

**CBSE**  
**SCIENCE**  
**CLASS X -2021-2022**  
**(CHEMISTRY)**

(CASE STUDY/PASSAGE BASED MCQ QUESTIONS & ASSERTION  
REASON QUESTIONS OF UNIT 1 TO 5 AS PER THE NEW AND  
UPDATED CURRICULUM OF 2021-2022)

**CHEMISTRY**  
**CLASS X**

**CASE STUDY/PASSAGE BASED  
MCQ QUESTIONS**

**ASSERTION & REASON  
QUESTIONS**

**COMPILED BY**

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# Chemical Reactions and Equations

## CASE STUDY / PASSAGE BASED QUESTIONS

**1**

Read the following and answer any four questions from 1(i) to 1(v).

Chemical equation is a method of representing a chemical reaction with the help of symbols and formulae of the substances involved in it. In a chemical equation, the substances which combine or react are called reactants and new substances produced are called products. A chemical equation is a short hand method of representing a chemical reaction. A balanced chemical equation has equal number of atoms of different elements in the reactants and products side. An unbalanced chemical equation has unequal number of atoms of one or more elements in reactants and products. Formulae of elements and compounds are not changed to balance an equation.

(i) Consider the following reaction:



When the equation is balanced, the coefficients  $p, q, r, s$  respectively are

(a) 1, 3, 3, 2

(b) 1, 6, 3, 2

(c) 1, 2, 3, 2

(d) 2, 3, 6, 2

(ii) Which of the following information is not conveyed by a balanced chemical equation?

(a) Physical states of reactants and products

(b) Symbols and formulae of all the substances involved in a particular reaction

(c) Number of atoms/molecules of the reactants and products formed

(d) Whether a particular reaction is actually feasible or not

(iii) The balancing of chemical equations is in accordance with

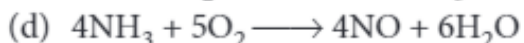
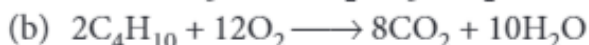
(a) law of combining volumes

(b) law of constant proportions

(c) law of conservation of mass

(d) both (b) and (c).

(iv) Which of the following chemical equations is an unbalanced one?



## Syllabus

Chemical equation, Balanced chemical equation, implications of a balanced chemical equation, types of chemical reactions :

combination, decomposition, displacement, double displacement, precipitation, neutralisation, oxidation and reduction.

- (v) Which of the following statements is/are correct?
- A chemical equation tells us about the substances involved in a reaction.
  - A chemical equation informs us about the symbols and formulae of the substances involved in a reaction.
  - A chemical equation tells us about the atoms or molecules of the reactants and products involved in a reaction.
  - All the above.

## 2

Read the following and answer any four questions from 2(i) to 2(v).

In decomposition reactions, a single reactant breaks down to form two or more products. Decomposition reaction is opposite to combination reaction. Thermal decomposition reactions use the energy in form of heat for decomposition of reactants. Electrolytic decomposition reactions involve the use of electrical energy for the decomposition of reactant molecules. Photolysis or photochemical decomposition involves the use of light energy for the purpose of decomposition.

- (i) Which of the following reactions is a decomposition reaction?
- |   |  |
|---|--|
| (a) $\text{NaOH} + \text{HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{O}$ | (b) $\text{NH}_4\text{CNO} \longrightarrow \text{H}_2\text{NCONH}_2$ |
| (c) $2\text{KClO}_3 \longrightarrow 2\text{KCl} + 3\text{O}_2$                  | (d) $\text{H}_2 + \text{I}_2 \longrightarrow 2\text{HI}$             |
- (ii)  $2\text{Pb}(\text{NO}_3)_2 \longrightarrow 2\text{PbO} + n\text{A} + \text{O}_2$   
What is  $n\text{A}$  in the given reaction?
- |                  |                    |                      |                   |
|------------------|--------------------|----------------------|-------------------|
| (a) $4\text{NO}$ | (b) $4\text{NO}_2$ | (c) $2\text{PbNO}_2$ | (d) $\text{NO}_2$ |
|------------------|--------------------|----------------------|-------------------|
- (iii) Amino acid is formed by the decomposition of which component of our diet?
- |                  |            |             |         |
|------------------|------------|-------------|---------|
| (a) Carbohydrate | (b) Starch | (c) Protein | (d) Fat |
|------------------|------------|-------------|---------|
- (iv) Silver chloride on exposure to sunlight for a long duration turns grey due to
- the formation of silver by decomposition of silver chloride
  - sublimation of silver chloride
  - decomposition of chlorine gas from silver chloride
  - oxidation of silver chloride
- The correct statement(s) is/are
- |              |                         |                       |               |
|--------------|-------------------------|-----------------------|---------------|
| (a) Only (I) | (b) Only (II) and (III) | (c) Only (I) and (II) | (d) Only (IV) |
|--------------|-------------------------|-----------------------|---------------|
- (v) What type of chemical reaction takes place when electricity is passed through water?
- |                                 |                                |
|---------------------------------|--------------------------------|
| (a) Thermal decomposition       | (b) Electrolytic decomposition |
| (c) Photochemical decomposition | (d) Displacement reaction      |

## 3

Read the following and answer any four questions from 3(i) to 3(v).

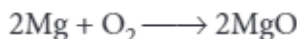
Redox reactions are those reactions in which oxidation and reduction occur simultaneously. A redox reaction is made up of two half reactions. In the first half reaction, oxidation takes place and in second half reaction, reduction occurs. Oxidation is a process in which a substance loses electrons and in reduction, a substance gains electrons. The substance which gains electrons is reduced and acts as an oxidising agent. On the other hand, a substance which loses electrons is oxidised and acts as a reducing agent.

- (i) Which of the following is a redox reaction?
- (a)  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$  (b)  $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$   
 (c)  $\text{CaO} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O}$  (d)  $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
- (ii) Identify the reaction in which  $\text{H}_2\text{O}_2$  is acting as a reducing agent.
- (a)  $\text{H}_2\text{SO}_3 + \text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{SO}_4 + \text{H}_2\text{O}$  (b)  $2\text{HI} + \text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{I}_2$   
 (c)  $\text{Cl}_2 + \text{H}_2\text{O}_2 \rightarrow 2\text{HCl} + \text{O}_2$  (d)  $2\text{FeCl}_2 + 2\text{HCl} + \text{H}_2\text{O}_2 \rightarrow 2\text{FeCl}_3 + 2\text{H}_2\text{O}$
- (iii) For the following reactions, identify the one in which  $\text{H}_2\text{S}$  acts as a reducing agent.
- (a)  $\text{CuSO}_4 + \text{H}_2\text{S} \rightarrow \text{CuS} + \text{H}_2\text{SO}_4$  (b)  $\text{Cd}(\text{NO}_3)_2 + \text{H}_2\text{S} \rightarrow \text{CdS} + 2\text{HNO}_3$   
 (c)  $2\text{FeCl}_3 + \text{H}_2\text{S} \rightarrow 2\text{FeCl}_2 + 2\text{HCl} + \text{S}$  (d) None of these
- (iv) For the following reaction, identify the correct statement.
- $$\text{ZnO} + \text{CO} \rightarrow \text{Zn} + \text{CO}_2$$
- (a) ZnO is being reduced. (b)  $\text{CO}_2$  is being oxidised.  
 (c) CO is being reduced. (d) ZnO is being oxidised.
- (v) In the following reaction, which substance is reduced?
- $$\text{PbS} + 4\text{H}_2\text{O}_2 \rightarrow \text{PbSO}_4 + 4\text{H}_2\text{O}$$
- (a)  $\text{H}_2\text{O}$  (b)  $\text{H}_2\text{O}_2$  (c) PbS (d)  $\text{PbSO}_4$

#### 4

Read the following and answer any four questions from 4(i) to 4(v).

In a balanced chemical reaction, equal number of atoms are present on both sides of reaction. A balanced chemical reaction is based on law of conservation of mass which means that total mass of reactants and products participating in a reaction must be equal. For example, a balanced chemical equation of burning of magnesium in oxygen to form magnesium oxide is written as :



The mass of reactants ( $2 \times 24 + 32 = 80$ ) is equal to the mass of products [ $2 \times (24 + 16) = 80$ ].

- (i) In a reaction, 35 g of reactant, PQ breaks down into 20 g of product, P and an unknown amount of product, Q. Using the law of conservation of mass, weight of products, Q will be
- (a) 25 g (b) 35 g (c) 30 g (d) 15 g
- (ii) When solid mercury (II) oxide is heated, liquid mercury and oxygen gas are produced. Which of the following statements is true regarding the balanced chemical equation for this process?
- (a) 1 mole of mercury (II) oxide produces two moles of mercury and one mole of oxygen gas.  
 (b) 2 moles of mercury (II) oxide produce one mole of mercury and one mole of oxygen gas.  
 (c) 1 mole of mercury (II) oxide produces half mole of mercury and half mole of oxygen gas.  
 (d) 2 moles of mercury (II) oxide produce 2 moles of mercury and one mole of oxygen gas.
- (iii) Which of the following laws is satisfied by a balanced chemical equation?
- (a) Law of multiple proportions (b) Law of conservation of mass  
 (c) Law of conservation of motion (d) Law of conservation of magnetism
- (iv) In the given chemical reaction,
- $$2\text{C}_6\text{H}_6(l) + 15\text{O}_2(g) \rightarrow m\text{CO}_2(g) + n\text{H}_2\text{O}(l)$$
- The values of  $m$  and  $n$  are respectively
- (a) 14 and 8 (b) 12 and 6 (c) 8 and 10 (d) 12 and 10



(v) Sulphur dioxide reacts with oxygen to form sulphur trioxide. What would be the molar ratio of sulphur dioxide to sulphur trioxide?

(a) 2 : 3

(b) 1 : 1

(c) 1 : 2

(d) 3 : 2

5

Read the following and answer any four questions from 5(i) to 5(v).

In a chemical reaction, reactants are converted into products. The conversion of reactants into products in a chemical reaction is often accompanied by some features which can be observed easily. These easily observed features which take place as a result of chemical reaction are known as characteristics of chemical reactions. Some important characteristics of chemical reactions are :

(I) Evolution of heat

(II) Formation of precipitate

(III) Change in colour

(IV) Change in temperature

(V) Change in state

Any one of these general characteristics can tell us whether a chemical reaction has taken place or not.

(i) Reaction of magnesium with air is a/an

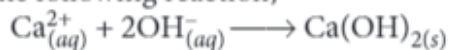
(a) exothermic reaction

(b) endothermic reaction

(c) reversible reaction

(d) substitution reaction.

(ii) In the following reaction,



precipitate of calcium hydroxide will be of

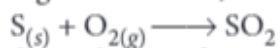
(a) green colour

(b) blue colour

(c) brown colour

(d) white colour.

(iii) In the given reaction,



the physical state of  $\text{SO}_2$  is

(a) liquid

(b) solid

(c) gaseous

(d) all three.

(iv) Which one of the following processes involve chemical reactions?

(a) Storing of oxygen gas under pressure in a gas cylinder.

(b) Keeping petrol in a china dish in the open.

(c) Liquefaction of air.

(d) Heating copper wire in the presence of air at high temperature.

(v) In which of the following reactions, high amount of heat energy will be evolved?

(a) Electrolysis of water

(b) Dissolution of  $\text{NH}_4\text{Cl}$  in water

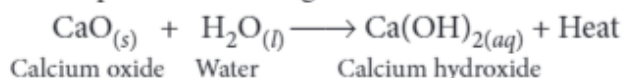
(c) Burning of L.P.G.

(d) Decomposition of  $\text{AgBr}$  in the presence of light

6

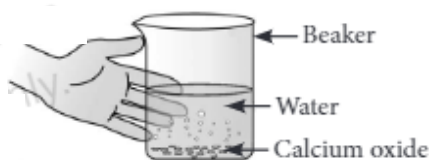
Read the following and answer any four questions from 6(i) to 6(v).

A reaction in which two or more reactants combine to form a single product is called a combination reaction. For example, calcium oxide reacts vigorously with water to form calcium hydroxide. The reaction is highly exothermic in nature, as lots of heat is produced during the reaction.



Solution of  $\text{Ca}(\text{OH})_2$  is used for white wash the walls. Calcium hydroxide reacts slowly with carbon dioxide in air to form a thin layer of calcium carbonate on the wall which gives a shiny appearance to wall. Calcium carbonate will form after two or three days of white wash.

- (i) What is the chemical name of quick lime?  
 (a) Calcium oxide      (b) Calcium carbonate      (c) Calcium hydroxide      (d) Carbon dioxide
- (ii) When carbon dioxide is passed through lime water,  
 (a) calcium hydroxide is formed      (b) white precipitate of CaO is formed  
 (c) lime water turns milky      (d) colour of lime water becomes green.
- (iii) Following observations are observed when calcium oxide reacts vigorously with water.



Identify the incorrect observations.

- (I) It is an endothermic reaction.      (II) Slaked lime is produced.  
 (III) Quick lime is produced.      (IV) It is an exothermic reaction.  
 (V) It is a combination reaction.
- (a) (I) and (II)      (b) (III) and (IV)      (c) (I) and (III)      (d) (II), (IV) and (V)
- (iv) Quick lime combines vigorously with water to form (A) which reacts slowly with the carbon dioxide in air to form (B).  
 Identify the compounds (A) and (B).
- | (A)                     | (B)                 |
|-------------------------|---------------------|
| (a) Calcium carbonate   | Calcium hydroxide   |
| (b) Calcium hydroxide   | Calcium carbonate   |
| (c) Calcium             | Calcium bicarbonate |
| (d) Calcium bicarbonate | Calcium             |
- (v) Among the following, the endothermic reaction is  
 (a) combination of carbon and oxygen to form carbon monoxide  
 (b) combination of nitrogen and oxygen to form nitrogen monoxide  
 (c) combination of glucose and oxygen to form carbon dioxide and water  
 (d) combination of zinc and hydrochloric acid to form zinc chloride and hydrogen.

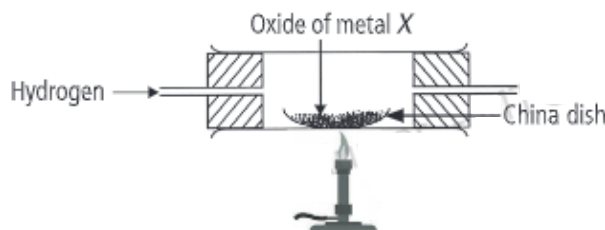
## 7

Read the following and answer any four questions from 7(i) to 7(v).

Reactions in which one element takes place of another element in a compound, are known as displacement reactions. In general, more reactive elements displaces a less reactive element from its compound. In all single displacement reactions, only one element displaces another element from its compound. The single displacement reactions are, however, written as just displacement reactions. The displacement reaction between iron (III) oxide and powdered aluminium produces so much heat that iron metal obtained is in molten form.

- (i) Copper displaces which of the following metals from its salt solution?  
 (a)  $ZnSO_4$       (b)  $FeSO_4$       (c)  $AgNO_3$       (d)  $NiSO_4$
- (ii) When zinc reacts with dilute sulphuric acid, the gas evolved is  
 (a) red in colour and have a sweet smelling.  
 (b) green in colour and have a foul smell.  
 (c) colourless, odourless and burns with a pop sound.  
 (d) colourless, pungent smelling and burns with a pop sound.

- (iii) When dry hydrogen is passed over a heated oxide of metal X using the apparatus shown below, a reddish-brown residue is obtained.



The reddish-brown residue could be

- (a) copper                      (b) lead                      (c) silver                      (d) zinc.
- (iv) Which of the following reactions is a displacement reaction?
- (a)  $\text{CaO} + \text{H}_2\text{O} \longrightarrow \text{Ca(OH)}_2$                       (b)  $\text{MgCO}_3 \longrightarrow \text{Mg} + \text{CO}_2$   
 (c)  $\text{Mg} + \text{CuSO}_4 \longrightarrow \text{MgSO}_4 + \text{Cu}$                       (d)  $\text{H}_2 + \text{Cl}_2 \longrightarrow 2\text{HCl}$
- (v) When dilute hydrochloric acid is added to granulated zinc placed in a test tube, the observation made is
- (a) the surface of the metal turns shining  
 (b) the reaction mixture turns milky  
 (c) greenish yellow gas is evolved  
 (d) the colourless and odourless gas evolves with a pop sound.

## 8

Read the following and answer any four questions from 8(i) to 8(v).

Those reactions in which two compounds react by an exchange of ions to form two new compounds are called double displacement reactions. A double displacement reaction usually occurs in solution and one of the products, being insoluble, precipitate out (separates as a solid). Any reaction in which an insoluble solid (called precipitate) is formed that separates from the solution is called a precipitation reaction. The reaction in which acid or acidic oxide reacts with base or basic oxide to form salt and water is called neutralisation reaction.

For example,  $2\text{NaOH} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$

- (i) When hydrogen sulphide gas is passed through a blue solution of copper sulphate, a black precipitate of copper sulphide is obtained and the sulphuric acid so formed remains in the solution. The reaction is an example of a
- (a) combination reaction                      (b) displacement reaction  
 (c) decomposition reaction                      (d) double displacement reaction.
- (ii) Which of the following is not a double displacement reaction?
- (a)  $\text{AgNO}_{3(aq)} + \text{NaCl}_{(aq)} \longrightarrow \text{AgCl}_{(s)} + \text{NaNO}_{3(aq)}$                       (b)  $\text{Zn}_{(s)} + \text{H}_2\text{SO}_{4(aq)} \longrightarrow \text{ZnSO}_{4(aq)} + \text{H}_{2(g)}$   
 (c)  $\text{CuSO}_{4(aq)} + \text{H}_2\text{S}_{(aq)} \longrightarrow \text{CuS}_{(s)} + \text{H}_2\text{SO}_{4(aq)}$                       (d)  $\text{Pb(NO}_3)_2(aq) + 2\text{KI}_{(aq)} \longrightarrow \text{PbI}_{2(s)} + 2\text{KNO}_{3(aq)}$
- (iii) Barium chloride on reaction with ammonium sulphate forms barium sulphate and ammonium chloride. Which of the following correctly represents the type of the reaction involved?
- (I) Displacement reaction                      (II) Precipitation reaction  
 (III) Combination reaction                      (IV) Double displacement reaction
- (a) (I) only                      (b) (II) only                      (c) (III) and (IV) only                      (d) (II) and (IV) only
- (iv) Identify A in the following reaction.
- $\text{AlCl}_{3(aq)} + 3\text{NH}_4\text{OH}_{(aq)} \longrightarrow \text{A} + 3\text{NH}_4\text{Cl}_{(aq)}$
- (a)  $\text{Al(OH)}_3$                       (b)  $\text{Al}_2\text{O}_3$                       (c)  $\text{AlH}_3$                       (d)  $\text{AlN}$



(v) Consider the following reaction,



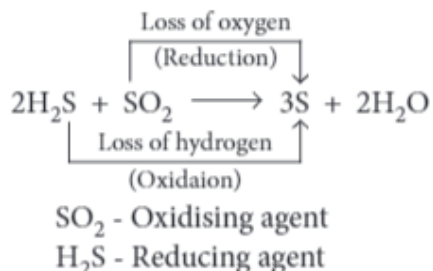
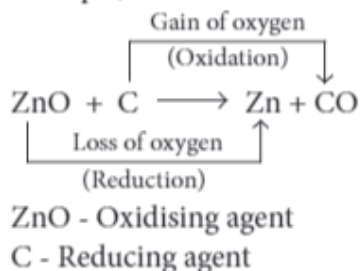
identify the precipitate in the reaction.

- (a)  $\text{BaCl}_2$                       (b)  $\text{BaSO}_4$                       (c)  $\text{Na}_2\text{SO}_4$                       (d)  $\text{NaCl}$

9

Read the following and answer any four questions from 9(i) to 9(v).

The earlier concept of oxidation and reduction is based on the addition or removal of oxygen or hydrogen elements so, in terms of oxygen and hydrogen, oxidation is addition of oxygen to a substance and removal of hydrogen from a substance. On the other hand, reduction is addition of hydrogen to a substance and removal of oxygen from a substance. The substance which gives oxygen to another substance or removes hydrogen from another substance in an oxidation reaction is known as oxidising agent, while the substance which gives hydrogen to another substance or removes oxygen from another substance in a reduction reaction is known as reducing agent. For example,



- (i) A redox reaction is one in which
- (a) both the substances are reduced  
(b) both the substances are oxidised  
(c) an acid is neutralised by the base  
(d) one substance is oxidised while the other is reduced.
- (ii) In the reaction,  $\text{H}_2\text{S} + \text{Cl}_2 \longrightarrow \text{S} + 2\text{HCl}$
- (a)  $\text{H}_2\text{S}$  is the reducing agent.                      (b)  $\text{HCl}$  is the oxidising agent.  
(c)  $\text{H}_2\text{S}$  is the oxidising agent.                      (d)  $\text{Cl}_2$  is the reducing agent.
- (iii) Which of the following processes does not involve either oxidation or reduction?
- (a) Formation of slaked lime from quick lime.  
(b) Heating mercuric oxide.  
(c) Formation of manganese chloride from manganese oxide ( $\text{MnO}_2$ ).  
(d) Formation of zinc from zinc blende.
- (iv)  $\text{Mg} + \text{CuO} \longrightarrow \text{MgO} + \text{Cu}$   
Which of the following is wrong relating to the above reaction?
- (a)  $\text{CuO}$  gets reduced.      (b)  $\text{Mg}$  gets oxidised.      (c)  $\text{CuO}$  gets oxidised.      (d) It is a redox reaction.
- (v) Identify the correct oxidising agent and reducing agent in the following reaction.  
 $\text{Fe}_2\text{O}_3 + 2\text{Al} \longrightarrow 2\text{Fe} + \text{Al}_2\text{O}_3$
- (a)  $\text{Al}$  - Oxidising agent,  $\text{Fe}_2\text{O}_3$  - Reducing agent      (b)  $\text{Fe}_2\text{O}_3$  - Oxidising agent,  $\text{Al}$  - Reducing agent  
(c)  $\text{Fe}$  - Oxidising agent,  $\text{Al}_2\text{O}_3$  - Reducing agent      (b)  $\text{Fe}_2\text{O}_3$  - Oxidising agent,  $\text{Al}_2\text{O}_3$  - Reducing agent



Read the following and answer any four questions from 10(i) to 10(v).

Oxidation has damaging effect on metals as well as on food. The damaging effect of oxidation on metal is studied as corrosion and that on food is studied as rancidity. The phenomenon due to which metals are slowly eaten away by the reaction of air, water and chemicals present in atmosphere, is called corrosion. For example, iron articles are shiny when new, but get coated with a reddish brown powder when left for sometime. This process is known as rusting of iron. Rancidity is the process of slow oxidation of oil and fat (which are volatile in nature) present in the food materials resulting in the change of smell and taste in them.

- (i) Rancidity can be prevented by
- (a) adding antioxidants (b) packaging oily food in nitrogen gas  
(c) both (a) and (b) (d) none of these.
- (ii) Combination of phosphorus and oxygen is an example of
- (a) oxidation (b) reduction (c) rancidity (d) none of these.
- (iii) A science teacher wrote the following statements about rancidity :
- (I) When fats and oils are reduced, they become rancid.  
(II) In chips packet, rancidity is prevented by oxygen.  
(III) Rancidity is prevented by adding antioxidants.  
Select the correct option.
- (a) (I) only (b) (II) and (III) only (c) (III) only (d) (I), (II) and (III)
- (iv) Two statements are given below regarding rusting of iron.
- (I) The rusting of iron is a redox reaction and reaction occurs as,  $4\text{Fe} + 3\text{O}_2 \longrightarrow 4\text{Fe}^{3+} + 6\text{O}^{2-}$   
(II) The metallic iron is oxidised to  $\text{Fe}^{2+}$  and  $\text{O}_2$  is reduced to  $\text{O}^{2-}$ .  
Select the correct statement(s).
- (a) I only (b) II only (c) Both I and II (d) None of these
- (v) Which of the following measures can be adopted to prevent or slow down rancidity?
- (I) Food materials should be packed in air tight container.  
(II) Food should be refrigerated.  
(III) Food materials and cooked food should be kept away from direct sunlight.
- (a) Only II and III (b) Only I and III (c) Only II and III (d) I, II and III

### ASSERTION & REASON

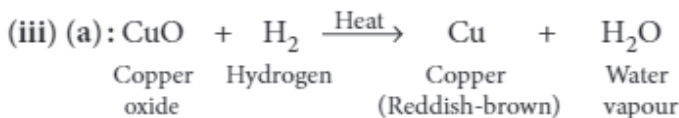
For question numbers 11-30, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :

- (a) Both A and R are true, and R is correct explanation of the assertion.  
(b) Both A and R are true, but R is not the correct explanation of the assertion.  
(c) A is true, but R is false.  
(d) A is false, but R is true.
11. **Assertion :** In the reaction,  $\text{Zn}_{(s)} + 2\text{H}^+_{(aq)} \rightarrow \text{Zn}^{2+}_{(aq)} + \text{H}_{2(g)}$ , zinc acts as an oxidising agent and  $\text{H}^+$  acts as a reducing agent.  
**Reason :** An oxidising agent accepts electrons while a reducing agent loses electrons.
12. **Assertion :**  $2\text{H}_2\text{S}_{(g)} + \text{O}_{2(g)} \longrightarrow 2\text{S}_{(s)} + 2\text{H}_2\text{O}_{(l)}$   
It is a redox reaction.  
**Reason :** In redox reaction, oxidation and reduction take place simultaneously.

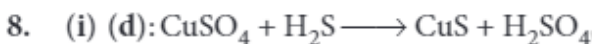
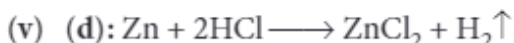
13. **Assertion :** The reaction during which hydrogen is lost is called oxidation reaction.  
**Reason :** Reducing agent removes hydrogen from another substance.
14. **Assertion :**  $\text{MnO}_2 + 4\text{HCl} \longrightarrow \text{MnCl}_2 + \text{Cl}_2 + 2\text{H}_2\text{O}$ , is a redox reaction.  
**Reason :**  $\text{MnO}_2$  oxidises HCl to  $\text{Cl}_2$  and gets reduced to  $\text{MnCl}_2$ .
15. **Assertion :** Magnesium wire burns in presence of  $\text{O}_2$ .  
**Reason :** Magnesium acts as a reducing agent.
16. **Assertion :** Corrosion of iron is commonly known as rusting.  
**Reason :** Corrosion of iron occurs in presence of moist air.
17. **Assertion :** Food materials are often packed in air tight container.  
**Reason :** Oxidation, resulting in rancidity, is prevented.
18. **Assertion :** The food items containing oil and fat are flushed with nitrogen.  
**Reason :** Oil and fat become rancid on oxidation which has the bad taste and smell.
19. **Assertion :** Following reaction describes the rusting of iron and is a redox reaction.  
$$4\text{Fe} + 3\text{O}_2 \rightarrow 4\text{Fe}^{3+} + 6\text{O}^{2-}$$
  
**Reason :** The metallic iron is oxidised to  $\text{Fe}^{3+}$ .
20. **Assertion :** Iron articles are painted so as to prevent them from rusting.  
**Reason :** When the surface of iron is coated with paint, its surface does not come in contact with oxygen and moisture therefore rusting does not take place.
21. **Assertion :** Chemical reaction changes the physical and chemical state of a substance.  
**Reason :** When electric current is passed through water (liquid), it decomposes to produce hydrogen and oxygen gases.
22. **Assertion :** In a balanced chemical equation, total mass of the reactants is equal to the total mass of the products.  
**Reason :** Mass can neither be created nor destroyed during a chemical change.
23. **Assertion :** When calcium carbonate is heated, it decomposes to give calcium oxide and carbon dioxide.  
**Reason :** The decomposition reaction takes place on application of heat, therefore, it is an endothermic reaction.
24. **Assertion :** Chips manufacturers usually flush bags of chips with gas such as nitrogen to prevent the chips from getting oxidised.  
**Reason :** This increase the taste of the chips and helps in their digestion.
25. **Assertion :** Rusting of iron metal is the most common form of corrosion.  
**Reason :** The effect of rusting of iron can be reversed if they are left open in sunlight.
26. **Assertion :** AgBr is used on photographic and X-ray film.  
**Reason :** AgBr is photosensitive and changes to Ag and bromine in presence of sunlight and undergoes decomposition reaction.
27. **Assertion :** Magnesium ribbon keeps on burning in atmosphere of nitrogen.  
**Reason :** Magnesium reacts with nitrogen to form magnesium nitride and this reaction is combination reaction.
28. **Assertion :** Zinc reacts with sulphuric acid to form zinc sulphate and hydrogen gas and it is a displacement reaction.  
**Reason :** Zinc reacts with oxygen to form zinc oxide.





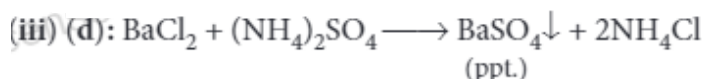


(iv) (c) : It is a single displacement reaction.

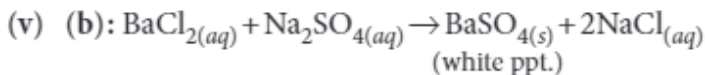


Both  $\text{CuSO}_4$  and  $\text{H}_2\text{S}$  exchange their ions to give new compounds-CuS and  $\text{H}_2\text{SO}_4$ . Hence, this is a double displacement reaction.

(ii) (b): It is an example of single displacement reaction.

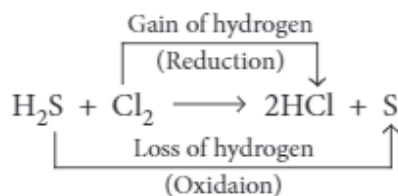


It is a precipitation reaction as well as double displacement reaction.



9. (i) (d) : In a redox reaction, one reactant is reduced while other reactant is oxidised.

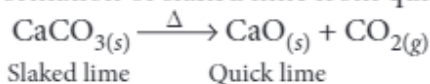
(ii) (a) :



$\text{Cl}_2$  - Oxidising agent

$\text{H}_2\text{S}$  - Reducing agent

(iii) (a) : Formation of slaked lime from quick lime:



It is a decomposition reaction.

(iv) (c) : Addition of oxygen is called oxidation while removal of oxygen is called reduction.

Thus, Mg gets oxidised and CuO gets reduced and it is a redox reaction.

(v) (b)

10. (i) (c) : Antioxidants and nitrogen gas prevent oxidation of food.



(iii) (c) : The oils and fats are slowly oxidised to certain bad smelling compounds, which release foul smell. This is known as rancidity.

Rancidity is prevented by filling nitrogen gas in chips packets.

(iv) (a) (v) (d)



In this reaction, zinc loses electrons and so it is a reducing agent, while  $\text{H}^+$  gains electrons and so it is an oxidising agent.

12. (a)

13. (c) : Reducing agent gives hydrogen to another substance.

14. (a) 15. (b)

16. (b) 17. (a)

18. (a)

19. (a) : Fe is oxidised to  $\text{Fe}^{3+}$  and acts as reducing agent.

20. (a) 21. (b)

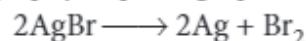
22. (a) : This is according to the law of conservation of mass.

23. (b) :  $\text{CaCO}_3$  on heating gives  $\text{CO}_2$  and  $\text{CaO}$ .

24. (c) : This is because nitrogen is an antioxidant. It prevents the chips from being oxidised.

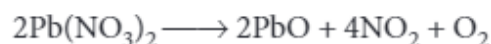
25. (c)

26. (a) : AgBr is a chemical compound. It is widely used in photography as photographic emulsions.



27. (a) 28. (b)

29. (b) : Decomposition reaction is a reaction in which a compound breaks down into two or more simpler substances.



30. (c)



## CASE STUDY / PASSAGE BASED QUESTIONS

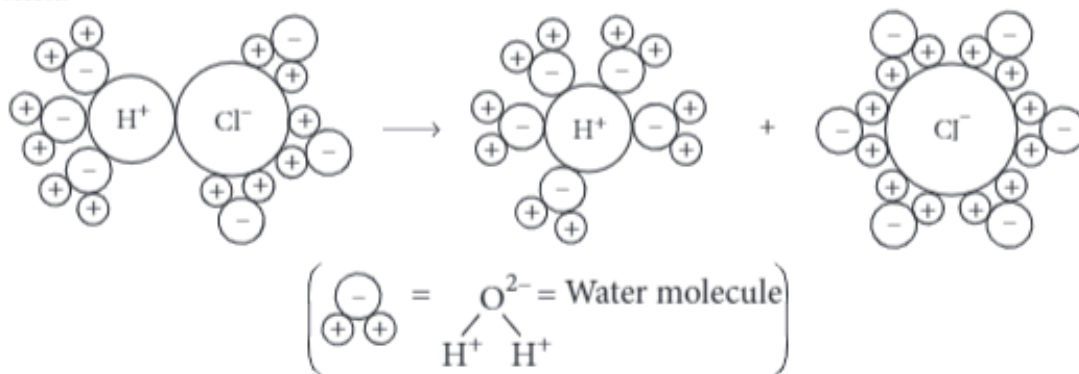
1

Read the following and answer any four questions from 1(i) to 1(v).

The acidic behaviour of acids is due to the presence of hydrogen( $H^+$ ) ions in them. They produce hydrogen ions in the presence of water. Water is a polar solvent and this property of water helps in weakening the bond between the ions and makes them soluble. Hence, acids and bases produce ions in aqueous solutions.

It may be noted that a dry HCl gas or a solution of hydrogen chloride in organic, non-polar solvents like toluene or benzene do not show acidic properties. This is because hydrogen chloride does not undergo ionization in toluene.

The reason why HCl splits into  $H^+$  and  $Cl^-$  ions in presence of water lies in the fact that water molecules, being polar, pull the  $H^+$  and  $Cl^-$  ions apart and thus, the bond in HCl is broken.



Dissociation of HCl into  $H^+$  and  $Cl^-$  ions in presence of water

- (i) Identify the wrong statement.
- Higher the hydronium ion concentration, lower is the pH value.
  - Universal indicator is used to judge how strong a given acid or base is.
  - As the pH value increases from 7 to 14, it represents increase in  $H^+$  ion concentration in the solution.
  - Value less than 7 on the pH scale represents an acidic solution.
- (ii) If the pH of a solution is 8, then its  $[H^+]$  ion is
- $\log 10^{-8}$
  - $10^8$
  - $10^{-8}$
  - 8
- (iii) In terms of acidic strength, which one of the following is in the correct increasing order?

## Syllabus

Their definitions in terms of furnishing of  $H^+$  and  $OH^-$  ions, General properties, examples and uses, concept of pH scale (Definition relating to logarithm not required), importance of pH in everyday life; preparation and uses of Sodium hydroxide, Bleaching powder, Baking soda, Washing soda and Plaster of Paris.

- (a) Water < Acetic acid < Hydrochloric acid      (b) Water < Hydrochloric acid < Acetic acid  
(c) Acetic acid < Water < Hydrochloric acid      (d) Hydrochloric acid < Water < Acetic acid

(iv) Which of the following compounds does not give  $H^+$  ions in aqueous solution?

- (a)  $H_3PO_4$       (b)  $C_2H_5OH$       (c)  $H_2CO_3$       (d)  $CH_3COOH$

(v) Four solutions labelled as P, Q, R and S have pH values 1, 9, 3 and 13 respectively.

Which of the following statements about the given solutions is incorrect?

- (a) Solution P has higher concentration of hydrogen ions than solution R.  
(b) Solution Q has lower concentration of hydroxide ions than solution S.  
(c) Solutions P and Q will turn red litmus solution blue.  
(d) Solution P is highly acidic while solution Q is weakly basic.

## 2

Read the following and answer any four questions from 2(i) to 2(v).

A compound, X of sodium forms a white powder. It is a constituent of baking powder and is used in some antacids. When heated it gives a compound, Y which is anhydrous and absorbs water to become a hydrated salt. When this salt is kept in open air, it loses water molecules in a process called efflorescence. When dissolved in water it forms a strong base and a weak acid, Z.

(i) What is the compound, X?

- (a)  $NaHCO_3$       (b)  $Na_2CO_3$       (c)  $NaOH$       (d)  $NaCl$

(ii) The compound, Y is

- (a)  $NaHCO_3$       (b)  $Na_2CO_3$       (c)  $Na_2CO_3 \cdot 10H_2O$       (d)  $NaCl$

(iii) What is the nature of the solution formed by dissolving Y in water?

- (a) Alkaline      (b) Acidic      (c) Neutral      (d) It remains insoluble.

(iv) Identify the compound, Z.

- (a)  $CO_2$       (b)  $H_2CO_3$       (c)  $NaOH$       (d)  $H_2O$

(v) Sodium carbonate is a basic compound because it is a salt of a

- (a) strong acid and strong base      (b) weak acid and weak base  
(c) strong acid and weak base      (d) weak acid and strong base.

## 3

Read the following and answer any four questions from 3(i) to 3(v).

Sodium chloride obtained from sea water or from lakes contains many impurities such as sulphates of sodium and magnesium along with chlorides of calcium and magnesium. The chlorides of calcium and magnesium are particularly undesirable on account of their deliquescent nature.

For its purification, common salt is dissolved in minimum quantity of water to get a saturated solution from which insoluble impurities are filtered off. Then hydrogen chloride gas is passed through the saturated solution and the crystals of pure  $NaCl$  separate out. The soluble impurities remain in the mother liquor. The crystals are filtered, washed and dried.

- (i) Select the correct statement regarding salt NaCl.
- (a) Pure NaCl is hygroscopic in nature.  
 (b) It is soluble in alcohol.  
 (c) Pure NaCl is not hygroscopic, it shows hygroscopic nature due to impurities.  
 (d) It is a brown crystalline solid.
- (ii) Nature of aqueous solution of common salt is
- (a) acidic                      (b) alkaline                      (c) basic                      (d) neutral.
- (iii) In the given series of reactions, Y and Z respectively are
- $$\begin{array}{ccc} \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2 + \text{NH}_3 & \xrightarrow{\quad} & \text{X} + \text{Y} \\ & & \downarrow \Delta \text{ } -\text{H}_2\text{O}, -\text{CO}_2 \\ & & \text{Z} \\ \text{Q} & \xleftarrow{+10\text{H}_2\text{O}} & \text{Z} \end{array}$$
- (Q is used in removing permanent hardness of water.)
- (a) NaHCO<sub>3</sub>, NaOCl<sub>2</sub>      (b) NH<sub>4</sub>Cl, Na<sub>2</sub>CO<sub>3</sub>      (c) Na<sub>2</sub>CO<sub>3</sub>, NH<sub>4</sub>Cl      (d) Na<sub>2</sub>CO<sub>3</sub>, NaHCO<sub>3</sub>
- (iv) Which of the following compounds is alkaline in aqueous medium?
- (a) Na<sub>2</sub>CO<sub>3</sub>                      (b) NaCl                      (c) H<sub>2</sub>CO<sub>3</sub>                      (d) CuSO<sub>4</sub>
- (v) Some statements regarding salt NaCl are given below:
- (I) It is prepared by chlor-alkali process.  
 (II) It is a white crystalline substance.  
 (III) It also exists in the form of rocks and is called rock salt.  
 (IV) It is a neutral salt, pH value of NaCl is 7.  
 Select the correct statements.
- (a) II and III only                      (b) III and IV only                      (c) I and IV only                      (d) II, III and IV only

#### 4

Read the following and answer any four questions from 4(i) to 4(v).

Chemically, Plaster of Paris (POP) is calcium sulphate hemihydrate, *i.e.*, containing half molecule of water of crystallisation. It is represented by the formula, CaSO<sub>4</sub>·1/2H<sub>2</sub>O. Half molecule of water of crystallisation means that one water molecule is shared by two formula units of CaSO<sub>4</sub>. Hence, we also represent its formula as (CaSO<sub>4</sub>)<sub>2</sub>·H<sub>2</sub>O. The name, plaster of Paris, was given to this compound because for the first time, it was made from gypsum which was mainly found in Paris.

- (i) The difference of water molecules in gypsum and plaster of Paris is
- (a) 5/2                      (b) 2                      (c) 1/2                      (d) 3/2
- (ii) Plaster of Paris hardens by
- (a) giving off CO<sub>2</sub>                      (b) changing into CaCO<sub>3</sub>  
 (c) combining with water                      (d) giving out water.
- (iii) Which of the following statements is incorrect?
- (a) Plaster of Paris is used to ornate designs on walls and ceilings.  
 (b) On heating gypsum above 373 K, CaSO<sub>4</sub> is obtained.  
 (c) Dead burnt plaster is CaSO<sub>4</sub>·2H<sub>2</sub>O.  
 (d) Setting of plaster is due to its hydration into gypsum.



- (iv) Select the incorrect statement with respect to gypsum.
- (a) It is slightly soluble in water.
  - (b) It is also known as alabaster.
  - (c) On heating gypsum at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate.
  - (d) Chemical formula of gypsum is  $\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$ .
- (v) Plaster of Paris is obtained by
- (a) adding water to calcium sulphate
  - (b) adding sulphuric acid to calcium hydroxide
  - (c) heating gypsum to a very high temperature
  - (d) heating gypsum to  $100^\circ\text{C}$ .

5

Read the following and answer any four questions from 5(i) to 5(v).

pH is quite useful to us in a number of ways in daily life. Some of its applications are :

**Control of pH of the soil :** Plants need a specific pH range for proper growth. The soil may be acidic, basic or neutral depending upon the relative concentration of  $\text{H}^+$  and  $\text{OH}^-$ . The pH of any soil can be determined by using pH paper. If the soil is too acidic, it can be corrected by adding lime to it. If the soil is too basic, it can be corrected by adding organic manure which contains acidic materials.

**Regaining shine of a tarnished copper vessel by use of acids :** A copper vessel gets tarnished due to formation of an oxide layer on its surface. On rubbing lemon on the vessel, the surface is cleaned and the vessel begins to shine again. This is due to the fact that copper oxide is basic in nature, which reacts with the acid (citric acid) present in lemon to form a salt (copper citrate) which is washed away with water. As a result, the layer of copper oxide is removed from the surface of the vessel and the shining surface is exposed.

**Self-defence by animals through chemical warfare :** Stings of bees and ants contain methanoic acid. When stung, it causes lot of pain and irritation. This can be cured by rubbing the affected area with mild base like baking soda.

- (i) When black copper oxide placed in a beaker is treated with dilute HCl, its colour changes to
- (a) white
  - (b) dark red
  - (c) bluish green
  - (d) no change.
- (ii) *P* is an aqueous solution of acid and *Q* is an aqueous solution of base. When these two are diluted separately, then
- (a) pH of *P* increases while that of *Q* decreases till neutralisation.
  - (b) pH of *P* decreases while that of *Q* increases till neutralisation.
  - (c) pH of both *P* and *Q* decrease.
  - (d) pH of both *P* and *Q* increase.
- (iii) Which of the following acids is present in bee sting?
- (a) Formic acid
  - (b) Acetic acid
  - (c) Citric acid
  - (d) Hydrochloric acid
- (iv) Sting of ant can be cured by rubbing the affected area with soap because
- (a) it contains oxalic acid which neutralises the effect of formic acid
  - (b) it contains aluminium hydroxide which neutralises the effect of formic acid
  - (c) it contains sodium hydroxide which neutralises the effect of formic acid
  - (d) none of these.



(v) The pH of soil X is 7.5 while that of soil Y is 4.5. Which of the two soils, should be treated with powdered chalk to adjust its pH?

- (a) X only                              (b) Y only                              (c) Both X and Y                      (d) None of these

6

Read the following and answer any four questions from 6(i) to 6(v).

Baking powder produces carbon dioxide on heating, so it is used in cooking to make the batter spongy. Although, baking soda also produces  $\text{CO}_2$  on heating, but it is not used in cooking because on heating, baking soda produces sodium carbonate along with carbon dioxide. Sodium carbonate, thus, produced, makes the taste bitter. Baking powder is the mixture of baking soda and a mild edible acid. Generally, tartaric acid is mixed with baking soda to make baking powder. When baking powder is heated,  $\text{NaHCO}_3$  decomposes to give  $\text{CO}_2$  which makes bread and cake fluffy. Tartaric acid helps to remove bitter taste due to formation of sodium tartrate.



(i) On passing excess  $\text{CO}_2$  gas in aqueous solution of sodium carbonate, the substance obtained is

- (a) NaOH                                  (b)  $\text{NaHCO}_3$   
 (c)  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$                   (d)  $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$

(ii) When sodium hydrogen carbonate is added to acetic acid, it evolves a gas. Which of the following statements are true about the gas evolved?

- (I) It turns lime water milky.                  (II) It extinguishes a burning splinter.  
 (III) It dissolves in a solution of sodium hydroxide.      (IV) It has a pungent odour.  
 (a) (I) and (II)                                  (b) (I), (II) and (III)  
 (c) (II), (III) and (IV)                        (d) (I) and (IV)

(iii) Select the correct statement regarding sodium hydrogen carbonate.

- (a) CO and  $\text{CO}_2$  are produced during the heating of  $\text{NaHCO}_3$ .  
 (b) It is insoluble in water.  
 (c) It is used in soda-acid fire extinguishers.  
 (d) All of these.

(iv) Acetic acid was added to a solid X kept in a test tube. A colourless and odourless gas was evolved. The gas was passed through lime water which turned milky. It was concluded that

- (a) solid X is sodium hydroxide and the gas evolved is  $\text{CO}_2$   
 (b) solid X is sodium bicarbonate and the gas evolved is  $\text{CO}_2$   
 (c) solid X is sodium acetate and the gas evolved is  $\text{CO}_2$   
 (d) solid X is sodium chloride and the gas evolved is  $\text{CO}_2$ .

(v) Which of the following statements are correct regarding baking soda?

- (I) Baking soda is sodium hydrogen carbonate.  
 (II) On heating, baking soda gives sodium carbonate.  
 (III) It is used for manufacture of soap.  
 (IV) It is an ingredient of baking powder.  
 (a) I and IV only                                  (b) I, II and III only  
 (c) I, II and IV only                              (d) I, II, III and IV

## 7

Read the following and answer any four questions from 7(i) to 7(v).

Bleaching powder is also known as chloride of lime. It is a solid and yellowish white in colour. Bleaching powder can be easily identified by the strong smell of chlorine. When calcium hydroxide (slaked lime) reacts with chlorine, it gives calcium oxychloride (bleaching powder) and water is formed. Aqueous solution of bleaching powder is basic in nature. The material to be bleached is first passed through solution of NaOH to remove greasy matter. Then it is passed through aqueous solution of bleaching powder and very dil. HCl solution. HCl reacts with bleaching powder to liberate nascent oxygen which bleaches material.

(i) Bleaching powder is used as

- (a) bleaching agent in textile, paper and jute industry
- (b) disinfectant for water to make water free of germs
- (c) oxidising agent in many industries
- (d) all of these.

(ii) Bleaching powder is also known as

- (a) calcium oxychloride
- (b) calcium hypochlorite
- (c) chloride of lime
- (d) all of these.

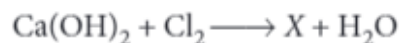
(iii) Bleaching powder gives smell of chlorine because it

- (a) is unstable
- (b) gives chlorine on exposure to atmosphere
- (c) is a mixture of chlorine and slaked lime
- (d) contains excess of chlorine.

(iv) Select the correct statement(s) regarding bleaching powder.

- (a) It is pale yellow powder having smell of chlorine.
- (b) It is sparingly soluble in water and gives milky suspension when dissolved in water.
- (c) As bleaching powder gives nascent oxygen, it shows bleaching property.
- (d) All of these.

(v) Identify the product 'X' in the given reaction.



(a)  $\text{CaOCl}_2$

(b)  $\text{CaCl}_2$

(c)  $\text{Ca(ClO}_3)_2$

(d)  $\text{CaCO}_3$

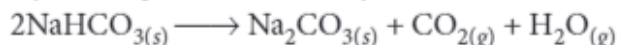
## 8

Read the following and answer any four questions from 8(i) to 8(v).

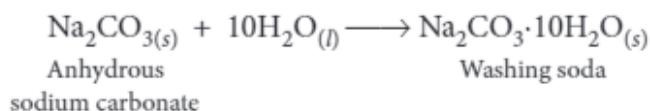
The preparation of washing soda is carried out through following steps :

**Step-I :** Manufacture of sodium hydrogen carbonate :  $\text{NaCl} + \text{H}_2\text{O} + \text{NH}_3 + \text{CO}_2 \longrightarrow \text{NaHCO}_3 + \text{NH}_4\text{Cl}$   
Sodium  
hydrogen carbonate

**Step-II :** Thermal decomposition of sodium hydrogen carbonate : When dry crystals of sodium hydrogen carbonate are heated strongly, they decompose to form anhydrous sodium carbonate (soda ash).



**Step-III :** Recrystallisation of sodium carbonate : Sodium carbonate thus obtained is recrystallised to form crystals of washing soda.



- (i) Some of the uses of washing soda are given below :  
(I) It is used for removing permanent hardness of water.  
(II) It is used in glass industry.  
(III) It is used in paper industry.  
(IV) It is used in the manufacture of sodium compounds such as borax.  
Select the correct option regarding uses of washing soda.  
(a) (I) and (II) only (b) (II) and (III) only  
(c) (II) and (IV) only (d) (I), (II), (III) and (IV)
- (ii) What products will be formed along with water when sodium carbonate reacts with dilute hydrochloric acid?  
(a) CO and NaCl (b) Na and CO<sub>2</sub>  
(c) NaCl and CO<sub>2</sub> (d) Na and CO
- (iii) Chief raw materials for the manufacture of washing soda are  
(a) sodium chloride, ammonia and limestone  
(b) ammonia, sodium hydrogen carbonate and copper sulphate  
(c) sodium hydroxide, calcium chloride and ammonia  
(d) calcium chloride, sodium chloride and copper sulphate.
- (iv) What is the action of sodium carbonate on litmus paper?  
(a) Turns red litmus blue (b) Turns blue litmus red (c) No change on litmus (d) Both (a) and (b)
- (v) What products will be obtained when solution of sodium carbonate and slaked lime is heated?  
(a) NaOH and CaCl<sub>2</sub> (b) CaCO<sub>3</sub> and NaOH  
(c) NaHCO<sub>3</sub> and NaOH (d) NaCl and CaCO<sub>3</sub>

## 9

Read the following and answer any four questions from 9(i) to 9(v).

“Indicator is a chemical compound which is added to the solution in very small amount to detect its acidic or basic nature.” As they show colour change in acidic and basic medium, they are also called acid-base indicators. In other words, “an acid-base indicator is that substance which possesses one colour in acidic medium and a different colour in alkaline medium.”

Indicators, basically, are coloured organic substances either extracted from plants (natural indicators) or synthesised in the laboratory (synthetic indicators). A few common acid base indicators are : Litmus, phenolphthalein, methyl orange etc. In addition to these there are some naturally occurring substances which have different smell in acidic and basic medium. These substances are called olfactory indicators.

- (i) Which one of the following will turn red litmus blue?  
(a) Vinegar (b) Baking soda solution (c) Lemon juice (d) Soft drinks
- (ii) A solution turns blue litmus red. The pH of the solution is probably  
(a) 8 (b) 10 (c) 12 (d) 6
- (iii) A solution in test tube ‘A’ turns red litmus blue, evolves hydrogen gas on reaction with zinc and does not react with sodium carbonate. Whereas, solution in test tube ‘B’ turns blue litmus red, liberates hydrogen gas on reaction with zinc and evolves carbon dioxide gas with sodium carbonate. Identify ‘A’ and ‘B’.  
(a) ‘A’ is an acid, ‘B’ is a base. (b) ‘A’ is a base, ‘B’ is an acid.  
(c) Both ‘A’ and ‘B’ are bases. (d) Both ‘A’ and ‘B’ are acids.



(iv) Select the incorrect option.

Indicator	Colour in acidic medium	Colour in basic medium
(a) Litmus (Purple)	Red	Blue
(b) Flower of hydrangea plant (Blue)	Red	Green
(c) Red cabbage juice (Purple)	Red or Pink	Green
(d) Turmeric Juice (Yellow)	Yellow	Reddish brown

(v) Which one of the following can be used as an acid-base indicator by visually impaired student?

- (a) Litmus                      (b) Turmeric                      (c) Vanilla essence                      (d) Methyl orange

10

Read the following and answer any four questions from 10(i) to 10(v).

Acids turn blue litmus red but have no effect on red litmus. Bases turn red litmus blue but have no effect on blue litmus. The sample in which phenolphthalein remains colourless while methyl orange changes to pink/red are acids while the samples in which phenolphthalein colour changes to pink and methyl orange changes to yellow are bases. Some observations of different sample solutions in litmus, phenolphthalein and methyl orange indicator are given in the table.

Sample solution	Red litmus solution	Blue litmus solution	Phenolphthalein indicator	Methyl orange indicator
HCl	No colour change	Red	Colourless	Red/ Pink
H <sub>2</sub> SO <sub>4</sub>	No colour change	Red	Colourless	Red/Pink
HNO <sub>3</sub>	No colour change	Red	Colourless	Red/Pink
CH <sub>3</sub> COOH	No colour change	Red	Colourless	Red/Pink
NaOH	Blue	No colour change	Pink	Yellow
Ca(OH) <sub>2</sub>	Blue	No colour change	Pink	Yellow
KOH	Blue	No colour change	Pink	Yellow
Mg(OH) <sub>2</sub>	Blue	No colour change	Pink	Yellow
NH <sub>4</sub> OH	Blue	No colour change	Pink (Becomes colourless after sometime)	Yellow (Becomes colourless after sometime)

(i) Which of the following substances does not turn red litmus solution to blue?

- (a) Al(OH)<sub>3</sub>                      (b) Mg(OH)<sub>2</sub>                      (c) H<sub>3</sub>PO<sub>4</sub>                      (d) NH<sub>4</sub>OH

(ii) Phenolphthalein's colour in basic medium is \_\_\_\_\_ but in acid it is \_\_\_\_\_.

- (a) pink, colourless                      (b) yellow, pink                      (c) pink, orange                      (d) blue, red

(iii) Which of the following acids are edible?

- (I) Citric acid                      (II) Tartaric acid                      (III) Hydrochloric acid                      (IV) Carbonic acid  
(a) (I) and (II) only                      (b) (I), (II) and (IV) only                      (c) (I), (II) and (III) only                      (d) (I), (II), (III) and (IV)

(iv) The colour of methyl orange in neutral solution is

- (a) red                      (b) orange                      (c) yellow                      (d) purple.

(v) Which of the following cannot act as an indicator?

- (a) Methyl orange                      (b) Methyl chloride                      (c) Turmeric juice                      (d) Phenolphthalein



## ASSERTION & REASON

For question numbers 11-30, two statements are given—one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :

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

11. **Assertion** : Calcium sulphate hemihydrate,  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$  is called plaster of Paris.

**Reason** : Plaster of Paris is used for producing moulds for pottery and ceramics and casts of statues.

12. **Assertion** : Phosphoric acid is a weak acid.

**Reason** : Phosphoric acid when dissolved in water dissociates partially and produces very little  $\text{H}^+$  ions.

13. **Assertion** : Antacids neutralize the effect of extra acid produced in the stomach during indigestion and thus provide relief.

**Reason** : Antacids are mild bases.

14. **Assertion** : HCl is a stronger acid than acetic acid.

**Reason** : On dissociation, HCl yields lesser hydrogen ions for the same concentration as compared to acetic acid.

15. **Assertion** :  $\text{pH} = 7$  signifies pure water.

**Reason** :  $\text{pH}$  of acetic acid is greater than 7.

16. **Assertion** :  $\text{pH}$  of ammonium nitrate solution is acidic.

**Reason** : Solution of a salt of weak base and strong acid is acidic.

17. **Assertion** : Acetic acid does not act as an acid in benzene solution.

**Reason** : Benzene is non-polar.

18. **Assertion** : Bleaching powder reacts with dilute acids to evolve chlorine.

**Reason** : The chlorine liberated by the action of dilute acids on bleaching powder is called available chlorine.

19. **Assertion** : Sodium carbonate pentahydrate is also known as washing soda.

**Reason** : Chief raw materials for the manufacture of washing soda are  $\text{NH}_3$ ,  $\text{NaCl}$  and  $\text{CaCO}_3$ .

20. **Assertion** : Common salt is used for the preparation of many chemicals such as sodium hydroxide, bleaching powder, baking soda, washing soda etc.

**Reason** : Main source of sodium chloride is sea water.

21. **Assertion** :  $\text{AlCl}_3$  is a basic salt.

**Reason** :  $\text{AlCl}_3$  is a salt of strong acid and a weak base.

22. **Assertion** : Baking soda is prepared by chlor-alkali process.

**Reason** : Brine decomposes to sodium hydroxide on passing electricity through it.

23. **Assertion** : Salt of  $\text{KNO}_3$  is formed by strong base and weak acid.

**Reason** : Salt of  $\text{NH}_4\text{Cl}$  is formed by weak base and strong acid.

24. **Assertion** : Strength of the acid or base decreases with dilution.

**Reason** : Ionization of an acid or a base increases with dilution.

25. **Assertion** : Higher the  $\text{H}^+$  ion concentration, lower is the  $\text{pH}$  value.

**Reason** : The  $\text{pH}$  of a neutral solution = 7, that of a basic solution  $< 7$  and that of an acidic solution  $> 7$ .

26. **Assertion :**  $\text{CH}_3\text{COOH}$  is used as vinegar in cooking and food preservatives.  
**Reason :** Strong acids are those acids which ionise almost completely in aqueous solution and hence produce a large amount of  $\text{H}^+$  ions.
27. **Assertion :** Tooth decay starts when the pH of the mouth is lower than 5.5.  
**Reason :** Enamel starts corroding below 5.5 pH.
28. **Assertion :** The chemical name of bleaching powder is calcium oxychloride.  
**Reason :** Bleaching powder is used as an oxidising agent in chemical industries.
29. **Assertion :** The process of dissolving an acid or a base in water is highly exothermic reaction.  
**Reason :** Water must always be added slowly to acid with constant stirring.
30. **Assertion :** Phenolphthalein is an acid-base indicator.  
**Reason :** Phenolphthalein gives different colours in acidic and basic medium.

## HINTS & EXPLANATIONS

1. (i) (c) : As the pH value increases from 7 to 14, it represents decrease in  $\text{H}^+$  ion concentration in the solution.

(ii) (c) :  $\text{pH} = -\log_{10} [\text{H}^+] = 8$   
 $\log_{10} [\text{H}^+] = -8$   
 $[\text{H}^+] = 10^{-8} \text{ mol/L}$

(iii) (a)

(iv) (b) :  $\text{C}_2\text{H}_5\text{OH}$  is not an ionic compound, it is a covalent compound and hence does not give  $\text{H}^+$  ions in aqueous solution.

(v) (c) : (a) Lower the pH of the solution, more acidic is the solution and higher is the  $[\text{H}^+]$  ions.

Thus, solution P (pH = 1) has higher  $[\text{H}^+]$  ions than solution R (pH = 3).

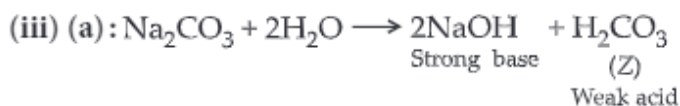
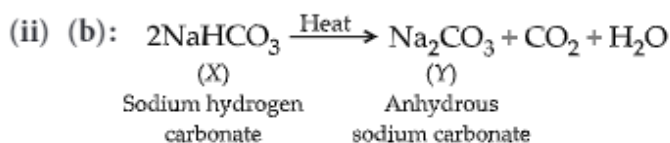
(b) Higher the pH of the solution, more basic is the solution and higher is the  $[\text{OH}^-]$  ions.

Thus, solution Q (pH = 9) has lower  $[\text{OH}^-]$  ions than solution S (pH = 13).

(c) Solution P (pH = 1) is acidic which turns blue litmus solution red whereas solution Q (pH = 9) is basic which turns red litmus solution blue.

(d) Solution P (pH = 1) is highly acidic while solution S (pH = 13) is highly basic and solution Q (pH = 9) is weakly basic.

2. (i) (a) : The compound of sodium that is a constituent of baking powder and is used in antacids, is sodium hydrogen carbonate ( $\text{NaHCO}_3$ ).



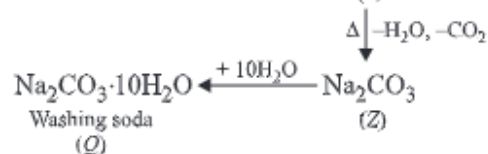
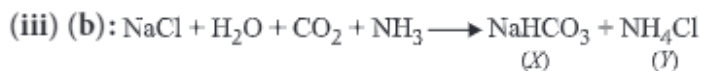
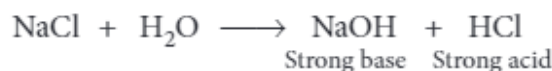
$\text{NaOH}$  ionises completely to give a large amount of  $\text{OH}^-$  ions whereas  $\text{H}_2\text{CO}_3$  ionises partially to give a small amount of  $\text{H}^+$  ions. Hence, the solution is overall alkaline.

(iv) (b) : Z is carbonic acid, a weak acid formed when  $\text{Na}_2\text{CO}_3$  is dissolved in water.

(v) (d)

3. (i) (c) :  $\text{NaCl}$  is insoluble in alcohol and it is a white crystalline solid. Pure  $\text{NaCl}$  is not hygroscopic in nature.

(ii) (d) : Aqueous solution of common salt is neutral in nature.



(iv) (a) : When  $\text{Na}_2\text{CO}_3$  (sodium carbonate) is dissolved in water then it forms alkaline aqueous

solution due to the formation of NaOH which is a strong alkali.

(v) (d): Sodium hydroxide (NaOH) is prepared by chlor-alkali process.

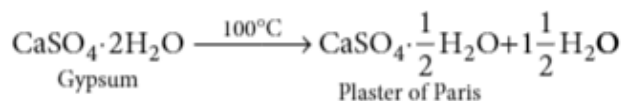
4. (i) (d): Gypsum is  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  and plaster of Paris is  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ . Difference in number of water molecules =  $\frac{3}{2}$

(ii) (c): Plaster of Paris is hardened by combining with water.

(iii) (c): Dead burnt plaster is  $\text{CaSO}_4$  (anhydrous calcium sulphate).

(iv) (d): Gypsum :  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$   
Plaster of paris:  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$

(v) (d): Gypsum on heating upto  $100^\circ\text{C}$  gives plaster of Paris.



5. (i) (c) :  $\text{CuO} + 2\text{HCl} \longrightarrow \text{CuCl}_2 + 2\text{H}_2\text{O}$   
(Bluish green)

(ii) (a): On diluting,  $\text{H}^+$  ion concentration reduces per unit volume thus, pH increases.

On the other hand, on diluting,  $\text{OH}^-$  concentration also reduces, pOH increases and pH decreases.

As,  $\text{pOH} + \text{pH} = 14$ .

Thus, pH of Q (basic solution) decreases while that of P (acidic solution) increases on dilution.

(iii) (c): Formic acid is the common name of methanoic acid, and it is present in bee sting.

(iv) (c)

(v) (b): Soil Y is acidic. Hence, it should be treated with powdered chalk to reduce its acidity.

6. (i) (b):  $\text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2 \longrightarrow 2\text{NaHCO}_3$

(ii) (b):  $\text{NaHCO}_3 + \text{CH}_3\text{COOH} \longrightarrow \text{CH}_3\text{COONa} + \text{CO}_2 \uparrow + \text{H}_2\text{O}$

Carbon dioxide gas is evolved which turns limewater milky. It extinguishes a burning splinter since it is not a supporter of combustion. It dissolves in sodium hydroxide solution and it is an odourless gas.

(iii) (c) :  $2\text{NaHCO}_3 \xrightarrow{\text{Heat}} \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$   
 $\text{NaHCO}_3$  is soluble in water.

(iv) (b):  $\text{NaHCO}_3 + \text{CH}_3\text{COOH} \longrightarrow \text{CH}_3\text{COONa} + \text{CO}_2 + \text{H}_2\text{O}$

(v) (c) : It is not used in manufacture of soap.

7. (i) (d) (ii) (d)

(iii) (b): Bleaching powder gives chlorine on exposure to air by reacting with  $\text{CO}_2$ .

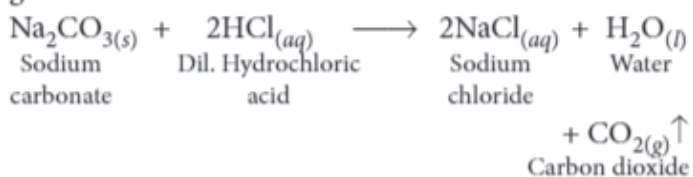


(iv) (d)

(v) (a) :  $\text{Ca}(\text{OH})_2 + \text{Cl}_2 \longrightarrow \text{CaOCl}_2 + \text{H}_2\text{O}$

8. (i) (d)

(ii) (c) :  $\text{Na}_2\text{CO}_3$  reacts with dilute acids to give  $\text{CO}_2$  gas with brisk effervescence.



(iii) (a) : Chief raw materials for the manufacture of washing soda are sodium chloride (NaCl), ammonia ( $\text{NH}_3$ ) and limestone ( $\text{CaCO}_3$ ).

(iv) (a) : Sodium carbonate turns red litmus blue.

(v) (b): Sodium hydroxide and calcium carbonate are formed when the solution of sodium carbonate and slaked lime,  $\text{Ca}(\text{OH})_2$  is heated.



9. (i) (b): Baking soda ( $\text{NaHCO}_3$ ) is basic in nature.

(ii) (d): The solution turns blue litmus red, hence it is acidic.

(iii) (b): Acids turn blue litmus red, liberate hydrogen gas with zinc and evolve carbon dioxide gas with metal carbonates. Bases turn red litmus blue, evolve hydrogen gas with zinc and do not react with metal carbonates.

(iv) (b):

Indicator	Colour in acidic	Colour in basic medium
Flowers of hydrangea plant (blue)	Blue	Pink

(v) (c) : Vanilla essence is an olfactory indicator. So, its smell is different in acidic and basic medium which can be detected easily by a visually impaired student.

10. (i) (c) (ii) (a)



(iii) (b): Citric and tartaric acid are from organic substances such as lemon and tamarind respectively and they are edible. Hydrochloric acid though formed inside stomach is not edible. Carbonic acid is a mild acid and is edible in the form of soda water.

(iv) (b)

(v) (b)

11. (b)

12. (a)

13. (a)

14. (c): On dissociation, HCl yields more hydrogen ions for the same concentration as compared to acetic acid.

15. (c): pH of acetic acid is less than 7.

16. (a): Ammonium nitrate is a salt of ammonium hydroxide (weak base) and nitric acid (strong acid).

17. (a): For ionization of an acid or base, polar solvents (like water) are required. As ionization does not take place in non-polar solvents (like benzene) so acetic acid does not act as an acid.

18. (b): The reaction involved is,  

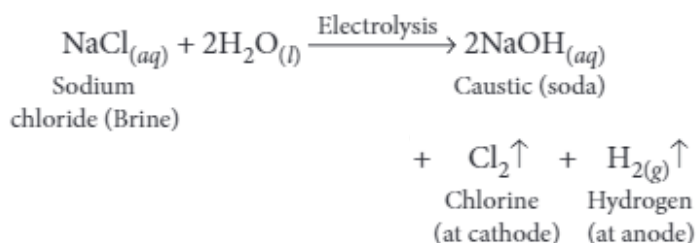
$$\text{CaOCl}_2 + \text{H}_2\text{SO}_4(\text{dilute}) \longrightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{Cl}_2\uparrow$$

19. (d): Washing soda is sodium carbonate decahydrate,  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ .

20. (b)

21. (d):  $\text{AlCl}_3$  is an acidic salt as it is a salt of strong acid (HCl) and a weak base [ $\text{Al}(\text{OH})_3$ ].

22. (d): Caustic soda (sodium hydroxide, NaOH) is prepared by chlor-alkali process. Brine decomposes to sodium hydroxide. Chlorine gas is formed at the anode and hydrogen gas at the cathode. Sodium hydroxide solution is formed near the cathode.



23. (d):  $\text{KOH} + \text{HNO}_3 \longrightarrow \text{KNO}_3 + \text{H}_2\text{O}$   
 (Strong base) (Strong acid)

$\text{NH}_4\text{OH} + \text{HCl} \longrightarrow \text{NH}_4\text{Cl}$   
 (Weak base) (Strong acid)

24. (b): Ionization of an acid or a basic increases on dilution but concentration of  $\text{H}^+$  or  $\text{OH}^-$  ions decreases per unit volume, thus strength of the acid or the base decreases with dilution.

25. (c): Higher the  $\text{H}^+$  ion concentration, lower is the pH value. The pH value less than 7 represents an acidic solution and value more than 7 represents a basic solution.

26. (b)

27. (a)

28. (b)

29. (c): The process of dissolving an acid or a base in water is highly exothermic reaction. Acid must always be added slowly to water with constant stirring.

30. (a): Phenolphthalein is a weak organic acid and may be represented as HPh.



(Colourless) (Colourless) (Pink)

In acidic medium, excess of  $\text{H}^+$  ions are present and so equilibrium is towards left and hence solution is colourless. While in basic medium,  $\text{OH}^-$  ions combine with  $\text{H}^+$  ions to form unionised water molecules and so equilibrium is towards right and hence solution has pink colour. Therefore, phenolphthalein is an acid-base indicator.

## CASE STUDY / PASSAGE BASED QUESTIONS

1

Read the following and answer any four questions from 1(i) to 1(v).

The chemical reactivity of an element depends upon its electronic configuration. All elements having less than eight electrons in the outermost shell show chemical reactivity. During chemical reactions, atoms of all elements tend to achieve a completely filled valence shell. Metals are electropositive in nature. They have tendency to lose one or more electrons present in the valence shell of their atoms to form cations and achieve nearest noble gas configuration. The compounds formed by the transfer of electrons from one element to other are known as ionic or electrovalent compounds.

(i) The electronic configurations of three elements X, Y and Z are :



Which of the following is correct regarding these elements?

- (a) X is a metal. (b) Y is a metal.  
(c) Z is a non-metal. (d) Y is a non-metal and Z is a metal.

(ii) Element X reacts with element Y to form a compound Z. During the formation of compound Z, atoms of X lose one electron each whereas atoms of Y gain one electron each. Which of the following properties is not shown by compound Z?

- (a) High melting point  
(b) Low melting point  
(c) Occurrence as solid  
(d) Conduction of electricity in molten state

(iii) Which of the following is correct representation of formation of magnesium chloride?

- (a)  $\text{Mg} : + \begin{array}{c} \times \times \\ \times \text{Cl} \times \times \\ \times \times \end{array} \longrightarrow (\text{Mg}^{2+}) \left[ \begin{array}{c} \times \times \\ \times \text{Cl} \times \times \\ \times \times \end{array} \right]_2$
- (b)  $\text{Mg} : + \begin{array}{c} \times \times \\ \times \text{Cl} \times \times \\ \times \times \end{array} \longrightarrow (\text{Mg}) \left( \begin{array}{c} \times \times \\ \times \text{Cl} \times \times \\ \times \times \end{array} \right)$
- (c)  $\text{Mg} : + \begin{array}{c} \times \times \\ \times \text{Cl} \times \times \\ \times \times \end{array} \longrightarrow (\text{Mg}^{2+}) \left[ \begin{array}{c} \times \times \\ \times \text{Cl} \times \times \\ \times \times \end{array} \right]_2^{2-}$
- (d) None of these

## Syllabus

Properties of metals and non-metals;

Reactivity series; Formation and properties of ionic compounds.

- (iv) The electronic configuration of sodium ion is  
 (a) 2, 8, 8                      (b) 2, 8, 2                      (c) 2, 6                      (d) 2, 8.
- (v) Which of the following represents an electropositive element?  
 (a) 2, 8, 6                      (b) 2, 8, 8                      (c) 2, 8, 8, 1                      (d) 2, 7

**2**

Read the following and answer any four questions from 2(i) to 2(v).

The arrangement of metals in a vertical column in the decreasing order of their reactivities is called the reactivity series or activity series of metals. The most reactive metal is at the top position of the reactivity series. The least reactive metal is at the bottom of the reactivity series.

Hydrogen, though a non-metal, has been included in the activity series of metals only for comparison. Apart from it, the hydrogen atom also has tendency to lose its valence electron and form cation which behaves like metal.



- (i) Which metal can be displaced by copper from its salt solution?  
 (a) Zinc                      (b) Silver                      (c) Iron                      (d) Lead
- (ii) An element 'X' after reacting with acids liberates hydrogen gas and can displace lead and mercury from their salt solutions. The metal 'X' is  
 (a) copper                      (b) gold                      (c) calcium                      (d) hydrogen.
- (iii) The most reactive metal is  
 (a) potassium                      (b) barium                      (c) zinc                      (d) calcium.
- (iv) The metal which does not liberate hydrogen gas after reacting with acid is  
 (a) zinc                      (b) lead                      (c) iron                      (d) gold.
- (v) Which of the following metals does not react with water at all?  
 (I) Sodium                      (II) Copper                      (III) Aluminium                      (IV) Lead  
 (a) I and III only                      (b) IV only                      (c) II and IV only                      (d) I, II, III and IV

**3**

Read the following and answer any four questions from 3(i) to 3(v).

Metals as we know, are very useful in all fields, industries in particular. Non-metals are no less in any way. Oxygen present in air is essential for breathing as well as for combustion. Non-metals form a large number of compounds which are extremely useful, e.g., ammonia, nitric acid, sulphuric acid, etc.

Non-metals are found to exist in three states of matter. Only solid non-metals are expected to be hard however, they have low density and are brittle. They usually have low melting and boiling points and are poor conductors of electricity.

- (i) \_\_\_\_\_ is a non-metal but is lustrous.  
 (a) Phosphorus                      (b) Sulphur                      (c) Bromine                      (d) Iodine
- (ii) Which of the following is known as 'King of chemicals'?  
 (a) Urea                      (b) Ammonia                      (c) Sulphuric acid                      (d) Nitric acid
- (iii) Which of the following non-metals is a liquid?  
 (a) Carbon                      (b) Bromine                      (c) Iodine                      (d) Sulphur



- (iv) Hydrogen is used  
(a) for the synthesis of ammonia (b) for the synthesis of methyl alcohol  
(c) in welding torches (d) all of these.
- (v) Generally, non-metals are bad conductors of electricity but 'X' which is a form of carbon is a good conductor of electricity and is an exceptional non-metal. 'X' is  
(a) diamond (b) graphite (c) coal (d) coke.

#### 4

Read the following and answer any four questions from 4(i) to 4(v).

Ionic compound is a chemical compound in which ions are held together by ionic bonds. An ionic bond is the type of chemical bond in which two oppositely charged ions are held through electrostatic forces. We know that, metal atoms have loosely bound valence electrons in their valence shell and non-metal atoms need electrons in their valence shell to attain noble gas configuration. The metal atom loses the valence electrons while non-metal atom accepts these electrons. By losing electrons, metal atoms change to cations and by accepting electrons, non-metals form anions. Ionic compounds are generally solid and exist in the form of crystal. They have high melting and boiling points.

- (i) Which of the following can change to a cation?  
(a) Fluorine (b) Oxygen (c) Potassium (d) Neon
- (ii) Which of the following can change to an anion?  
(a) Iodine (b) Magnesium (c) Calcium (d) Xenon
- (iii) Ionic compounds are soluble in \_\_\_\_\_.  
(a) Kerosene (b) Petrol (c) Water (d) None of these
- (iv) Which of the following statements is correct about ionic compounds?  
I. They conduct electricity in solid state.  
II. They conduct electricity in solutions.  
III. They conduct electricity in molten state.  
(a) I only (b) II only (c) III only (d) II and III only
- (v) Select the incorrect statement.  
(a) Ionic compounds are generally brittle.  
(b) Ions are the fundamental units of ionic compounds.  
(c) Formation of ionic bonds involve sharing of electrons.  
(d) NaCl is an ionic compound.

#### 5

Read the following and answer any four questions from 5(i) to 5(v).

An element is a pure substance made up of same kind of atoms. At present, nearly 118 elements are known but all of them do not occur free in nature, some of them have been synthesized by artificial methods. Based on their properties, they are mainly classified as metals and non-metals. Metals are those elements which lose electrons and form positive ions *i.e.*, they are electropositive in nature. They are generally hard, good conductors of heat and electricity, malleable, ductile and have striking lustre. They have a significant role to play in our daily life.

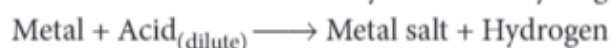
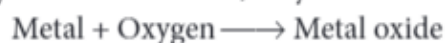
- (i) Metals which are of vital importance to the national defence, energy and industry sector are called strategic metals. Which of the following is a strategic metal?  
(a) Titanium (b) Zirconium (c) Manganese (d) All of these

- (ii) Which metal is the best conductor of electricity?  
 (a) Silver (b) Platinum (c) Nickel (d) Iron
- (iii) Which of the following metals is not a coinage metal?  
 (a) Copper (b) Silver (c) Iron (d) Gold
- (iv) Which of the following are the most malleable metals?  
 (I) Sodium (II) Gold (III) Potassium (IV) Silver  
 (a) (I) and (IV) (b) (II) and (III) (c) (III) and (IV) (d) (II) and (IV)
- (v) Identify the correct statement(s).  
 (I) The wires that carry current in our homes have a coating of PVC or a rubber like material.  
 (II) School bells are made of metals.  
 (III) Metals do not conduct electricity.  
 (IV) Metals which produce a sound on striking a hard surface are said to be non-sonorous.  
 (a) (I) and (III) (b) (I) and (II) (c) (III) and (IV) (d) Only (II)

## 6

Read the following and answer any four questions from 6(i) to 6(v).

The chemical properties of metals are mostly linked with the electron releasing tendency of their atoms. Greater the tendency, more will be the reactivity of the metal. They react with oxygen, water, hydrogen, acids, etc. Since they can lose electrons, they act as reducing agents. Some reactions of metals are given as :



- (i) Metals such as \_\_\_\_\_ and \_\_\_\_\_ react so vigorously that they catch fire if kept in the open. Hence, to protect them and to prevent accidental fires, they are kept immersed in \_\_\_\_\_.  
 (a) phosphorus, magnesium, water (b) sodium, potassium, kerosene oil  
 (c) sodium, potassium, water (d) tin, lead, alcohol
- (ii) Which of the following pairs will give displacement reaction?  
 (a) NaCl solution and copper metal (b) MgCl<sub>2</sub> solution and aluminium metal  
 (c) FeSO<sub>4</sub> solution and silver metal (d) AgNO<sub>3</sub> solution and copper metal
- (iii) There are four metals *K*, *L*, *M* and *N*. Identify them by using the hints given below.  
*K* forms basic oxide.  
*L* forms amphoteric oxide.  
 Oxide of *M* dissolves in water to form alkali.  
*N* does not react with water at all.  
 (a) *K* → Zn, *L* → Al, *M* → Na, *N* → Fe (b) *K* → Fe, *L* → Na, *M* → K, *N* → Zn  
 (c) *K* → K, *L* → Cu, *M* → Pb, *N* → Na (d) *K* → Cu, *L* → Zn, *M* → K, *N* → Pb
- (iv) Which metal does not react with dilute hydrochloric acid?  
 (a) Iron (b) Sodium (c) Zinc (d) Copper
- (v) Food cans are coated with tin and not with zinc because  
 (a) zinc is costlier than tin (b) zinc has a higher melting point than tin  
 (c) zinc is more reactive than tin (d) zinc is less reactive than tin.

Read the following and answer any four questions from 7(i) to 7(v).

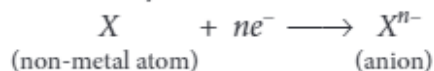
On the basis of reactivity of different metals with oxygen, water and acids as well as displacement reactions, the metals have been arranged in the decreasing order of their reactivities. This arrangement is known as activity series or reactivity series of metals.

The basis of reactivity is the tendency of metals to lose electrons. If a metal can lose electrons easily to form positive ions, it will react readily with other substances. Therefore, it will be a reactive metal. On the other hand, if a metal loses electrons less rapidly to form a positive ion, it will react slowly with other substances. Therefore, such a metal will be less reactive.

- (i) Which of the following metals is less reactive than hydrogen?  
 (a) Copper (b) Zinc (c) Magnesium (d) Lead
- (ii) Which of the following metals is more reactive than hydrogen?  
 (a) Mercury (b) Platinum (c) Iron (d) Gold
- (iii) Which of the following metals reacts vigorously with oxygen?  
 (a) Zinc (b) Magnesium (c) Sodium (d) Copper
- (iv) Which of the following represents the correct order of reactivity for the given metals?  
 (a)  $\text{Na} > \text{Mg} > \text{Al} > \text{Cu}$  (b)  $\text{Mg} > \text{Na} > \text{Al} > \text{Cu}$  (c)  $\text{Na} > \text{Mg} > \text{Cu} > \text{Al}$  (d)  $\text{Mg} > \text{Al} > \text{Na} > \text{Cu}$
- (v) Hydrogen gas is not evolved when a metal reacts with nitric acid. It is because  $\text{HNO}_3$  is a strong oxidising agent. It oxidises the  $\text{H}_2$  produced to water and itself gets reduced to any of the nitrogen oxides ( $\text{N}_2\text{O}$ ,  $\text{NO}$ ,  $\text{NO}_2$ ). But \_\_\_\_\_ and \_\_\_\_\_ react with very dilute  $\text{HNO}_3$  to evolve  $\text{H}_2$  gas.  
 (a) Pb, Cu (b) Na, K (c) Mg, Mn (d) Al, Zn

Read the following and answer any four questions from 8(i) to 8(v).

Non-metals are highly electronegative in nature. They have a tendency to gain electrons in their valence shell to achieve nearest noble gas configuration. Thus, they form anions and act as good oxidising agents.



They react with air or oxygen on heating to form oxides which react with water to form acids. Thus, non-metal oxides are acidic in nature. Non-metals do not react with dilute acids at all. This is because they are electronegative and therefore, cannot displace hydrogen from acids but they form covalent hydrides when heated with hydrogen.

- (i) The acid formed when sulphur trioxide reacts with water is  
 (a) sulphurous acid (b) sulphuric acid (c) both (a) and (b) (d) none of these.
- (ii) An element 'X' forms an oxide  $\text{XO}_2$ , which is a very useful gas used in the process of photosynthesis. The element 'X' is  
 (a) sulphur (b) nitrogen (c) carbon (d) phosphorus.
- (iii) Non-metals generally act as  
 (a) oxidising agents (b) reducing agents (c) both (a) and (b) (d) none of these.
- (iv) Which of the following elements produces basic oxide on reacting with oxygen?  
 (a) Chlorine (b) Sulphur (c) Phosphorus (d) Magnesium



(v) Which of the following is a covalent hydride?



(d) All of these

9

Read the following and answer any four questions from 9(i) to 9(v).

Although there is no sharp line of distinction between metals and non-metals yet there are some distinctive differences. The main points of differences are :

Property	Metals	Non-metals
Electronic structure	They have 1 to 3 electrons in the outermost shell of their atoms.	They have 4 to 8 electrons in the outermost shell of their atoms.
State of existence	They are mostly solid at room temperature except mercury and gallium which are liquid.	They are either solids or gases at room temperature (except bromine which is a liquid).
Density	They have high density.	They have low density.
Nature of ions	They are electropositive elements and hence, lose one or more electrons to form positive ions.	They are electronegative elements and hence, gain one or more electrons to form negative ions.
Nature of chlorides	They generally combine with chlorine to form solid ionic chlorides which conduct electricity in the aqueous solution or in the molten state.	They combine with chlorine to form covalent chlorides. These are either gases or liquids. Non-metal chlorides do not contain ions, therefore, they do not conduct electricity.
Nature of oxides	They form basic oxides, though some oxides are amphoteric also.	They form acidic or neutral oxides.
Displacement of hydrogen from acids	Metals which lie above hydrogen in the reactivity series displace hydrogen from acids.	They do not displace hydrogen from acids.

(i) Match column-I with column-II and select the correct option using the given codes.

**Column-I**

P. A metal that forms amphoteric oxides

Q. A metal which melts when keep on our palm

R. A metal that has highest density

S. A metal which cannot displace hydrogen from acids

(a) P-(II), Q-(I), R-(III), S-(IV)

(c) P-(IV), Q-(II), R-(III), S-(I)

**Column-II**

(I) Ga

(II) Au

(III) Al

(IV) Os

(b) P-(III), Q-(I), R-(IV), S-(II)

(d) P-(III), Q-(II), R-(I), S-(IV)

(ii) State True (T) or False (F) for the following statements.

(I) Non-metals react with acids to give a salt and hydrogen gas.

(II) Zinc oxide is amphoteric in nature.

(III) Copper oxide is basic in nature.

(IV) Hydrogen gas is evolved when a metal reacts with dilute acid.

(V) Copper reacts vigorously with dilute HCl.

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

(a) F T F T T

(b) T F T F F

(c) F T F F T

(d) F T T T F

- (iii) Tick (✓) the correct statements and cross (×) the incorrect statements.
- (I) Non-metals are either solids or gases except mercury which is a liquid.  
 (II) Sodium is a metal and can lose its electrons easily.  
 (III) Most non-metals produce acidic oxides when dissolved in water. Most metals produce basic oxides on reaction with water.  
 (IV) Graphite is a conductor of electricity.

	(I)	(II)	(III)	(IV)
(a)	✓	×	✓	×
(b)	×	✓	×	✓
(c)	×	✓	✓	✓
(d)	×	✓	✓	×

- (iv) An element X (atomic number 12) reacts with another element Y (atomic number 17) to form a compound Z. Which of the following statements are true regarding this compound?

- I. Molecular formula of Z is  $XY_2$ .  
 II. It is soluble in water.  
 III. X and Y are joined by sharing of electrons.  
 IV. It would conduct electricity in the molten state.

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

- (v) Which of the following metals form an amphoteric oxide?

- (a) Zn      (b) Ca      (c) Na      (d) Cu

10

Read the following and answer any four questions from 10(i) to 10(v).

Sample pieces of five metals P, Q, R, S and T are added to the tabulated solutions separately. The results observed are shown in the table given below :

Metal	Solutions			
	$CuSO_4$	$ZnSO_4$	$FeSO_4$	$AgNO_3$
P	No change	No change	No change	A coating on metal
Q	Brown coating	—	Grey deposit	A coating on metal
R	No change	No change	No change	No change
S	—	No change	No change	Brown deposit
T	Brown deposit	New coating	New coating	New coating

Based on the observations recorded in the table answer the following questions :

- (i) Which is the most reactive metal?

- (a) Q      (b) R      (c) S      (d) T

- (ii) Which is the least reactive metal?

- (a) P      (b) R      (c) T      (d) Q

- (iii) Activity series of elements is

- (a) the arrangement of elements in increasing order of reactivity.  
 (b) the arrangement of elements in decreasing order of reactivity.  
 (c) the arrangement of oxides of elements in increasing order of reactivity.  
 (d) none of these.

- (iv) Which of the following metal is least reactive?  
 (a) Zn (b) Cu (c) Ag (d) Fe
- (v) Decreasing order of reactivity is  
 (a)  $P > Q > R > S > T$  (b)  $Q > T > R > S > P$   
 (c)  $T > Q > S > P > R$  (d)  $S > R > Q > T > P$

## ASSERTION & REASON

For question numbers 11-30, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :

- (a) Both A and R are true, and R is correct explanation of the assertion.  
 (b) Both A and R are true, but R is not the correct explanation of the assertion.  
 (c) A is true, but R is false.  
 (d) A is false, but R is true.
11. **Assertion :** Different metals have different reactivities with water and dilute acids.  
**Reason :** Reactivity of a metal depends on its position in the reactivity series.
12. **Assertion :** Iron is the most widely used metal. But it is never used in its pure state.  
**Reason :** Pure iron is very soft and stretches easily when hot.
13. **Assertion :** Gold occurs in native state.  
**Reason :** Gold is a reactive metal.
14. **Assertion :** The property of beating a metal into sheets is called ductility.  
**Reason :** Gold and silver are most malleable metals.
15. **Assertion :** Silver and gold do not react with oxygen even at high temperatures.  
**Reason :** Silver and gold are less active metals.
16. **Assertion :** The oxides of sulphur and phosphorus are acidic in nature.  
**Reason :** Metal oxides are basic in nature.
17. **Assertion :** Bromine cannot displace chlorine from its salt solution.  
**Reason :** Chlorine is more reactive than bromine.
18. **Assertion :** MgO exists in liquid state.  
**Reason :** The electrostatic forces of attraction between  $Mg^{2+}$  and  $O^{2-}$  ions constitute ionic bond.
19. **Assertion :** On reacting with water, calcium starts floating over water.  
**Reason :** Calcium reacts with cold water at room temperature.
20. **Assertion :** The arrangement of metals in order of decreasing reactivities is called reactivity series.  
**Reason :** Metals at the top of series are very reactive and metals at the bottom are least reactive.
21. **Assertion :** Non-metals are electronegative in nature.  
**Reason :** They have tendency to lose electrons.
22. **Assertion :** Ionic compounds have high melting and boiling points.  
**Reason :** A large amount of energy is required to break the strong inter-ionic attraction in ionic compounds.
23. **Assertion :** Metals in general have very high melting and boiling points.  
**Reason :** Metals have the strongest chemical bonds which are metallic in nature.
24. **Assertion :** Electrovalency of Na is +1.  
**Reason :** The number of electrons which an atom either loses or gains in the formation of an ionic bond is known as its valency.

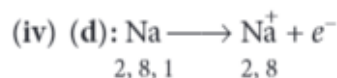
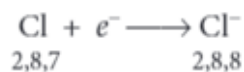
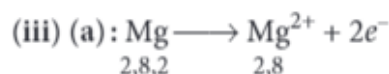


25. **Assertion :** Metals generally act as reducing agents.  
**Reason :** The reducing character is expressed in terms of electron releasing tendency.
26. **Assertion :** Magnesium reacts with oxygen upon heating and burns brightly to form magnesium oxide.  
**Reason :** Magnesium oxide is basic in nature.
27. **Assertion :** The reaction of calcium with water is less violent in comparison to that of sodium.  
**Reason :** The heat evolved is not sufficient for the hydrogen to catch fire.
28. **Assertion :** C and N do not react with dil. HCl and dil. H<sub>2</sub>SO<sub>4</sub>.  
**Reason :** Metals do not react with dil. HCl and dil. H<sub>2</sub>SO<sub>4</sub>.
29. **Assertion :** Copper displaces silver from silver nitrate solution.  
**Reason :** Copper is more reactive than silver.
30. **Assertion :** Aluminum oxide and zinc oxide are acidic in nature.  
**Reason :** Amphoteric nature means that substance have both acidic and basic character.

## HINTS & EXPLANATIONS

1. (i) (d)

(ii) (b): 'Z' is an ionic compound.



(v) (c): (a) and (d) represent electronegative elements and (b) represents a noble gas.

2. (i) (b): Copper is more reactive than silver thus, it can displace silver from its salt solution.

(ii) (c): Calcium is more reactive than lead and mercury.

(iii) (a): Potassium is present at the top of the activity series.

(iv) (d): Gold is below hydrogen in the reactivity series so, it does not liberate hydrogen gas on reaction with acids.

(v) (c): Metals such as lead, copper, silver and gold do not react with water at all.

3. (i) (d): Iodine is a lustrous non-metal.

(ii) (c): H<sub>2</sub>SO<sub>4</sub> is known as 'King of Chemicals'.

(iii) (b): Bromine exists as a liquid.

(iv) (d)

(v) (b): Graphite conducts electricity because of the delocalised electrons in its structure.

4. (i) (c): Potassium, being a metal, can change to cation by losing its valence electron.

(ii) (a): Iodine, being a non-metal, can change to anion by gaining electron.

(iii) (c): Ionic compounds are generally soluble in water and insoluble in kerosene and petrol.

(iv) (d): Ionic compounds do not conduct electricity in solid state as ions are very closely packed and are free to move.

(v) (c): Formation of ionic bonds involve complete transfer of electrons from metal atom to non-metal atom.

5. (i) (d): Titanium, zirconium and manganese are used in defence equipments as they are light and durable and therefore, are called strategic metals.

(ii) (a)

(iii) (c): Copper, silver and gold are called coinage metals because they are used in making coins, jewellery etc.

(iv) (d)

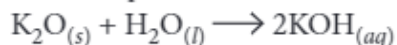
(v) (b): Metals conduct electricity. Metals which produce a sound on striking a hard surface are said to be sonorous.

6. (i) (b)

(ii) (d): As copper is more reactive than silver, it displaces silver from silver nitrate solution.

(iii) (d): CuO is basic in nature, ZnO is amphoteric in nature.

Oxide of potassium dissolves in water to form alkali.



Pb does not react with water at all.

Thus, K, L, M and N are Cu, Zn, K and Pb respectively.

(iv) (d)

(v) (c): Zinc being more reactive than tin can react with food elements kept in food cans.

7. (i) (a): Copper is placed below hydrogen in activity series therefore, it is less reactive than hydrogen.

(ii) (c): Iron is placed above hydrogen in activity series therefore, it is more reactive than hydrogen.

(iii) (c)

(iv) (a)

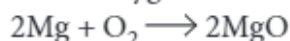
(v) (c)

8. (i) (b):  $SO_3 + H_2O \longrightarrow H_2SO_4 + \text{heat}$

(ii) (c): Carbon forms  $CO_2$  on reaction with oxygen. During photosynthesis plants take in  $CO_2$ .

(iii) (a): Non-metals act as oxidising agents since they can accept electrons.

(iv) (d): Magnesium, being a metal, produces basic oxide on reaction with oxygen.



(v) (d): Carbon, nitrogen and sulphur are non-metals hence, they form covalent hydrides.

9. (i) (b)

(ii) (d)

(iii) (c)

(iv) (d): An element (X) with atomic number 12 is Mg. Element (Y) with atomic number 17 is Cl. Therefore, compound (Z) will be  $MgCl_2$ . It is soluble in water. It is an ionic compound and it conducts electricity in the molten state.

(v) (a)

10. (i) (d): The most reactive metal is T.

(ii) (b): The least reactive metal is R.

(iii) (b)

(iv) (c)

(v) (c):  $T > Q > S > P > R$

11. (a): The metals placed at the top of the series are most reactive.

12. (a)

13. (c): Gold is a noble metal.

14. (d): The property of beating a metal into sheets is called malleability.

15. (a)

16. (b): Sulphur and phosphorus are non-metals. Non-metals form either acidic or neutral oxides.

17. (a)

18. (d): MgO exists in solid state.

19. (b): Calcium floats over water because the bubbles of hydrogen gas formed get stick to the surface of the water.

20. (b): Metals at the top of the series are very reactive and therefore, they do not occur free in nature. The metals at the bottom of the series are least reactive and therefore, they normally occur free in nature.

21. (c): Non-metals have a tendency to gain electrons.

22. (a)

23. (a)

24. (a)

25. (b): Metals have a strong tendency to lose electrons and hence they behave as reducing agents.

26. (b): Metals react with oxygen to form metal oxides which are basic in nature.

27. (a)

28. (c): Metals react with dilute HCl and dil.  $H_2SO_4$ . Non-metals do not react with dilute acids.

29. (a)

30. (d): Aluminum and zinc oxides are amphoteric in nature.

# Carbon and its Compounds

## CASE STUDY / PASSAGE BASED QUESTIONS

1

Read the following and answer any four questions from 1(i) to 1(v).

A series of organic compounds having same functional group, with similar or almost identical chemical characteristics in which all the members can be represented by the same general formula and the two consecutive members of the series differ by  $-\text{CH}_2$  group or 14 mass unit in their molecular formulae is called a homologous series. For example, all the members of alcohol family can be represented by the general formula,  $\text{C}_n\text{H}_{2n+1}\text{OH}$  where,  $n$  may have the values 1, 2, 3, ... etc. The various members of a particular homologous series are called homologues. The physical properties such as density, melting point, boiling point, solubility, etc. of the members of a homologous series show almost regular variation in ascending or descending the series.

- (i) Which of the following is not a characteristic of members of a homologous series?
- They possess varying chemical properties.
  - Their physical properties vary in regular and predictable manner.
  - Their formulae fit the general molecular formula.
  - Adjacent members differ by one carbon and two hydrogen atoms.
- (ii) All the members of homologous series of alkynes have the general formula
- $\text{C}_n\text{H}_{2n}$
  - $\text{C}_n\text{H}_{2n+2}$
  - $\text{C}_n\text{H}_{2n-2}$
  - $\text{C}_n\text{H}_{2n-4}$
- (iii) Which of the following statements is not correct?
- A common functional group is present in different members of a homologous series.
  - Two consecutive members of a homologous series differ by a  $-\text{CH}_3$  group.
  - The molecular mass of a compound in the series differs by 14 a.m.u. from that of its neighbour.
  - All the members of a homologous series have common general methods of preparation.
- (iv) Identify the correct statements.
- As the molecular mass increases in any homologous series, a gradation in physical properties is seen.
  - The melting and boiling points decrease with increasing molecular mass.

### Syllabus

Covalent bonding in carbon compounds.  
Versatile nature of carbon.  
Homologous series.



(III) Other physical properties such as solubility in a particular solvent decreases with increasing molecular mass.

(IV) The chemical properties, which are determined solely by the functional group, remain similar in a homologous series.

(a) (II) and (III)

(b) (II) and (IV)

(c) (I), (III) and (IV)

(d) (I), (II), (III) and (IV)

(v) The table shows the formulae of three organic compounds that belong to the same homologous series.

First member of the homologous series	$\text{CH}_3\text{—O—CH}_3$
Second member of the homologous series	$\text{CH}_3\text{CH}_2\text{—O—CH}_3$
Third member of the homologous series	$\text{CH}_3\text{CH}_2\text{CH}_2\text{—O—CH}_3$

What is the general formula of this series?

(a)  $\text{C}_n\text{H}_{2n}\text{O}$

(b)  $\text{C}_n\text{H}_{2n+2}\text{O}$

(c)  $\text{C}_n\text{H}_{2n}\text{OH}$

(d)  $\text{C}_n\text{H}_{2n+2}\text{OH}$

2

Read the following and answer any four questions from 2(i) to 2(v).

When an element exists in two or more different forms in the same physical state, these different forms are called allotropes and the phenomenon is known as allotropy. Allotropes have similar chemical properties but they differ in their physical properties. Carbon exists in crystalline and amorphous forms. In crystalline form, it occurs as diamond, graphite and fullerenes. Diamond is a colourless, transparent substance having extraordinary brilliance. It is the hardest natural substance known. It is used for cutting marble, granite and glass. Graphite is a greyish-black, opaque substance. It is lighter than diamond *i.e.*, it has lower density. It has sheet like structure having hexagonal layers. One layer slides over the other layer which makes it soft to touch. It is the reason that graphite is used as a lubricant.

(i) Substance X is a moderate conductor of electricity. Substance X has the structure shown below :



Which statements about substance X are correct?

(I) It is a covalent compound.

(II) It has a giant molecular structure.

(III) It has the same structure as graphite.

(IV) It has the same structure as diamond.

(a) (I) and (III)

(b) (II) and (III)

(c) (II) and (IV)

(d) (I), (II) and (IV)

(ii) Which of the following is correct about the structure of diamond?

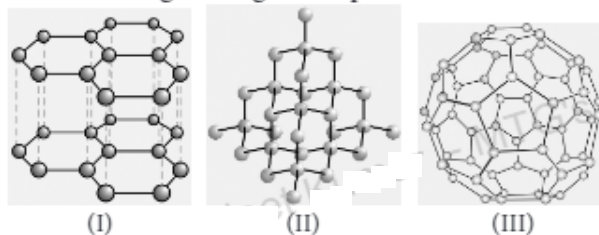
(a) Carbon atoms are held together by single covalent bonds.

(b) Electrons move freely through the structure.

(c) Layers of atoms slide easily over each other.

(d) Carbon atoms conduct electricity in the molten state.

(iii) Which three allotropes of carbon, do the given figures represent?

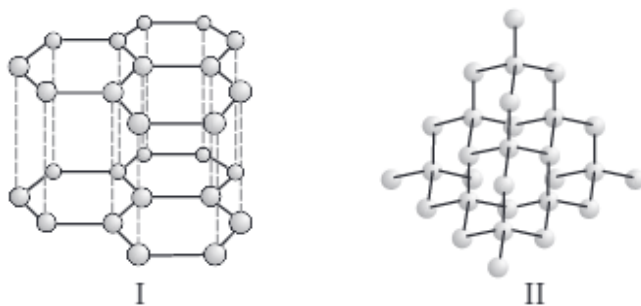


- | (I)          | (II)                  | (III)                 |
|--------------|-----------------------|-----------------------|
| (a) Diamond  | Graphite              | Buckminster fullerene |
| (b) Graphite | Buckminster fullerene | Diamond               |
| (c) Diamond  | Buckminster fullerene | Graphite              |
| (d) Graphite | Diamond               | Buckminster fullerene |

(iv) Identify the incorrect statement(s).

- (I) Diamond is the hardest substance known while graphite is smooth and slippery.  
 (II) Diamond is made up of billions of carbon atoms. Each carbon atom is bonded to four other carbon atoms in a tetrahedral manner to form a giant lattice. All carbon atoms are bonded by strong covalent bonds.  
 (III) Graphite is a poor conductor of electricity unlike other non-metals.  
 (IV) Graphite has a giant covalent structure that is made up of layers of carbon atoms. In each layer, each carbon atom is bonded to three other carbon atoms to form hexagonal rings of carbon atoms.
- (a) (I) and (III)      (b) Only (III)      (c) (II) and (IV)      (d) (I), (II) and (IV)

(v) Structures of two different forms of carbon are given below :



Identify the two forms (I and II respectively) and how are they related to each other?

- (a) Diamond, Graphite, Isotopes of carbon      (b) Graphite, Diamond, Allotropes of carbon  
 (c)  $C^{12}$ ,  $C^{14}$ , Allotropes of carbon      (d)  $C^{14}$ ,  $C^{12}$ , Isotopes of carbon

3

Read the following and answer any four questions from 3(i) to 3(v).

As neutral atom carbon has electronic configuration  $K L$ . To gain inert gas configuration carbon can either

2, 4

donate 4 valence electrons (helium gas configuration) or gain 4 electrons (neon gas configuration), but it cannot do so. To acquire inert gas configuration carbon can only share its 4 valence electrons with other atoms forming covalent bonds. A covalent bond can be defined as a chemical bond formed between two atoms by mutual sharing of valence electrons so that each atom acquires the stable electronic configuration of the nearest noble gas. The concept of covalent bonds was given by Langmuir and Lewis to explain bonding in non-ionic

compounds. The covalent bonds are of three types. If each atom contributes one electron, the covalent bond formed is called a single covalent bond and is represented by a single line (–) and if each atom contributes two electrons, the covalent bond formed is called a double bond and is represented by a double line (=) and if each atom contributes three electrons, the covalent bond formed is called a triple bond and is represented by a triple line ( $\equiv$ ).

(i) Which of the following do not contain a double bond?

- |                   |                     |                     |                   |
|-------------------|---------------------|---------------------|-------------------|
| I. $\text{SO}_2$  | II. $\text{NH}_3$   | III. $\text{HCl}$   | IV. $\text{O}_2$  |
| (a) I and II only | (b) II and III only | (c) III and IV only | (d) I and IV only |

(ii) Which of the following contains a triple bond?

- |                  |                  |                   |                  |
|------------------|------------------|-------------------|------------------|
| (a) $\text{N}_2$ | (b) $\text{O}_2$ | (c) $\text{CO}_2$ | (d) $\text{H}_2$ |
|------------------|------------------|-------------------|------------------|

(iii) The shared pair of electrons is said to constitute a \_\_\_\_\_ bond between two hydrogen atoms.

- |            |            |            |           |
|------------|------------|------------|-----------|
| (a) single | (b) double | (c) triple | (d) ionic |
|------------|------------|------------|-----------|

(iv) Which of the following molecules has all its atoms joined together by double covalent bonds?

- |             |           |                    |                          |
|-------------|-----------|--------------------|--------------------------|
| (a) Methane | (b) Water | (c) Carbon dioxide | (d) Nitrogen trichloride |
|-------------|-----------|--------------------|--------------------------|

(v) Chlorine forms a diatomic molecule,  $\text{Cl}_2$ . The electron dot structure for this molecule is

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

4

Read the following and answer any four questions from 4(i) to 4(v).

Two allotropic forms of carbon which are crystalline in nature, are diamond and graphite. They differ physically but chemically they are similar. Diamond is the hardest crystalline form of carbon. In diamond, each carbon atom is linked to four other carbon atoms by covalent bonds. In graphite, each carbon atom is linked to three other carbon atoms by covalent bond. Graphite is relatively soft and greasy. It is also a good conductor of electricity. The C—C bond length in graphite is 141.5 pm while in diamond it is 154 pm.

(i) Which of the following is a good conductor of heat and electricity?

- |          |             |              |              |
|----------|-------------|--------------|--------------|
| (a) Coal | (b) Diamond | (c) Charcoal | (d) Graphite |
|----------|-------------|--------------|--------------|

(ii) Graphite is a good conductor of electricity because

- |                           |                       |                       |                            |
|---------------------------|-----------------------|-----------------------|----------------------------|
| (a) it has free electrons | (b) it has free atoms | (c) it is crystalline | (d) it is soft and greasy. |
|---------------------------|-----------------------|-----------------------|----------------------------|

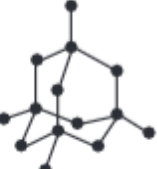
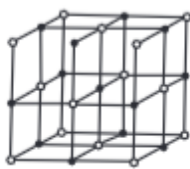

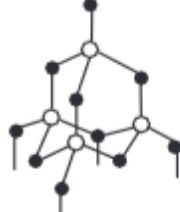
(iii) Which of the following types of binding forces is present in the structure of diamond?

- |           |                    |              |                   |
|-----------|--------------------|--------------|-------------------|
| (a) Ionic | (b) van der Waals' | (c) Covalent | (d) None of these |
|-----------|--------------------|--------------|-------------------|

(iv) Diamond is not a good conductor of electricity because

- |                             |                                   |
|-----------------------------|-----------------------------------|
| (a) it is very hard         | (b) its structure is very compact |
| (c) it is not water soluble | (d) it has no free electron.      |

(v) Which of the following is the structure of diamond?

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



Read the following and answer any four questions from 5(i) to 5(v).

The compounds which have the same molecular formula but differ from each other in physical or chemical properties are called isomers and the phenomenon is called isomerism. When the isomerism is due to difference in the arrangement of atoms within the molecule, without any reference to space, the phenomenon is called structural isomerism. In other words, structural isomers are compounds that have the same molecular formula but different structural formulas, *i.e.*, they are different in the order in which different atoms are linked. In these compounds, carbon atoms can be linked together in the form of straight chains, branched chains or even rings.

- (i) Which of the following sets of compounds have same molecular formula?
- (a) Butane and *iso*-butane  
(b) Cyclohexane and hexene  
(c) Propanal and propanone  
(d) All of these
- (ii) In order to form branching, an organic compound must have a minimum of
- (a) four carbon atoms  
(b) three carbon atoms  
(c) five carbon atoms  
(d) any number of carbon atoms.
- (iii) Which of the following is an isomeric pair?
- (a) Ethane and propane  
(b) Ethane and ethene  
(c) Propane and butane  
(d) Butane and 2-methylpropane
- (iv) Among the following the one having longest chain is
- (a) *neo*-pentane  
(b) *iso*-pentane  
(c) 2-methylpentane  
(d) 2, 2-dimethylbutane.
- (v) The number of isomers of pentane is
- (a) 2  
(b) 3  
(c) 4  
(d) 5

Read the following and answer any four questions from 6(i) to 6(v).

Study the table related to three hydrocarbons A, B, C and answer the questions that follow.

Organic compound	Molecular formula
A	$C_3H_8$
B	$C_5H_{10}$
C	$C_4H_6$

- (i) A, B and C are classified as hydrocarbons because
- (a) they contain hydrogen  
(b) they contain carbon  
(c) they contain both carbon and hydrogen  
(d) none of these.
- (ii) Which of these organic compounds is an alkyne?
- (a) A  
(b) B  
(c) C  
(d) All of these
- (iii)  $C_5H_{10}$  belongs to
- (a)  $C_nH_{2n+2}$  series  
(b)  $C_nH_{2n}$  series  
(c)  $C_nH_{2n-2}$  series  
(d) none of these.

(iv) Identify the incorrect statement about these three hydrocarbons.

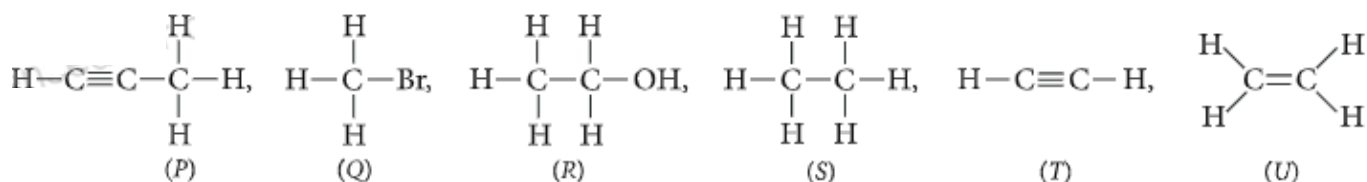
- (a) All have different general formula. (b) *A* and *B* differ by  $-\text{CH}_2$  unit.  
(c) *C* is an alkyne. (d) *B* is an alkene.

(v) General formula for alkane is

- (a)  $\text{C}_n\text{H}_{2n}$  (b)  $\text{C}_n\text{H}_{2n+2}$  (c)  $\text{C}_n\text{H}_{2n-2}$  (d)  $\text{C}_n\text{H}_n$

## 7

Read the following and answer any four questions from 7(i) to 7(v).



(i) Which of the following compounds belong to same homologous series?

- (a) *S* and *T* (b) *T* and *U* (c) *P* and *U* (d) *P* and *T*.

(ii) The functional group of compound (*R*) is

- (a) alcohol (b) aldehyde (c) ketone (d) carboxylic acid.

(iii) Compound (*T*) belongs to homologous series of

- (a) alkynes (b) alkenes (c) alkanes (d) none of these.

(iv) Which of the following compounds is unsaturated hydrocarbon?

- (a) *S* (b) *Q* (c) *U* (d) *R*

(v) Which of the following compounds belongs to alkane series?

- (a) *P* (b) *S* (c) *T* (d) *U*

## 8

Read the following and answer any four questions from 8(i) to 8(v).

The table given below shows six organic compounds *A*, *B*, *C*, *D*, *E* and *F* having different molecular formula :

Organic compound	Molecular formula
<i>A</i>	$\text{C}_7\text{H}_{16}$
<i>B</i>	$\text{C}_8\text{H}_{16}$
<i>C</i>	$\text{C}_4\text{H}_6$
<i>D</i>	$\text{C}_6\text{H}_{10}$
<i>E</i>	$\text{C}_5\text{H}_{10}$
<i>F</i>	$\text{C}_9\text{H}_{20}$

(i) Which of the following compounds belong to same homologous series?

- (a) *E* and *F* (b) *B* and *C* (c) *A* and *B* (d) *C* and *D*

(ii) Which of the following is the member of the same homologous series as *E*?

- (a) *D* (b) *A* (c) *F* (d) *B*

(iii) Identify the correct statements.

- (a) *A* and *F* are saturated hydrocarbons while all others are unsaturated hydrocarbons.
- (b) *C* and *D* belong to a homologous series having general formula  $C_nH_{2n}$ .
- (c) *B* and *E* are alkynes.
- (d) All the compounds have same physical and chemical properties.

(iv) Compound *B* is

- (a) an alkane
- (b) an alkene
- (c) an alkyne
- (d) none of these.

(v) Compound (*F*) has a general formula

- (a)  $C_nH_{2n-2}$
- (b)  $C_nH_{2n}$
- (c)  $C_nH_{2n+4}$
- (d)  $C_nH_{2n+2}$

**9**

Read the following and answer any four questions from 9(i) to 9(v).

A hydrocarbon (*P*) has the molecular formula  $C_{10}H_{22}$ . A hydrocarbon (*Q*) has two carbon atoms less than (*P*) and belong to the same homologous series. A hydrocarbon (*R*) has two carbon atoms more than (*P*) and belong to the same homologous series.

(i) What is the molecular formula of (*Q*)?

- (a)  $C_{12}H_{26}$
- (b)  $C_8H_{16}$
- (c)  $C_8H_{18}$
- (d)  $C_8H_{14}$

(ii) To which homologous series do the compound (*P*), (*Q*) and (*R*) belong?

- (a)  $C_nH_{2n}$
- (b)  $C_2H_{2n-2}$
- (c)  $C_nH_{2n+2}$
- (d)  $C_nH_{2n+1}$

(iii) What is the molecular formula of (*R*)?

- (a)  $C_{12}H_{26}$
- (b)  $C_{12}H_{24}$
- (c)  $C_{12}H_{22}$
- (d)  $C_{12}H_{28}$

(iv) Identify the correct statement about compounds (*P*), (*Q*) and (*R*).

- (a) They have same melting and boiling points.
- (b) They have same chemical properties.
- (c) They have different general formula.
- (d) They differ by  $-CH_2$  unit.

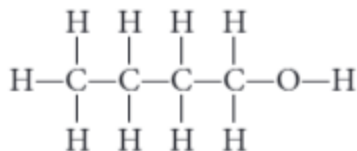
(v) Compounds (*P*), (*Q*) and (*R*) are

- (a) alkanes
- (b) alkenes
- (c) alkynes
- (d) none of these.

**10**

Read the following and answer any four questions from 10(i) to 10(v).

An organic molecule has the following structure :



(i) To which homologous series does this molecule belong?

- (a) Aldehydes
- (b) Ketones
- (c) Alcohols
- (d) Alkanes

(ii) What is the general formula of this homologous series?

- (a)  $C_nH_{2n+1}OH$
- (b)  $C_nH_{2n+2}$
- (c)  $C_nH_{2n}O$
- (d)  $C_nH_{2n+1}CHO$

(iii) Which is the next member of this series?

- (a)  $C_4H_9OH$
- (b)  $C_3H_7OH$
- (c)  $C_5H_{11}OH$
- (d)  $C_6H_{13}OH$



- (iv) Which is the third member of this series?  
(a)  $C_3H_7OH$                       (b)  $C_4H_9OH$                       (c)  $C_2H_5OH$                       (d)  $CH_3OH$
- (v) Which is the second member of this series?  
(a) Ethanol                      (b) Methanol                      (c) Propanol                      (d) Butanol

### ASSERTION & REASON

For question numbers 11-25, two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :

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

11. **Assertion :** Saturated hydrocarbons are chemically less reactive.  
**Reason :** All the valencies of carbon atom are satisfied by single covalent bonds.
12. **Assertion :** Both aldehydes and ketones contain carbonyl group.  
**Reason :** In aldehydes, the functional group is attached to atleast one hydrogen atom.
13. **Assertion :** In alkanes, alkenes and alkynes the valency of carbon is always four.  
**Reason :** All hydrocarbons except alkanes contain double bonds.
14. **Assertion :** Graphite is a good conductor of electricity.  
**Reason :** It has one free valence electron.
15. **Assertion :** The functional group present in alcohols is  $-OH$ .  
**Reason :** It is the same group as present in water, hence water and alcohol have similar properties.
16. **Assertion :** Ethanol is first member of the alcohol homologous series.  
**Reason :** A homologous series can be represented by a general formula.
17. **Assertion :** Carbon and its compounds can be used as fuels.  
**Reason :** They are highly inflammable and have high calorific value.
18. **Assertion :** Diamond is not good conductor of electricity.  
**Reason :** It has no free electrons.
19. **Assertion :** Covalent compounds are generally poor conductor of electricity.  
**Reason :** They consist of molecules and not ions which can transfer charge.
20. **Assertion :** Carbon possesses property of catenation.  
**Reason :** Carbon atoms form double as well as triple bonds during catenation.
21. **Assertion :** Two members of a homologous series have similar chemical properties.  
**Reason :** Propane and butane are members of same homologous series.
22. **Assertion :** Olefins have the general formula  $C_nH_{2n+1}$ .  
**Reason :** There is atleast one double bond between two carbon atoms in their molecules.
23. **Assertion :** Diamond is the hardest natural known substance.  
**Reason :** Diamond is used for cutting marble, granite and glass.
24. **Assertion :** Diamond and graphite do not have the same crystal structure.  
**Reason :** Diamond is crystalline while graphite is amorphous.
25. **Assertion :** Graphite is soft and slippery to touch.  
**Reason :** Graphite has sheet like layered structure.

## HINTS & EXPLANATIONS

1. (i) (a): All the members of homologous series show similar chemical properties.

(ii) (c): Alkynes have the general formula  $C_nH_{2n-2}$ , e.g., Ethyne ( $C_2H_2$ ), Propyne ( $C_3H_4$ ), Butyne ( $C_4H_6$ ).

(iii) (b): Two consecutive members of a homologous series differ by a  $-CH_2$  group

(iv) (c): The melting and boiling points increase with increasing molecular mass.

(v) (b): Molecular formula of first member :  $C_2H_6O$

Molecular formula of second member :  $C_3H_8O$

Molecular formula of third member :  $C_4H_{10}O$

Thus, the general formula of the homologous series is  $C_nH_{2n+2}O$ .

2. (i) (c): Each atom is covalently bonded to four other atoms, which in turn, are bonded to four more atoms. Thus, X is a giant molecule and has a structure similar to that of diamond. Substance X is not a compound as it consists of only one type of atoms. Thus, X is an element. Graphite has layers of carbon atoms.

(ii) (a) (iii) (d)

(iv) (b): In graphite only three valence electrons are used for bond formation and hence fourth electron is free to move which makes it a good conductor of electricity.

(v) (b): Given structures are of graphite and diamond and these are allotropes of carbon.

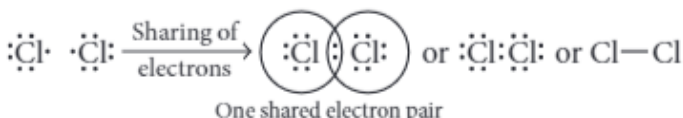
3. (i) (b): Both  $NH_3$  and  $HCl$  have single bonds.

(ii) (a):  $N \equiv N$

(iii) (a)

(iv) (c):  $O = C = O$

(v) (c): In chlorine molecule, both chlorine atoms contribute one electron and thus share single electron pair to form single covalent bond. As shared pair is shared by both atoms, they acquire inert gas configuration of argon atom in valence shell.



4. (i) (d) (ii) (a)

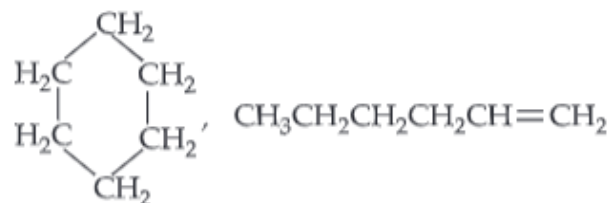
(iii) (c)

(iv) (d): In diamond, one carbon is attached to four other carbon atoms hence it has no free electron.

(v) (a)

5. (i) (d):  $CH_3CH_2CH_2CH_3$ ,  $\begin{array}{c} CH_3CHCH_3 \\ | \\ CH_3 \end{array}$

(Butane and *iso*-Butane- $C_4H_{10}$ )



(Cyclohexane and hexene- $C_6H_{12}$ )

$CH_3CH_2CHO$ ,  $CH_3COCH_3$

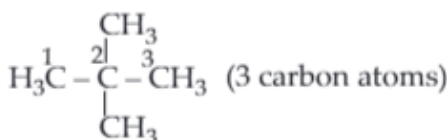
(Propanal and propanone- $C_3H_6O$ )

(ii) (a)

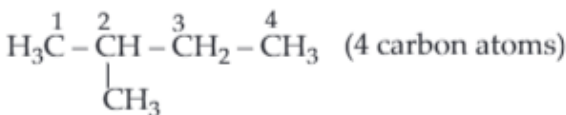
(iii) (d):  $CH_3CH_2CH_2CH_3$  and  $\begin{array}{c} CH_3CHCH_3 \\ | \\ CH_3 \end{array}$  have

different structural formulas and same molecular formula.

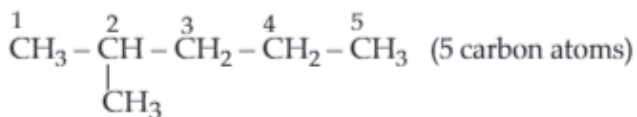
(iv) (c): *neo*-Pentane :



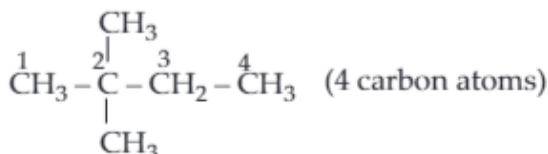
*iso*-Pentane :



2-Methylpentane :

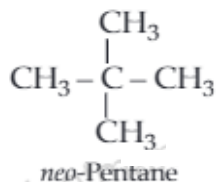
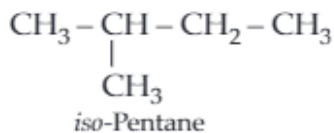
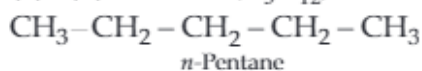


2,2-Dimethylbutane :



Hence, 2-methylpentane has the longest carbon chain.

(v) (b): Pentane ( $C_5H_{12}$ ) has three structural isomers :



6. (i) (c): *A*, *B* and *C* are classified as hydrocarbons because these compounds are made up of carbon and hydrogen only.

(ii) (c): *C* is an alkane.

(iii) (b):  $C_5H_{10}$  is an alkene having a general formula  $C_nH_{2n}$ .

(iv) (b): *A* and *B* do not belong to same homologous series. *A* is an alkane while *B* is an alkene.

(v) (b)

7. (i) (d): (*P*) and (*T*) are alkynes.

(ii) (a): Alcohol ( $-OH$ ).

(iii) (a): (*T*) is an alkyne having general formula of  $C_nH_{2n-2}$ .

(iv) (c): (*U*) is an alkene.

(v) (b)

8. (i) (d): *A* and *F* are alkanes ; *B* and *E* are alkenes ; *C* and *D* are alkynes.

(ii) (d): *B* is an alkene having general formula  $C_nH_{2n}$ , the homologous series to which *E* belongs.

(iii) (a): *C* and *D* belong to a homologous series having general formula  $C_nH_{2n-2}$ . *B* and *E* are alkenes. All the compounds have different physical and chemical properties.

(iv) (b): (*B*) is alkene.

(v) (d): (*F*) is an alkane.

9. (i) (c): Molecular formula of (*Q*) is  $C_8H_{18}$  as it has two carbon atoms less than (*P*).

(ii) (c): Compounds (*P*), (*Q*) and (*R*) are alkanes having general formula  $C_nH_{2n+2}$ .

(iii) (a): Molecular formula of (*R*) is  $C_{12}H_{26}$  as it has two carbon atoms more than (*P*).

(iv) (b): Compound (*P*), (*Q*) and (*R*) belong to same homologous series so they have different physical properties but similar chemical properties. They have same general formula  $C_nH_{2n+2}$ . They differ by 2 carbon atoms and 4 hydrogen atoms.

(v) (a)

10. (i) (c): Alcohol ( $-OH$ ).

(ii) (a):  $C_nH_{2n+1}OH$  is the general formula of the homologous series of alcohol.

(iii) (c)

(iv) (a)

(v) (a): Ethanol ;  $C_2H_5OH$  is the second member of this series.

11. (a)

12. (b)

13. (c): Only alkenes contain double bond, alkynes contain triple bond, but in all hydrocarbons carbon remains tetravalent.

14. (a)

15. (c): In alcohols  $-OH$  group is attached to an alkyl group hence water and alcohol have different properties.

16. (d): Methanol is first member of the alcohol homologous series.

17. (a)

18. (a): In diamond, one carbon atom is attached to four other carbon atoms, hence it has no free electron.

19. (a)

20. (b): Catenation property of carbon is primarily due to its small size, electronic configuration and unique strength of carbon-carbon bonds.

21. (b): All the members of homologous series contain the same functional group, show gradation in physical properties and similarity in chemical properties.

22. (d): Olefins are unsaturated hydrocarbons. There is at least one double bond between two carbon atoms in their molecules and they have the general formula  $C_nH_{2n}$ .

23. (b)

24. (c): In diamond, C-atoms are  $sp^3$  hybridized while in graphite, they are  $sp^2$  hybridized. Diamond and graphite both are crystalline forms of carbon.

25. (a)



# Periodic Classification of Elements

## CASE STUDY / PASSAGE BASED QUESTIONS

1

Read the following and answer any four questions from 1(i) to 1(v).

After the discovery of large number of elements it became necessary to classify them and arrange them in a regular manner in order of their periodic properties. In 1817, Johann Wolfgang Dobereiner tried to arrange the elements with similar properties into groups. He identified some groups of three elements having similar physical and chemical properties, known as Dobereiner's triads.

In 1865, John Newlands arranged all known elements in the order of increasing atomic masses and found that the properties of every eighth element are similar to the properties of the first element.

- (i) If Cl, Br, I is a Dobereiner's triad and the atomic masses of Cl and I are 35.5 and 127 respectively, then the atomic mass of Br is
- |           |            |
|-----------|------------|
| (a) 162.5 | (b) 91.5   |
| (c) 81.25 | (d) 45.625 |
- (ii) Example of Dobereiner's triad is
- |                |               |
|----------------|---------------|
| (a) Li, Al, Ca | (b) Li, Na, K |
| (c) Li, K, Na  | (d) K, Al, Ca |
- (iii) *A* and *B* are two elements having similar properties which obey Newlands' law of octaves. How many elements are there in between *A* and *B*?
- |       |       |
|-------|-------|
| (a) 7 | (b) 8 |
| (c) 5 | (d) 6 |
- (iv) According to the Newlands' law of octaves, the properties of magnesium are similar to those of
- |               |                |
|---------------|----------------|
| (a) beryllium | (b) lithium    |
| (c) sodium    | (d) potassium. |
- (v) On what basis the elements are arranged in Dobereiner's triad?
- |                        |                         |
|------------------------|-------------------------|
| (a) Atomic number      | (b) Atomic mass         |
| (c) Number of neutrons | (d) Number of electrons |

### Syllabus

Need for classification, early attempts at classification of elements (Dobereiner's Triads, Newlands' Law of Octaves, Mendeleev's Periodic Table), Modern periodic table, gradation in properties, valency, atomic number, metallic and non-metallic properties.

Read the following and answer any four questions from 2(i) to 2(v).

Mendeleev arranged the 63 elements known at that time in order of their ascending atomic masses and prepared a periodic table. Mendeleev's periodic table contains vertical columns called 'groups' and horizontal rows called 'periods'. Elements with similar properties were placed in same groups.

The basis of Mendeleev's classification is his periodic law which states that :

- (I) Atomic mass is the fundamental property of elements.  
 (II) The physical and chemical properties of elements are periodic function of their atomic masses.
- (i) Which of the following metals is not placed in eighth group of Mendeleev's periodic table?  
 (a) Fe (b) Na (c) Co (d) Ni
- (ii) In Mendeleev's periodic table, silver belongs to IB group. The group to which silver belongs in the modern periodic table is  
 (a) first (b) eleventh (c) tenth (d) sixteenth.
- (iii) In Mendeleev's periodic table, gaps were left for the elements to be discovered later. Which of the following elements found a place in the periodic table later?  
 (a) Chlorine (b) Silicon (c) Oxygen (d) Germanium
- (iv) The properties of *eka*-aluminium predicted by Mendeleev were the same as properties of which element that was discovered later?  
 (a) Scandium (b) Germanium (c) Gallium (d) Aluminium
- (v) Which of the following statements is not correct about Mendeleev's periodic table?  
 (a) In the Mendeleev's periodic table, some places were left vacant for new elements which were not discovered at that time.  
 (b) Group VIII like groups I-VII has been divided into two sub-groups A and B.  
 (c) The group of an element in the periodic table represents its valency.  
 (d) Li and C belong to same period in Mendeleev's periodic table.

Read the following and answer any four questions from 3(i) to 3(v).

In 1913, Henry Moseley showed that the atomic number of an element is the more fundamental property than its atomic mass. Accordingly, Mendeleev's periodic law was modified and atomic number was adopted as the basis of modern periodic table.

In this periodic table, the elements are arranged in increasing order of their atomic numbers.

There are 18 vertical columns in the periodic table which constitute 18 groups or families. The groups are numbered as 1, 2, 3, ... upto 18. All the members of a particular group have similar outer shell electronic configuration. There are seven horizontal rows of the periodic table which are known as periods.

- (i) According to modern periodic law, the properties of elements are the periodic function of their  
 (a) atomic masses (b) atomic volumes (c) atomic numbers (d) densities.
- (ii) All the elements in a period in the periodic table have the same  
 (a) atomic number (b) electronic configuration  
 (c) atomic weight (d) valence shell.
- (iii) Which of the following combinations of elements belong to the same group?  
 (a) N, P, As (b) Li, Be, Al (c) Na, Mg, Al (d) O, S, Cl

- (iv) The atoms of elements belonging to the same group of periodic table have same number of  
 (a) protons (b) electrons  
 (c) neutrons (d) electrons in outermost shell.
- (v) In the periodic table, the element with atomic number 16 will be placed in the group  
 (a) fourteen (b) sixteen (c) thirteen (d) fifteen.

#### 4

Read the following and answer any four questions from 4(i) to 4(v).

Maximum number of electrons that can be accommodated in a shell is given by the formula :  $2n^2$ , where  $n$  is the number of the outermost from the nucleus.

For example,

$K$  shell -  $2 \times (1)^2 \Rightarrow 2$ , hence,  $K$ -shell can accommodate maximum 2 electrons.

$L$  shell -  $2 \times (2)^2 \Rightarrow 8$ , hence,  $L$ -shell can accommodate maximum 8 electrons.

In the modern periodic table, elements are placed according to their electronic configuration. The elements present in any group have the same number of valence electrons. The elements present in any period contain the same number of shells. The first period of the modern periodic table corresponds to the filling of electrons in the first energy shell, *i.e.*,  $K$ -shell, first period has two elements. The second period of the periodic table corresponds to the filling of electrons in the second energy shell, *i.e.*,  $L$ -shell, second period contains eight elements. The third, fourth, fifth, sixth and seventh periods have 8, 18, 18, 32 and 32 elements respectively.

- (i) Electronic configuration of an element 'X' is 2, 1. The number of elements present in the period to which 'X' belongs is  
 (a) 8 (b) 32 (c) 18 (d) 2
- (ii) Among the given elements A, B, C, D and E with atomic numbers 2, 3, 7, 10 and 30 respectively, which of these belong to the same period?  
 (a) A, B, C (b) B, C, D (c) A, D, E (d) B, D, E
- (iii) The elements A, B, C and D have atomic numbers 4, 12, 17 and 19 respectively. Which pair of elements belong to the same period?  
 (a) B and C (b) A and B (c) A and D (d) C and D
- (iv) Which of the following have the same number of electrons in outermost shell?  
 (a) Elements with atomic numbers 3, 11, 19 (b) Elements with atomic numbers 14, 15, 16  
 (c) Elements with atomic numbers 12, 20, 28 (d) Elements with atomic numbers 10, 18, 26
- (v) Which of the following elements has two shells and both are completely filled?  
 (a) Helium (b) Neon (c) Calcium (d) Fluorine

#### 5

Read the following and answer any four questions from 5(i) to 5(v).

All the elements on the left side and in the middle of the periodic table (except hydrogen) are metallic elements or metals. Also, majority of elements in periodic table are metals. In the modern periodic table, the metals are separated from non-metals by a zig-zag line. Some non-metals are gases, some are liquids and rest are solids at room temperature. They generally differ from metals in appearance and in other physical properties. Some elements that lie along the zig-zag line that separates metals from non-metals, have properties that fall between those of metals and non-metals. These elements are regarded as semi-metals or metalloids.



- (i) From the given set of metals and non-metals, identify the non-metals.  
S, Mg, Al, P, N, Na, K
- (a) S, P, K                      (b) Mg, Al, Na                      (c) S, P, N                      (d) S, Al, K
- (ii) Which of the following groups contains metals, non-metals and metalloids?  
(a) Group 1                      (b) Group 17                      (c) Group 14                      (d) Group 2
- (iii) Which of the following elements is a metalloid?  
(a) Pb                      (b) Sb                      (c) Bi                      (d) Zn
- (iv) Silicon is a metalloid because  
(a) its valency is 4                      (b) it has three electron shells  
(c) it shows properties of both metals and non-metals                      (d) it is a liquid metal.
- (v) The lightest metal is  
(a) Li                      (b) Fe                      (c) Cu                      (d) Ag

## 6

Read the following and answer any four questions from 6(i) to 6(v).

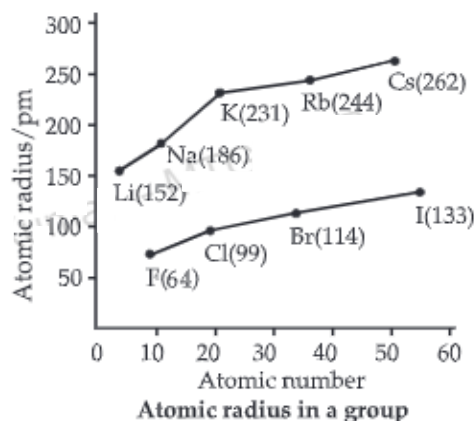
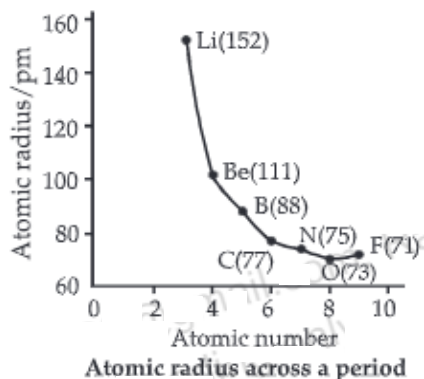
Generally metals possessing 1, 2 or 3 electrons in their respective valence shells have a strong tendency to lose electrons to form positive ions. Non-metals, on the other hand, having 4 to 8 electrons in their respective outermost shells generally have a tendency to gain electrons to form negative ions. Metallic character is called electropositive character and non-metallic character is called electronegative character. The metallic character increases down a group and non-metallic character increases along a period.

- (i) Which of the following electronic configurations represent most electropositive element?  
(a) 2, 1                      (b) 2, 8, 1                      (c) 2, 2                      (d) 2, 8, 2
- (ii) Considering the elements B, C, N, F and Si, the correct order of their non-metallic character is  
(a)  $B > C > Si > N > F$                       (b)  $Si > C > B > N > F$                       (c)  $F > N > C > B > Si$                       (d)  $F > N > C > Si > B$
- (iii) Which of the following is least metallic?  
(a) N                      (b) P                      (c) As                      (d) Sb
- (iv) To which of the following categories does the element with atomic number 14 belong?  
(a) Metal                      (b) Metalloid  
(c) Non-metal                      (d) Left-hand side element
- (v) Non-metals are present in the periodic table at  
(a) right side                      (b) left side                      (c) middle                      (d) both right and left.

## 7

Read the following and answer any four questions from 7(i) to 7(v).

The distance between the centre of the nucleus and the outermost shell of electrons is known as atomic radius. On moving from left to right along a period, atomic radii decrease because effective nuclear charge increases. For example, the atomic size decreases regularly from Li to F in the second period and from Na to Cl in the third period. It may, however, be noted that in any period, the noble gas has the largest size. On moving down in a group, atomic radii increase.



- (i) Which of the following has the maximum atomic radius?  
 (a) Al (b) Si (c) P (d) Mg
- (ii) The element with the smallest size in group 13 is  
 (a) gallium (b) thallium (c) aluminium (d) boron.
- (iii) The atomic radius decreases as we move across a period because  
 (a) atomic mass increases (b) atomic number decreases  
 (c) effective nuclear charge increases (d) electrons are removed.
- (iv) In the third period of the periodic table, the element having smallest size is  
 (a) Na (b) Ar (c) Cl (d) Si
- (v) Among O, C, F, Cl, Br, the correct order of increasing atomic radii is  
 (a) F, O, C, Cl, Br (b) F, C, O, Cl, Br (c) F, Cl, Br, O, C (d) C, O, F, Cl, Br

## 8

Read the following and answer any four questions from 8(i) to 8(v).

Study the following table in which positions of six elements A, B, C, D, E and F are shown as they are in the modern periodic table :

Group →	1	2	3-12	13	14	15	16	17	18
Period ↓									
2	A					B			C
3				D	E				F

- (i) Which element in the given table has same number of electrons as in  $K^+$  and  $Cl^-$ .  
 (a) C (b) F (c) E (d) D
- (ii) The formula of the oxide of element D will be  
 (a) DO (b)  $D_2O$  (c)  $D_2O_3$  (d)  $D_2O_5$
- (iii) Which of the following elements has most metallic character?  
 (a) F (b) D (c) E (d) B
- (iv) Element E forms a chloride with formula  
 (a)  $ECl_2$  (b)  $ECl_3$  (c)  $ECl_4$  (d) ECl
- (v) Which of the following elements is a metalloid?  
 (a) A (b) B (c) C (d) E

Read the following and answer any four questions from 9(i) to 9(v).

The recurrence of properties of the elements after a certain regular intervals, when they are arranged in the increasing order of their atomic numbers, is called periodicity. There are a number of physical properties such as atomic size, metallic and non-metallic character, etc. which show periodic variation. In periodic table, various properties vary differently from moving left to right in a period and going down in a group. In a period, properties vary because from moving left to right in a period, number of shells remain same but valence electron increases by one number hence nuclear charge increases. In a group, on going down, number of valence shells increases while number of valence electrons remains same.

- (i) From top to bottom in a group of the periodic table, the electropositive character of the element  
 (a) increases (b) decreases (c) remains unchanged (d) changes irregularly.
- (ii) Which element has the largest size in the second period?  
 (a) N (b) F (c) Li (d) Be
- (iii) Which of the following elements has three valence electrons?  
 (a) Cs (b) Ca (c) Al (d) S
- (iv) In the periodic table, the metallic character of elements  
 (a) decreases from left to right and decreases down the group  
 (b) decreases from left to right and increases down the group  
 (c) increases from left to right and increases down the group  
 (d) increases from left to right and decreases down the group.
- (v) Which of the following increases along the period?  
 (a) Number of valence electrons (b) Atomic size  
 (c) Electropositive character (d) All of these

Read the following and answer any four questions from 10(i) to 10(v).

“Properties of elements are the periodic function of their atomic numbers.” This is known as modern periodic law. It means that the properties of elements depend on their atomic numbers and the elements are given positions in the periodic table on the basis of their increasing atomic number. Atomic number determines the distribution of electrons in the orbit, and electrons of the outermost orbit determine the properties of an element. There are 18 groups (vertical columns) and 7 periods (horizontal lines) in modern form of the periodic table. The number of the period is equal to the number of shells in the atoms of the elements belonging to that period.

- (i) What is the atomic number of element of period 3 and group 17?  
 (a) 10 (b) 14 (c) 17 (d) 12
- (ii) Atomic number of an element is 2, 8, 6. Its period number and valency are respectively  
 (a) 3, 2 (b) 6, 6 (c) 6, 2 (d) 2, 2
- (iii) An element has mass number 40 and contains 20 neutrons in its atom. To which period and group of the periodic table does it belong?  
 (a) Period-3, Group-3 (b) Period-4, Group-3 (c) Period-4, Group-2 (d) Period-4, Group-4



- (iv) An element 'X' has an atomic number of 16. With which of the following elements will it show similar chemical properties?  
(a) Ne (10)                      (b) N (7)                      (c) O (8)                      (d) Be (4)
- (v) Identify the statement(s) which is(are) true for the modern periodic table.  
(a) It reflects trends in physical and chemical properties of the elements.  
(b) It helps to reflect the relative atomicity of bonds between any two elements.  
(c) It helps to predict the stable valency state of the elements.  
(d) All of these

## ASSERTION & REASON

For question numbers 11-30, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :

- (a) Both A and R are true, and R is correct explanation of the assertion.  
(b) Both A and R are true, but R is not the correct explanation of the assertion.  
(c) A is true, but R is false.  
(d) A is false, but R is true.
11. **Assertion :** Atomic radius in general decreases along a period.  
**Reason :** In a period, effective nuclear charge decreases.
12. **Assertion :** Decreasing order of atomic radii is :  $\text{Cl} > \text{F} > \text{O} > \text{S}$ .  
**Reason :** Atomic radius increases as the number of energy level increases and decreases as nuclear charge increases.
13. **Assertion :** Elements in the same vertical column have similar properties.  
**Reason :** Periodic properties of elements is a function of atomic number.
14. **Assertion :** Number of valence electrons decreases down the group.  
**Reason :** Number of valence electrons increases when we move left to right in a period.
15. **Assertion :** Down the group, atomic radius increases.  
**Reason :** Electrons are added in new shell.
16. **Assertion :** Atomic size of potassium is greater than that of sodium.  
**Reason :** As we go down the group, atomic radius increases.
17. **Assertion :** Increasing order of non-metallic character is :  $\text{Si} < \text{B} < \text{C} < \text{N} < \text{F}$ .  
**Reason :** Non-metallic character increases along a period and decreases down the group.
18. **Assertion :** Nobel elements were not included in Mendeleev's periodic table.  
**Reason :** Mendeleev arranged the then known elements in order of their increasing atomic mass.
19. **Assertion :** Atomic mass of certain elements are expressed in fraction taking in account the availability of its various isotopes.  
**Reason :** Isotopes of an element have the same atomic mass but different atomic number.
20. **Assertion :** Increasing order of metallic character is :  $\text{P} < \text{Si} < \text{Be} < \text{Mg} < \text{Na}$   
**Reason :** Metallic character increases along a period and decreases down a group.
21. **Assertion :** Li and Mg are elements of second period.  
**Reason :** Both are metals.

22. **Assertion :** According to Mendeleev's periodic law, the properties of elements is the periodic function of their atomic numbers.  
**Reason :** Mendeleev placed some elements with higher atomic mass before the elements with lower atomic mass.
23. **Assertion :** Alkali metals do not form dipositive ions.  
**Reason :** After loss of one electron alkali metals achieve stable configuration of noble gas.
24. **Assertion :** The group 18 consists of elements which are in gaseous state under ordinary conditions.  
**Reason :** All the elements of group 18 have stable configuration.
25. **Assertion :** In Dobereiner's triad, the three elements present have same gaps of atomic numbers.  
**Reason :** Elements in a triad have similar properties.
26. **Assertion :** Argon (at. mass 39.94) has been placed before potassium (at. mass 39.10) in the periodic table.  
**Reason :** In modern periodic table, elements have been placed in order of their increasing atomic numbers.
27. **Assertion :** In Newlands' octaves, the properties of lithium and sodium were found to be same.  
**Reason :** Sodium is the eighth element after lithium.
28. **Assertion :** Group 18 is placed at the extreme right of the periodic table.  
**Reason :** It is in accordance with their electronic configuration.
29. **Assertion :** Chlorine is the most electronegative element of the halogen family.  
**Reason :** Size of chlorine is more than that of fluorine.
30. **Assertion :** Atomic size of As is more than that of P.  
**Reason :** Atomic size decreases along a period.

## HINTS & EXPLANATIONS

1. (i) (c): In a triad, the atomic mass of the central atom is near average of the atomic masses of the other two atoms. In the triad, Cl, Br, I, the mass of Br will be the average mass of Cl and I.

$$\text{Atomic mass of bromine} = \frac{35.5 + 127}{2} = 81.25$$

(ii) (b): Li, Na, K is a Dobereiner's triad. The atomic mass of middle element is approximately the arithmetic mean of the atomic masses of other two elements of the triad.

(iii) (d)

(iv) (a): Properties of magnesium are similar to those of beryllium because magnesium is eighth element starting from beryllium.

(v) (b)

2. (i) (b)

(ii) (b)

(iii) (d)

(iv) (c): Scandium – *eka*-boron

Gallium – *eka*-aluminium

Germanium – *eka*-silicon

(v) (b): Group VIII consists of three triads such as Fe, Co, Ni; Ru, Rh, Pd and Os, Ir, Pt arranged in 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> periods respectively.

3. (i) (c): According to modern periodic law, the properties of elements are the periodic function of their atomic numbers.

(ii) (d): All the elements in a period have the same valence shell.

(iii) (a): N, P and As belong to the same group (group 15).

(iv) (d)

(v) (b): Element with atomic number 16 has electronic configuration 2, 8, 6. Hence, it will be placed in  $10 + 6 = 16^{\text{th}}$  group.

4. (i) (a): 'X' is Li. It belongs to second period. Number of elements present in a period =  $2 \times n^2$ , where  $n$  is the number of outermost shell from the nucleus. Thus, second period has  $2 \times 2^2$  i.e., 8 elements.

(ii) (b): B is Li, C is N, D is Ne and they all belong to second period.

(iii) (a): Electronic configurations of

	K	L	M	N	
A :	2,	2			$\Rightarrow$ 2 <sup>nd</sup> period
B :	2,	8,	2		$\Rightarrow$ 3 <sup>rd</sup> period
C :	2,	8,	7		$\Rightarrow$ 3 <sup>rd</sup> period
D :	2,	8,	8,	1	$\Rightarrow$ 4 <sup>th</sup> period

Thus, B and C belong to the same period.

(iv) (a): Li, Na and K belong to group 1.

(v) (b):  ${}_{10}\text{Ne} : \overset{K}{2} \overset{L}{8}$

Both K and L shells are completely filled.

5. (i) (c): S, P, N are non-metals while Mg, Al, K and Na are metals.

(ii) (c): Group-14 

C	Si	Ge	Sn	Pb
Non-metal	Metalloids		Metals	

(iii) (b)

(iv) (c)

(v) (a): Li is the lightest metal.

6. (i) (b): Metallic character or electropositive character increases down a group and decreases along a period. The given elements are Li, Na, Be and Mg respectively. Among these elements, Na is most electropositive.

(ii) (c): Non-metallic character increases left to right in a period and decreases from top to bottom in a group.

(iii) (a)

(iv) (b): The element with atomic number 14 is Si which is a metalloid.

(v) (a)

7. (i) (d): In general, the atomic radii decrease along a period and increase down a group.

Atom	${}_{12}\text{Mg}$	${}_{13}\text{Al}$	${}_{14}\text{Si}$	${}_{15}\text{P}$
Radius (pm)	160	143	118	110

Thus, Mg has maximum atomic radius.

(ii) (d): Boron is the first element of group 13, hence it is smallest in size.

(iii) (c): Effective nuclear charge increases along a period and due to addition of electrons in the same shell it causes the incoming electron to experience more force of attraction by the nucleus. Therefore, the size of the atom decreases.

(iv) (c): Atomic size decreases across the period. Cl has smaller size than Ar. Argon has larger atomic size as compared to Cl due to the inert nature (it has completely filled outer shell).

(v) (a): Atomic size decreases from left to right in a period and increases from top to bottom in a group. Thus, the order is  $\text{F} < \text{O} < \text{C} < \text{Cl} < \text{Br}$ .

8. (i) (b): F is argon which has atomic number 18. It has 18 electrons.  $\text{K}^+$  and  $\text{Cl}^-$  ions also have 18 electrons each.

(ii) (c): D is aluminium which is an element of group 13. Valency of aluminium is 3. Hence, the formula of its oxide will be  $\text{Al}_2\text{O}_3$ .

(iii) (b): D is aluminium, which has the most metallic character among the given elements.

(iv) (c): Valency of E is 4. Hence, the formula of the chloride will be  $\text{ECl}_4$ .

(v) (d): E is silicon which is a metalloid.

9. (i) (a): As the size of the atom increases down the group, electropositive character increases.

(ii) (c): Li is the first element of the second period. As the size decreases in the period from left to right, therefore, Li is the largest atom in the period.

(iii) (c): Al ( $Z = 13$ ): 2, 8, 3

(iv) (b): Metallic character of elements decreases from left to right and increases down the group.

(v) (a): As we move from left to right along a period, the number of valence electrons increases from 1 to 8.

10. (i) (c): The element is chlorine ( $Z = 17$ ).

(ii) (a): The element (sulphur) belongs to third period and its valency is 2.

(iii) (c): Atomic number of the element =  $40 - 20 = 20$   
Electronic configuration of the element is 2, 8, 8, 2; i.e., the element is calcium which belongs to 4<sup>th</sup> period and 2<sup>nd</sup> group of the periodic table.



(iv) (c): The element is sulphur. Sulphur and oxygen belong to group 16.

(v) (d)

11. (c): Effective nuclear charge increases along a period.

12. (d): Correct order is  $S > Cl > O > F$ .

13. (b): Elements in the same vertical column (group) have similar properties due to similar outer electronic configurations.

14. (d): Number of valence electrons remains same in a group.

15. (a): New shells are added down the group, hence, atomic radius increases.

16. (a)

17. (a):	Period/Group	13	14	15	16	17
	2	B	C	N	—	F
	3	—	Si	—	—	—

As non-metallic character increases along a period and decreases down a group, Si is the least non-metallic element and non-metallic character increases from B to C to N to F. Hence, increasing order of non-metallic character is :  $Si < B < C < N < F$ .

18. (b): The noble gases were not known at Mendeleev's time.

19. (c): Isotopes have same atomic number but different atomic mass.

20. (c): The elements can be arranged in different periods and groups as follows :

Period/Group	1	2	13	14	15
2 <sup>nd</sup>	—	Be	—	—	—
3 <sup>rd</sup>	Na	Mg	—	Si	P

As metallic character decreases along a period and increases down a group, so Na is the most metallic element and P is the least metallic element and among Be and Mg, Mg is more metallic. Hence, increasing order of metallic character is :  $P < Si < Be < Mg < Na$ .

21. (d): Lithium belongs to second period whereas magnesium belongs to third period and both are metals.

22. (d): According to Mendeleev's periodic law, the properties of elements are the periodic function of their atomic masses.

23. (a)

24. (b): Noble gases have stable configuration and they are gases at room temperature.

25. (d): In Dobereiner's triad, the atomic mass of the middle element was roughly the average of the atomic masses of other two elements.

26. (a)

27. (a)

28. (a)

29. (d): Fluorine is most electronegative element of the halogen family.

30. (b): Atomic size increases down a group.