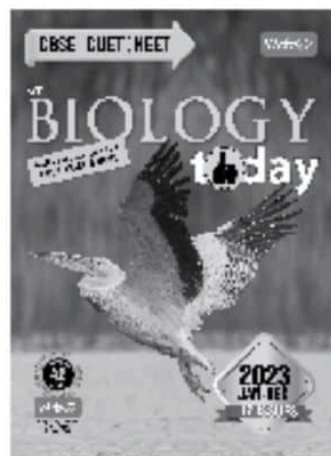
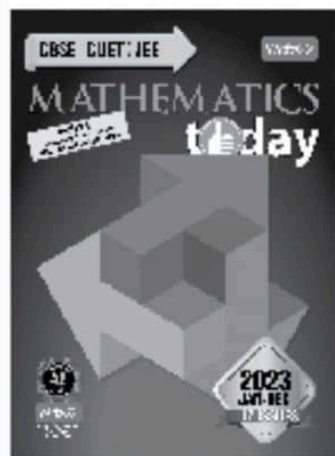
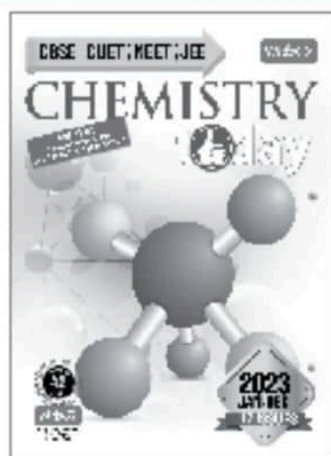
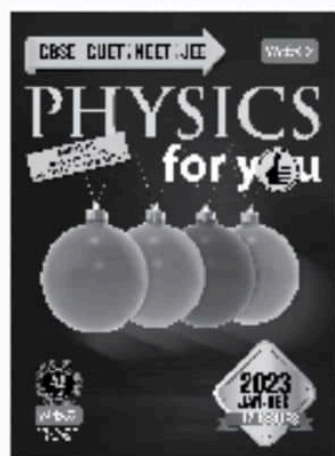
Initially it decreases due to the decrease in H^+ ions and then increases due to the increase in OH^- ions.

Hence, S \rightarrow 1

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TOPIC

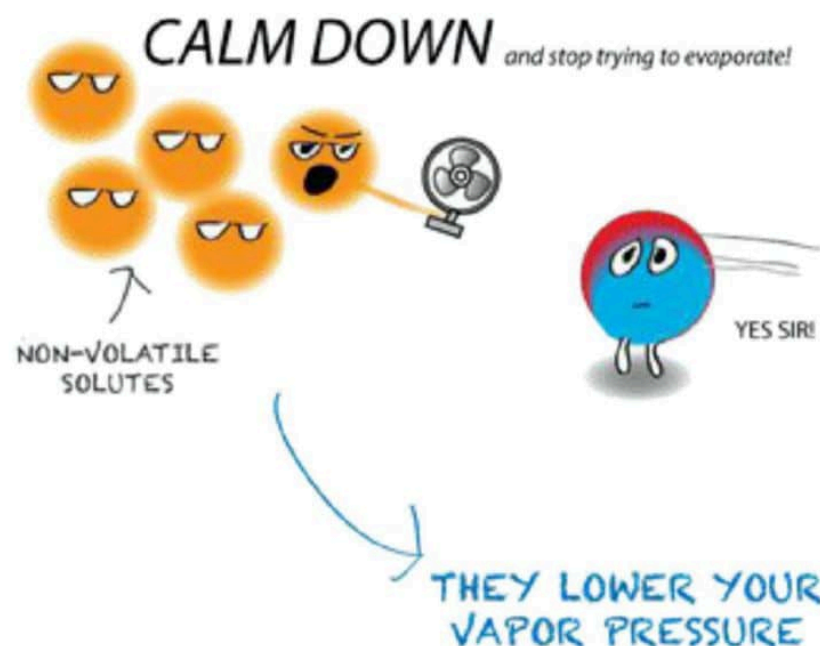
Colligative Properties

Detailed theory with High Definition images of the given topic is covered under this heading.



RELATIVE LOWERING OF VAPOUR PRESSURE

One might think that the reason volatile solvent molecules in a solution are less likely to escape to the gas phase, compared to the pure solvent, is that, the solute molecules are physically blocking the solvent molecules from leaving the surface. This is a common misconception. A solution consisting of a volatile liquid solvent and a non-volatile solute forms spontaneously because of the increase in entropy that accompanies their mixing. In effect, the solvent molecules are stabilized in their liquid state by this process and thus have a lower tendency to escape into the vapour state. Therefore, when a non-volatile solute is present, the vapour pressure of the solvent is lower than the vapour pressure of the pure solvent.



● Volatile solvent particles ● Non-volatile solute particles

Equilibrium Add non-volatile solute Rate of vaporization reduced by presence of non-volatile solute Equilibrium re-established with fewer molecules in gas phase

The presence of non-volatile solute particles in a liquid solvent results in a reduction of the vapour pressure above the liquid.



OSMOTIC PRESSURE

STEP 1

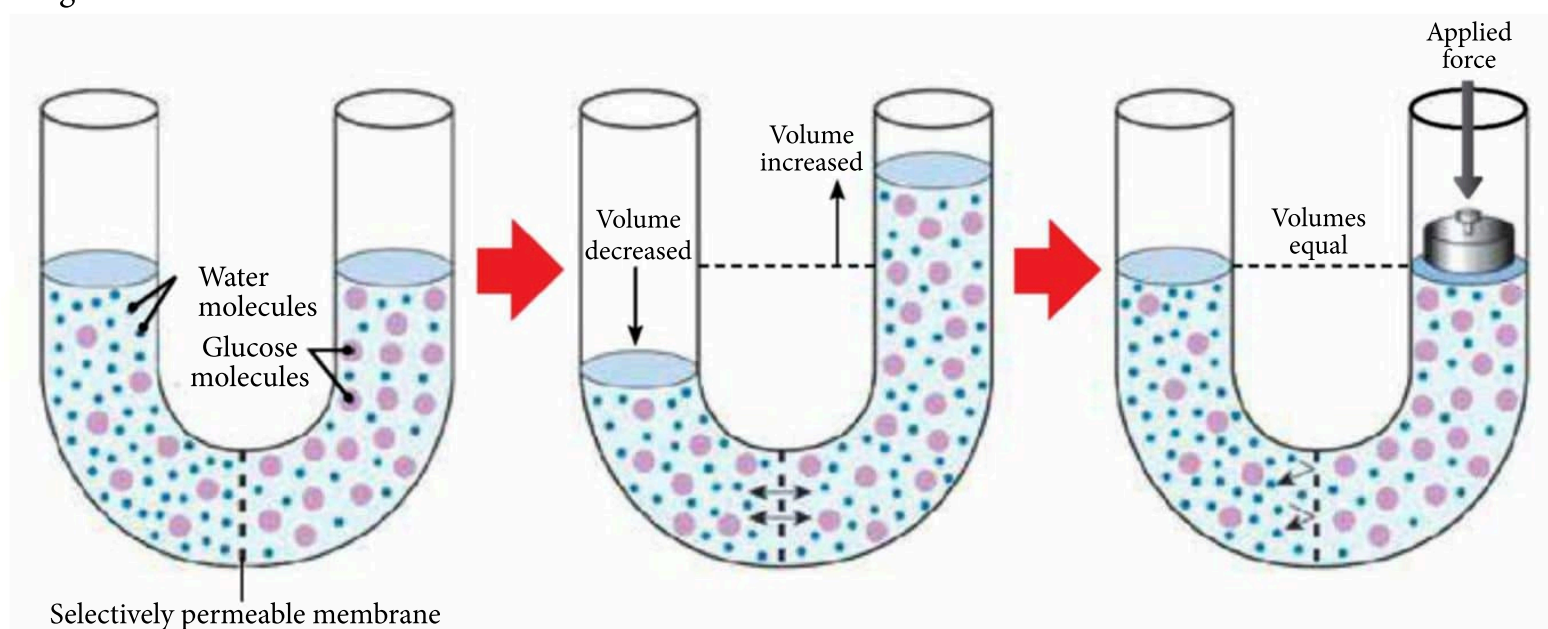
Two solutions of different solute concentrations are separated by a selectively permeable membrane. Water molecules begin to cross the membrane towards glucose solution with higher concentration of solutes.

STEP 2

At equilibrium, the concentrations of solute on the two sides of the membrane are equal. The volume of glucose solution has increased at the expense of that of the water molecules.

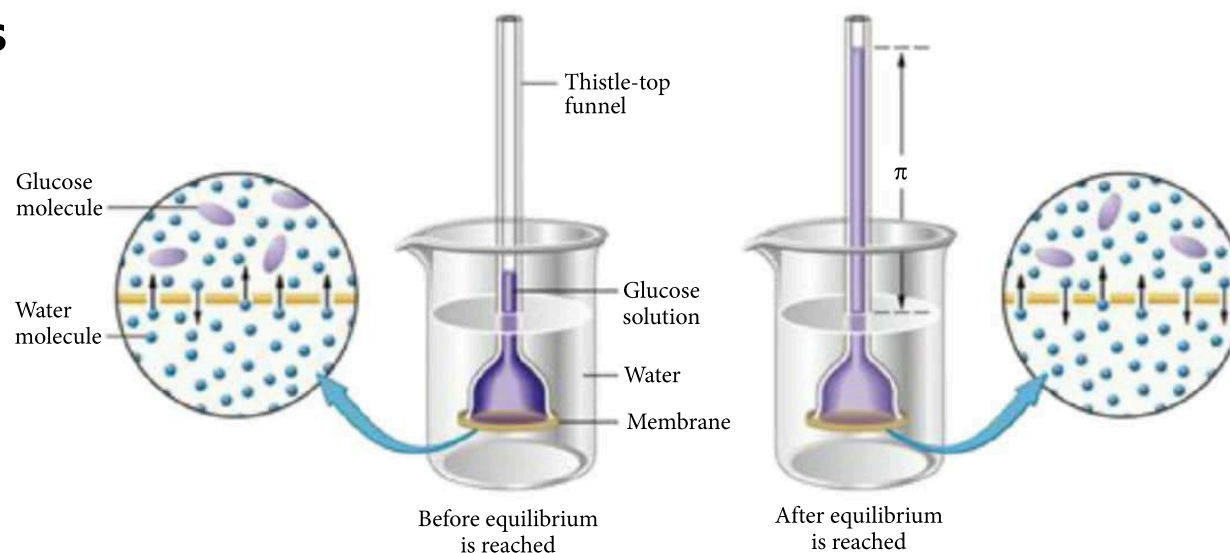
STEP 3

Osmosis can be prevented by resisting the change in volume. The osmotic pressure of glucose solution is equal to the amount of hydrostatic pressure required to stop the osmotic flow.



- ◆ A U-shaped tube is used which is divided by a membrane that is permeable to only water molecules.
- ◆ The solute concentration is increased in the right-half of the tube.
- ◆ The free water concentration is decreased on the right as well.
- ◆ Water rises on the side of the solutes – This is called Osmosis.
- ◆ Counteract this rise in water by applying pressure – This is called Osmotic Pressure.
- ◆ Therefore, increasing the solute concentration increases the Osmotic Pressure.
- ◆ Water will move towards that area to decrease this pressure.

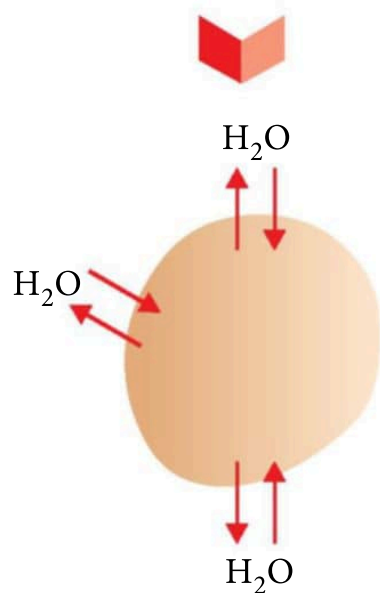
Osmosis



Fluids

Isotonic solution

- ◆ Osmotic pressure is the same both inside and outside the cell.
- ◆ Cells neither shrink nor swell with fluid movement.
- ◆ Electrolytes such as NaCl, KCl, CaCl, and sodium lactate.



Outside = Inside
EQUAL
concentration

Overall concentration is equal;
cell remains constant

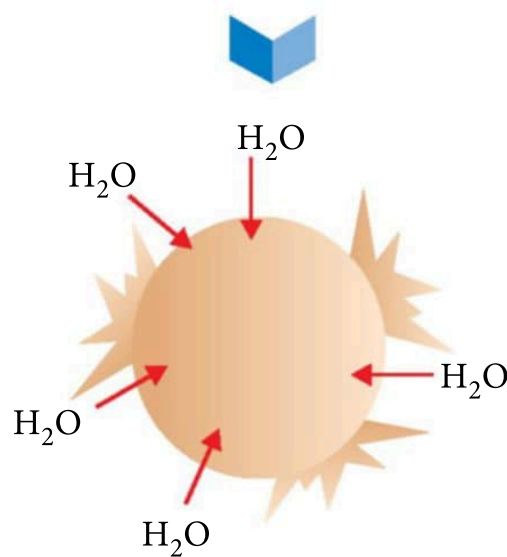
RBCs in
Isotonic
Solution



No change

Hypotonic solution

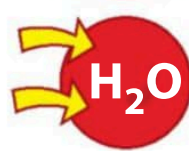
- ◆ Osmotic pressure is lesser than that of intracellular fluid. Hypotonic solutions have a lower concentration of solutes (particles).
- ◆ Water gets into the cells to equalize the concentration, which causes the cells to swell.
- ◆ Hypotonic solution containing glucose to provide calories for metabolism.



Outside < Inside
LOWER
concentration

Water moves into the cell
and it expands and lyses

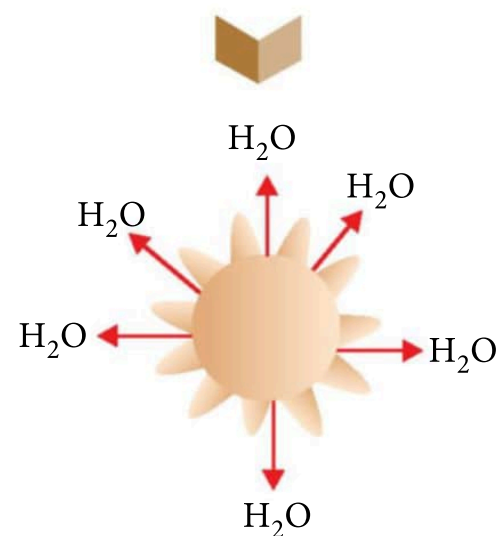
RBCs in
Hypotonic
Solution



Swollen RBCs

Hypertonic solution

- ◆ Have a greater concentration of dissolved particles than does intracellular fluid. Fluid pulled from cells.
- ◆ Osmotic pressure is greater than intracellular fluid.
- ◆ Water is drawn from the cells from the extracellular fluid causing them to shrink.



Outside > Inside
HIGHER
concentration

Water moves out from cell;
causing shrinkage

RBCs in
Hypertonic
Solution



Shrunken RBCs

CONCEPT MAP

SOLUTIONS

METHODS OF EXPRESSING CONCENTRATIONS

Normality

(g. equiv. per litre of solution)

$$N = \frac{\text{Weight of solute (g)}}{\text{Eq. weight of solute} \times \text{Volume of solution (L)}}$$

Molarity

(Moles per litre of solution)

$$M = \frac{\text{Weight of solute (g)}}{\text{Molar mass of solute} \times \text{Volume of solution (L)}}$$

Molality

(Moles per kg of solvent)

$$m = \frac{\text{Weight of solute (g)}}{\text{Molar mass of solute} \times \text{Mass of solvent (kg)}}$$

Mole Fraction

$$x_A = \frac{n_A}{n_A + n_B}; x_B = \frac{n_B}{n_A + n_B}$$

$$x_B = 1 - x_A$$

Relation

$$N = M \times \frac{\text{Molar mass}}{\text{Equivalent mass}}$$

Relation

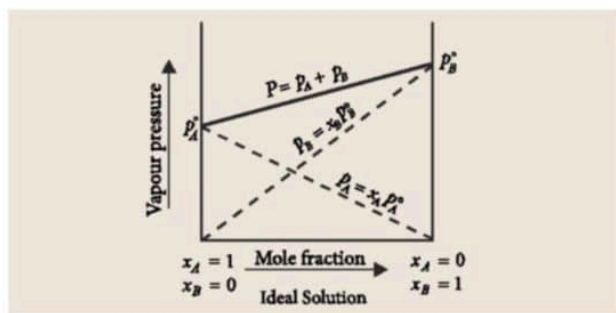
$$m = \frac{M}{d - \frac{M \times M_B}{1000}}$$

Relation

$$m = \frac{x_A \times 1000}{(1 - x_A) M_B}$$

IDEAL SOLUTIONS

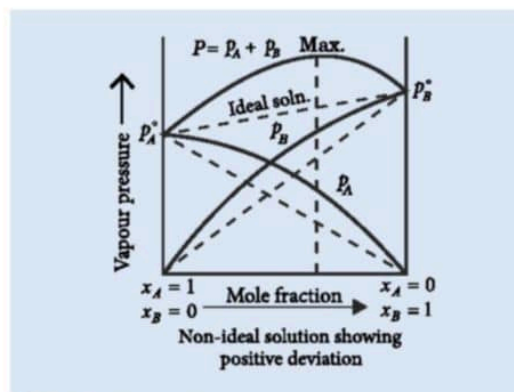
- Obey Raoult's law at all temperatures and concentrations.
- $p_1 = x_1 p_1^\circ; p_2 = x_2 p_2^\circ$
- $\Delta H_{\text{mix}} = 0, \Delta V_{\text{mix}} = 0$
- A - B interactions \approx A - A and B - B interactions.
- Do not form azeotropes (constant boiling mixtures).



Solutions showing positive deviation

- $A - B \ll A - A$ or $B - B$ interactions.
- $\Delta H_{\text{mix}} > 0, \Delta V_{\text{mix}} > 0$
- $p_i > p_i^\circ x_i$
- Form minimum boiling azeotropes.

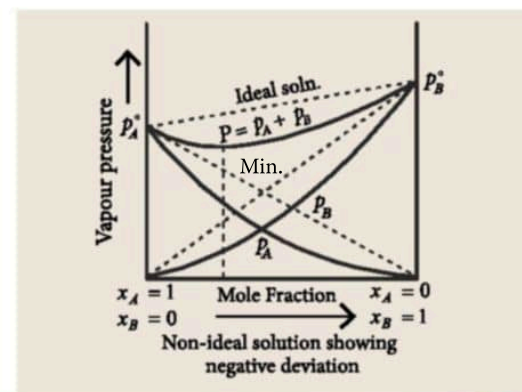
Examples : Ethanol and acetone, Carbon disulphide



Solutions showing negative deviation

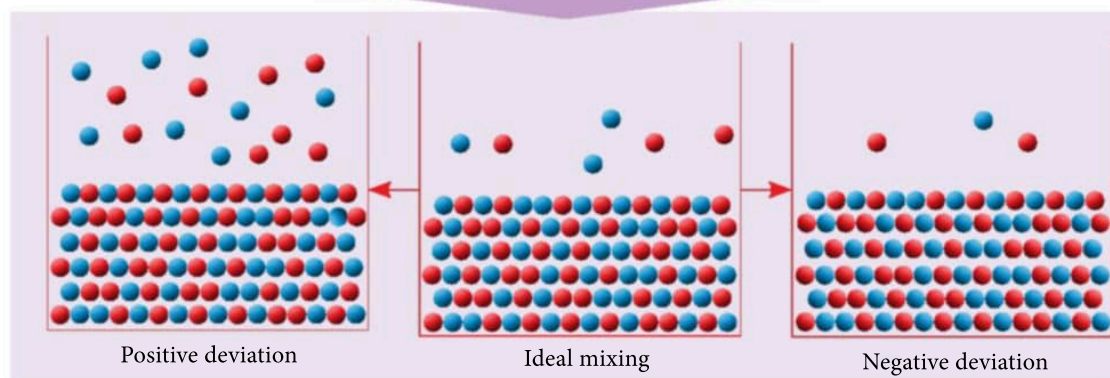
- $A - B \gg A - A$ or $B - B$ interactions.
- $\Delta H_{\text{mix}} < 0, \Delta V_{\text{mix}} < 0$
- $p_i < p_i^\circ x_i$
- Form maximum boiling azeotropes.

Examples : Phenol and aniline, Chloroform and acetone,



NON-IDEAL SOLUTIONS

- Do not obey Raoult's law at all temperatures and concentrations.
- $\Delta H_{\text{mix}} \neq 0, \Delta V_{\text{mix}} \neq 0$
- $p_1 \neq x_1 p_1^\circ; p_2 \neq x_2 p_2^\circ$
- Form azeotropes.



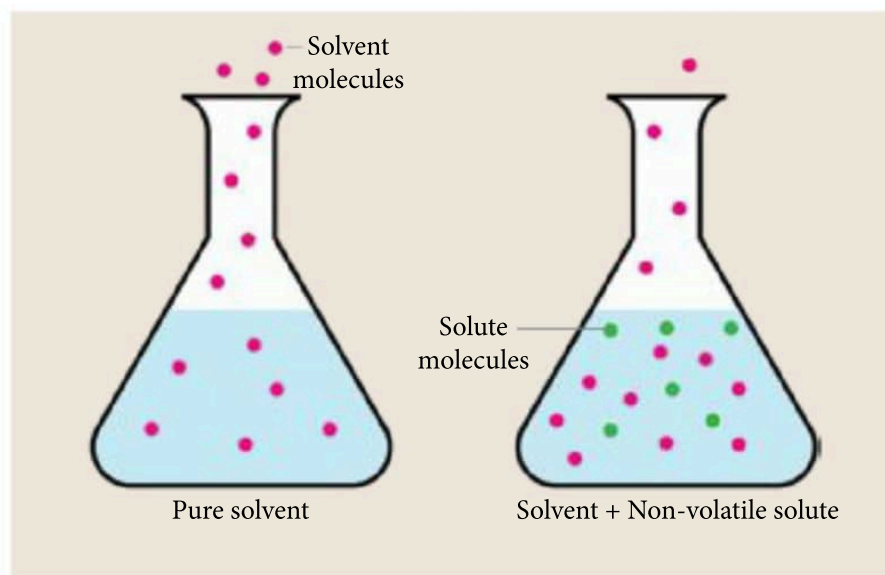
▶ **RAOULT'S LAW**

The French chemist, Francois Marte Raoult (1886) gave the quantitative relationship between them. The relationship is known as the Raoult's law which states that for a solution of volatile liquids, the partial vapour pressure of each component of the solution is directly proportional to its mole fraction present in solution.

Thus, for component 1, $p_1 \propto x_1$ and $p_1 = p_1^\circ x_1$ where p_1° is the vapour pressure of pure component 1 at the same temperature.

Similarly, for component 2, $p_2 = p_2^\circ x_2$ where p_2° represents the vapour pressure of the pure component 2.

Total pressure above the liquid = $p_{\text{total}} = p_1 + p_2$



▶ **HENRY'S LAW**

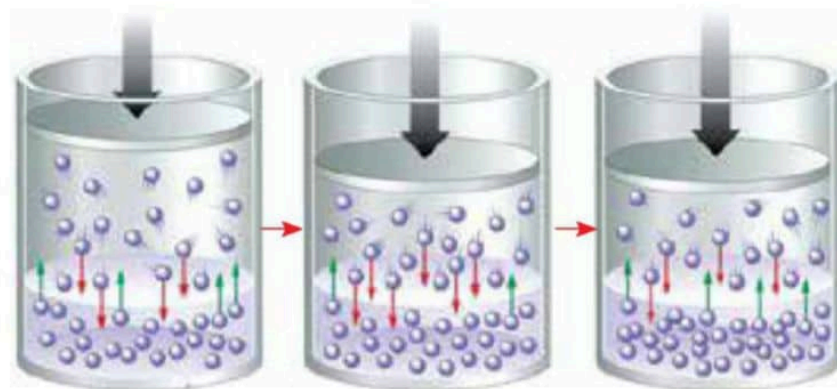
At a constant temperature, the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of liquid or solution.

The partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x) in the solution and is expressed as :

$$p = K_H x$$

Here K_H is the Henry's law constant.

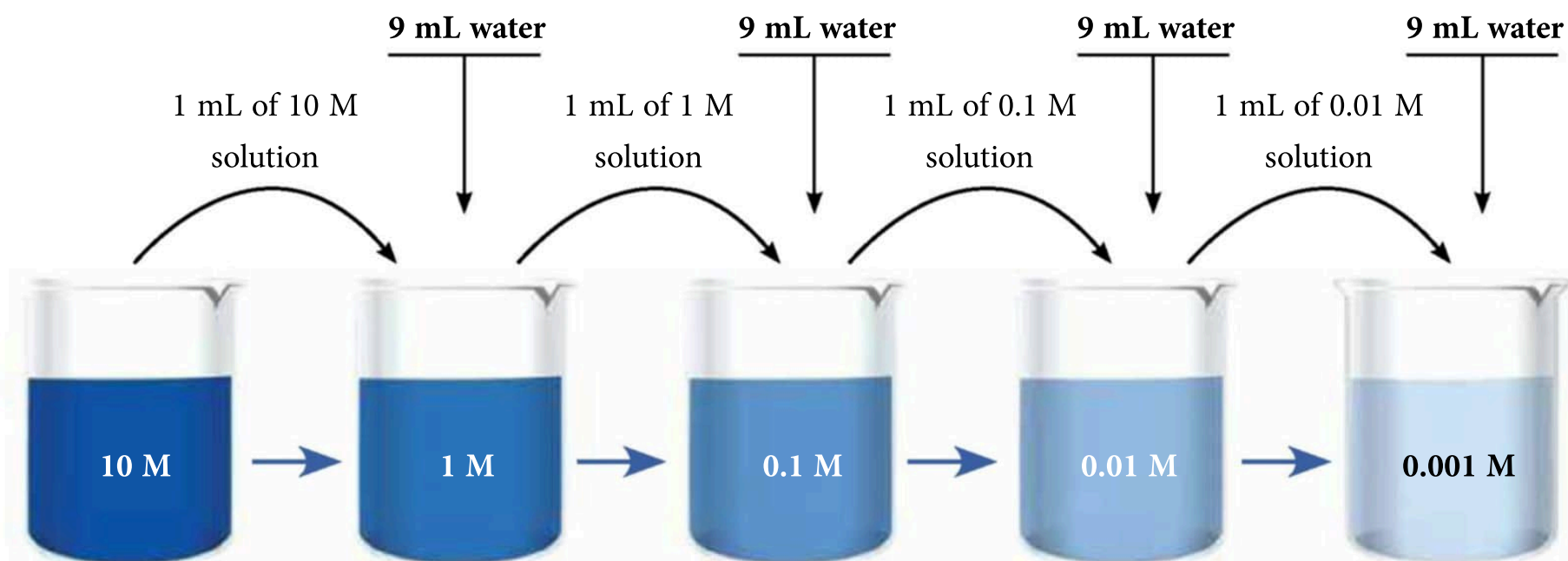
Solubility of the gas increases with the increase in pressure.

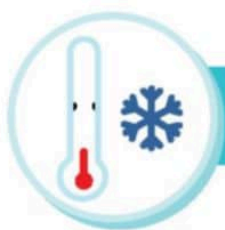


▶ **SERIAL DILUTION OF CHEMICALS**

A serial dilution is a simple technique for reducing the concentration of a solution in a systematic way.

- start by taking 1 mL of the stock concentration of your chemical.
- transfer it into 9 mL of water, and mixing.
- Use this dilution factor throughout the series to produce experimental concentrations as shown in the illustration below.



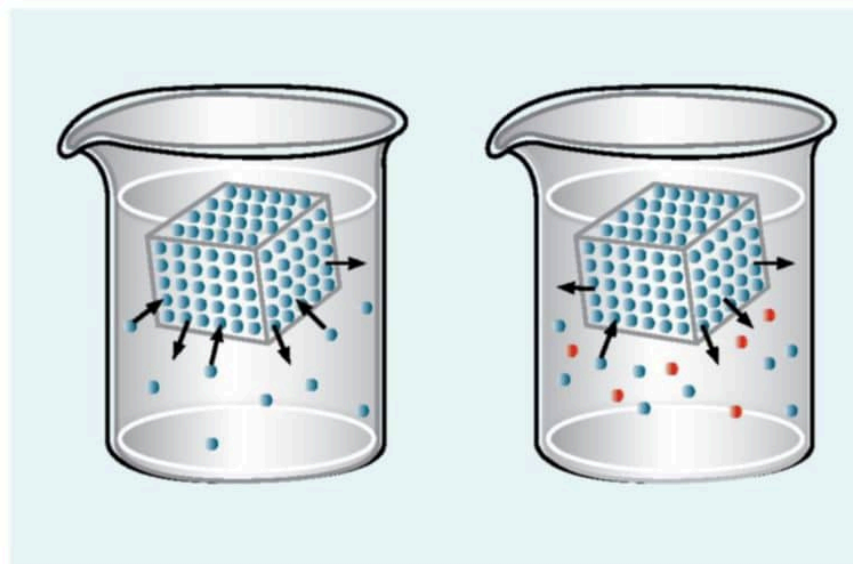


DEPRESSION IN FREEZING POINT

- ◆ Freezing point of a liquid is the temperature at which the vapour pressure of solid is equal to the vapour pressure of liquid.
- ◆ The lowering of vapour pressure of a solution causes a lowering of the freezing point compared to that of the pure solvent. The decrease in freezing point, $\Delta T_f = T_f^\circ - T_f$ is known as depression in freezing point.
- ◆ When a solution freezes, it is only the pure solvent which separates out in the solid form. It is this that causes a depression in the freezing point.

$$\Delta T_f \propto m \text{ or } \Delta T_f = K_f m = K_f \left(\frac{w_2 \times 1000}{M_2 \times w_1} \right)$$

where K_f is known as freezing point depression constant or molal depression constant or cryoscopic constant, having unit K kg mol^{-1} .



Dissolved solutes lower the freezing point of liquids.

- ◆ Solute molecules block solvent from getting to the crystal to freeze.
- ◆ The equilibrium is shifted towards the liquid.



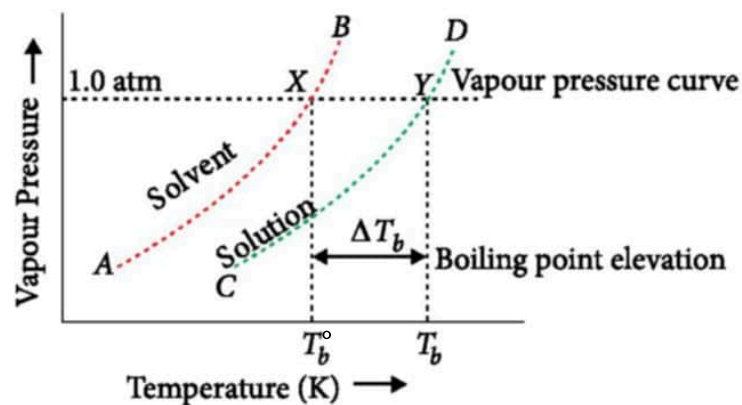
ELEVATION IN BOILING POINT

- ◆ Boiling point of a liquid is the temperature at which its vapour pressure becomes equal to the atmospheric pressure.
- ◆ Solution has lower vapour pressure and hence higher boiling point than pure solvent. The increase in the boiling point, $\Delta T_b = T_b - T_b^\circ$ is known as elevation of boiling point.

$$\Delta T_b \propto m$$

$$\Delta T_b = K_b m = K_b \left(\frac{w_2 \times 1000}{M_2 \times w_1} \right)$$

where m is molality of solution and K_b is called boiling point elevation constant or molal elevation constant or ebullioscopic constant, having unit K kg mol^{-1} .



Let w_2 gram of a solute of molar mass M_2 is dissolved in w_1 gram of solvent of molar mass M_1

$$\frac{p^\circ - p_s}{p^\circ} = \frac{n_2}{(n_1 + n_2)}$$

$$M_2 = \frac{(w_2 M_1) \times p^\circ}{w_1 (p^\circ - p_s)} \quad (n_2 \ll n_1)$$

Relative lowering of vapour pressure

Elevation in boiling point

$$\Delta T_b = \frac{K_b \times w_2 \times 1000}{M_2 \times w_1}$$

$$\text{then, } M_2 = \frac{K_b \times w_2 \times 1000}{\Delta T_b \times w_1}$$

Determination of Molar Mass

Osmotic pressure

$$\pi = \frac{w_2 RT}{M_2 V}$$

$$M_2 = \frac{w_2 RT}{\pi V}$$

Molecular mass of a non-volatile solute can be determined from osmotic pressure of its solution.

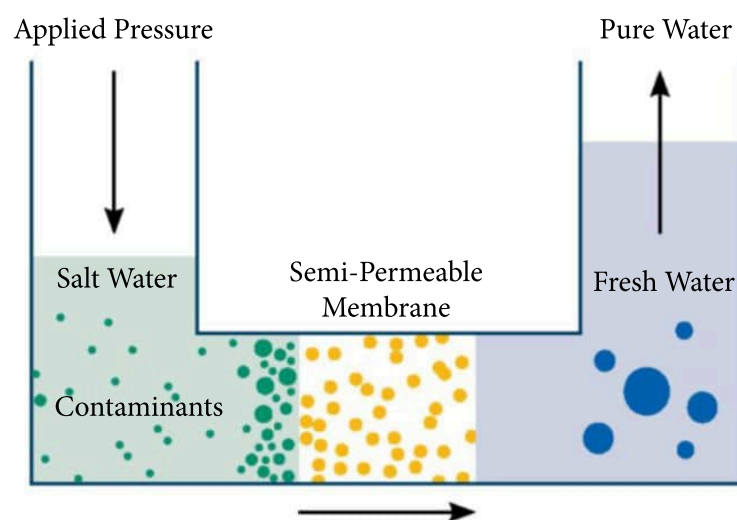
$$\Delta T_f = \frac{K_f \times w_2 \times 1000}{M_2 \times w_1}$$

$$\Rightarrow M_2 = \frac{K_f \times w_2 \times 1000}{\Delta T_f \times w_1}$$

Depression in freezing point

Reverse Osmosis

When the pressure applied on the solution is more than osmotic pressure then solvent will start flowing out from the solution through semipermeable membrane. The process is called reverse osmosis. It is used in the desalination of water *i.e.*, removal of salts from sea water.



Fascinating Facts

When you step inside a bath tub, the water level will immediately go up, as per Archimedes' law. But when you add a volume of sodium chloride (salt) to a volume of water, the overall volume actually decreases by up to 2%. The net reduction in observed volume is due to solvent molecules which became more ordered in the vicinity of dissolved ions.

When you mix half a litre of alcohol and half a litre of water, the total volume of the liquid will be less than one litre. There is strong hydrogen bonding between water and methyl alcohol that draws the different molecules closer. Second, vacant spaces in the liquid are very less because the methyl alcohol interferes with any temporary open structures that are similar to those of solid water. Thus, the two different molecules pack closer together than in pure solution, resulting in a reduction of volume.

van 't Hoff factor

In 1880 van 't Hoff introduced a factor i , known as the van 't Hoff factor, to account for the extent of dissociation or association.

$$i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}} = \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

$$= \frac{\text{Total number of moles of particles after association / dissociation}}{\text{Number of moles of particles before association / dissociation}}$$

Here abnormal molar mass is the experimentally determined molar mass and calculated colligative properties are obtained by assuming that the non-volatile solute is neither associated nor dissociated.

Formulae Based on van 't Hoff Factor

- Relative lowering of vapour pressure of solvent,

$$\frac{p^\circ - p_s}{p^\circ} = i \cdot \frac{n_2}{n_1}$$

- Elevation in boiling point,

$$\Delta T_b = iK_b m$$

- Depression in freezing point,

$$\Delta T_f = iK_f m$$

- Osmotic pressure of solution,

$$\pi = in_2 RT/V$$

For association, $i < 1$; for dissociation, $i > 1$

- Degree of dissociation,

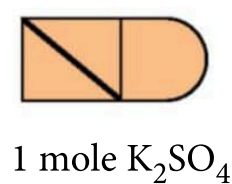
$$\alpha = \frac{\text{Number of moles dissociated}}{\text{Total number of moles taken}}$$

$$\alpha = \frac{i-1}{n-1}; \text{ where } n = \text{no. of ions}$$

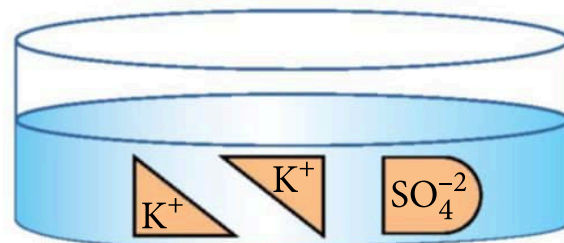
- Degree of association,

$$\alpha = \frac{\text{Number of moles associated}}{\text{Total number of moles taken}}$$

$$\alpha = \frac{1-i}{1/n-1}$$

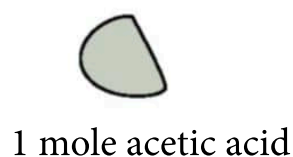


+ Water

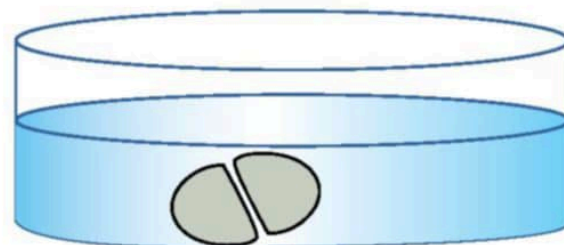


Dissociates to give 3 mole of ions

$$i \approx 3$$



+ Benzene



Dimerises to form 1/2 mole

$$i \approx 1/2$$

Class XI

Monthly test



This specially designed column enables students to self analyse their extent of understanding of all chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Organic Chemistry - Some Basic Principles and Techniques | Hydrocarbons

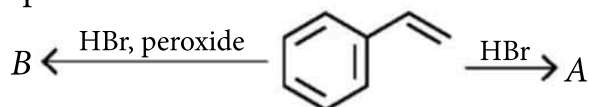
Total Marks : 120

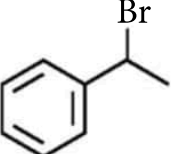
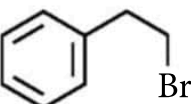
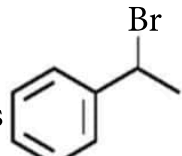
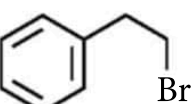
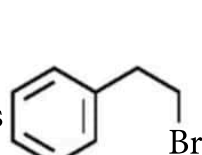
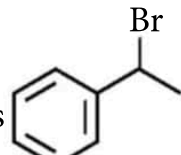
Time taken : 60 Min.

NEET

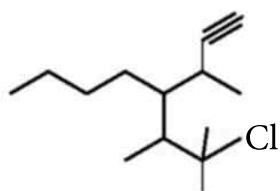
Only One Option Correct Type

1. Observe the following reactions and predict the major products A and B.



- (a) A and B both are 
- (b) A and B both are 
- (c) A is  and B is 
- (d) A is  and B is 

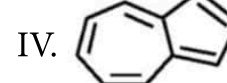
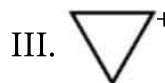
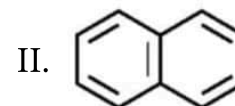
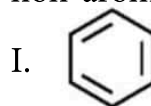
2. What is the correct IUPAC name of the compound shown below?



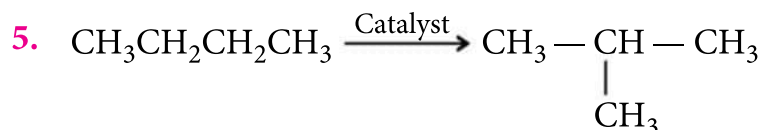
- (a) 4-(2-Chloro-1,2-dimethylpropyl)-3-methyloct-1-yne
- (b) 4-Butyl-6-chloro-3,5,6,6-tetramethylhept-1-yne

- (c) 4-Butyl-2-chloro-2,3,5-trimethylhept-6-yne
- (d) 4-Butyl-6-chloro-3,5,6-trimethylhept-1-yne

3. Which of the following chemical systems is/are non-aromatic?

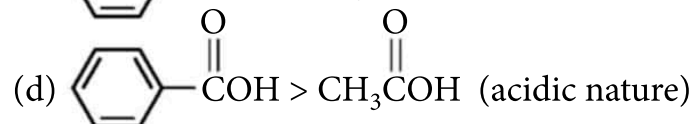
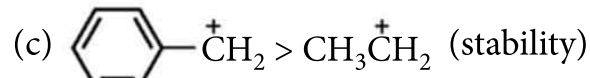
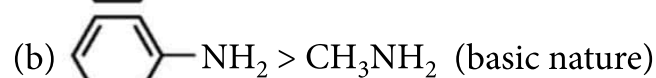
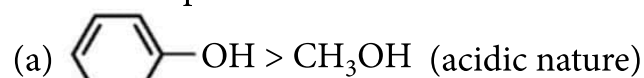


- (a) Only III
- (b) Only IV
- (c) Only II and IV
- (d) None of these
4. The number of sigma (σ) and pi (π) bonds in pent-2-en-4-yne is
- (a) 13 σ bonds and no π bond
- (b) 10 σ bonds and 3 π bonds
- (c) 8 σ bonds and 5 π bonds
- (d) 11 σ bonds and 2 π bonds.

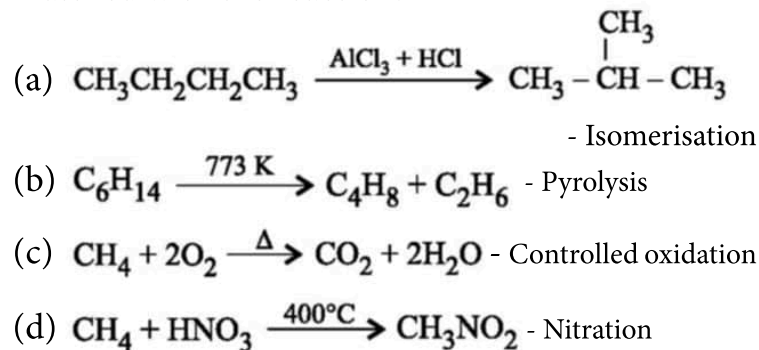


The catalyst used in the above conversion reaction is

- (a) ZnCl_2/HCl
- (b) AlCl_3/HCl
- (c) PdCl_2/HCl
- (d) CuCl/HCl
6. Which comparison is not correct as indicated?



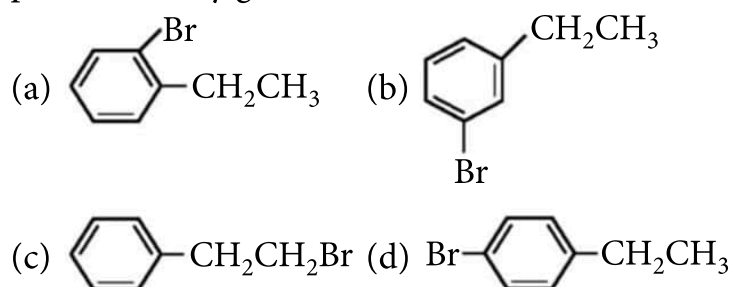
7. Few reactions of alkanes are given below. Identify the name of the reaction which is not correctly matched with the reaction.



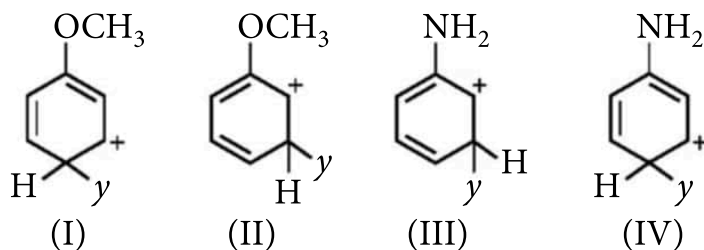
8. Which type of intermediate (A) is formed during the reaction?

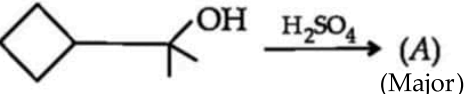


- (a) Carbocation (b) Carbanion
(c) Free radical (d) Carbene
9. Ethylbenzene with bromine in presence of FeBr_3 , predominantly gives

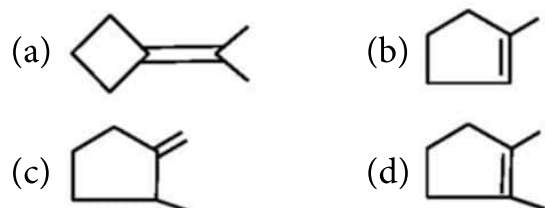


10. Give the stability order of the following compounds.



- (a) I > II > III > IV (b) IV > I > II > III
(c) IV > I > III > II (d) IV > II > I > III
11. In the reaction,  (Major)

the product (A) is



12. Kjeldahl's method cannot be used for the estimation of nitrogen in
- (a) pyridine (b) nitro compounds
(c) azo compounds (d) all of these.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

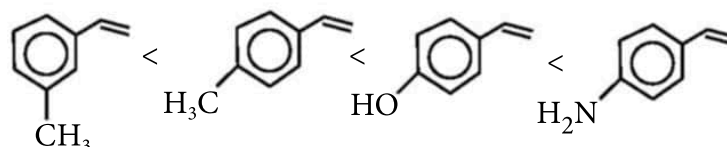
13. **Assertion :** Liquids with a difference of more than 30°C in their boiling points can be separated by simple distillation.

Reason : Simple distillation can help in separating a mixture of propan-1-ol (boiling point 97°C) and propanone (boiling point 56°C).

14. **Assertion :** Electrophilic addition of Br_2 to alkyne proceeds faster than that of alkene.

Reason : Bromonium ion intermediate of alkene is stable than that of alkyne.

15. **Assertion :** Relative reactivity towards electrophilic addition is



Reason : Electron releasing group stabilises carbocation. More the +M effect, more is stability of $-\overset{+}{\text{C}}-$.

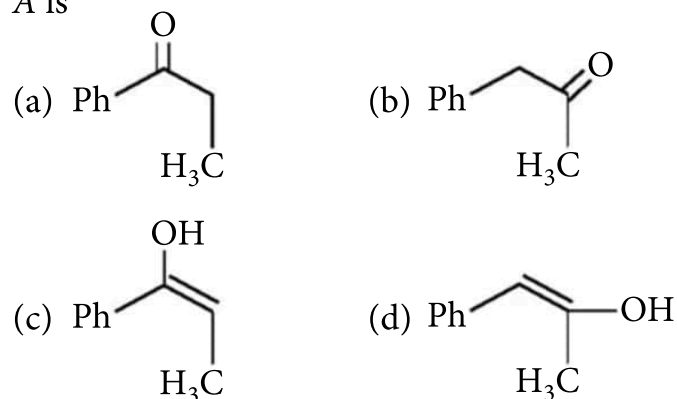
JEE (Main & Advanced)

Only One Option Correct Type

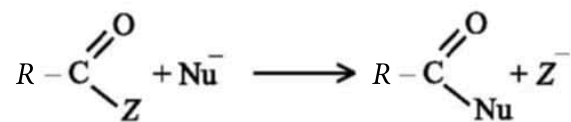
16. 0.765 g of an acid gives 0.535 g of CO_2 and 0.138 g of H_2O . Then the ratio of the percentage of carbon and hydrogen is
(a) 1 : 9 (b) 20 : 16 (c) 18 : 11 (d) 19 : 2

17. $\text{Ph}-\text{C}\equiv\text{C}-\text{CH}_3 \xrightarrow{\text{Hg}^{2+}/\text{H}^+} \text{A}$

A is



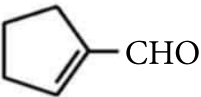
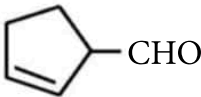
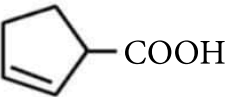
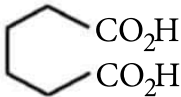
18. Rate of the reaction,



is fastest when Z is

- (a) Cl (b) NH₂
(c) OC₂H₅ (d) OCOCH₃

19. Cyclohexene on ozonolysis followed by reaction with zinc dust and water gives compound E. Compound E on further treatment with aqueous KOH yields compound F. Compound F is

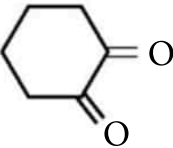
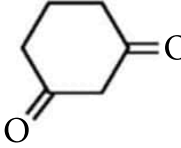

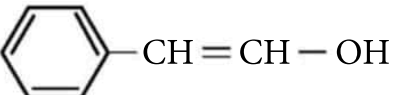
- (a)  (b) 
(c)  (d) 

More than One Option Correct Type

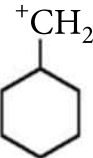
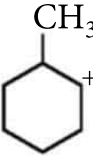
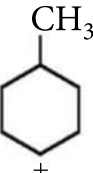
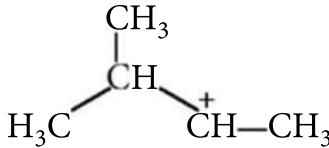
20. Which of the following reactions are not feasible?

- (a) HC≡CH + KOH →
(b) HC≡CH + NaNH₂ →
(c) HC≡CH + NaOH →
(d) HC≡CH + (CH₃)₃C-Br →

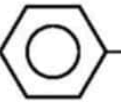
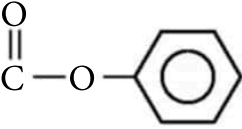

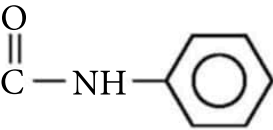

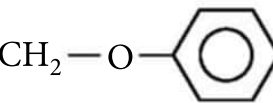

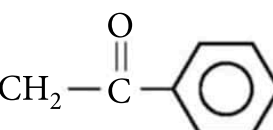
21. Which of the following structures exhibit tautomerism?

- (a)  (b) 
(c)  (d) 

22. Which of the following carbocations would you expect to rearrange?

- (a)  (b) 
(c)  (d) 

23. In which of the following compounds electrophilic aromatic substitution takes place in phenyl ring present in right hand side (RHS)?

- | | LHS | RHS |
|-----|---|---|
| (a) |  |  |
| (b) |  |  |
| (c) |  |  |
| (d) |  |  |

Integer / Numerical Value Type

24. The total number of alkenes possible by dehydrobromination of 3-bromo-3-cyclopentylhexane using alcoholic KOH is _____.
25. In the estimation of phosphorus in an organic compound by the Carius method, 2.79 g of the compound gave 1.332 g of magnesium pyrophosphate (Mg₂P₂O₇). Calculate the percentage of phosphorus in the compound.

TRIO

Here are the nine shuffled words containing 3 sets of trio. The three letters of trio can be arranged in any sequence. Complete these words by finding 3 sets of trio.

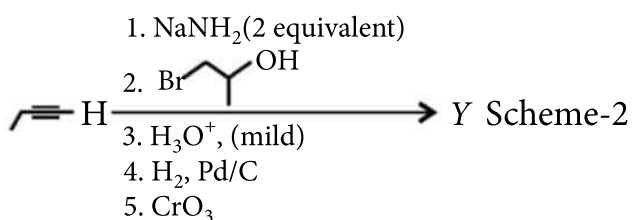
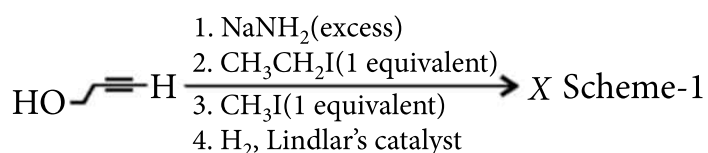
JO _ _ _
MO _ _ _ VIUM
I _ _ _ HOR
METH _ _ _ ETHIONINE
_ _ _ ENT
G _ _ _ E
O _ _ _ M
A _ _ _ OSE
GLY _ _ _ IDE

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names will be published in next issue.

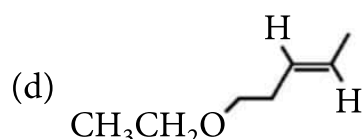
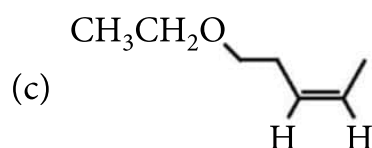
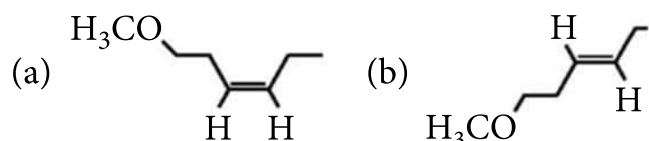
26. Among the following groups, the number of *m*-directing groups is _____.
- Cl, —CN, —SO₂Cl, —OH, —SH, —CHO, —COOR, —NR₂, —CCl₃, —NO₂

Comprehension Type

Schemes 1 and 2 describe sequential transformation of alkynes *M* and *N*. Consider only the major products formed in each step for both the schemes.



27. The product *X* is



28. The correct statement with respect to product *Y* is
- (a) it gives a positive Tollens' test and is a functional isomer of *X*
- (b) it gives a positive Tollens' test and is a geometrical isomer of *X*
- (c) it gives a positive iodoform test and is a functional isomer of *X*
- (d) it gives a positive iodoform test and is a geometrical isomer of *X*

Matching Type

29. Match the column I with column II and select the correct option.

	Column I		Column II
(A)	Simple distillation	(p)	To separate the liquids which are steam volatile, insoluble in water and contains non-volatile impurities
(B)	Fractional distillation	(q)	To separate liquids which decomposes at a temperature below their normal boiling points
(C)	Vacuum distillation	(r)	To separate two or more liquids which have boiling points close to each other
(D)	Steam distillation	(s)	To separate liquid from non-volatile impurities

- (a) A → s; B → q; C → r; D → p
 (b) A → p; B → q; C → r; D → s
 (c) A → s; B → r; C → q; D → p
 (d) A → r; B → s; C → q; D → p

30. Match the column I with column II and select the correct option.

	Column I (Reaction)		Column II (Major Product)
(A)	Dehydrohalogenation of 1-chlorobutane	(p)	<i>trans</i> -2-Butene
(B)	Dehydration of 1-butanol	(q)	2, 3-Dimethylbutane
(C)	Wurtz reaction of isopropyl bromide	(r)	Methane
(D)	Decarboxylation of sodium ethanoate	(s)	1-Butene

- (a) A-s; B-p; C-q; D-r (b) A-r; B-q; C-p; D-s
 (c) A-q; B-r; C-p; D-s (d) A-p; B-s; C-q; D-r

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted

No. of questions correct

Marks scored in percentage

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

GET SET GO

JEE

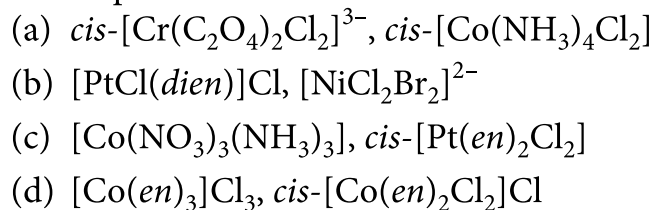
for



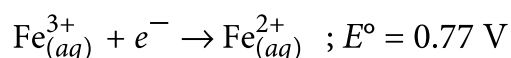
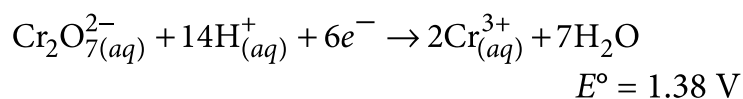
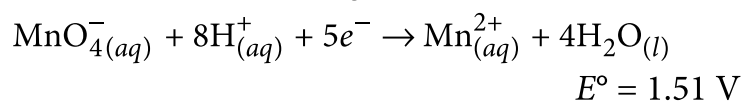
with exclusive and brainstorming questions

Practicing these questions helps to strengthen your concepts and give you extra edge in your JEE preparation

1. In which of the following pairs both the complexes show optical isomerism?



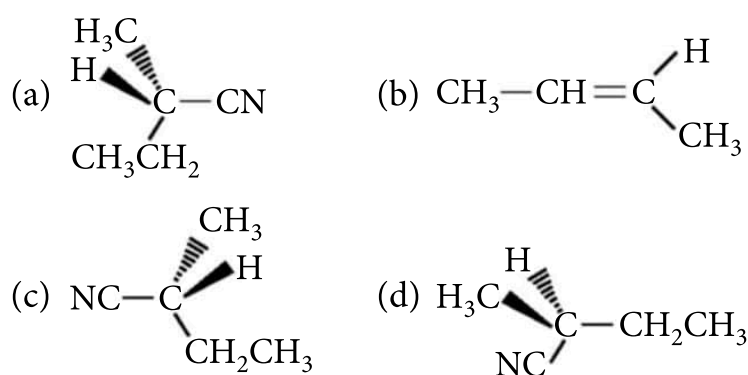
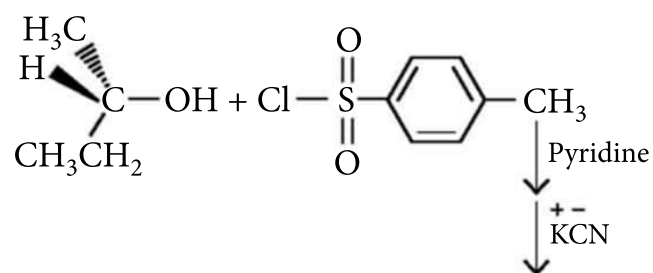
2. Standard electrode potential data are useful for understanding the suitability of an oxidant in a redox titration. Some half cell reactions and their standard potentials are given below :



Identify the only incorrect statement regarding the quantitative estimation of aqueous $Fe(NO_3)_2$.

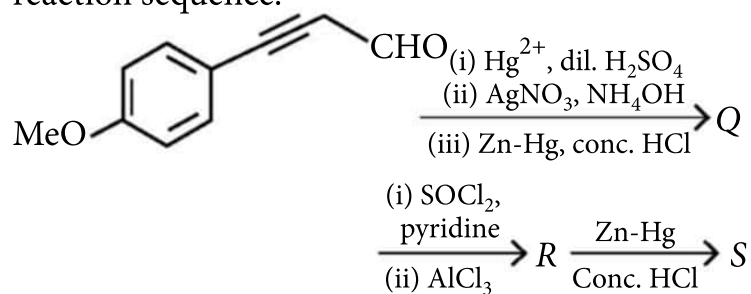
- (a) MnO_4^- can be used in aqueous HCl.
 (b) $Cr_2O_7^{2-}$ can be used in aqueous HCl.
 (c) MnO_4^- can be used in aqueous H_2SO_4 .
 (d) $Cr_2O_7^{2-}$ can be used in aqueous H_2SO_4 .

3. Find the major product of following reaction :

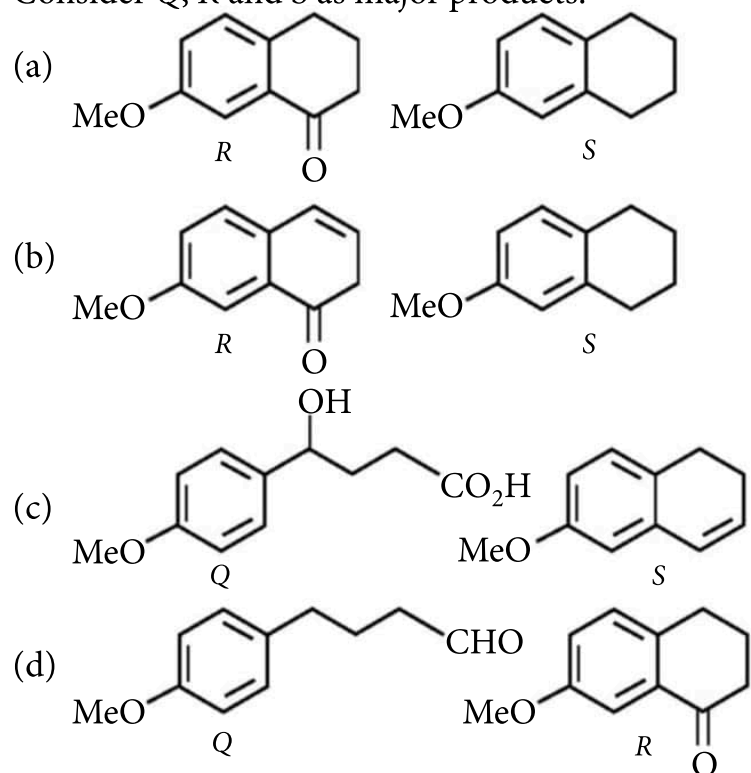


4. The standard reduction potential for the half cell: $NO_3^-(aq) + 2H^+(aq) + e^- \rightarrow NO_2 + H_2O$ is 0.78 V. The reduction potential at 8 M H^+ and in neutral solution respectively are. Assume all other species to be at unit concentration.
- (a) 0.7769 V, -0.037 V
 (b) 0.9924 V, -0.0052 V
 (c) 0.8862 V, -0.046 V
 (d) 0.6468 V, -0.093 V

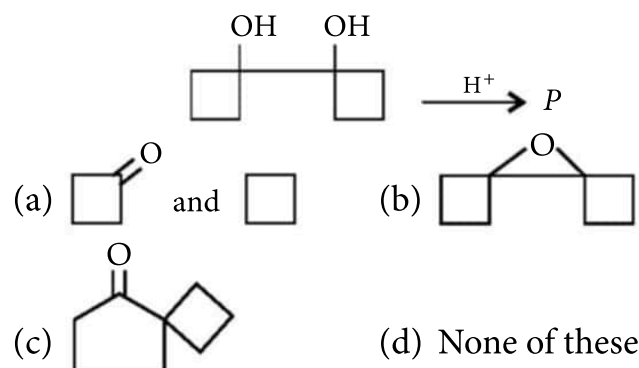
5. Choose the correct option for the following reaction sequence.



Consider Q, R and S as major products.



6. Identify the product (P) in the following reaction.



7. The rate constant for the first order decomposition of H_2O_2 is given by the following equation :

$$\log k = 14.34 - 1.25 \times 10^4 \text{ K}/T$$

E_a for this reaction and temperature at which its half-period will be 256 minutes respectively are

- (a) 339.449 kJ mol^{-1} , 563 K
 (b) 239.339 kJ mol^{-1} , 669 K
 (c) 2.390 kJ mol^{-1} , 669 K
 (d) 3.39 kJ mol^{-1} , 563 K
8. Which of the following hormones stimulates glycogenolysis in the liver of human beings under the conditions of stress?

- (a) Thyroxin (b) Insulin
 (c) Adrenaline (d) Estradiol

9. In a binary compound, atoms of element A form a hcp structure and those of element M occupy $2/3$ of the tetrahedral voids of the hcp structure. The formula of the binary compound is

- (a) MA_3 (b) M_2A_3 (c) M_4A_3 (d) M_4A

10. Which of the following statements is/are true?

- (A) β -Black phosphorus is prepared by heating white phosphorus at 473 K under a very high pressure.
 (B) In aqueous medium, HCl is a stronger acid than HF.
 (C) HClO_4 is a weaker acid than HClO_3 .
 (D) HNO_3 is a stronger acid than HNO_2 .

- (a) (A), (B) and (D) only
 (b) (B) only
 (c) (A) and (C) only
 (d) (D) only

11. Potassium manganate (K_2MnO_4) is formed when

- (I) chlorine is passed into aqueous KMnO_4 solution
 (II) manganese dioxide is fused with potassium hydroxide in air
 (III) formaldehyde reacts with potassium permanganate in presence of a strong alkali
 (IV) potassium permanganate reacts with concentrated sulphuric acid.

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

12. KI (excess) is added to the following solutions separately :

- (I) CuSO_4 (II) HgCl_2 (III) $\text{Pb}(\text{NO}_3)_2$

The correct observation is

- (a) a white precipitate of Cu_2I_2 in (I), an orange precipitate of HgI_2 in (II) which further dissolves and a yellow precipitate of PbI_2 in (III) are formed
 (b) white precipitates of Cu_2I_2 , HgI_2 and PbI_2 are formed respectively
 (c) yellow precipitate in each case is formed
 (d) a white precipitate of Cu_2I_2 in (I), an orange precipitate of K_2HgI_4 in (II) and a yellow precipitate of PbI_2 in (III) are formed.

INTEGER / NUMERICAL VALUE TYPE

13. How many of the following compounds do not give NO_2 and O_2 simultaneously on heating at low temperature?

$\text{Pb}(\text{NO}_3)_2, \text{NaNO}_3, \text{NH}_4\text{NO}_3, \text{NH}_4\text{NO}_2, \text{Mn}(\text{NO}_3)_2, \text{CsNO}_3$

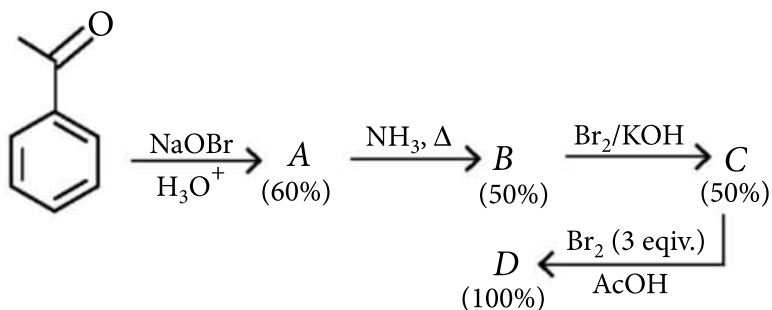
14. When 9.45 g of ClCH_2COOH is added to 500 mL of water, its freezing point drops by 0.5°C . The dissociation constant of ClCH_2COOH is $x \times 10^{-3}$. The value of x is _____.

(Rounded off to the nearest integer)

$[K_f(\text{H}_2\text{O}) = 1.86 \text{ K kg mol}^{-1}]$

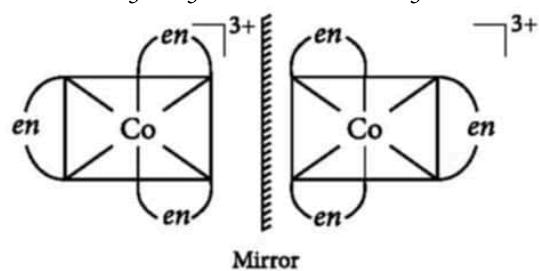
15. In the following reaction sequence, the amount of D (in g) formed from 10 moles of acetophenone is _____.

(Atomic weights in g mol^{-1} : $\text{H} = 1, \text{C} = 12, \text{N} = 14, \text{O} = 16, \text{Br} = 80$. The yield (%) corresponding to the product in each step is given in the parenthesis.)

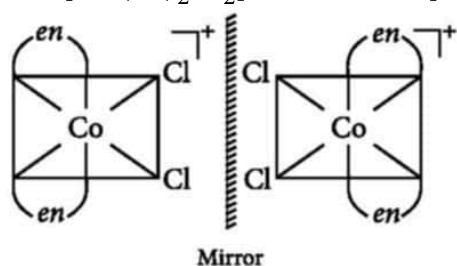


SOLUTIONS

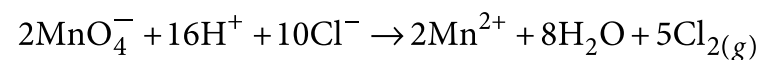
1. (d): Optical isomerism is shown by octahedral complexes of the type $[M(\text{AA})_2\text{X}_2]$ and $[M(\text{AA})_3]$. $[\text{Co}(\text{en})_3]\text{Cl}_3$ i.e., $[\text{Co}(\text{en})_3]^{3+}$



$\text{cis-}[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ i.e., $\text{cis-}[\text{Co}(\text{en})_2\text{Cl}_2]^+$



2. (a): The oxidation of Cl^- ion by MnO_4^- can be represented as



The cell corresponding to the above equation is



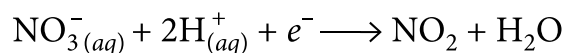
$$E_{\text{cell}}^\circ = (1.51 - 1.40) \text{ V} = 0.11 \text{ V}$$

Since E_{cell}° is positive so ΔG° ($\Delta G^\circ = -nFE^\circ$) must be negative and so this cell is feasible.

MnO_4^- will oxidise both Fe^{2+} ions and Cl^- ions simultaneously and so it cannot be used for the quantitative estimation of $\text{aq. Fe}(\text{NO}_3)_2$.

3. (c)

4. (c): The half cell reaction is



According to Nernst equation,

$$E = E^\circ - \frac{0.059}{1} \log \frac{[\text{NO}_2][\text{H}_2\text{O}]}{[\text{NO}_3^-][\text{H}^+]^2}$$


$$E = 0.78 - 0.059 \log \frac{1}{(8)^2}$$

$$= 0.78 - 0.1062 = 0.8862 \text{ V}$$

In neutral solution, $[\text{H}^+] = 10^{-7} \text{ M}$

$$\therefore E = 0.78 - \frac{0.059}{1} \log \frac{1}{(10^{-7})^2}$$


$$= 0.78 + 0.059 \times 14 = 0.78 - 0.826 = -0.046 \text{ V}$$



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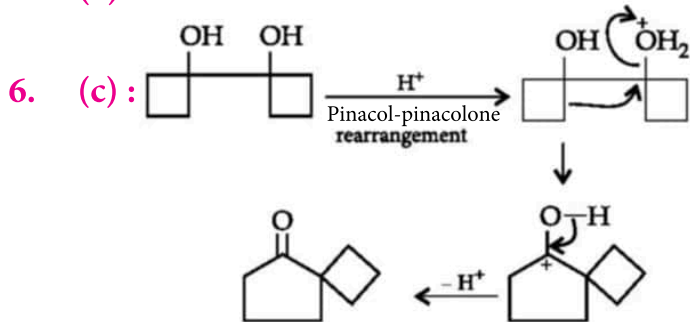
JEE Main



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5. (a)



7. (b): $\log k = 14.34 - 1.25 \times 10^4 K/T$... (i)
Comparing with equation,

$$\log k = \log A - \frac{E_a}{2.303RT} \text{ we get}$$

$$\frac{E_a}{2.303 R} = 1.25 \times 10^4$$

$$\therefore E_a = 1.25 \times 10^4 \times 2.303 \times 8.314 = 239339 \text{ J mol}^{-1} \text{ or } 239.339 \text{ kJ mol}^{-1}$$

Now, $t_{1/2} = 256 \text{ min} = 256 \times 60 \text{ s}$

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{256 \times 60 \text{ s}} = 4.51 \times 10^{-5} \text{ s}^{-1}$$

Substituting in equation (i)

$$\log (4.51 \times 10^{-5}) = 14.34 - 1.25 \times 10^4 K/T$$

$$-4.35 = 14.34 - \frac{1.25 \times 10^4 K}{T}$$

$$\text{or } \frac{1.25 \times 10^4}{T} = 18.69 \text{ or } T = \frac{1.25 \times 10^4 K}{18.69} = 669 \text{ K}$$

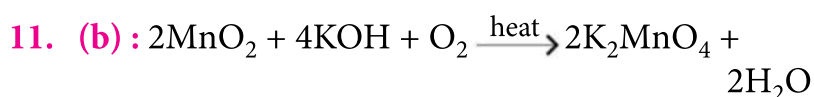
8. (c)

9. (c): Atoms of element A form hcp structure. So, let the number of atoms which crystallise to form hcp be 'N'.

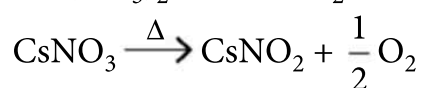
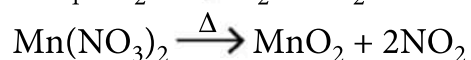
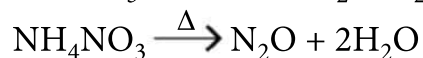
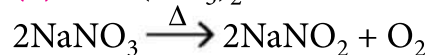
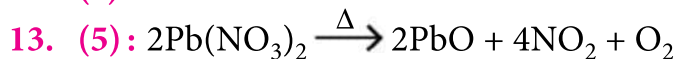
As the atoms of element M occupy 2/3 tetrahedral voids, so the number of atoms of M = $\frac{2}{3} \times 2N$

The formula of the compound = $M_{\frac{4}{3}N} A_N = M_4 A_3$

10. (a)



12. (a)



14. (35): $\Delta T_f = 0.5^\circ\text{C}$; $V = 500 \text{ mL}$

$$K_f = 1.86 \text{ K kg mol}^{-1}$$

Mass of compound = 9.45 g

$$M = 35.5 + 24 + 3 + 32 = 94.5$$

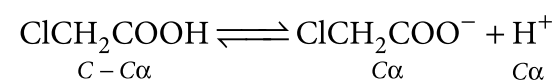
$$m = \frac{9.45}{94.5} \times \frac{1000}{500} = 0.2 \text{ [density of water } \approx 1 \text{ g/mL]}$$

$$\Delta T_f = i K_f m; 0.5 = i \times 0.2 \times 1.86$$

$$i = \frac{0.5}{0.2 \times 1.86} = 1.34$$

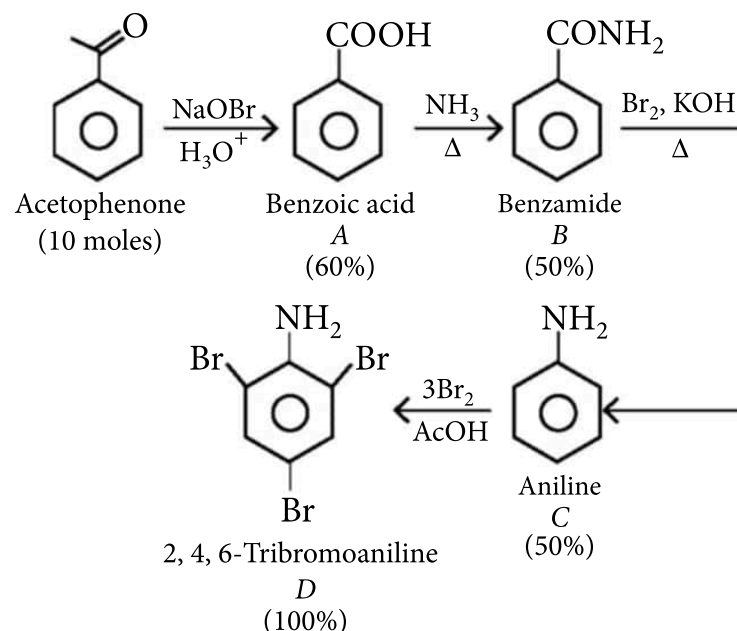
$$1 + \alpha = 1.34 \Rightarrow \alpha = 0.34$$

At equilibrium:



$$K_a = \frac{(C\alpha)^2}{(C-C\alpha)} = \frac{C\alpha^2}{1-\alpha} = \frac{0.2 \times (0.34)^2}{(1-0.34)} = 35 \times 10^{-3}$$

15. (495):



$$\text{Yield of D in moles} = 10 \times \frac{60}{100} \times \frac{50}{100} \times \frac{50}{100} = 1.5 \text{ moles}$$

$$\text{Amount of D} = \text{Number of moles} \times \text{Molecular weight} = 1.5 \times 330 = 495 \text{ g}$$

MONTHLY TEST DRIVE CLASS XI

ANSWER

KEY

- | | | | | |
|-------------|-------------|-------------|---------|-------------|
| 1. (c) | 2. (a) | 3. (a) | 4. (b) | 5. (b) |
| 6. (b) | 7. (c) | 8. (c) | 9. (d) | 10. (c) |
| 11. (d) | 12. (d) | 13. (a) | 14. (c) | 15. (a) |
| 16. (d) | 17. (a) | 18. (b) | 19. (a) | 20. (a,c,d) |
| 21. (a,b,d) | 22. (a,b,d) | 23. (a,b,c) | 24. (5) | 25. (13.33) |
| 26. (6) | 27. (a) | 28. (c) | 29. (c) | 30. (a) |

NEET / JEE

Brush up your concepts to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

Unit 4
▶ Amines ▶ Biomolecules

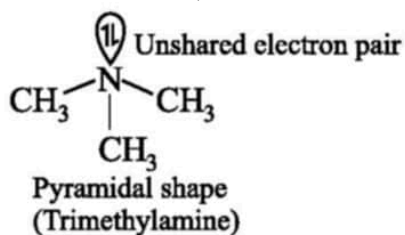
AMINES

INTRODUCTION

Amines are special class of organic compounds which are obtained by replacing one, two or all of three hydrogen atoms of ammonia molecule by alkyl/aryl groups. In nature, they occur in form of proteins, vitamins, alkaloids and hormones. A large number of amines have also been synthesized in the laboratory which are used as polymers, dyes and drugs.

STRUCTURE OF AMINES

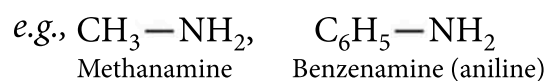
Nitrogen orbitals in amines are sp^3 hybridised and the geometry of amines is **pyramidal**. Due to the presence of unshared pair of electrons, the angle C–N–E, (where E is C or H) is **less than 109.5°** . For instance, it is 108° in case of trimethylamine as shown in figure.



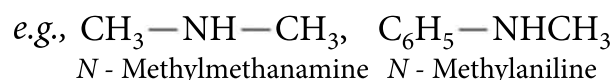
CLASSIFICATION

Amines can be classified as 1° , 2° or 3° amines depending on the number of alkyl/aryl groups present in ammonia molecule, RNH_2 (1° amine), R_2NH (2° amine) and R_3N (3° amine).

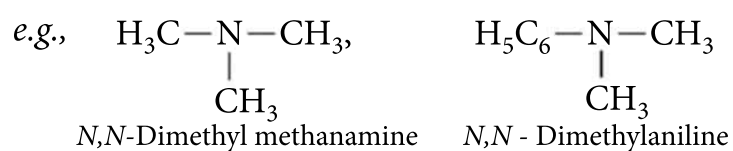
- **Primary amines** : Amines containing $-NH_2$ group are called primary amines.



- **Secondary amines** : Amines containing $-NH-$ group are called secondary amines.



- **Tertiary amines** : Amines containing $-N-$ group are called tertiary amines.



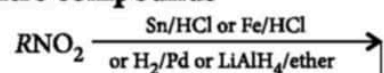
NOMENCLATURE

- In common system an aliphatic amine is named by prefixing alkyl group to amine *i.e.*, alkylamine. In IUPAC system, amines are named as alkanamines. For aromatic amines, in common system they are named as arylamines and in IUPAC system the terminal 'e' is replaced from the name of corresponding arene by the suffix amine.

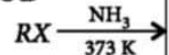
Amines	Common name	IUPAC name
$\text{CH}_3-\text{CH}_2-\text{NH}_2$	Ethylamine or Aminoethane	Ethanamine
$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}_3 \\ \\ \text{NH}_2 \end{array}$	<i>iso</i> -Propylamine or 2-Aminopropane	Propan-2-amine or 2-Propanamine
$\begin{array}{c} \text{CH}_3-\text{N}-\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	Trimethylamine or <i>N,N</i> -Dimethylaminomethane	<i>N,N</i> -Dimethylmethanamine
$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{N}-\text{CH}_2-\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	<i>N</i> -Ethyl- <i>N</i> -methylaminoethane	<i>N</i> -Ethyl- <i>N</i> -methylethanamine
$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{N}-\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	Ethyldimethyl amine or <i>N,N</i> -dimethylaminoethane	<i>N,N</i> -Dimethylethanamine
$\text{C}_6\text{H}_5-\overset{\beta}{\text{CH}_2}-\overset{\alpha}{\text{CH}_2}-\text{NH}_2$	β -Phenylethylamine or 2-Phenylaminoethane	2-Phenylethanamine
$\text{C}_6\text{H}_5-\overset{\gamma}{\text{CH}_2}-\overset{\beta}{\text{CH}_2}-\overset{\alpha}{\text{CH}_2}-\text{NH}_2$	γ -Phenylpropylamine or 1-Amino-3-phenylpropane	3-Phenylpropan-1-amine

PREPARATION

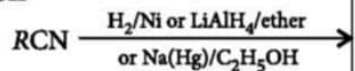
Reduction of nitro compounds



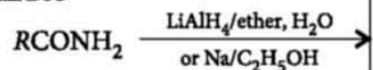
Hofmann's ammonolysis method



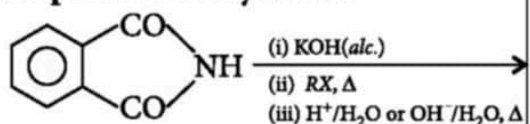
Mendius reduction



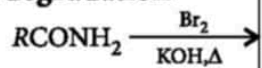
Reduction of amides



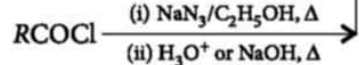
Gabriel phthalimide synthesis



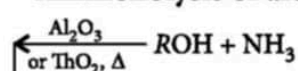
Hoffmann's bromamide degradation



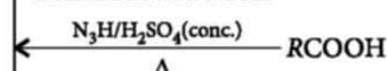
Curtius reaction



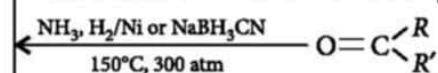
Ammonolysis of alcohols



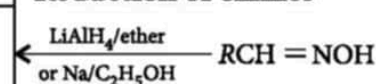
Schmidt reaction



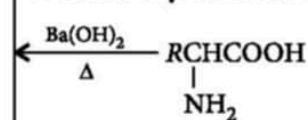
Reductive amination of aldehydes or ketones



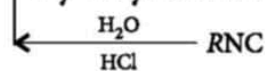
Reduction of oximes



Decarboxylation of α -amino acids



Hydrolysis of isocyanates



R-NH₂

PHYSICAL PROPERTIES

- **Physical state** : Lower aliphatic amines are gases with fishy odour.
 - Primary amines with C₃ or more are liquids and the higher ones are solids.
 - Lower aromatic amines are liquids with characteristic unpleasant odour but higher ones are solids which are odourless.
- **Colour** : Pure arylamines are colourless but get colour due to atmospheric oxidation.
- **Solubility** : Amines are soluble in water as they can form hydrogen bonds with water.
 - As the size of alkyl group increases, solubility decreases.
 - Higher amines are insoluble in water but soluble in organic solvents.

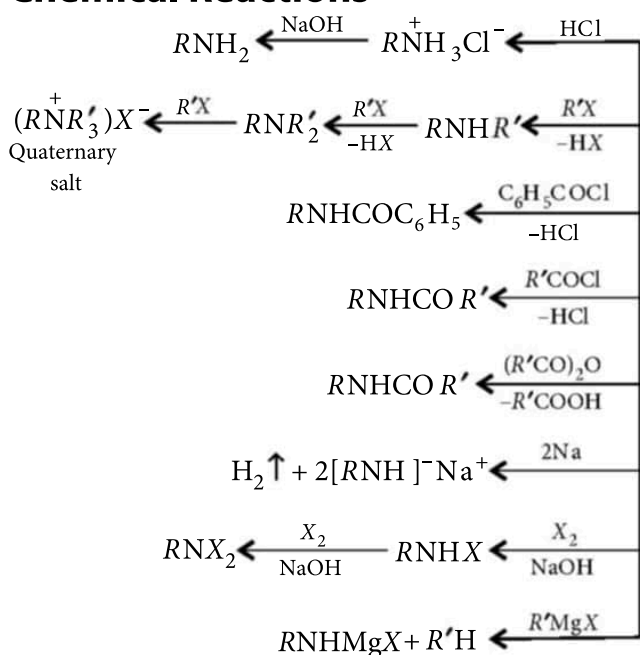
- Aromatic amines are insoluble in water. They are soluble in organic solvents such as benzene, ether and alcohol.
- **Boiling point** : Amines being polar, form intermolecular hydrogen bonds and exist as associated molecules, therefore, show higher boiling points than hydrocarbons of comparable molecular masses.
 - The intermolecular association is more in primary amines than in secondary amines due to presence of two hydrogen atoms. Therefore, the order of boiling points of isomeric amines is $1^\circ > 2^\circ > 3^\circ$.

CHEMICAL PROPERTIES

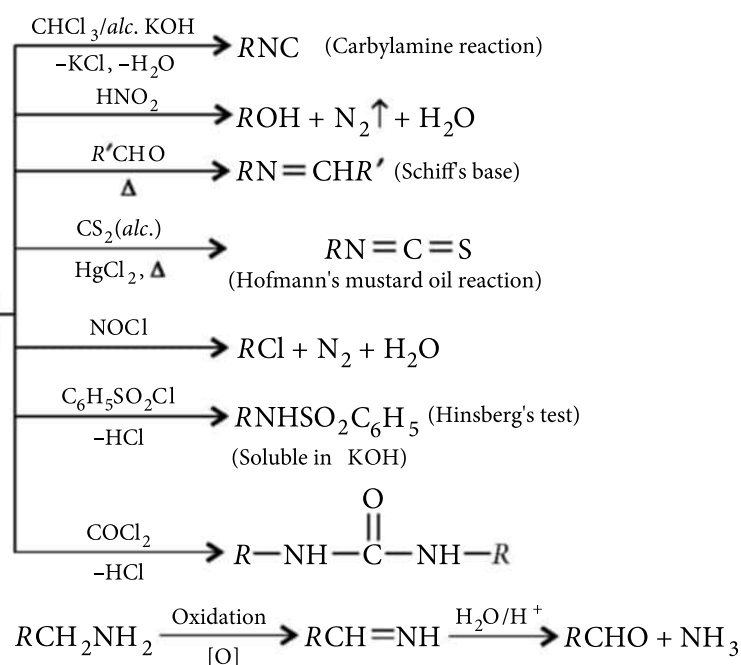
Basic Character of Amines

- Amines are basic in nature due to the presence of lone pair of electrons on nitrogen atom.

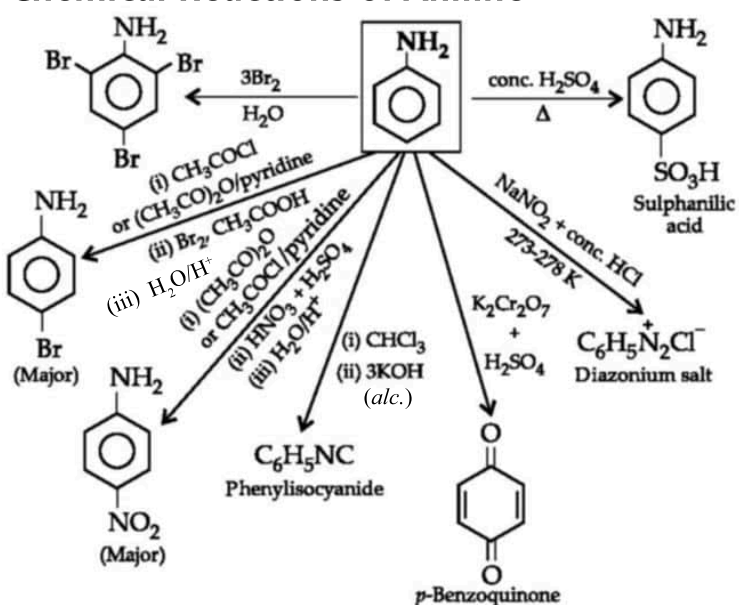
Chemical Reactions



- Aliphatic amines are stronger bases than ammonia due to +I effect of alkyl groups present in amines.
- Aromatic amines are weaker bases than ammonia due to delocalisation of electrons in benzene ring.
- Besides inductive effect, there are other effects like steric effect, solvation effect, resonance effect which effect the basic strength of amines.
- In gaseous phase, the order of basicity of amines is $3^\circ \text{ amine} > 2^\circ \text{ amine} > 1^\circ \text{ amine} > \text{NH}_3$.
- In aqueous phase, despite of inductive effect, solvation effect and steric hindrance also play an important role. Thus, the order of basicity of amines is $(\text{C}_2\text{H}_5)_2\text{NH} > (\text{C}_2\text{H}_5)_3\text{N} > \text{C}_2\text{H}_5\text{NH}_2 > \text{NH}_3$ and $(\text{CH}_3)_2\text{NH} > \text{CH}_3\text{NH}_2 > (\text{CH}_3)_3\text{N} > \text{NH}_3$
- Greater the value of K_b or smaller the value of $\text{p}K_b$, stronger is the base.

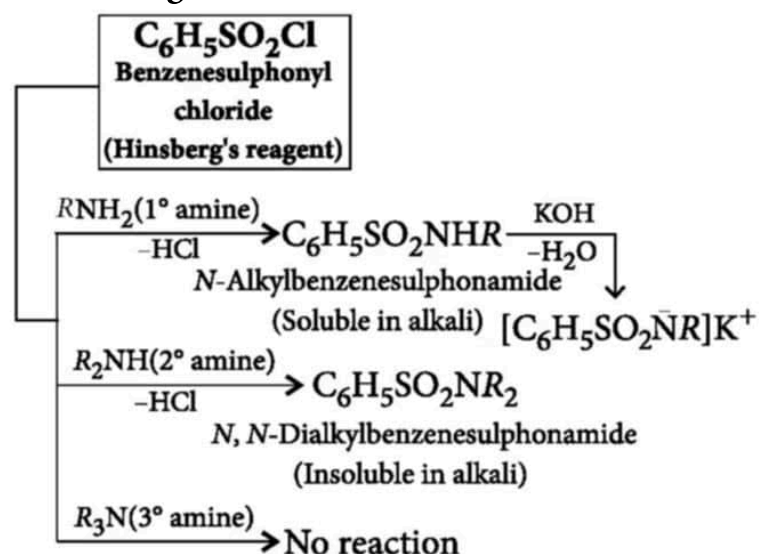


Chemical Reactions of Aniline



Distinction Between 1°, 2° and 3° Amines

- **Hinsberg's test** :



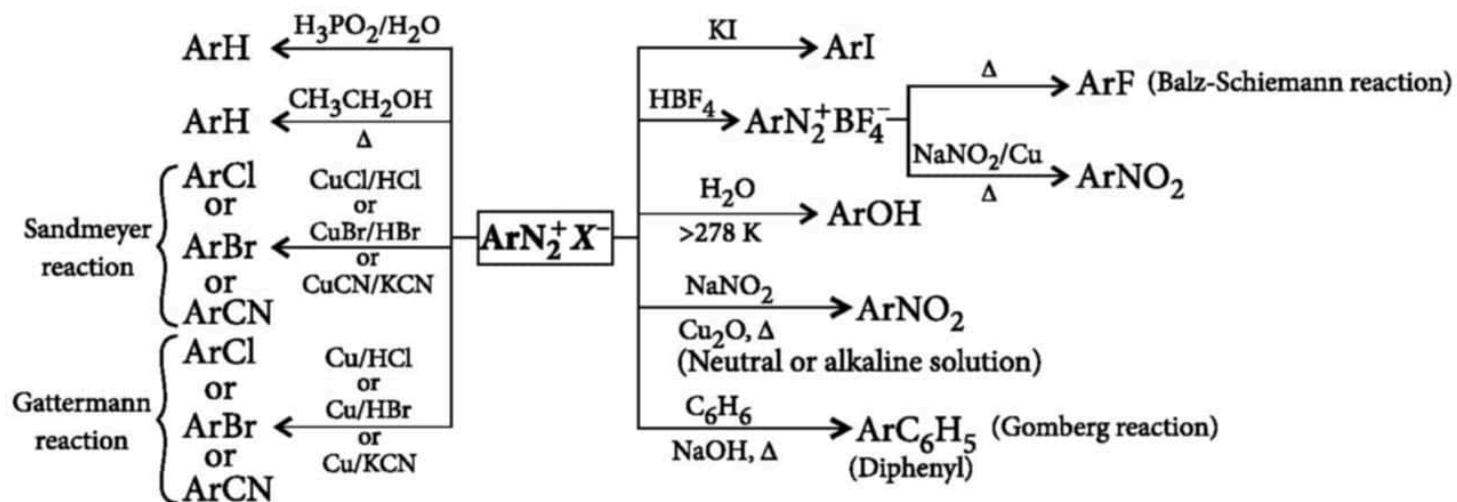
- **Carbylamine test** : Only **aliphatic** and **aromatic primary amines** give this test.
- **Azo dye test** : Only primary aromatic amines will give orange coloured azo dyes.
- **Nitrous acid test** : On reaction with nitrous acid at 0-5 °C, aromatic primary amines give benzenediazonium salts, aliphatic primary amines give alcohols with the evolution of nitrogen gas, both secondary aliphatic and aromatic amines gives yellow oily compounds called *N*-nitrosamines and tertiary aliphatic amines gives water soluble nitrite salts. Aromatic tertiary amines gives green coloured *p*-nitroso-*N,N*-dialkylamines.

DIAZONIUM SALTS

- Arene diazonium salts have general formula ArN_2^+X^- where Ar stands for aryl group and X^- may be any an ion such as Cl^- , Br^- , NO_3^- , HSO_4^- , BF_4^- etc.

Chemical Reactions

- Reactions involving displacement of nitrogen (diazo group) :

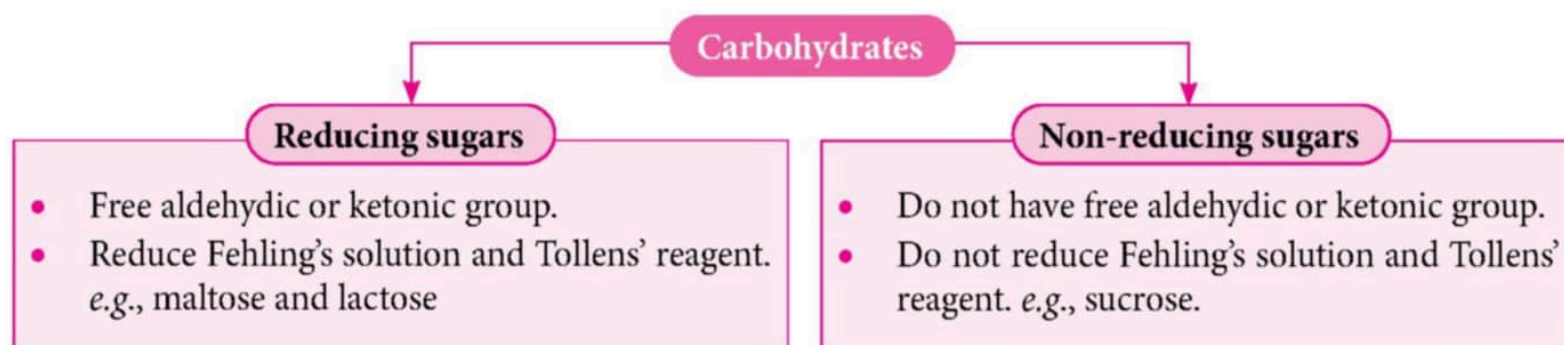


BIOMOLECULES

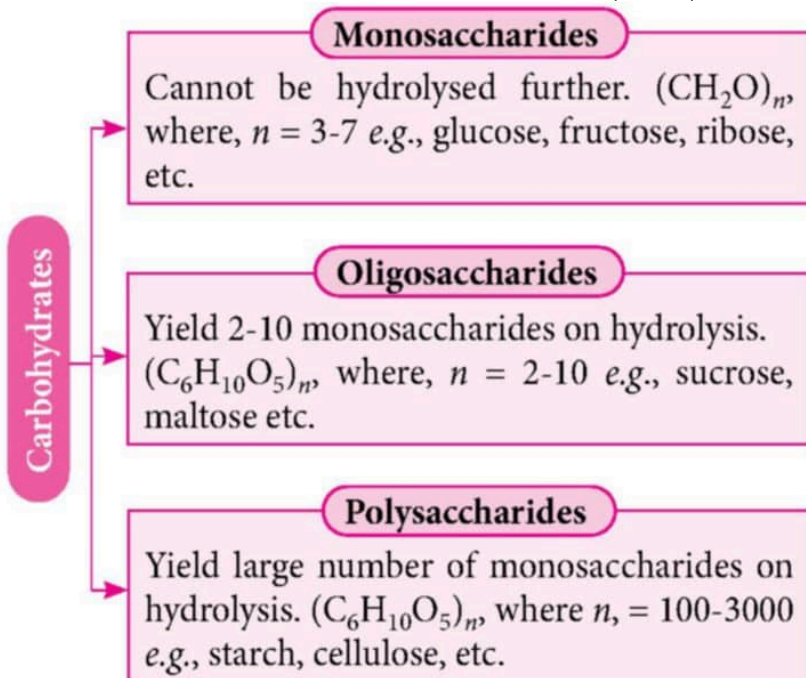
CARBOHYDRATES

- **General formula** : $\text{C}_x(\text{H}_2\text{O})_y$
- **Sugars or saccharides** : They are optically active polyhydroxy aldehydes or ketones.

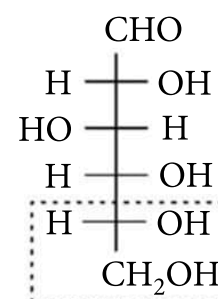
- **Classification** : Carbohydrates are classified as either reducing or non-reducing sugars :



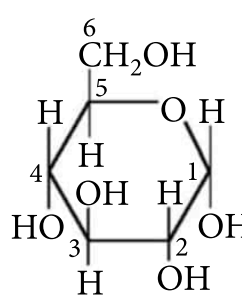
On the basis of their behaviour towards hydrolysis :



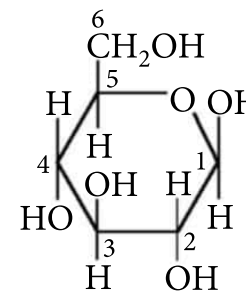
> **Structure :**



Fischer projection of *D*-(+)-Glucose



α -*D*-(+)-Glucopyranose



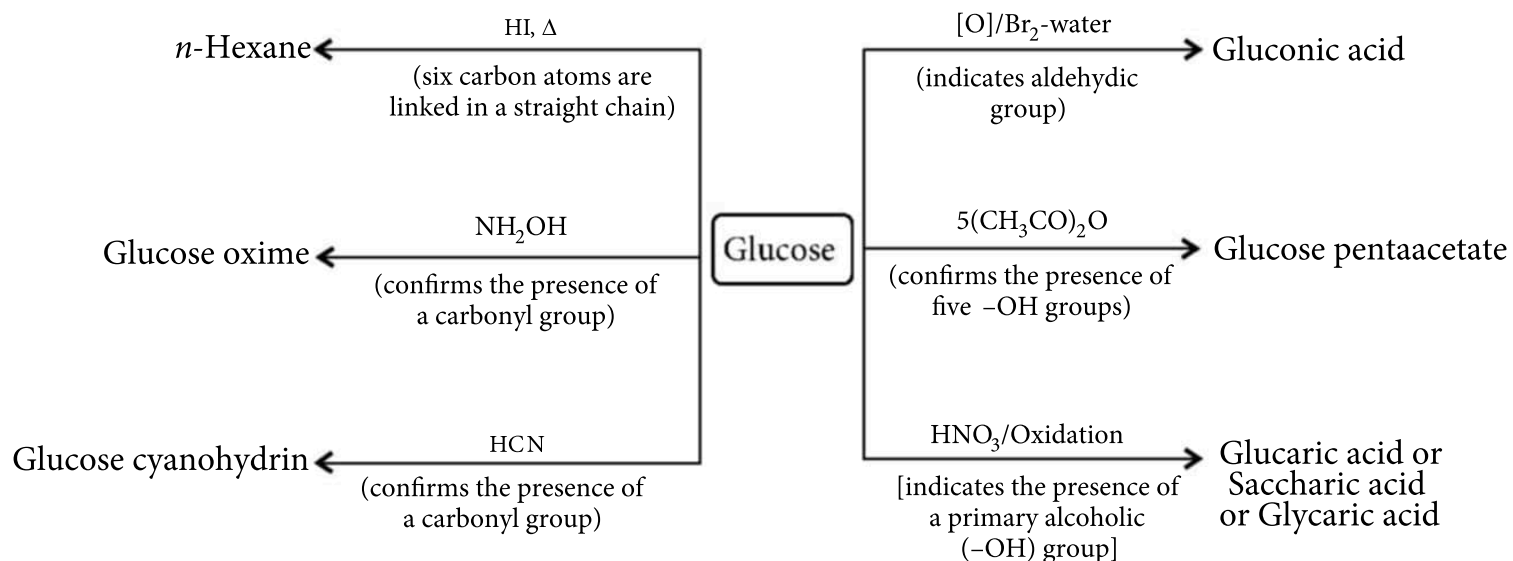
β -*D*-(+)-Glucopyranose

(Haworth structure)

Monosaccharides

- **Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$)** : Glucose is an aldohexose as it contains six carbon atoms with an aldehydic group.

> **Evidences of Open Chain Structure of Glucose**

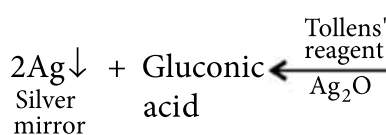
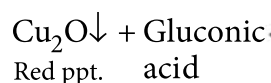


Chemical Properties

Reduction



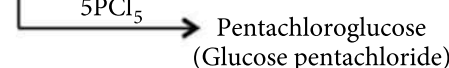
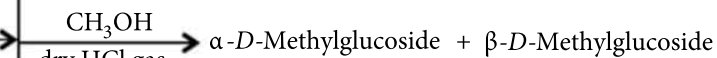
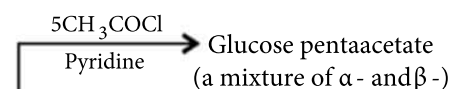
Oxidation



Due to -CHO group

Glucose

Due to -OH group



Disaccharides and Polysaccharides

Carbohydrate	Hydrolysis products	Linkage	Reducing property
Sucrose (Disaccharide)	α -D-Glucose and β -D-Fructose	C-1 (Glucose) and C-2(Fructose)	Non-reducing
Maltose (Disaccharide)	α -D-Glucose	C-1 (Glucose) and C-4 (Glucose)	Reducing
Lactose (Disaccharide)	β -D-Galactose and β -D-Glucose	C-1 (Galactose) and C-4 (Glucose)	Reducing
Starch (Polysaccharide)	Amylose and Amylopectin	Amylose (C-1 and C-4 glycosidic linkage between α -D-Glucose). Amylopectin (C-1 and C-4 linkage between α -D-Glucose and branching occurs by C-1 and C-6 linkage)	Non-reducing
Cellulose (Polysaccharide)	β -D-Glucose	C-1(Glucose) and C-4(Glucose)	Non-reducing
Glycogen (Polysaccharide)	α -D-Glucose	C-1 (Glucose) and C-4(Glucose)	Non-reducing

Tests of Carbohydrates

With little conc. H_2SO_4	Charred residue of carbon
With dilute NaOH	First yellow and then brown
Molisch test : Two drops of alcoholic solution of α -naphthol + 2 mL of glucose + conc. H_2SO_4 along the sides of test tube (general test for carbohydrates)	Violet ring at the junction of two liquids
Silver mirror test : With Tollens' reagent	Silver mirror appears
With Fehling's solution	Red ppt. of Cu_2O

PROTEINS

Proteins are fundamental basis of structure and functions of life. They are high molecular mass complex biopolymers of α -amino acids. They occur naturally in milk, cheese, pulses, peanuts, fish, meat, etc.

Proteins $\xrightarrow{\text{Hydrolysis}}$ Peptides $\xrightarrow{\text{Hydrolysis}}$ α -Amino acids.

Classification of Proteins

Fibrous proteins

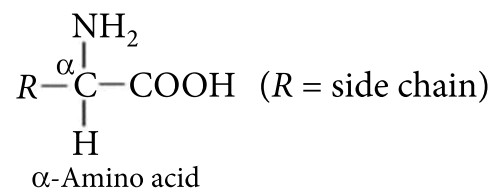
In fibrous proteins, polypeptide chains are parallel and are held together by hydrogen and disulphide bonds. These are insoluble in water, e.g., keratin and myosin.

Globular proteins

Globular proteins results when the polypeptide chains coil around to give three dimensional spherical shape. These are soluble in water, e.g., insulin and albumins.

α -Amino Acids

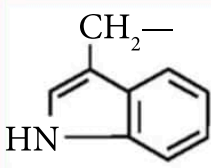
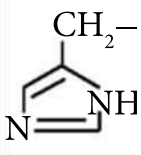
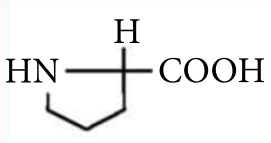
Amino acids contain amino ($-NH_2$) and carboxyl ($-COOH$) as functional groups. They are classified as α -, β -, γ -, etc. amino acids depending on the relative position of $-NH_2$ group w.r.t $-COOH$ group.



There are about 20 amino acids which make up the bioproteins. Out of these 10 amino acids (**non-essential**) are synthesised by our bodies and rest are essential in the diet (**essential amino acids**) and supplied to our bodies by food which we take because they cannot be synthesised in the body.

	Name of amino acid	Structure of R	Three letter symbol
1	Glycine	-H	Gly
2	Alanine	-CH ₃	Ala

3	Valine*	$-\text{CH}(\text{CH}_3)_2$	Val
4	Leucine*	$-\text{CH}_2\text{CH}(\text{CH}_3)_2$	Leu
5	Isoleucine*	$-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2\text{CH}_3$	Ile
6	Arginine*	$-(\text{CH}_2)_3\text{NH}-\underset{\text{NH}}{\text{C}}-\text{NH}_2$	Arg
7	Lysine*	$-(\text{CH}_2)_4\text{NH}_2$	Lys
8	Glutamic acid	$-\text{CH}_2\text{CH}_2\text{COOH}$	Glu
9	Aspartic acid	$-\text{CH}_2\text{COOH}$	Asp
10	Glutamine	$-\text{CH}_2\text{CH}_2\text{CONH}_2$	Gln
11	Asparagine	$-\text{CH}_2\text{CONH}_2$	Asn
12	Threonine*	$-\text{CHOH}.\text{CH}_3$	Thr
13	Serine	$-\text{CH}_2\text{OH}$	Ser

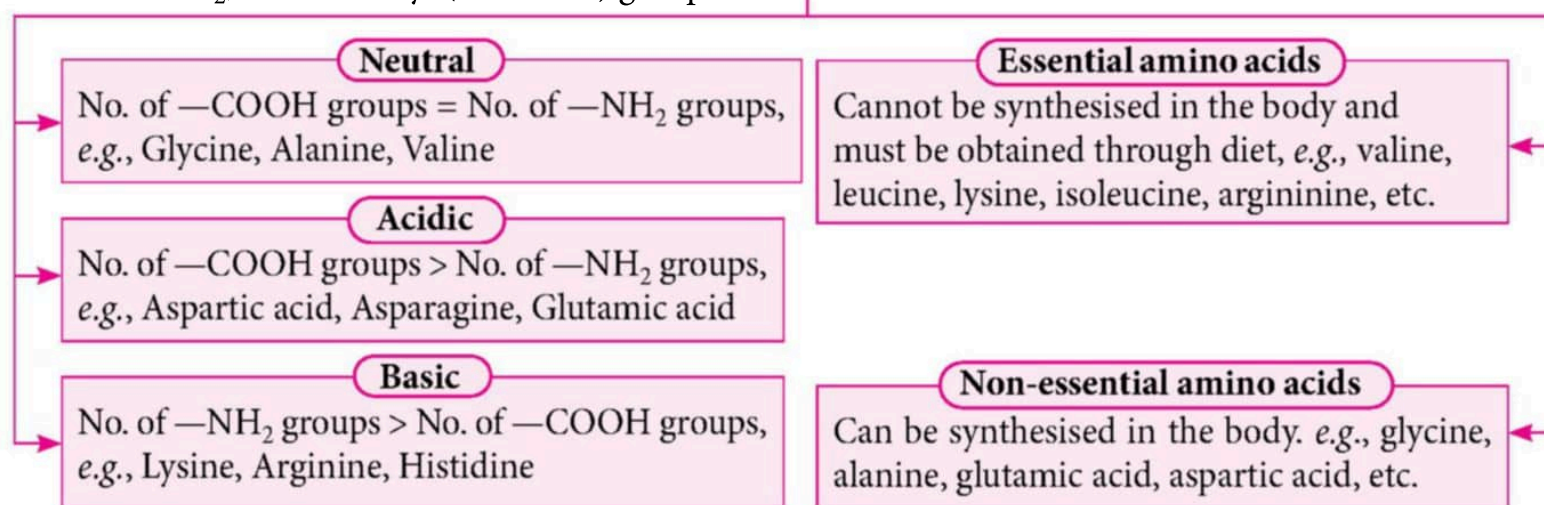
14	Cysteine	$-\text{CH}_2\text{SH}$	Cys
15	Methionine*	$-\text{CH}_2\text{CH}_2\text{SCH}_3$	Met
16	Phenylalanine*	$-\text{CH}_2\text{C}_6\text{H}_5$	Phe
17	Tyrosine	$-\text{CH}_2\text{C}_6\text{H}_4\text{OH}(p)$	Tyr
18	Tryptophan*		Trp
19	Histidine*		His
20	Proline		Pro

*Essential amino acids

Classification of amino acids

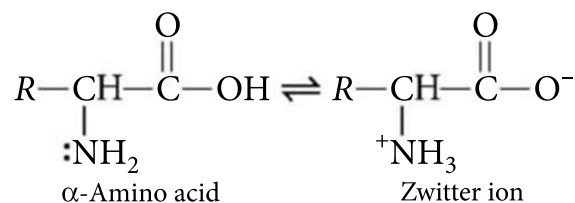
Depending upon the relative number of amino ($-\text{NH}_2$) and carboxyl ($-\text{COOH}$) groups

On the basis of their synthesis

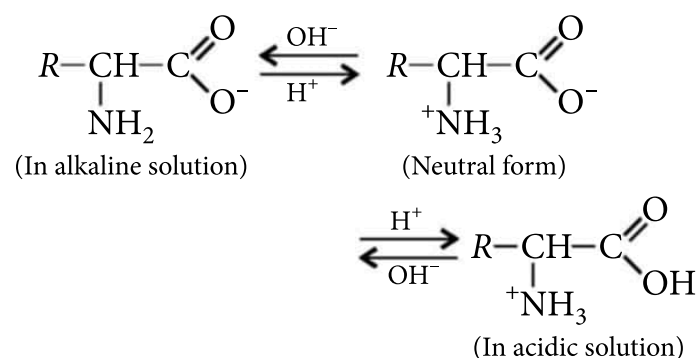


Properties

- In aqueous solution, the carboxylic group can lose a proton and amino group can accept a proton giving rise to a dipolar ion known as *zwitter ion*. This is overall neutral but contains both positive and negative charges.



Since, these form salts with acids as well as with bases, their chemical reactions are similar to primary amines and carboxylic acids.



- Isoelectric point** : The pH at which dipolar ion (zwitter ion) exists as neutral ion, i.e., +ve and -ve charge is equal and it does not migrate to either electrode, is called *isoelectric point*. The amino acids have least solubility in water at isoelectric point which helps in their separation.

Structure of Proteins

- **Primary Structure** : Primary structure refers to the number, nature and sequence of amino acids present in a protein molecule.
- **Secondary Structure** : Secondary structure refers to the conformation which the polypeptide chains assume as a result of H-bonding. There are two types of secondary structures :
 - **α -Helix** : In this type of protein, polypeptide chains coil up to form a spiral-like structure. There occurs extensive intermolecular hydrogen bonding between two adjacent turns so that the helix is rigid.
 - **β -Flat sheet or β -pleated sheet structure** : In this structure polypeptide chains are extended and held together by intermolecular hydrogen bond.
- **Tertiary Structure** : Tertiary structure refers to the three dimensional structure of proteins. It explains the way, the molecule folds to produce a specific shape.
- **Quaternary Structure** : It describes the arrangement and ways in which different sub units are held together.

Denaturation of Proteins

- When a protein in its native form, is subjected to physical changes like change in temperature or chemical changes like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called *denaturation of protein*.
- The denaturation causes change in secondary and tertiary structures but primary structure remains intact *e.g.*, coagulation of egg white on boiling, curdling of milk, formation of cheese, when an acid is added to milk.

VITAMINS

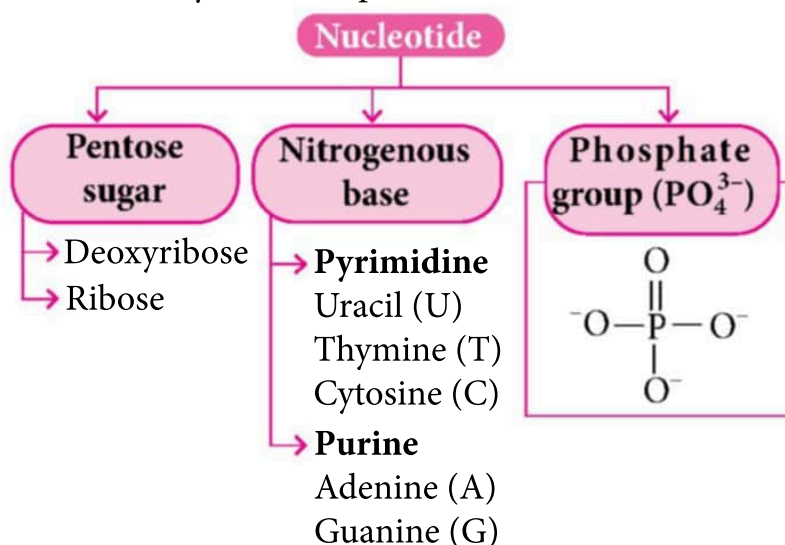
- Vitamins are the organic compounds required in small amounts in our diet but their deficiency causes specific diseases. Most of the vitamins cannot be synthesised in our body but plants can synthesise almost all of them. Hence, vitamins are considered as essential food factors. Vitamins are designated by alphabets A, B, C, D, etc. Some of them are further named as subgroups. *e.g.* B₁, B₂, B₆, B₁₂, etc.

Classification

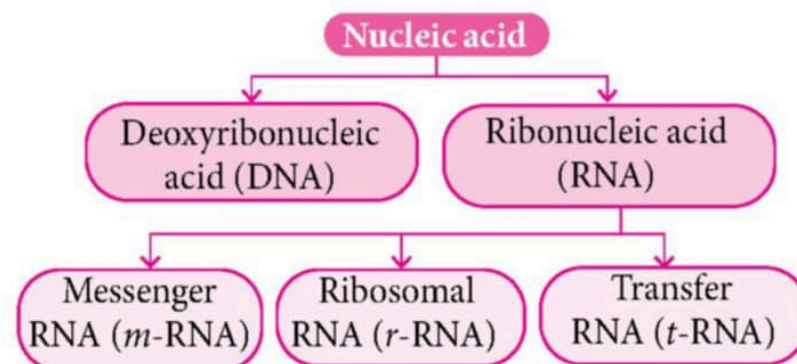
- **Water Soluble Vitamins** : Soluble in water, must be supplied regularly in diet as they are regularly excreted in urine (except vitamin B₁₂) *e.g.*, Vitamin– B₁, B₂, B₆, B₇, B₁₂ and C.
- **Fat Soluble Vitamins** : Soluble in fat and oils, stored in liver and adipose tissues *e.g.*, Vitamin – A, D, E and K.
- Deficiency of more than one vitamin in the body causes avitaminosis while excess intake of vitamins (A and D) may cause hypervitaminosis.

NUCLEIC ACIDS

- Nucleic acids are the *polymers of nucleotides* present in nucleus of all living cells and play an important role in transmission of the hereditary characteristics and biosynthesis of proteins.



- **Types of nucleic acids :**



- **Chargaff's rule** : Amount of purine bases is always equal to that of pyrimidine bases. Purine base of one strand of DNA molecule pairs with pyrimidine base of the other strand. Adenine (A) pairs with thymine (T) through two H-bonds (A=T) and guanine (G) pairs with cytosine (C) through three H-bonds (G=C). In case of RNA, adenine (A) pairs with uracil (U), (A=U).

- **Replication** : It is the process by which a single DNA molecule produces two identical copies of itself.
- **Protein synthesis** : It occurs in two steps :
 - **Transcription** : It is the process of synthesis of RNA.
 - **Translation** : The synthesis of proteins occur in the cytoplasm of the cell. The *m*-RNA directs protein synthesis with the help of *r*-RNA and *t*-RNA.

ENZYMES

- Enzymes are essential biological catalysts which are needed to catalyse biochemical reactions. Almost all the enzymes are globular proteins. Enzymes are very specific for a particular reaction and for a particular substrate.
- **Some Common Enzymes :**

Enzymes	Reactions which is catalysed
Amylase	Starch $\longrightarrow n \times$ Glucose
Maltase	Maltose $\longrightarrow 2 \times$ Glucose

Lactase	Lactose \longrightarrow Glucose + galactose
Invertase	Sucrose \longrightarrow Glucose + fructose
Pepsin	Proteins \longrightarrow Amino acid
Trypsin	Proteins \longrightarrow Amino acid
Nucleases	DNA, RNA \longrightarrow Nucleotides
Urease	Urea \longrightarrow $\text{NH}_3 + \text{CO}_2$
Carbonic anhydrase	$\text{H}_2\text{CO}_3 \longrightarrow \text{CO}_2 + \text{H}_2\text{O}$

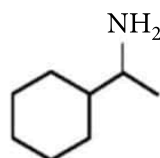
HORMONES

- **Hormones** : They are the molecules that act as intercellular messengers and are poured directly in the blood stream by endocrine glands.
- **Types of hormones :**
 - **Steroids** : Estrogens and androgens
 - **Polypeptides** : Insulin and endorphins
 - **Amino acid derivatives** : Epinephrine and norepinephrine.

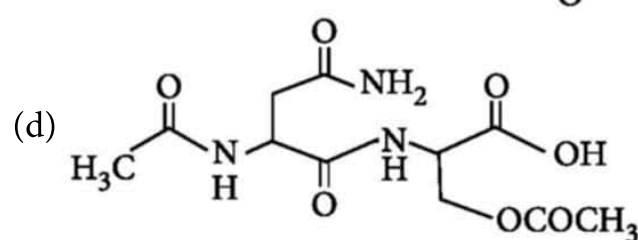
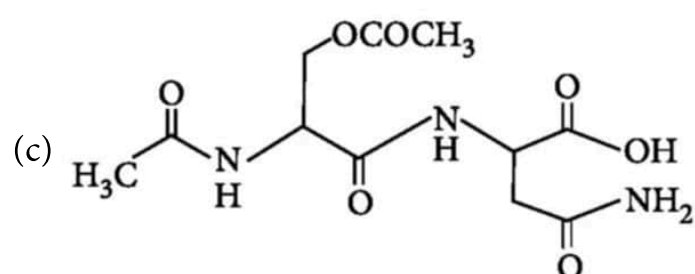
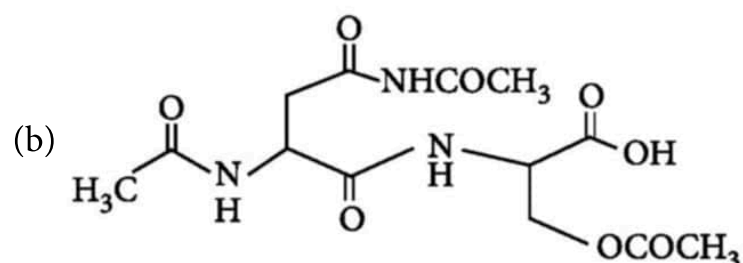
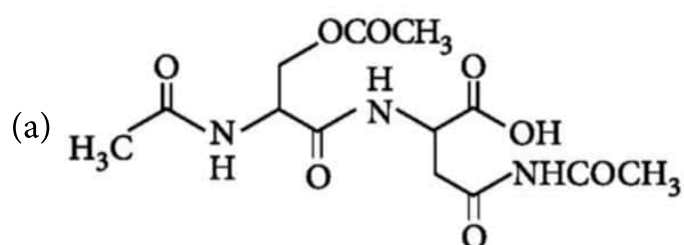
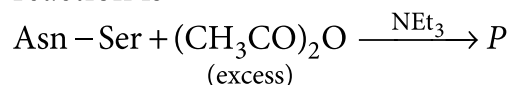
WRAP it up!

MCQs TYPE QUESTIONS

1. The IUPAC name of the following compound is



- (a) 2-cyclohexyl-2-methylethanamine
 (b) 1-cyclohexyl-1-methylethanamine
 (c) 1-(1-methylethanamine) cyclohexane
 (d) 1-cyclohexylethanamine.
2. The correct structure of product 'P' in the following reaction is



3. **Statement-I** : Ketoses give Seliwanoff's test faster than aldoses.

Statement-II : Ketoses undergo β -elimination followed by formation of furfural.

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

4. Amine is not formed in which of the following?

- I. hydrolysis of RCN
 II. reduction of RCN
 III. hydrolysis of RNC
 IV. hydrolysis of $RCONH_2$

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

5. Which one of the following statements is not true regarding (+)-lactose?

- (a) (+)-Lactose, $C_{12}H_{22}O_{11}$ contains 8 $-OH$ groups.
 (b) On hydrolysis (+)-lactose gives equal amount of $D-(+)$ glucose and $D-(+)$ -galactose.
 (c) (+)-Lactose is a β -glycoside formed by the union of molecule of $D-(+)$ -glucose and a molecule of $D-(+)$ -galactose.
 (d) (+)-Lactose is a non-reducing sugar.

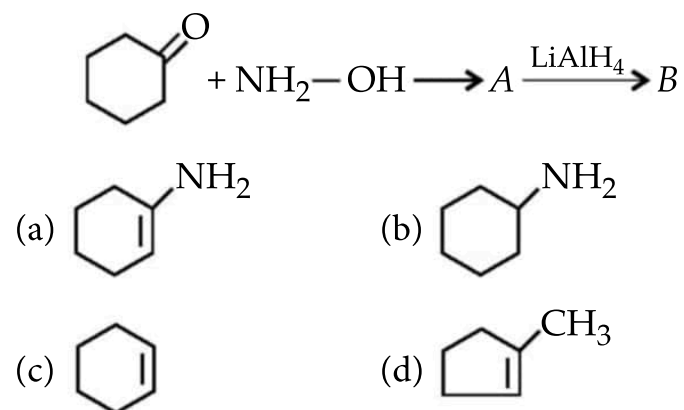
6. Among the following compounds, a primary amine is

- (a) isobutylamine (b) n -butylamine
 (c) t -butylamine (d) all of these.

7. Which of the following tests cannot be used for identifying amino acids?

- (a) Biuret test (b) Ninhydrin test
 (c) Barfoed test (d) Xanthoproteic test

8. Product (B) of the following reaction is



9. Match List I with List II.

List I (Enzymatic reaction)		List II (Enzyme)	
A.	Sucrose \rightarrow Glucose and Fructose	I.	Zymase
B.	Glucose \rightarrow Ethyl alcohol and CO_2	II.	Pepsin
C.	Starch \rightarrow Maltose	III.	Invertase
D.	Proteins \rightarrow Amino acids	IV.	Diastase

Choose the correct answer from the options given below :

- (a) A-I, B-II, C-IV, D-III (b) A-I, B-IV, C-III, D-II
 (c) A-III, B-I, C-II, D-IV (d) A-III, B-I, C-IV, D-II

10. Which of the following does not give a sulphur compound with a 1° amine?

- (a) Hinsberg reaction
 (b) Mustard oil reaction
 (c) Schotten-Baumann reaction
 (d) Conc. H_2SO_4

11. The conversion of maltose into glucose is possible by the enzyme

- (a) zymase (b) lactase
 (c) maltase (d) diastase.

12. Given below are two statements one is labelled as Assertion and other is labelled as Reason.

Assertion : Gabriel phthalimide synthesis cannot be used to prepare aromatic primary amines.

Reason : Aryl halides do not undergo nucleophilic substitution reaction.

In the light of the above statements, choose the correct answer from the options given below.

- (a) Assertion is true but reason is false.
 (b) Assertion is false but reason is true.
 (c) Both assertion and reason are true and reason is the correct explanation of assertion.
 (d) Both assertion and reason are true but reason is not the correct explanation of assertion.

13. On boiling the egg, what structural changes are taking place in the egg white?

- (a) The colour of the egg changes from colourless to white.
 (b) 2° and 3° structures are destroyed but 1° structure remains intact.
 (c) 1° , 2° and 3° structures of egg are destroyed.
 (d) A reversible change takes place which can be reversed by decreasing the temperature.

14. Which of the following is least soluble in water at 298 K?

- (a) CH_3NH_2 (b) $(\text{CH}_3)_3\text{N}$
(c) $(\text{CH}_3)_2\text{NH}$ (d) $\text{C}_6\text{H}_5\text{NH}_2$

15. Some statements are given below :

1. Glucose is pentahydroxy aldehyde.
2. Fructose is ketohexose and contains four chiral centers.
3. Polymer of glucose is starch.
4. Fatty acids are aliphatic saturated higher monocarboxylic acids.

Among the above, correct statement(s) is/are

- (a) 1 and 3 (b) 4 only
(c) 1, 3 and 4 (d) 1 and 4

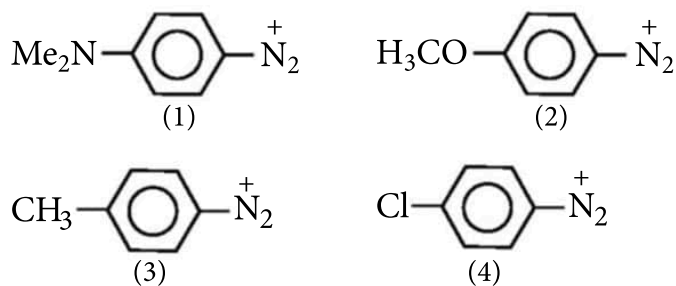
16. In which of the following sequence of reaction the end product does not exhibit tautomerism?

- (a) $\text{CH}_3\text{CH}_2\text{NH}_2 \xrightarrow{\text{NOCl}} \xrightarrow{\text{AgNO}_2}$
(b) $(\text{CH}_3)_2\text{CHNH}_2 \xrightarrow{\text{NOCl}} \xrightarrow{\text{AgNO}_2}$
(c) $(\text{CH}_3)_3\text{CNH}_2 \xrightarrow{\text{NOCl}} \xrightarrow{\text{AgNO}_2}$
(d) $\text{CH}_3\text{CH}(\text{NH}_2)\text{C}_2\text{H}_5 \xrightarrow{\text{NOCl}} \xrightarrow{\text{AgNO}_2}$

17. A nucleoside on hydrolysis gives

- (a) an aldopentose and a nitrogenous base
(b) an aldopentose and phosphoric acid
(c) an aldopentose, a nitrogenous base and phosphoric acid
(d) a nitrogenous base and phosphoric acid.

18. Consider the following ions :



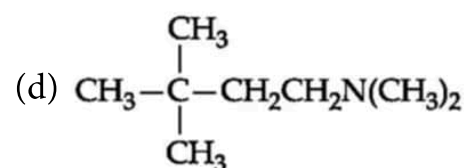
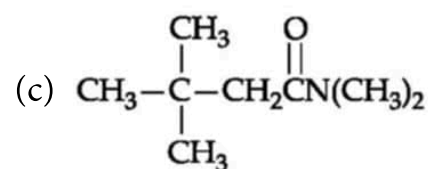
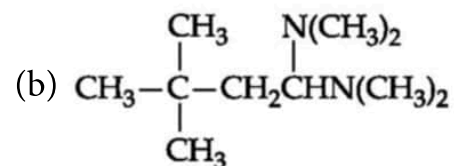
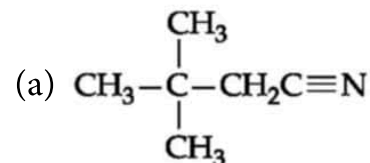
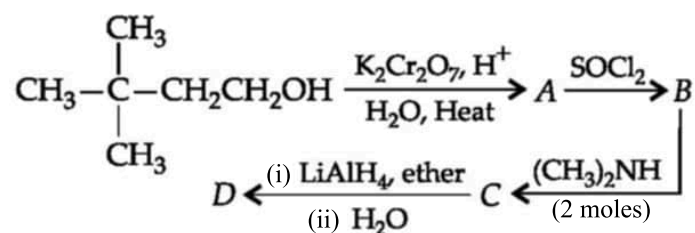
The reactivities of these ions in azo-coupling reactions (under similar conditions) will be in the order

- (a) $3 < 1 < 4 < 2$ (b) $1 < 4 < 2 < 3$
(c) $1 < 2 < 3 < 4$ (d) $3 < 1 < 2 < 4$

19. Two samples of DNA, A and B have melting points 340 K and 350 K respectively. This is because

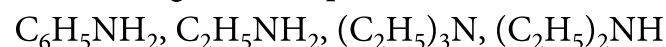
- (a) B has more GC content than A
(b) A has more GC content than B
(c) B has more AT content than A
(d) both have same AT content.

20. Identify product D in the following reaction sequence:



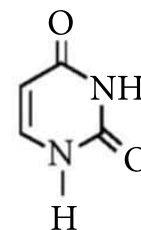
NUMERICAL VALUE TYPE QUESTIONS

21. How many of the following amines will show higher basic strength as compared to ammonia?



22. Maximum number of molecules of CH_3I that can react with a molecule of CH_3NH_2 is _____.

23. Uracil is a base present in RNA with the following structure. % of N in uracil is _____.



Given : Molar mass N = 14 g mol^{-1}

O = 16 g mol^{-1}

C = 12 g mol^{-1}

H = 1 g mol^{-1} .

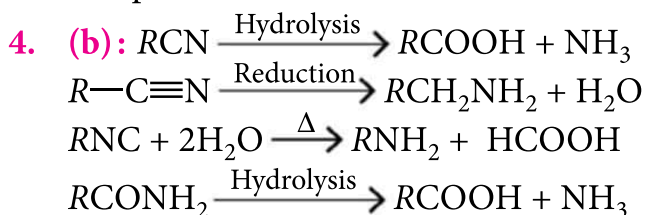
24. Acetaldehyde reacts with ethyl amine in presence of H_2/Ni . Nature of N in the final product is x° . The value of x is _____.

25. The number of tripeptides formed by three different amino acids is _____.

SOLUTIONS

1. (d) 2. (d)

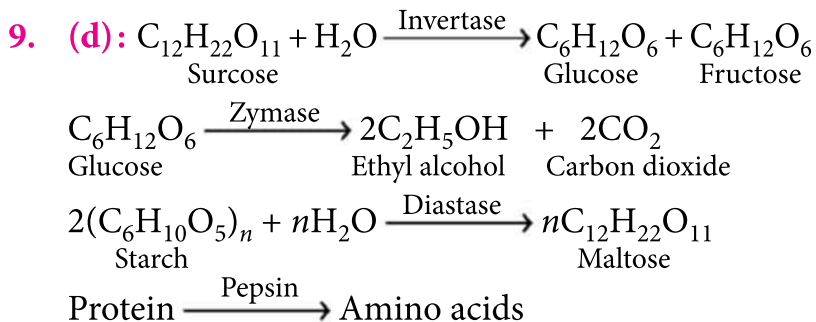
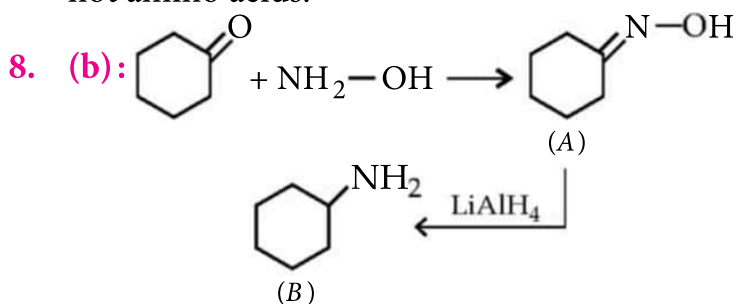
3. (c) : Seliwanoff's test is a differentiating test for ketose and aldose. Keto-hexose are more rapidly dehydrated to form 5-hydroxymethyl furfural, when heated in acidic medium which on condensation with resorcinol gives brown coloured complex.



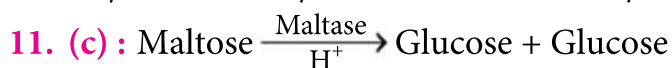
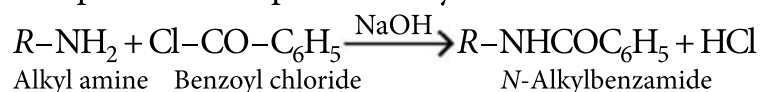
5. (d) : (+)-Lactose is a reducing sugar.

6. (d)

7. (c) : Barfoed test is used to detect the presence of monosaccharide (reducing sugars) in solutions, not amino acids.



10. (c) : In Schotten-Baumann reaction, a sulphur compound is not produced by a 1° amine.



12. (c) : Gabriel phthalimide is used for preparation of aliphatic primary amines. Aromatic amines cannot be prepared as aryl halides do not undergo nucleophilic substitution.

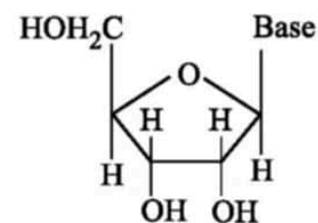
13. (b) : During denaturation of proteins, 2° and 3° structures are destroyed but primary structure remains intact.

14. (d) : Aromatic amines are insoluble in water. This is due to the larger hydrocarbon part which tends to retard the formation of H-bond.

15. (c)

16. (c) : In the reaction sequence of option (c), the end product is a 3° -nitro compound $(\text{CH}_3)_3\text{CNO}_2$. This compound does not have α -hydrogen and hence, tautomerism is not possible.

17. (a) : Nucleoside is a unit formed by the attachment of a base to an aldopentose sugar.

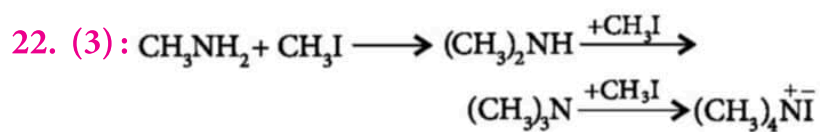


18. (c) : Electron releasing groups decrease the electrophilic character of $-\text{N}_2^+$.

19. (a) : Since, GC base pair having three H-bonds is more stable than AT base pair having two H-bonds. Therefore, DNA, B has, more GC content than DNA, A.

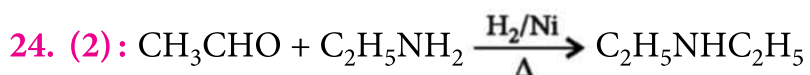
20. (d)

21. (3) : The order of basic strength in the aqueous phase is as follows :



23. (25) : Molecular mass of uracil

$$\begin{aligned}
 &= 14 \times n_{\text{N}} + 16 \times n_{\text{O}} + 12 \times n_{\text{C}} + 1 \times n_{\text{H}} \\
 &= 14 \times 2 + 16 \times 2 + 12 \times 4 + 1 \times 4 \\
 &= 28 + 32 + 48 + 4 = 112 \text{ g} \\
 \therefore \% \text{N} &= \frac{28}{112} \times 100 = 25\%
 \end{aligned}$$



\therefore The nature of N = 2° .

25. (6) : Since, each amino acid has one N-terminal end and one C-terminal end, therefore, three different amino acids will form $2 \times 3 = 6$ different tripeptides.



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CLASS-XII

CBSE

Warm-up!

Chapterwise practice questions for CBSE Exams as per the latest pattern and syllabus by CBSE for the academic session 2024-25.

Series-4

The *d*- and *f*-Block Elements | Coordination Compounds

General Instructions : Read the following instructions carefully and follow them :

- This question paper contains 33 questions. All questions are compulsory.
- This question paper is divided into five sections – Section A, B, C, D and E.
- Section A – questions number 1 to 16 are multiple choice type questions. Each question carries 1 mark.
- Section B – questions number 17 to 21 are very short answer type questions. Each question carries 2 marks.
- Section C – questions number 22 to 28 are short answer type questions. Each question carries 3 marks.
- Section D – questions number 29 and 30 are case-based questions. Each question carries 4 marks.
- Section E – questions number 31 to 33 are long answer type questions. Each question carries 5 marks.
- There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the sections except section A.
- Kindly note that there is a separate question paper for Visually Impaired candidates.
- Use of calculators is not allowed.

Time Allowed : 3 hours

Maximum Marks : 70

SECTION-A

Questions No. 1 to 16 are multiple choice type questions carrying 1 mark each.

- The number of $3d$ -electrons in Fe^{3+} ion is equal to that of
(a) s -electrons in Mg (b) p -electrons in Ne
(c) p -electrons in Cl (d) none of these.
- The IUPAC name of $\text{K}_3[\text{Ir}(\text{C}_2\text{O}_4)_3]$ is
(a) potassium trioxalatoiridium(III)
(b) potassium trioxalatoiridate(III)
(c) potassium *tris*(oxalato)iridium(III)
(d) potassium *tris*(oxalato)iridate(III).
- A metal which is 'not' affected by conc. H_2SO_4 , HNO_3 or alkalis forms a compound X. This compound X can be used to give a complex which finds its application for toning in photography. The metal is
(a) Au (b) Ag
(c) Hg (d) Cu
- CrO_3 dissolves in aqueous NaOH to give
(a) CrO_4^{2-} (b) $\text{Cr}(\text{OH})_3$
(c) $\text{Cr}_2\text{O}_7^{2-}$ (d) $\text{Cr}(\text{OH})_2$
- Among the following transition metal ions, the one where all metal ions have $3d^2$ electronic configuration is
(a) Ti^{3+} , V^{2+} , Cr^{3+} , Mn^{4+}
(b) Ti^+ , V^{4+} , Cr^{6+} , Mn^{7+}
(c) Ti^{2+} , V^{3+} , Cr^{2+} , Mn^{3+}
(d) Ti^{2+} , V^{3+} , Cr^{4+} , Mn^{5+}
- Which of the following compounds shows optical isomerism?
(a) $[\text{Cu}(\text{NH}_3)_4]^{2+}$ (b) $[\text{ZnCl}_4]^{2-}$
(c) $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$ (d) $[\text{Co}(\text{CN})_6]^{3-}$
- When MnO_2 is fused with KOH in the presence of air, a coloured compound is formed, the product and its colour is
(a) K_2MnO_4 , dark green (b) KMnO_4 , purple
(c) Mn_2O_3 , brown (d) Mn_3O_4 , black.

8. Low spin complex of d^6 -cation in an octahedral field will have the following energy (Δ_o = crystal field splitting energy in an octahedral field, P = electron pairing energy)

(a) $\frac{-12}{5}\Delta_o + P$ (b) $\frac{-12}{5}\Delta_o + 3P$
 (c) $\frac{-2}{5}\Delta_o + 2P$ (d) $\frac{-2}{5}\Delta_o + P$

9. Select the correct decreasing order of ionic character.

- (a) $\text{Sm}(\text{OH})_3 > \text{Gd}(\text{OH})_3 > \text{Tb}(\text{OH})_3 > \text{Lu}(\text{OH})_3$
 (b) $\text{Tb}(\text{OH})_3 > \text{Gd}(\text{OH})_3 > \text{Lu}(\text{OH})_3 > \text{Sm}(\text{OH})_3$
 (c) $\text{Lu}(\text{OH})_3 > \text{Sm}(\text{OH})_3 > \text{Gd}(\text{OH})_3 > \text{Tb}(\text{OH})_3$
 (d) $\text{Tb}(\text{OH})_3 > \text{Sm}(\text{OH})_3 > \text{Gd}(\text{OH})_3 > \text{Lu}(\text{OH})_3$

10. In the coordination compound, $\text{K}_4[\text{Ni}(\text{CN})_4]$, the oxidation state of nickel is

- (a) -1 (b) 0 (c) +1 (d) +2

11. Select the transition metal oxides which are amphoteric in nature.

- (a) VO , TiO , Cu_2O (b) Cr_2O_3 , NiO , FeO
 (c) Fe_3O_4 , Cr_2O_3 , MnO_2 (d) V_2O_5 , CrO_3 , Ti_2O_3

12. Match the lists I and II and pick the correct matching from the codes given below :

	List I		List II
(A)	$[\text{Ag}(\text{CN})_2]^-$	1.	Square planar and 1.73 B.M.
(B)	$[\text{Cu}(\text{CN})_4]^{3-}$	2.	Linear and zero
(C)	$[\text{Cu}(\text{CN})_6]^{4-}$	3.	Octahedral and zero
(D)	$[\text{Cu}(\text{NH}_3)_4]^{2+}$	4.	Tetrahedral and zero
(E)	$[\text{Fe}(\text{CN})_6]^{4-}$	5.	Octahedral and 1.73 B.M.

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

For questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

- (c) Assertion (A) is true, but Reason (R) is false.

- (d) Assertion (A) is false, but Reason (R) is true.

13. **Assertion (A)** : $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ gives white precipitate with barium chloride.

Reason (R) : The complex dissociates in the solution to give Br^- and SO_4^{2-} .

14. **Assertion (A)** : In transition elements, radii of $5d$ series are virtually the same as those of the corresponding members of $4d$ series.

Reason (R) : The filling of $4f$ orbitals before $5d$ orbitals results in regular decrease in atomic radii.

15. **Assertion (A)** : The metal-carbon bond in metal carbonyls possesses both σ and π characters.

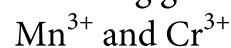
Reason (R) : The metal to ligand bonding creates a synergic effect which strengthens the bond between CO and the metal.

16. **Assertion (A)** : KMnO_4 acts as an oxidising agent in acidic, basic or neutral medium.

Reason (R) : KMnO_4 oxidises ferrous sulphate to ferric sulphate.

SECTION-B

17. Calculate the number of unpaired electrons in the following gaseous ions :



(Atomic number of Cr = 24, Mn = 25)

Which one of them is most stable in aqueous solution and why?

18. What is the difference between a complex and a double salt?

OR

When a coordination compound $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ is mixed with AgNO_3 , 2 moles of AgCl are precipitated per mole of the compound. Write structural formula of the complex.

19. State with balanced equation what happens when :

(a) Potassium permanganate is added to a hot solution of manganous sulphate.

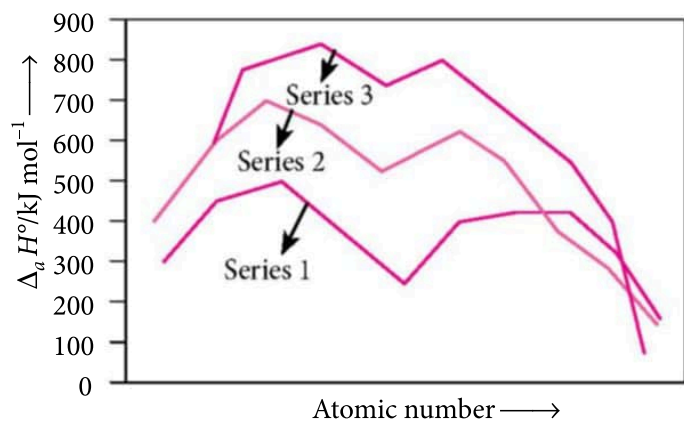
(b) Na_2CO_3 is added to a solution of copper sulphate.

20. How many stereoisomers of compound $[\text{CrCl}_2(\text{ox})_2]^{3-}$ are possible?

21. Give reasons for the following :
- Of the d^4 species, Cr^{2+} is strongly reducing while Mn^{3+} is strongly oxidising.
 - The d^1 configuration is very unstable in ions.

SECTION-C

22. Answer the following questions on the basis of the figure given below :



- Which element in 3d series has lowest enthalpy of atomisation?
 - Why do metals of the second and third series have greater enthalpies of atomisation?
 - Why are enthalpies of atomisation of transition metals quite high?
23. Name the type of isomerism exhibited by the following compounds : **(any three)**
- $[\text{Cr}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$ and $[\text{Cr}(\text{NH}_3)_4(\text{CN})_2][\text{Cr}(\text{NH}_3)_2(\text{CN})_4]$
 - $[\text{Co}(\text{py})_2(\text{H}_2\text{O})_2\text{Cl}_2]\text{Cl}$ and $[\text{Co}(\text{py})_2(\text{H}_2\text{O})\text{Cl}_3]\text{H}_2\text{O}$
 - $[\text{Pt}(\text{NH}_3)_4\text{Br}_2]\text{Cl}_2$ and $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Br}_2$
 - $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$ and $[\text{Co}(\text{NH}_3)_5\text{ONO}]\text{Cl}_2$
24. Give reasons for the following :
- Actinoids show irregularities in their electronic configurations.
 - Actinoids exhibit a greater range of oxidation states than lanthanoids.
25. Explain the following :
- Anhydrous CuSO_4 is white while hydrated CuSO_4 is blue in colour.
 - $[\text{Ti}(\text{H}_2\text{O})_6]\text{Cl}_3$ is violet in colour but becomes colourless on heating.
26. Explain the following observations :
- Many of the transition elements are known to form interstitial compounds.
 - There is a general increase in density from titanium ($Z = 22$) to copper ($Z = 29$).

SECTION-D

The following questions are case-based questions. Read the case carefully and answer the questions that follow.

29. Potassium dichromate acts as a strong oxidising agent in acidic medium. When heated with a metal chloride and conc. sulphuric acid, it gives orange red fumes. On passing these fumes through a sodium hydroxide, it gives a yellow solution of Na_2CrO_4 and this acidified yellow solution gives yellow precipitate, PbCrO_4 with lead acetate.

Answer the following questions :

- What is oxidation state of 'Cr' in potassium dichromate?
- Write electronic configuration of Cr^{2+} .
- Draw the structure of dichromate ion.

OR

- Which transition metal exhibits maximum oxidation state, +7?

30. Metal carbonyl is an example of coordination compounds in which carbon monoxide (CO) acts as ligand. These are also called homoleptic carbonyls. These compounds contain both σ and π character. Some carbonyls have metal-metal bonds. The reactivity of metal carbonyls is due to (i) the metal centre and (ii) the CO ligands. CO is capable of accepting an appreciable amount of electron density from the metal atom into their empty π or π^* orbitals. These types of ligands are called π -acceptor or π -acid ligands. These interactions increase the Δ_o value.

Answer the following questions :

- What is the oxidation state of metal in $[\text{Mn}_2(\text{CO})_{10}]$?
- Out of $[\text{Cr}(\text{CO})_6]$ and $[\text{V}(\text{CO})_6]^-$, which has the lowest C—O bond order?
- Which of the following can be reduced easily? $\text{V}(\text{CO})_6$, $[\text{Co}(\text{CO})_4]^-$, $\text{Mo}(\text{CO})_6$, $\text{Fe}(\text{CO})_5$

OR

- What is the oxidation state of cobalt in $\text{K}[\text{Co}(\text{CO})_4]$?

SECTION-E

31. Explain why :

- (a) $[\text{Cr}(\text{NH}_3)_6]^{3+}$ is paramagnetic while $[\text{Ni}(\text{CN})_4]^{2-}$ is diamagnetic.
- (b) A solution of $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is green but $[\text{Ni}(\text{CN})_4]^{2-}$ is colourless.
- (c) The low spin tetrahedral complexes are rarely observed.

OR

- (a) $[\text{Ni}(\text{Cl})_2(\text{P}(\text{CH}_3)_3)_2]$ is a paramagnetic complex of Ni(II). Analogous Pd(II) complex is diamagnetic. How many geometrical isomers will be possible for Ni(II) and Pd(II) complexes? Also explain their magnetic behaviour.
- (b) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ is strongly paramagnetic whereas $[\text{Fe}(\text{CN})_6]^{3-}$ is weakly paramagnetic. Explain.
- (c) Magnetic moment of $[\text{MnCl}_4]^{2-}$ is 5.92 BM. Explain giving reason.

32. Attempt **any five** of the following :

- (a) What are the different oxidation states exhibited by the lanthanoids?
- (b) What happens when green vitriol is strongly heated?
- (c) Which one of Fe^{2+} and Fe^{3+} ions is more paramagnetic and why?
- (d) Why are Sm^{2+} , Eu^{2+} and Yb^{2+} good reducing agents?
- (e) Why does Mn(II) show maximum paramagnetic character amongst the bivalent ions of the first transition series? Calculate the theoretical value of magnetic moment.
- (f) Write two differences between lanthanides and actinides.
- (g) Can lanthanum ($Z = 57$) exhibit +4 oxidation state?

33. (a) Out of the ions Ag^+ , Co^{2+} and Ti^{4+} which will be coloured in aqueous solution? If each one of the given ionic species is placed in a magnetic field, how will they respond and why?

(b) Explain the following :

- (i) Acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution turns green when sodium sulphite is added.
- (ii) A ferrous salt decolourises acidified KMnO_4 solution.

OR

(a) What is Lanthanoid contraction? Write down its two consequences?

(b) Explain the following :

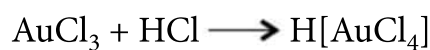
- (i) Why is europium (II) more stable than cerium (II)?
- (ii) Why is +3 oxidation state of gadolinium ($Z = 64$) and lutetium ($Z = 71$) especially stable?

SOLUTIONS

1. (c) : Electronic configuration of $\text{Fe}^{3+} = [\text{Ar}]3d^5$
 Electronic configuration of $\text{Cl} = 1s^2 2s^2 2p^6 3s^2 3p^5$
 d -electrons in $\text{Fe}^{3+} = p$ -electrons in $\text{Cl} = 5$

2. (b) : $\text{K}_3[\text{Ir}(\text{C}_2\text{O}_4)_3]$: Potassium trioxalatoiridate(III).

3. (a) : Except Au all other metals, *i.e.*, Ag, Hg and Cu are dissolved in conc. H_2SO_4 or conc. HNO_3 . The compound X is AuCl_3 which forms a complex with HCl.



It is used for toning in photography.

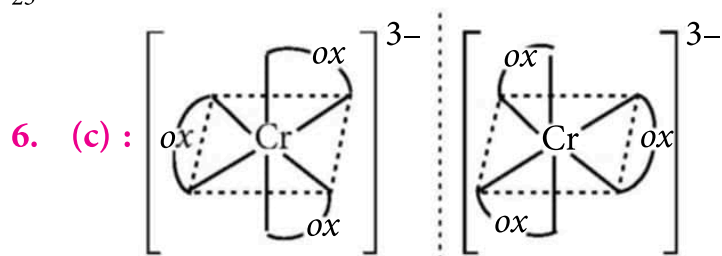
4. (a) : $\text{CrO}_3 + 2\text{NaOH} \longrightarrow \text{Na}_2\text{CrO}_4 + \text{H}_2\text{O}$

5. (d) : ${}_{22}\text{Ti} = 3d^2 4s^2$, $\text{Ti}^{2+} = 3d^2$

${}_{23}\text{V} = 3d^3 4s^2$, $\text{V}^{3+} = 3d^2$

${}_{24}\text{Cr} = 3d^5 4s^1$, $\text{Cr}^{4+} = 3d^2$

${}_{25}\text{Mn} = 3d^5 4s^2$, $\text{Mn}^{5+} = 3d^2$



7. (a) : $2\text{MnO}_2 + 4\text{KOH} + \text{O}_2 \longrightarrow 2\text{K}_2\text{MnO}_4 + 2\text{H}_2\text{O}$

8. (b) : C.F.S.E. = $(-0.4x + 0.6y)\Delta_o + zP$

where x = number of electrons occupying t_{2g} orbital

y = number of electrons occupying e_g orbital

z = number of pairs of electrons

For low spin d^6 complex, electronic configuration

$= t_{2g}^6 e_g^0$ or $t_{2g}^{2,2,2} e_g^0$

$\therefore x = 6, y = 0, z = 3$

C.F.S.E. = $(-0.4 \times 6 + 0 \times 0.6)\Delta_o + 3P = \frac{-12}{5}\Delta_o + 3P$

9. (a) : Ionic size (M^{3+}) of lanthanoids decreases from left to right.

10. (b) : Let the oxidation number of Ni = x

$\Rightarrow 1 \times 4 + x + (-1) \times 4 = 0$

$\Rightarrow 4 + x - 4 = 0 \Rightarrow x = 0$

11. (c) : $\text{VO} \Rightarrow$ Basic oxide

$\text{TiO} \Rightarrow$ Basic oxide

$\text{Cu}_2\text{O} \Rightarrow$ Basic oxide

- Cr₂O₃ ⇒ Amphoteric oxide
 NiO ⇒ Basic oxide
 FeO ⇒ Basic oxide
 Fe₃O₄ ⇒ Amphoteric oxide
 MnO₂ ⇒ Amphoteric oxide
 V₂O₅ ⇒ Acidic oxide
 CrO₃ ⇒ Acidic oxide
 Ti₂O₃ ⇒ Basic oxide

12. (a) : [Ag(CN)₂]⁻ is linear (*sp*) with no unpaired electron hence magnetic moment = 0

[Cu(CN)₄]³⁻ is tetrahedral (*sp*³) with no unpaired electron hence magnetic moment = 0

[Cu(CN)₆]⁴⁻ is octahedral (*sp*³*d*²) with one unpaired electron hence magnetic moment = $\sqrt{1(1+2)} = 1.73$ B.M.

[Cu(NH₃)₄]²⁺ is square planar (*dsp*²) with one unpaired electron hence magnetic moment = $\sqrt{1(1+2)} = 1.73$ B.M.

[Fe(CN)₆]⁴⁻ is octahedral (*d*²*sp*³) with no unpaired electron, hence magnetic moment = 0.

13. (c) : The complex dissociates to give [Co(NH₃)₅Br]²⁺ and SO₄²⁻ ions. SO₄²⁻ ion reacts with barium chloride to give white ppt. of BaSO₄.



14. (a)

15. (b)

16. (b)

17. Mn³⁺ : 3*d*⁴

No. of unpaired electrons = 4

Cr³⁺ : 3*d*³

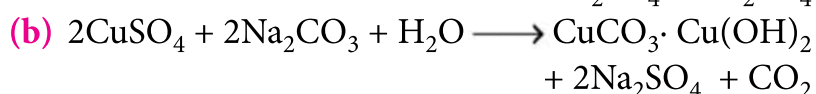
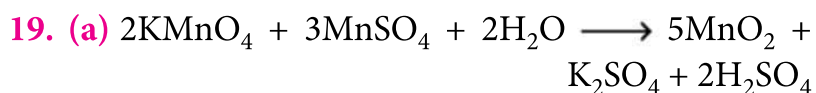
No. of unpaired electrons = 3

Out of these, Cr³⁺ is most stable in aqueous solution due to half filled *t*_{2g} level, i.e., *t*_{2g}³.

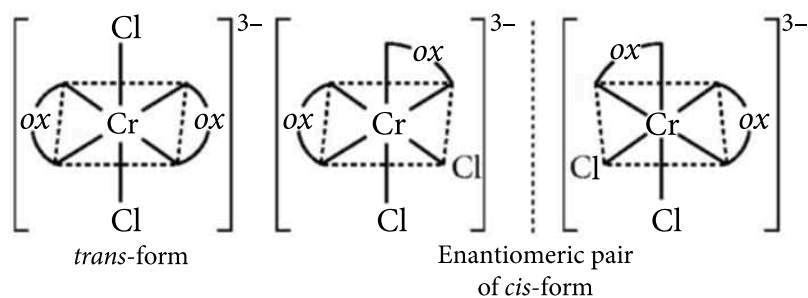
18. Double salts dissociate into ions completely when dissolved in water. On the other hand, in complexes, the complex ion does not dissociate.

OR

For one mole of the compound, two moles of AgCl are precipitated which indicates two ionisable chloride ions in the complex. Hence, its structural formula is [CrCl(H₂O)₅]Cl₂.H₂O



20. [CrCl₂(ox)₂]³⁻ can exist in *cis* and *trans*-forms (geometrical isomers). *Cis*-form is optically active and thus exists in enantiomeric pair.



21. (a) Cr²⁺ is reducing as its configuration changes from *d*⁴ to *d*³ and *d*³ has stable half-filled *t*_{2g}³ configuration. On the other hand, change of Mn³⁺ to Mn²⁺ results in half-filled *d*⁵ stable configuration thus Mn³⁺ acts as strong oxidising agent.

(b) Transition metal ions with *d*¹ configuration have a tendency to lose this single electron and provide ion with a noble gas configuration.

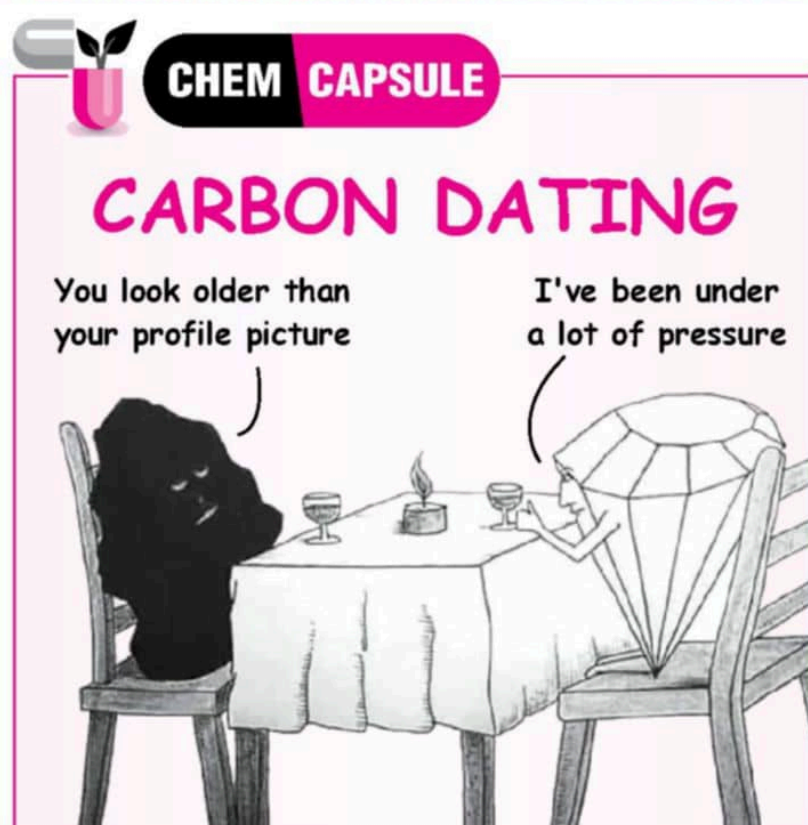
22. (a) Enthalpy of atomisation depends on the number of unpaired electrons in the valence shell. Greater the number of valence electrons, stronger is the resultant bonding and higher will be the enthalpy of atomisation. In 3*d* series, zinc has no unpaired electrons in valence shell so, it has lowest enthalpy of atomisation.

(b) The enthalpies of second and third transition series are high because of the poor shielding of electrons in 4*d* and 5*d* orbitals in comparison to electrons in 3*d* orbital which results in strong metallic bonding.

(c) Transition metals have high enthalpies of atomisation because of presence of unpaired electrons and poor shielding effect of *d*-orbitals.

23. (a) Coordination isomerism

(b) Hydrate isomerism



- (c) Ionisation isomerism
(d) Linkage isomerism

24. (a) The irregularities in the electronic configurations of actinoids are due to extra stabilities of the f^0 , f^7 and f^{14} orbitals.

(b) Actinoids exhibit greater range of oxidation states than lanthanoids. This is because there is less energy difference between $5f$ and $6d$ orbitals in actinoids than the energy difference between $4f$ and $5d$ orbitals in case of lanthanoids.

25. (a) Anhydrous CuSO_4 has no ligand. So, crystal field splitting does not occur so, it does not show any colour but in hydrated form, it is linked with H_2O ligand so, it shows colour due to $d-d$ transition.

(b) $[\text{Ti}(\text{H}_2\text{O})_6]\text{Cl}_3$ is a complex compound. In presence of six H_2O molecules, the d -orbitals of Ti^{3+} undergo splitting. The compound is coloured (violet) due to $d-d$ transition. On heating, water molecules escape, d -orbitals become degenerate. There is no $d-d$ transition. Hence, compound becomes colourless.

26. (a) Transition metals form a large number of interstitial compounds because small atoms of certain non-metallic elements (H, B, C, N, etc.) get trapped in voids or vacant spaces of lattices of the transition metals.

(b) As we move along transition metal series from left to right (*i.e.*, Ti to Cu), the atomic radii decrease due to increase in nuclear charge. Hence, the atomic volume decreases. At the same time, atomic mass increases. Hence, the density from titanium to copper increases.

27. Unidentate ligands are those which bind to the metal ion through a single donor atom. *e.g.*, Cl^- , H_2O .

Bidentate ligands are those which bind to the metal ion through two donor atoms. *e.g.*, ethane-1,2-diamine ($\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$), oxalate ($\text{C}_2\text{O}_4^{2-}$) ion.

Ambidentate ligands are those which can bind to metal ion through two different donor atoms. *e.g.*, NO_2^- and SCN^- ions.

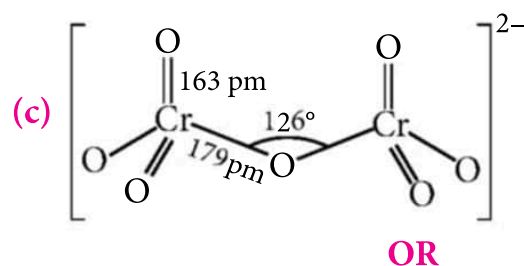
28. Chemistry of actinoids is more complicated than lanthanoids because :

- (i) actinoids show greater number of oxidation states due to the comparable energies of $5f$, $6d$ and $7s$ orbitals.
(ii) most of the actinoids are radioactive and the study of their chemistry in the laboratory is difficult.

29. (a) $\text{K}_2\text{Cr}_2\text{O}_7 \Rightarrow 2 + 2x + 7(-2) = 0$
 $2 + 2x - 14 = 0$
 $2x = +12 \quad x = +6$

Therefore, oxidation state of Cr in $\text{K}_2\text{Cr}_2\text{O}_7$ is +6.

(b) $[\text{Ar}]3d^44s^0$



(c) Manganese

30. (a) Oxidation state of Mn in $[\text{Mn}_2(\text{CO})_{10}]$ is zero.

(b) In $[\text{V}(\text{CO})_6]^-$, the anionic carbonyl complex can delocalise more electron density to antibonding π -orbital ($d\pi-p\pi$ back bonding) of CO and thus lowers the bond order.

(c) $\text{V}(\text{CO})_6$ can be easily reduced to $[\text{V}(\text{CO})_6]^-$.

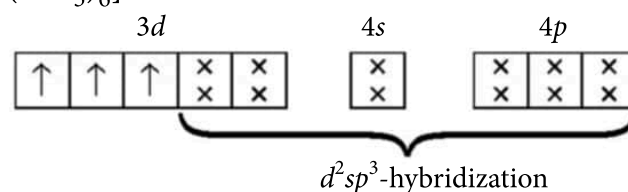
$\text{V}(\text{CO})_6$ has a total of 17 bonding electrons, hence it is very reactive and unstable. $[\text{V}(\text{CO})_6]^-$ on the other hand has complete set of 18 bonding electrons as an electron is added into the bonding orbital when $\text{V}(\text{CO})_6$ gets reduced to $[\text{V}(\text{CO})_6]^-$. All others have 18 bonding electrons.

OR

(c) $\text{K}[\text{Co}(\text{CO})_4]$

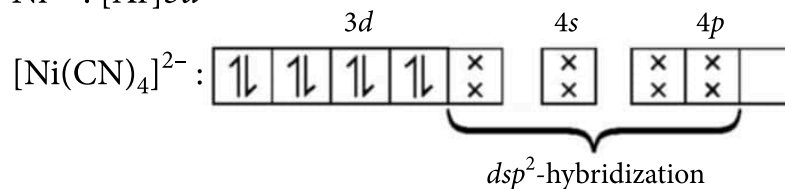
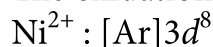
$$+1 + (x) + 4(0) = 0 \quad \text{or} \quad x = -1$$

31. (a) The oxidation state of Cr in the complex is +3.



Three unpaired electrons are present, hence it is paramagnetic.

The oxidation state of Ni in the complex is +2.



As CN^- is a strong ligand, unpaired electrons are paired up, hence it is diamagnetic.

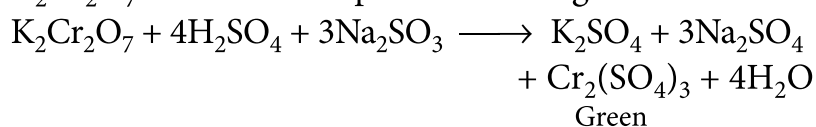
MONTHLY TEST DRIVE CLASS XII ANSWER KEY

- | | | | | |
|------------|-------------|-----------|------------|-----------|
| 1. (c) | 2. (b) | 3. (b) | 4. (c) | 5. (a) |
| 6. (b) | 7. (b) | 8. (c) | 9. (b) | 10. (b) |
| 11. (d) | 12. (c) | 13. (a) | 14. (b) | 15. (c) |
| 16. (d) | 17. (c) | 18. (b) | 19. (c) | 20. (b,c) |
| 21. (b,d) | 22. (a,b,c) | 23. (a,b) | 24. (9.97) | 25. (5) |
| 26. (2.72) | 27. (b) | 28. (d) | 29. (d) | 30. (a) |

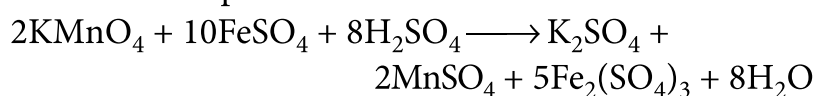
(g) La^{3+} has a stable configuration of an inert gas ($[\text{Xe}]5d^06s^0$). To obtain +4 oxidation state, the stable configuration is to be disturbed which is not possible under ordinary conditions and hence, La^{4+} does not exist.

33. (a) The ionic species which possess unpaired electron or electrons in $(n-1)d$ -subshell will show colour. Out of the ions $\text{Ag}^+(4d^{10})$, $\text{Co}^{2+}(3d^7)$ and $\text{Ti}^{4+}(3d^0)$, Co^{2+} will be coloured as it contains three unpaired electrons, Ag^+ and Ti^{4+} will be colourless. When placed in magnetic field, Co^{2+} will be attracted because it is paramagnetic due to unpaired electrons. Ag^+ and Ti^{4+} ions will be repelled by the magnetic field as they are diamagnetic.

(b) (i) Na_2SO_3 is a reducing agent. It reduced acidified $\text{K}_2\text{Cr}_2\text{O}_7$ to chromic sulphate which is green in colour.



(ii) Ferrous salt acts as a reducing agent. It reduces acidified KMnO_4 into MnSO_4 and K_2SO_4 which form colourless solution, *i.e.*, decolourisation of KMnO_4 solution takes place.



OR

(a) The steady decrease in the atomic and ionic radii of lanthanoid elements with increase in atomic number is called lanthanoid contraction. It is caused due to poor shielding of nuclear charge by $4f$ -electrons.

Consequences of lanthanoid contraction :

(i) The basic strength of oxides and hydroxides of lanthanoids decreases with increasing atomic number.

(ii) Atomic and ionic sizes of $4d$ transition series elements and $5d$ series elements are similar. *e.g.*, atomic radius of zirconium (Zr) is same as that of hafnium (Hf).

(b) (i) Europium(II) has electronic configuration $[\text{Xe}]4f^75d^0$ while cerium(II) has electronic configuration $[\text{Xe}]4f^15d^1$. In Eu^{2+} , $4f$ -subshell is half-filled and $5d$ -subshell is empty. Since half-filled and completely filled electronic configurations are more stable, hence Eu^{2+} ions is more stable than Ce^{2+} .

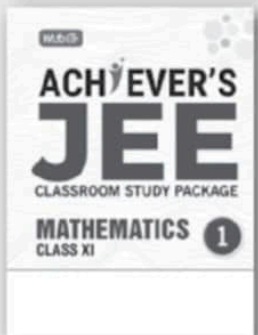
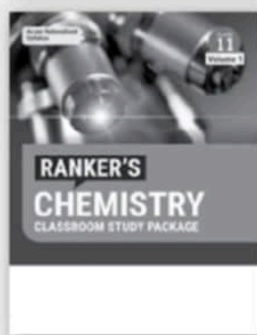
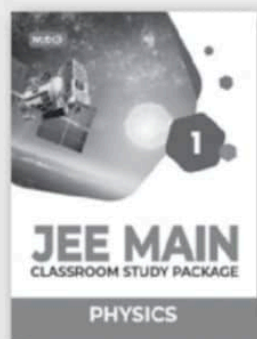
(ii) This is because gadolinium in +3 state has half filled $4f$ -subshell ($4f^7$) and lutetium in +3 state has completely filled $4f$ -subshell which are very stable configurations.



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Class XII

Monthly test



This specially designed column enables students to self analyse their extent of understanding of all chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Electrochemistry | Surface Chemistry

Total Marks : 120

Time taken : 60 Min.

NEET

Only One Option Correct Type

- When $[Zn^{2+}] = [Cu^{2+}] = 1$, the electrical potential of Daniell cell is 1.1 V. However,
 - when $E_{ext} < 1.1$ V, current flows from Zn to Cu
 - when $E_{ext} = 1.1$ V, current flows from Cu to Zn
 - when $E_{ext} > 1.1$ V, current flows from Zn to Cu
 - when $E_{ext} < 1.1$ V, electrons flow from Cu to Zn.
- If $E_{Fe^{2+}/Fe}^{\circ} = x_1$ V, $E_{Fe^{3+}/Fe^{2+}}^{\circ} = x_2$ V, what is the value of $E_{Fe^{3+}/Fe}^{\circ}$?
 - $\frac{2x_1 + x_2}{4}$
 - $\frac{2x_1 + x_2}{3}$
 - $\frac{2x_1 + x_2}{2}$
 - $2x_1 + x_2$
- During the charging of lead storage battery, the reaction at anode is represented by
 - $Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$
 - $PbSO_4 + 2e^- \rightarrow Pb + SO_4^{2-}$
 - $Pb \rightarrow Pb^{2+} + 2e^-$
 - $Pb^{2+} + 2e^- \rightarrow Pb$
- Kohlrausch's law is applicable to a dilute solution of
 - potassium chloride in hexane
 - acetic acid in water
 - hydrochloric acid in water
 - benzoic acid in benzene.
- The platinum foil in SHE is coated with platinum black because it
 - increases its surface area for adsorption
 - is a good conductor
 - maintains better electrical contact
 - prevents the electrode from damage.
- The correct order of molar conductance at infinite dilution of LiCl, NaCl and KCl is
 - LiCl > NaCl > KCl
 - KCl > NaCl > LiCl
 - NaCl > KCl > LiCl
 - LiCl > KCl > NaCl
- The half cell potential of a hydrogen electrode at pH = 10 will be
 - 0.50 V
 - 0.59 V
 - 0.059 V
 - none of these
- Given electrode potentials :
 $Fe^{3+} + e^- \rightarrow Fe^{2+}$, $E^{\circ} = 0.771$ volts
 $I_2 + 2e^- \rightarrow 2I^-$, $E^{\circ} = 0.536$ volts
 E°_{cell} for cell reaction, $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$ is
 - 1.006 volt
 - 0.503 volt
 - 0.235 volt
 - 0.235 volt
- In electrolysis of NaCl when Pt electrode is taken then H_2 is liberated at cathode while with Hg cathode it forms sodium amalgam because
 - Hg is more inert than Pt
 - more voltage is required to reduce H^+ at Hg than at Pt
 - Na gets dissolved in Hg while it does not dissolve in Pt
 - concentration of H^+ ions is larger when Pt electrode is taken.
- E° for the cell, $Zn|Zn^{2+}_{(aq)} || Cu^{2+}_{(aq)}|Cu$ is 1.10 V at 25°C. The equilibrium constant for the cell reaction, $Zn + Cu^{2+}_{(aq)} \rightleftharpoons Cu + Zn^{2+}_{(aq)}$ is of the order of
 - 10^{-37}
 - 10^{37}
 - 10^{-17}
 - 10^{17}

11. 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
 (a) + 1.66 V (b) - 3.26 V
 (c) + 3.26 V (d) - 1.66 V
12. The specific conductance of a saturated solution of AgCl at 25 °C is 1.821×10^{-5} mho cm^{-1} . What is the solubility of AgCl in water (in g L^{-1}), if limiting molar conductivity of AgCl is 130.26 mho $\text{cm}^2 \text{mol}^{-1}$?
 (a) 1.89×10^{-3} g L^{-1} (b) 2.78×10^{-2} g L^{-1}
 (c) 2.004×10^{-2} g L^{-1} (d) 1.43×10^{-3} g L^{-1}

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
 (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) If assertion is true but reason is false.
 (d) If both assertion and reason are false.

13. **Assertion :** 96500 C charge is required for the reduction of one mole of silver ions.

Reason : The amount of electricity (or charge) required for oxidation or reduction depends on the stoichiometry of the electrode reaction.

14. **Assertion :** KCl, NaCl, NH_4Cl , etc. cannot be used in the salt bridge of a cell containing silver.

Reason : A salt bridge contains concentrated solution of an inert electrolyte like KCl, KNO_3 , K_2SO_4 , etc. or solidified solution of such an electrolyte in agar-agar and gelatine.

15. **Assertion :** Corrosion of Fe can be prevented by connecting it with one metal whose standard reduction potential is less than Fe.

Reason : The metal having lower standard reduction potential gets reduced preferentially.

JEE (Main & Advanced)

Only One Option Correct Type

16. Which one of the following is an example for homogeneous catalysis?
 (a) Manufacture of ammonia by Haber's process
 (b) Manufacture of sulphuric acid by Contact process
 (c) Hydrogenation of oil
 (d) Hydrolysis of sucrose in presence of dilute hydrochloric acid

17. When electricity is passed through molten $\text{Al}_2\text{O}_3 + \text{Na}_3\text{AlF}_6$ and 13.5 g of Al are deposited, the number of Faraday must be
 (a) 0.5 (b) 1.0
 (c) 1.5 (d) 2.0

18. What is the value of $1/n$, in Freundlich adsorption isotherm?
 (a) Between 2 and 4 in all cases
 (b) Between 0 and 1 in all cases
 (c) 1 in case of chemisorption
 (d) 1 in case of physical adsorption

19. Equivalent conductance of BaCl_2 , H_2SO_4 and HCl are x_1 , x_2 and x_3 $\text{S cm}^2 \text{equiv}^{-1}$ at infinite dilution. If specific conductance of saturated BaSO_4 solution is y S cm^{-1} then K_{sp} of BaSO_4 is

- (a) $\frac{10^3 y}{2(x_1 + x_2 - 2x_3)}$ (b) $\frac{10^6 y^2}{(x_1 + x_2 - 2x_3)^2}$
 (c) $\frac{10^6 y^2}{4(x_1 + x_2 - 2x_3)^2}$ (d) $\frac{x_1 + x_2 - 2x_3}{10^6 y^2}$

More than One Option Correct Type

20. A gas undergoes physical adsorption on a surface and follows the given Freundlich adsorption isotherm equation,

$$\frac{x}{m} = kp^{0.5}$$

Adsorption of the gas increases with

- (a) decrease in p (b) decrease in T
 (c) increase in p (d) increase in T .

21. The correct relationships among the following are :

- (a) $E_{\text{cell}} = \frac{RT}{nF} \ln K$
 (b) Cell constant (G^*) = Conductivity (κ) \times Resistance (R)
 (c) $1 \text{ S m}^{-1} = 100 \text{ S cm}^{-1}$
 (d) Equilibrium constant (K) = $e^{-\Delta G^\circ/RT}$

UNSCRAMBLED WORDS

AUGUST 2024

- 1-e-SYLVANITE 2-g-TERBIUM
 3-b-SOXHLET 4-h-NAPHTHOQUINONES
 5-d-HAHNIUM 6-a-ANNEALING
 7-j-PRASEODYMIUM 8-i-NEPHELINE
 9-c-TROUTON 10-f-GLYME

Winners : Kaushikkumar Kevadiya

22. A catalyst
 (a) alters the speed of reaction
 (b) changes the energy of activation of the given process
 (c) cannot change the position of equilibrium
 (d) initiates the reaction.
23. Conductivity of an electrolytic solution depends on
 (a) nature of electrolyte
 (b) concentration of electrolyte
 (c) power of AC source
 (d) distance between the electrodes.

Integer / Numerical Value Type

24. For the electrochemical cell,
 $\text{Mg}_{(s)} \mid \text{Mg}^{2+} (aq, 1 \text{ M}) \parallel \text{Cu}^{2+} (aq, 1 \text{ M}) \mid \text{Cu}_{(s)}$ the standard emf of the cell is 2.70 V at 300 K. When the concentration of Mg^{2+} is changed to $x \text{ M}$, the cell potential changes to 2.67 V at 300 K. The value of x is _____. (Given, $F/R = 11500 \text{ K V}^{-1}$, where F is the Faraday constant and R is the gas constant, $\ln(10) = 2.30$)
25. 1 g of charcoal adsorbs 100 mL 0.5 M CH_3COOH to form a monolayer, and thereby the molarity of CH_3COOH reduces to 0.49. The surface area of the charcoal adsorbed by each molecule of acetic acid is $x \times 10^{-19} \text{ m}^2$. The value of x is _____. (Surface area of charcoal = $3.0 \times 10^2 \text{ m}^2/\text{g}$.) (Nearest integer)
26. The density of copper is 8.94 g/mL. The number of coulombs needed to plate an area of $10 \text{ cm} \times 10 \text{ cm}$ to a thickness 10^{-2} cm using CuSO_4 solution as electrolyte is _____ $\times 10^4$.

Comprehension Type

Weak electrolytes do not dissociate completely even at infinite dilution. Hence, it is not possible to determine their molar conductivity at infinite dilution (Λ_m°) experimentally. The problem was solved by Kohlrausch by putting forward Kohlrausch's law. This law not only helped to find Λ_m° for weak electrolytes but also helped to find degree of dissociation of weak electrolytes at any concentration and also the dissociation constant of the weak electrolyte. Knowing the ionic conductances of

the cations and anions at infinite dilution, their ionic mobilities (speed of the ion under a potential gradient of 1 volt/cm) can also be calculated.

27. Given that Λ_m° values of BaCl_2 , $\text{Ba}(\text{OH})_2$ and NH_4Cl in $\Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$ are 240.6, 461 and 129.8 respectively. The Λ_m° for NH_4OH in $\Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$ will be
 (a) 350.2 (b) 240.0 (c) 175.1 (d) 119.7
28. If a centinormal solution of NH_4OH has molar conductivity equal to $9.6 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$, the percent dissociation of NH_4OH at this dilution will be
 (a) 8% (b) 12% (c) 6% (d) 4%

Matching Type

29. Match the column I with column II and mark the correct option.

Column I		Column II	
(A)	Colloidal antimony	(P)	Colloidal solution of gold
(B)	Argyrol	(Q)	Colloidal solution of graphite
(C)	Aquadag	(R)	Kala-azar
(D)	Purple of Cassius	(S)	Eye lotion

- (a) A-Q; B-P; C-R; D-S (b) A-R; B-Q; C-P; D-S
 (c) A-S; B-P; C-Q; D-R (d) A-R; B-S; C-Q; D-P

30. Match the column I with column II and mark the correct option.

Column I		Column II	
(A)	Dry cell	(P)	KOH solution
(B)	Lead storage battery	(Q)	38% H_2SO_4
(C)	Ni - Cd cell	(R)	$\text{MnO}_2 + \text{C}$
(D)	$\text{H}_2 - \text{O}_2$ fuel cell	(S)	Concentrated hot aq KOH solution

- (a) A → R; B → Q; C → P; D → S
 (b) A → P; B → R; C → Q; D → S
 (c) A → R; B → P; C → S; D → Q
 (d) A → Q; B → R; C → S; D → P

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted
 No. of questions correct
 Marks scored in percentage

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- > 90%** EXCELLENT WORK ! You are well prepared to take the challenge of final exam.
90-75% GOOD WORK ! You can score good in the final exam.
74-60% SATISFACTORY ! You need to score more next time.
< 60% NOT SATISFACTORY! Revise thoroughly and strengthen your concepts.

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- U.V. Patel College of Engineering, Ganpat Vidyanagar, Gujarat
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Job Prospects

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Approved Intake : 30

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OR

Passed Diploma in Engineering and Technology examination from Institutions and Boards, recognized by Central or State Government/Universities with at least 45% marks (40% marks in case of candidates belonging to "SC/ST/Non-creamy layer OBC/ Non-creamy layer MBC and PwD category" of Rajasthan State) subjected to vacancies in the First Year, in case the vacancies at lateral entry are exhausted.



UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I

1. POHYTPRANT
2. NVITCADIFOITREI
3. SECTNHOPSERHOP
4. ITRETBYTE
5. LECRTNIOLESLOU
6. NMNERGTEUIO
7. VGRDESIRI
8. MUIINMI
9. EISTHELEC
10. NANTISN

Column II

- (a) It is a common name for any of a variety of somewhat poisonous copper salts of acetic acid, which range in colour from green to a bluish-green depending on their chemical composition.
- (b) It is the type of material which can store the absorbed light energy for some time and release the light later, resulting in an afterglow that persists after the light has been switched off.
- (c) It is an amino acid needed for normal growth in infants and for the production and maintenance of the body's proteins, muscles, enzymes, and neurotransmitters.
- (d) It is the naturally occurring form of lead tetroxide, also known as red lead.
- (e) These are the polyphenolic biomolecules that bind to and precipitate proteins and various other organic compounds including amino acids and alkaloids and are found in many species of plants.
- (f) It is a mineral, also known as gadolinite, named after a village in Sweden.
- (g) It is a synthetic chemical element which is extremely radioactive and can only be created in a laboratory.
- (h) It is an important ore of tungsten with the chemical formula CaWO_4 , occasionally fashioned into gemstones.
- (i) It is a highly flammable compound formed by nitrating cellulose through exposure to a mixture of nitric acid and sulphuric acid, formerly used as guncotton in firearms.
- (j) It is the process of crystallisation of glass which makes glass opaque.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.



Unlock Your Knowledge!

- _____ axes are lines drawn parallel to lines of intersection of any three faces of the unit cell which are not in the same plane.
- A _____ is a piece of laboratory apparatus that is used to support a crucible being heated by a Bunsen burner or other heat source.
- The tendency for diesel fuels to produce knocking in service is designated as _____.
- _____ refers to aluminium oxide that has been dehydrated in such a way that a porous structure of large surface area is obtained.
- The transition boundary which separates the mesosphere from the stratosphere is called the _____.
- Richard Smalley shared the 1996 Nobel Prize in Chemistry for the discovery of _____.
- Aqueous solution of potash alum is acidic in nature due to _____.
- _____, also known as chronic beryllium disease (CBD), is a granulomatous disease caused by exposure to beryllium.
- _____ is the rarest naturally occurring element in the Earth's crust, occurring only as the decay product of various heavier elements.
- _____ is a solution of mercuric and mercurous nitrate in nitric acid.
- Mesityl oxide is formed when two molecules of _____ in the presence of HCl combine with the elimination of one molecule of water.
- _____ states that during oxidation of unsymmetrical ketones, the point of cleavage is such that keto group stays preferentially with the smaller alkyl group.
- Copper wire test for halogens is known as _____ test.
- _____ is the discoverer of deuterium for which he was awarded the 1934 Nobel Prize in Chemistry.
- _____ is the only alkali metal which directly reacts with nitrogen to form nitride.
- _____ is used as an anti-knocking compound in gasoline.
- The aryl group obtained by removing one hydrogen atom from toluene ring is called _____.
- Human hair on heating strongly with soda-lime smells of ammonia as they contain _____.
- Thiophene can be removed from commercial benzene by shaking it with concentrated _____.
- _____ metal is most commonly used to dry organic solvents.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

SOLUTIONS TO AUGUST 2024 QUIZ CLUB

- | | |
|--------------------------|----------------------|
| 1. Oxymuriatic acid | 11. G.H. Hess |
| 2. Bidentate | 12. Icing sugar |
| 3. Crystallographic axes | 13. Flame retardants |
| 4. Charcoal | 14. Yeasts |
| 5. Carbonic, Bicarbonate | 15. Benzenoid |
| 6. Levelling | 16. Brimstone |
| 7. Fluorosis | 17. +3 |
| 8. Aerogens | 18. Daltonism |
| 9. Spiro | 19. Curie |
| 10. Pericyclic | 20. DDT |

Winners : Chirag, Hemant

WORD GRID

Readers are requested to send their responses of word grid. Be the Winner!

Find and encircle the words in the given grid, running in one of the possible directions; horizontal, vertical or diagonal by reading the clues given below.



Clues

1. It is the first name of one of the joint winners of the 1935 Nobel Prize in Chemistry for the discovery of artificial radioactivity.
2. It is a ring-shaped iron-containing molecular component of haemoglobin, which is necessary to bind oxygen in the bloodstream.
3. It is a violet-coloured substance obtained on oxidation of aromatic amines with arsenic acid.
4. It is a mixture of TNT (20%) and NH_4NO_3 (80%) and is used in coal mining.
5. It is an organic compound (also called rosolic acid or corallin) which is soluble in strong acids to form yellow solution, or in aqueous alkalis to form carmine red solutions, which is why, it can be used as a pH indicator.
6. It is one of the three essential branched chain amino acids, which can be used by skeletal muscle to give energy during exercise.
7. It is a soft, silvery-white, radioactive actinoid metal.
8. It is the direct method for determination of molecular formula of gaseous hydrocarbons without determining the percentage composition of various elements in it and without knowing the molecular weight of the hydrocarbon.

Note :- Please send entries of solutions both with words and scanned copy of the grid by 10th of every month.





Enhance Your General Knowledge with Current Updates!

SPORTS

- According to the Asian Cricket Council's Invitation for Expression of Interest (IEOI), India will host the men's Asia Cup Cricket Tournament in 2025 as a practice for the 2026 T20 World Cup, which is slated to take place in the nation.
- Indian shooters, Manu Bhaker and Sarabjot Singh scripted history with a bronze medal in the 10m air pistol mixed team shooting event at the Paris Olympics on 30th July 2024. This was India's sixth Olympic medal in shooting and first-ever in a shooting team event. The result also made Manu Bhaker, the first athlete of independent India, to win two medals in one edition of the Olympics.
- At the Hungarian Grand Prix, Kush Maini of India became victorious in his first Formula 2 Sprint Race after Richard Verschoor, the first runner-up, was disqualified for a technical violation. The 23-year-old Invicta racing driver scored total 10 points to his season after finishing at the top of the podium.
- In the women's trap category, Indian shooter Sabeera Haris achieved third place in the ISSF Junior World Cup in Porpetto, Italy. India gained another medal at this significant event with our victory. Sabeera Haris showcased her outstanding shooting in the last round by striking 29 of 40 targets.
- Center of Excellence in Sports Science and Analytics (CESSA) of IIT Madras has made a new announcement to make India the world's most important chess hub. The news was announced at the Sports Tech Start-Up Conclave in New Delhi.
- Olympic Bronze medalist and well-known shooter, Gagan Narang, replaced M.C. Mary Kom as the Chef-de-Mission for the Indian team at the 2024 Paris Olympics, following a recent tension in the country's sports administration. This change is the result of Mary Kom's resignation for personal reasons.
- Former cricketer and opener of Indian cricket team, Gautam Gambhir, has been named as the men's cricket team's head coach after replacing Rahul Dravid. It is his first role as an international coach. He will be leading the team till the end of 2027.
- At the Leon Masters in Spain, Viswanathan Anand defeated Jaime Santos Latasa by 3-1 in the championship match to claim his tenth title. Anand has been a five times world chess champion. The long-lasting dominance of Vishy Anand in universal chess has been demonstrated by this accomplishment in Leon.
- The 16-year-old para-swimmer, Jiya Rai, who is suffering from autism spectrum disorder, has set a new world record as the youngest and fastest para-swimmer to cross the English Channel. She finished her 34-kilometer swim from Abbott's Cliff in England to Pointe de la Courte-Dune in France in 17 hours and 25 minutes.
- Rohan Bopanna, one of India's most accomplished tennis players, has announced his retirement from representing India in international competitions following his exit from the Paris 2024 Olympics.
- Nita Ambani, the founder of Reliance Foundation and an IOC member, inaugurated the India House during Paris Olympics 2024. This marks India's first-ever country house at the Olympics, highlighting a significant milestone in India's Olympic journey.

Test Yourself!

- Which para swimmer has recently (in 2024) completed a swim across the English Channel?
(a) Sajan Prakash (b) Avani Lekhara
(c) Deepa Malik (d) Jiya Rai
- Deodhar Trophy is related to which of the following sports?
(a) Hockey (b) Baseball
(c) Football (d) Cricket
- Where are the headquarters of International Gymnastics Federation situated?
(a) Kosovo (b) Switzerland
(c) Turkey (d) Australia
- Who is the new head coach of Indian men's cricket team after Rahul Dravid?
(a) Harbhajan Singh
(b) Mahendra Singh Dhoni
(c) Yuvraj Singh
(d) Gautam Gambhir
- Who is the first Indian woman to win an Asian Games gold in 400 m run?
(a) M.L. Valsamma (b) P.T. Usha
(c) Kamaljit Sandhu (d) K. Malleshwari
- Which team won the Women's Asia Cup 2024?
(a) Indonesia (b) India
(c) Sri Lanka (d) Bangladesh
- What is the title of the autobiography of Major Dhyanchand?
(a) Goal
(b) Hockey and I
(c) Goal of Hockey
(d) Hockey Changed My Life
- Who is the first athlete of independent India to win two medals in one edition of the Olympics?
(a) Gagan Narang
(b) Manu Bhaker
(c) Sarabjot Singh
(d) Abhinav Bindra
- BFI has recently established an academy in collaboration with the Corvuss American Academy. It is associated to which sport?
(a) Basketball (b) Baseball
(c) Volleyball (d) Football
- Sabeera Haris is associated with which of the following sports?
(a) Badminton (b) Boxing
(c) Shooting (d) Rowing

Answer Key

- | | | | | |
|--------|-------|-------|-------|-------|
| (a) 10 | (e) 6 | (q) 8 | (e) 7 | (c) 9 |
| (c) 5 | (d) 4 | (p) 3 | (d) 2 | (d) 1 |

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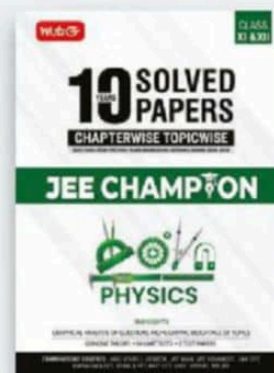
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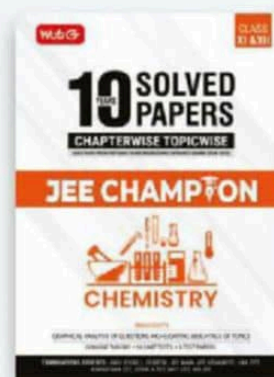
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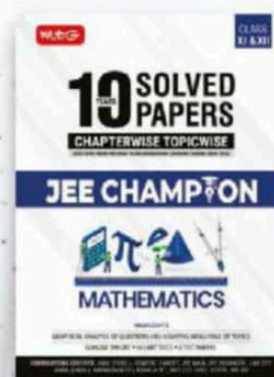
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