Chapter 3

Chemical Reactions and their various types

- **Chemical Reaction :** The process in which a substance undergoes change to produce new substances with new properties are known as chemical reaction.
- **Chemical Equation :** The qualitative representation of a chemical reaction in a short hand or concise form in term of symbols and formulae, is called a chemical equation. For example. The burning of magnesium wire in oxygen(air) to produce magnesium oxide can be written as under in the form of a *word equation*.

$$\underbrace{\text{Magnesium + oxygen}}_{\text{Reactants}} \longrightarrow \underbrace{\text{Magnesium oxide}}_{\text{Product}}$$

Word equations represent simply change of reactants into products. They do not give the true picture of the chemical reactions.

- **Skeletal Chemical Equation or Symbol Equation :** A chemical equation written in the form of symbols and formulae is called a skeletal chemical equation. *Such a chemical equation may or may not be balanced* e.g.

$$\text{Magnesium + oxygen} \longrightarrow \text{Magnesium oxide (word equation)}$$

$$Mg + O_2 \longrightarrow MgO \text{ (skeletal equation)}$$

In the skeletal equation given above there are two oxygen atoms (O_2 = 2 atoms of oxygen) in the reactants and only one oxygen atom in products so it is not a balanced equation.

- **Balanced Chemical Equation :** A chemical equation in which number of atoms of each elements on L.H.S. (i.e. reactants) and R.H.S. (i.e.products) is equal is called a balanced chemical equation for example, magnesium reacts with sulfuric acid to form magnesium sulphate and hydrogen, can be represented as follows.

$$\text{Magnesium + Sulfuric acid} \longrightarrow \text{Magnesium Sulphate + Hydrogen (word equation)}$$

$$Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2\uparrow \text{ (Balanced equation)}$$

The balancing of a chemical equation is essential or necessary to fulfill the requirement of the **Law of Conservation of Mass.**

- **Balancing of Chemical Equations :**

The process of making the number of different elements on both side of the equation equal is known as balancing of chemical equation.

Hit and Trial Method : The reaction between hydrogen and oxygen to form water can be represented as under :-

$$\text{Hydrogen + oxygen} \longrightarrow \text{water (word equation)}$$

$$H_2 + O_2 \longrightarrow H_2O \text{ (skeletal equation)}$$

This equation is **unbalanced** and can be balanced by hit and trial method as follows :-

Oxygen will be balanced if 2 is written before H_2O (product).

It will give us the following equation.

$$H_2 + O_2 \longrightarrow 2H_2O$$

In doing so the number of hydrogen atoms becomes unbalanced. On the L.H.S. there are only 2 atoms of hydrogen while on RHS we have 4 atoms of hydrogen. To balance hydrogen atoms write 2 before H_2.

$$2H_2 + O_2 \longrightarrow 2H_2O \text{ (balanced equation)}$$

In a balanced chemical equation, homoatomic gases with atomicity two or more are always written in molecular from e.g. H_2, O_2, N_2, Cl_2, O_3 etc. Atomicity may be defined as the number of atoms in one molecule of the gas.

- **Essential of a Chemical Equation :**

A chemical equation-

(i) should represent an actual chemical change
(ii) should be balanced, and
(iii) should be molecular, i.e., all the substances should be in the form of molecules.

- **Implications of a Chemical Equation or Information by a Chemical Equation :**

A chemical equation conveys a large number of informations as described below-

(i) It tells us about the names of the reactants and products.
(ii) It expresses the number of molecules of reactants and products.
(iii) It expresses the relative weight of the reactants and the products.
(iv) It expresses the volume of the gaseous reactants and products.

Types of chemical reactions :

- **Decomposition reactions :** Decomposition reactions are those reactions in which a compound breaks down into simpler compounds (or substances). This type of reaction is simply the reverse of combination reactions. These reactions require energy in the form of heat, light, electricity etc.

Kinds of decomposition reactions :

Various kinds of decomposition reactions are :

(i) Thermal decomposition : This type of reaction takes place on heating a substance. For example,

$$ZnCO_3(s) \xrightarrow{\text{heat}} ZnO(s) + CO_2(g)$$

(ii) Electrolytic decomposition : This type of reaction takes place on passing electric current for example

$$2H_2O(\ell) \xrightarrow[\text{(acidified water)}]{\text{Electric current}} 2H_2(g) + O_2(g)$$

(iii) Catalytic decompositions : This type of reaction takes place in presence of a catalyst. For example

$$CH_4(g) \xrightarrow{\text{Catalyst}} CO + 2H_2(g)$$

(iv) Photochemical decomposition : This type of reaction takes place in presence of light. For example

$$2AgBr \xrightarrow{light} 2Ag + Br_2$$

- The reaction in which a hydrated salt loses molecules of water of crystallisation is known as **dehydration reaction**.

$$\underset{(Green)}{FeSO_4.7H_2O} \xrightarrow{Heat} \underset{(Dirty\ white)}{FeSO_4(s)} + 7H_2O(g)$$

- **Simple Displacement Reaction and Simple Substitutions**

A displacement reaction is a reaction in which an atom, or group of atoms, present in a molecule is displaced by another atom. Some examples of displacement reactions are :

(i) $CuSO_4(aq) + Mg(s) \longrightarrow MgSO_4(aq) + Cu(s)$

(ii) $Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + Fe$

A more reactive metal will displace a less reactive metal from its compound in solution. There are the sorts of things you observe in this type of reaction :

- the more reactive metal gradually dissolves
- the less reactive metal coats the more reactive metal
- the solution may change colour

- **Double Displacement Reactions or Double Decomposition**

The reactions in which mutual exchange of radicals takes place are known as double decomposition reactions. As a result of double decomposition reactions two new substances are formed.

Examples :

(I) When sodium chloride reacts with conc. sulphuric acid, two new substances (sodium sulphate and hydrogen chloride) are formed.

$$2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl$$

(II) When potassium bromide and silver nitrate reacts together, silver bromide and potassium nitrate are formed.

$$KBr + AgNO_3 \longrightarrow KNO_3 + AgBr$$

The double-displacement reactions have two major features in common. First, two compounds exchange ions or elements to form new compounds. Second, one of the products is either a compound that will separate from the reaction mixture in some way (commonly as a solid or gas) or a stable covalent compound, often water.

- **Precipitation Reactions :** A precipitation reaction occurs when two solutions are mixed together and a solid separates from the solution. The solid part that forms and separates from the mixture is called the precipitate the reaction shown below is a precipitation reaction.

$$BaCl_2 + 2Na_2SO_4 \longrightarrow BaSO_4 \downarrow + 2NaCl$$

- **Oxidation-Reduction Reactions**

Oxidation reactions : Oxidation is defined as a process which involve addition of oxygen or removal of hydrogen.

Addition of oxygen

$$N_2 + O_2 \longrightarrow 2NO$$

Removal of hydrogen :

$$Cl_2 + H_2S \longrightarrow 2HCl + S$$

Reduction : The term reduction is defined as a process which involve the removal of oxygen or addition of hydrogen.

Removal of oxygen :

$$CuO + H_2 \longrightarrow Cu + H_2O$$

Addition of hydrogen :

$$H_2 + S \longrightarrow H_2S$$

- **Oxidation - Reduction in terms of Electronic Concept :**

Oxidation is a loss of electrons

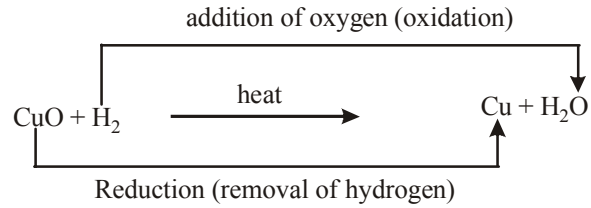
Reduction is a gain of electrons.

Oxidizing agent accepts electrons. Some common oxidising agents are $KMnO_4$, $K_2Cr_2O_7$ etc.

Reducing agent lose electrons. Some common reducing agents are $LiAlH_4$, $NaBH_4$ etc.

- **Redox Reactions :** Those reactions in which oxidation and reduction takes place simultaneously, are known as redox reactions.

Example :



Redox processes are very important as they play important role in governing a number of natural processes like corrosion, combustion, biological processes like respiration etc.

- **Exothermic reactions :** The chemical reactions which proceed with the evolution of heat energy are called exothermic reactions.

The heat energy produced during the reaction is indicated by writing +q on the product side. In general, exothermic reactions may be represented as :

$$A + B \longrightarrow C + D + Q(\text{heat energy})$$

(i) All combustion reactions are exothermic.

(ii) Respiration is an exothermic reaction.

(iii) The decomposition of vegetable matter into compost is also an example of exothermic reaction.

- **Endothermic reactions :** The chemical reactions which proceed with the absorption of heat energy are called endothermic reactions.

The heat energy absorbed during the reaction can be indicated by writing +q with the reactants or it can be indicated by writing –q (or the actual numerical value) with the products. In general, an endothermic reaction can represented as : $A + B \longrightarrow C + D - Q(\text{heat})$, where Q is the heat absorbed.

(i) Decomposition reactions are generally endothermic.

(ii) The number of endothermic reactions is much less than the exothermic reactions.

- **Combustion Reactions :** A chemical reaction in which a substance burns or gets oxidised in the presence of air or oxygen is called combustion reaction. For example, kerosene,

coal, charcoal, wood etc, burn in air and thus undergo combustion. All substances acting as fuels undergo combustion reactions. These are highly exothermic and are accompanied by release of energy which is quite useful in our daily life. All combustion reactions are not accompanied by flame. Combustion accompanied by release of energy.

- **Homogeneous reactions :** In case all the reactants and products of a chemical reaction are in the same physical state then such a reaction is known as **homogeneous reactions.**

  For representation of a physical state of reactants/products we write (g) for gases, (ℓ) for liquids and (s) for solids state.

  Example :

  $$H_2(g) + Cl_2(g) \longrightarrow 2HCl(g)$$

- **Heterogeneous reaction :** If in a chemical reaction, all the products and reactants are *not* in the same physical state then such a reaction is known as **heterogeneous reaction**.

  Example :

  $$CaCO_3(s) \xrightarrow{heat} CaO(s) + CO_2(g)$$

- **Corrosion (Erosion by chemical action) :** Corrosion is the degradation of metals and generally called rust. Corrosion causes damage to car bodies, iron railings, ships and to all objects made of metals, specially those of iron. Corrosion of iron is a serious problem. Corrosion is the primary means by which metals deteriorate. Most metal corrode on contact with water (and moisture in the air), acids, bases, salts, oils, aggressive metals polishes, and other solid and liquid chemicals. To minimize corrosion, protective coatings are applied to prevent the direct contact of moisture and oxygen with that metal.
- **Rancidity :** The most important cause of deterioration in fats and fatty foods is oxidation of fats. What we perceive is an unpleasant change in the flavour and odour of a food, called rancidity. Factors which accelerate fat oxidation include trace metals (iron, zinc, etc.), salt, light, water, bacteria, and moulds. Fat oxidation can be retarded by use of antioxidants by use of spices such as sage and rosemary, and by use of light and or air tight wrapping.

Exercise 1

DIRECTIONS : This section contains multiple choice questions. Each question has 4 choices (1), (2), (3) and (4) out of which only one is correct.

1. A student added dilute HCl to a test tube containing zinc granules and made following observations :
   I. The zinc surface became dull and black.
   II. A gas evolved which burnt with a pop sound.
   III. The solution remained colourless.
   Correct observations are -
   (1) I and II (2) I and III
   (3) II and III (4) I, II and III
2. A balanced chemical equation is accordance with-
   (1) Law of multiple proportion
   (2) Law of conservation of mass
   (3) Both (1) and (2)
   (4) Neither (1) nor (2)
3. A change is said to be a chemical change when-
   (1) Energy change occurs
   (2) New substances are formed
   (3) The change cannot be easily reversed
   (4) All statements are correct
4. Which of the following are chemical changes ?
   (i) Digestion of food
   (ii) Liquefaction of air
   (iii) Ripening of fruit
   (iv) Dissolution of sulphur in carbon disulphide
   (v) Freezing of water
   (vi) Electrolysis of water
   (1) (i) to (iv) all (2) (i), (iii) and (v)
   (3) (i), (iii) and (vi) (4) (iii), (iv) and (vi)
5. Which of the following statements is true?
   (1) The total mass of the substance remains same in chemical change
   (2) Chemical change is permanent and irreversible
   (3) Physical change is temporary and reversible
   (4) All of these
6. Which of the following statements is not correct?
   (1) A chemical equation tells us about the substances involved in a reaction.
   (2) A chemical equation informs us about the symbols and formula of substances involved in a reaction
   (3) A chemical equation tells us about the atom or molecules of the reactants and products involved in a reaction
   (4) All are correct
7. Which one is not a balanced equation?
   (1) $Fe + Cl_2 \longrightarrow FeCl_3$
   (2) $Mg + CuSO_4 \longrightarrow MgSO_4 + Cu$
   (3) $Zn + S \longrightarrow ZnS$
   (4) $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$
8. Which of the following reactions involved the combination of two element ?
   (1) $CaO + CO_2 \longrightarrow CaCO_3$
   (2) $4Na + O_2 \longrightarrow 2Na_2O$
   (3) $SO_2 + \frac{1}{2}O_2 \longrightarrow SO_3$
   (4) $NH_3 + HCl \longrightarrow NH_4Cl$

9. Consider the reaction

$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$

The above reaction is an example of
(1) combination reaction
(2) double displacement reaction
(3) decomposition reaction
(4) simple displacement reaction

10. What happens when dilute hydrochloric acid is added to iron fillings? Tick the correct answer.
(1) Hydrogen gas and iron chloride are formed.
(2) Chlorine gas and iron chloride are formed.
(3) No reaction takes place.
(4) Iron salts and water are produced.

11. What happens when copper rod is dipped in iron sulphate solution?
(1) Copper displaces iron
(2) Blue colour of copper sulphate solution is obtained
(3) No reaction takes place
(4) Reaction is exothermic

12. Which of the following is a decomposition reaction?
(1) $2HgO \xrightarrow{Heat} 2Hg + O_2$
(2) $CaCO_3 \xrightarrow{Heat} CaO + CO_2$
(3) $2H_2O \xrightarrow{Electrolysis} H_2 + O_2$
(4) All of these

13. $AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$

Above reaction is -
(1) precipitation reaction
(2) double displacement reaction
(3) combination reaction
(4) (1) and (2) Both

14. The reaction in which two compounds exchange their ions to form two new compounds is -
(1) a displacement reaction
(2) a decomposition reaction
(3) an isomerization reaction
(4) a double displacement reaction

15. When the gases sulphur dioxide and hydrogen sulphide mix in the presence of water, the reaction is

$SO_2 + 2H_2S \longrightarrow 2H_2O + 3S$. Here hydrogen sulphide is acting as
(1) an oxidising agent (2) a reducing agent
(3) a dehydrating agent (4) a catalyst

16. $CuO + H_2 \longrightarrow H_2O + Cu$ reaction is an example of -
(1) redox reaction (2) synthesis reaction
(3) neutralisation (4) analysis reaction

17. A substance which oxidises itself and reduces other is known as-
(1) oxidising agent (2) reducing agent
(3) Both of these (4) None of these

18. In the reaction $PbO + C \longrightarrow Pb + CO$
(1) PbO is oxidising agent
(2) C acts as a oxidising agent
(3) C acts as a reducing agent
(4) This reaction does not represent redox reaction

19. A redox reaction is one in which -
(1) both the substance are reduced
(2) both the substance are oxidised
(3) an acid is neutralised by the base
(4) one substance is oxidised while the other is reduced

20. In the equation, $NaOH + HNO_3 \longrightarrow NaNO_3 + H_2O$

nitric acid is acting as -
(1) an oxidising agent (2) an acid
(3) a nitrating agent (4) a dehydrating agent

21. Which of the statement about the following reaction is correct ?

$2PbO(s) + C(s) \longrightarrow 2Pb(s) + CO_2(s)$
(i) Lead is getting reduced
(ii) Carbon dioxide is getting oxidised
(iii) Carbon is getting oxidised
(iv) Lead oxide is getting reduced.
(1) (i) and (ii) (2) (i) and (iii)
(3) (i), (ii) and (iii) (4) All are correct

22. Slow eating away of iron articles in the presence of moist air is called
(1) galvanisation (2) crystallisation
(3) rusting (4) neutralisation

23. An oxidation reaction involves
(1) addition of hydrogen or removal of oxygen
(2) addition of oxygen or removal of hydrogen
(3) addition of oxygen only
(4) addition of hydrogen only

24. A neutralization reaction is a
(1) decomposition reaction.
(2) displacement reaction.
(3) combination reaction.
(4) double displacement reaction.

25. In a combination reaction, how many products are formed?
(1) Only one (2) Only two
(3) One or two only (4) Many

26. Which of the following reaction is based on activity series of metals?
(1) Decomposition reaction
(2) Displacement reaction
(3) Double displacement reaction
(4) Synthesis reaction

27. Which of the following reaction is endothermic?
(1) $C + O_2 \longrightarrow CO_2$
(2) $CaCO_3 \longrightarrow CaO + CO_2$
(3) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
(4) $CaO + H_2O \longrightarrow Ca(OH)_2$

28. Which of the following is a homogeneous reaction?
(1) $C(s) + O_2(g) \longrightarrow CO_2(g)$
(2) $2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$
(3) $N_2(g) + O_2(g) \longrightarrow 2NO(g)$
(4) $CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(aq)$

29. The conversion of Fe^{++} to Fe^{+++} is :
(1) oxidation (2) reduction
(3) ionisation (4) nuclear reaction

30. Consider the following reactions :
(a) $Cu + I_2 \rightarrow CuI_2$ (b) $Fe + S \rightarrow FeS$
Which of the above reactions is/are redox reactions ?
(1) Only (a) (2) Only (b)
(3) Both (a) and (b) (4) Neither (a) nor (b)

31. Which one of the following statements is correct ?
In the reaction
$$2FeCl_2 + Cl_2 \rightleftharpoons 2FeCl_3$$
(1) $FeCl_2$ is an oxidizing agent
(2) Cl_2 is an oxidizing agent
(3) $FeCl_3$ is an oxidising agent
(4) Cl_2 is a reducing agent

32. The following reaction is an example of a
$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$
(i) displacement reaction
(ii) combination reaction
(iii) redox reaction
(iv) neutralisation reaction
(1) (i) and (iv) (2) (iii) and (iii)
(3) (i) and (iii) (4) (iii) and (iv)

33. Which of the following statements about the given reaction are correct ?
$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$
(i) Iron metal is getting oxidised
(ii) Water is getting reduced
(iii) Water is acting as reducing agent
(iv) Water is acting as oxidising agent
(1) (i), (ii) and (iii) (2) (iii) and (iv)
(3) (i), (ii) and (iv) (4) (ii) and (iv)

34. Three beakers labelled as A, B and C each containing 25 mL of water were taken. A small amount of NaOH, anhydrous $CuSO_4$ and NaCl were added to the beakers A, B and C respectively. It was observed that there was an increase in the temperature of the solutions contained in beakers A and B, whereas in case of beaker C, the temperature of the solution falls. Which one of the following statement(s) is (are) correct?
(i) In beakers A and B, exothermic process has occurred.
(ii) In beakers A and B, endothermic process has occurred.
(iii) In beaker C exothermic process has occurred.
(iv) In beaker C endothermic process has occurred.
(1) (i) only (2) (ii) only
(3) (i) and (iv) (4) (ii) and (iii)

35. Which among the following statement(s) is(are) true? Exposure of silver chloride to sunlight for a long duration turns grey due to
(i) the formation of silver by decomposition of silver chloride
(ii) sublimation of silver chloride
(iii) decomposition of chlorine gas from silver chloride
(iv) oxidation of silver chloride
(1) (i) only (2) (i) and (iii)
(3) (ii) and (iii) (4) (iv) only

36. Solid calcium oxide reacts vigorously with water to form calcium hydroxide accompanied by liberation of heat. This process is called slaking of lime. Calcium hydroxide dissolves in water to form its solution called lime water. Which among the following is (are) true about slaking of lime and the solution formed?
(i) It is an endothermic reaction
(ii) It is an exothermic reaction
(iii) The pH of the resulting solution will be more than seven
(iv) The pH of the resulting solution will be less than seven
(1) (i) and (ii) (2) (ii) and (iii)
(3) (i) and (iv) (4) (iii) and (iv)

37. Barium chloride on reacting 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
(1) (i) only (2) (ii) only
(3) (iv) only (4) (ii) and (iv)

38. In the double displacement reaction between aqueous potassium iodide and aqueous lead nitrate, a yellow precipitate of lead iodide is formed. While performing the activity if lead nitrate is not available, which of the following can be used in place of lead nitrate?
(1) Lead sulphate (insoluble)
(2) Lead acetate
(3) Ammonium nitrate
(4) Potassium sulphate

39. In which of the following chemical equations, the abbreviations represent the correct states of the reactants and products involved at reaction temperature?
(1) $2H_2(l) + O_2(l) \rightarrow 2H_2O(g)$
(2) $2H_2(g) + O_2(l) \rightarrow 2H_2O(1)$
(3) $2H_2(g) + O_2(g) \rightarrow 2H_2O(1)$
(4) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

40 The following reaction is used for the preparation of oxygen gas in the laboratory
$$2KClO_3(s) \xrightarrow[\text{Catalyst}]{\text{Heat}} 2KCl(s) + 3O_2(g)$$
Which of the following statement(s) is (are) correct about the reaction?
(1) It is a decomposition reaction and endothermic in nature
(2) It is a combination reaction
(3) It is a decomposition reaction and accompanied by release of heat
(4) It is a photochemical decomposition reaction and exothermic in nature

41. A magnesium ribbon (X) about 2 cm long and a piece of coal (Y) were taken in a watch-glass by four students P, Q, R and S. On burning of these two 'X' and 'Y' by using burner following observation were recorded in the form of table as given below:

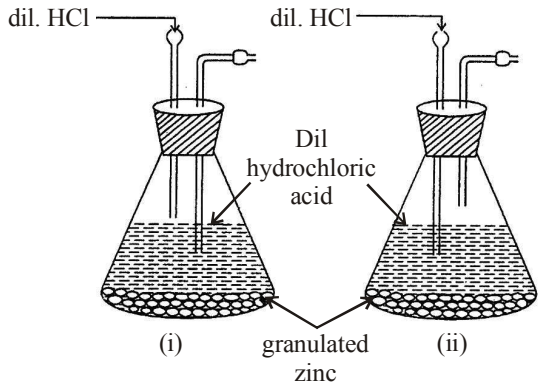
Observation by	Item	Flame's colour	Residue obtained
P	X	Dazzling white flame	Greyish Ash
	Y	Yellowish flame	Black ash
Q	X	Dazzling white flame	White powder
	Y	Sooty flame	Blackish grey ash
R	X	White flame	Grey powder
	Y	White flame	Black coke
S	X	Yellowish flame	Greyish Ash
	Y	Sooty flame	Black Ash

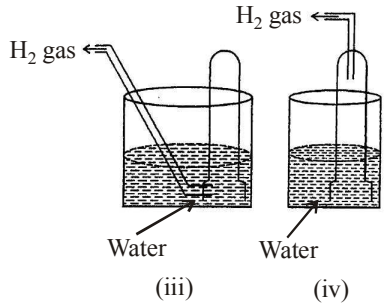
The correct observation was made by the student.

(1) P (2) Q

(3) R (4) S

42. Which two experimental set-up would you choose to prepare and collect hydrogen gas in the laboratory ?

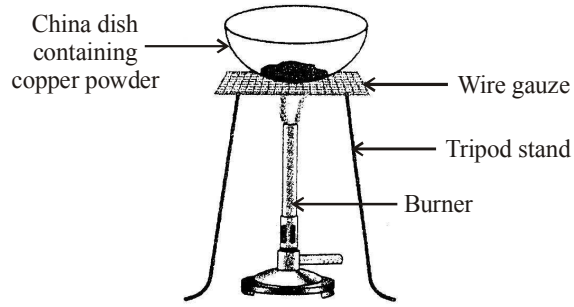




(1) (i) and (iii) (2) (i) and (iv)

(3) (ii) and (iv) (4) (ii) and (iii)

43. Observe this experiment carefully :



In above experiment copper powder turned to black coloured product on heating. It is due to the reason that:

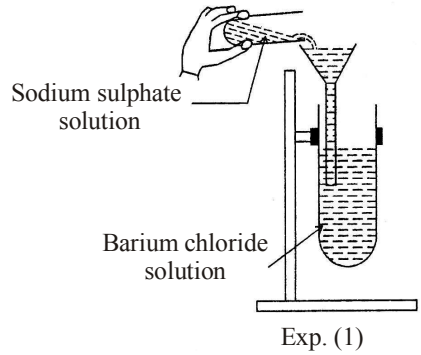
(1) Copper has absorbed heat

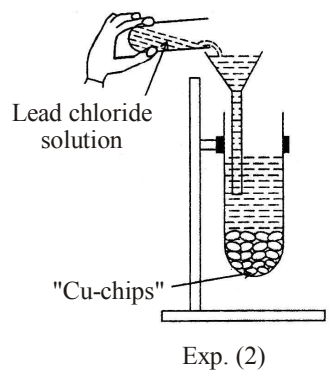
(2) Copper (ii) oxide is formed

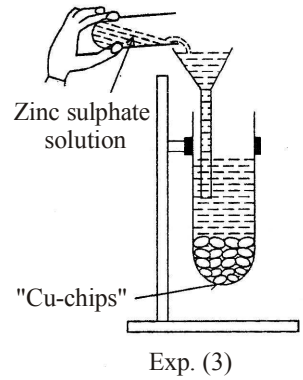
(3) Copper (i) oxide is formed

(4) Both (1) & (3) are correct

44. Observe the experiment set-up carefully:







In which experiment an insoluble precipitate is formed and of which substance ?

(1) Exp 1, Na_2SO_4 (2) Exp 2, $CuCl_2$

(3) Exp 3, $CuSO_4$ (4) Exp 1, $BaSO_4$

45. Two test tubes 'A' and 'B' contain aqueous solution of potassium iodide and lead nitrate separately. When these two test-tubes 'A' and 'B' are mixed to each other, results into 'X' and 'Y' . The 'X' and 'Y' are:

(1) Yellow ppt, yellow solution

(2) Yellow ppt, colourless solution

(3) White ppt, yellow solution

(4) White ppt, colourless solution

46. Oily and fatty food items are flushed with nitrogen gas because :
(1) Nitrogen reacts with oils and fats and thus prevents rancidity.
(2) Nitrogen is inert gas and prevent a direct contact of air with oily and fatty food items
(3) Nitrogen helps in the decomposition of food items and makes them tasty
(4) All given statements are wrong

47. In an experiment to prepare a compound using iron filings and sulphur powder, the teacher instructed the students not to heat the mixture or iron and sulphur without test-tube holder because :
(1) the reaction between iron and sulphur is exothermic
(2) the reaction between iron and sulphur is endothermic
(3) the test-tube is likely to melt
(4) the reaction is explosive

48. In order to study the reaction between barium chloride and sodium sulphate, the two compounds are mixed in the form of :
(1) aqueous solutions (2) dry powders
(3) molten liquids (4) gases

49. The equation
$Cu + xHNO_3 \rightarrow Cu(NO_3)_2 + yNO_2 + 2H_2O$
The values of x and y are –
(1) 3 and 5 (2) 8 and 6
(3) 4 and 2 (4) 7 and 1

50. A dilute solution of sodium carbonate was added to two test-tubes – one containing dil HCl (1) and the other containing dilute NaOH (2). The correct observation was –
(1) a brown coloured gas liberated in test-tube A
(2) a brown coloured gas liberated in test-tube B
(3) a colourless gas liberated in test-tube A
(4) a colourless gas liberated in test-tube B

51. Write the physical states of reactants and products denoted by 'x', 'y', 'z' and 'w'.
$CH_4(x) + 2O_2(y) \longrightarrow CO_2(z) + H_2O(w)$
(1) g, g, g, l (2) g, g, g, g
(3) g, g, l, l (4) l, g, g, g

Exercise 2

Matching Based MCQ

DIRECTIONS (Qs. 1 to 5) : Match Column-I with Column-II and select the correct answer using the codes given below the columns.

1.

	Column I	Column II
(A)	$C + O_2 \rightarrow CO_2$	(p) Displacement
(B)	$2AgBr \xrightarrow{Light} 2Ag + Br_2$	(q) Combination
(C)	$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$	(r) Decomposition
(D)	$2Ca + O_2 \rightarrow 2CaO$	(s) Oxidation
(E)	$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$	(t) Double displacement reaction

(1) A – (r), B – (q), C – (p), D – (s) E – (t)
(2) A – (q), B – (r), C – (p), D – (s) E – (t)
(3) A – (q), B – (r), C – (s), D – (p) E – (t)
(4) A – (q), B – (r), C – (p), D – (t) E – (s)

2.

	Column I	Column II
(A)	$2Ca + O_2 \rightarrow$	(p) 2 HCl
(B)	$4\,Fe + 3O_2 \xrightarrow{moisture}$	(q) 2 CaO
(C)	$H_2 + Cl_2 \xrightarrow{hv}$	(r) $2\,Fe_2O_3$
(D)	$2\,Fe + 3\,Cl_2 \longrightarrow$	(s) $2\,FeCl_3$
(E)	$4NO_2 + O_2 + 2H_2O \longrightarrow$	(t) $4HNO_3$

(1) A – (r), B – (q), C – (p), D – (s) E – (t)
(2) A – (q), B – (r), C – (p), D – (t) E – (s)
(3) A – (q), B – (r), C – (s), D – (p) E – (t)
(4) A – (q), B – (r), C – (p), D – (s) E – (t)

3.

	Column I	Column II
(A)	$H_2(g) + S(l) \xrightarrow{(boiling)} H_2S(g)$	(p) Displacement reaction
(B)	$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$	(q) Neutralisation reaction
(C)	$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$	(r) Decomposition reaction
(D)	$2Cu(NO_3)_2 \longrightarrow 2CuO + 4NO_2 + O_2$	(s) Combination reaction

(1) A – (s), B – (p), C – (r), D – (q)
(2) A – (p), B – (s), C – (q), D – (r)
(3) A – (s), B – (p), C – (q), D – (r)
(4) A – (s), B – (q), C – (p), D – (r)

4.

	Column I	Column II
(A)	$2C_4H_{10} + 13O_4 \longrightarrow 8CO_2 + 5H_2O$	(p) Combustion
(B)	$2AgBr \longrightarrow 2Ag + Br_2$	(q) Exothermic
(C)	$BaCl_2(aq) + H_2SO_4(aq) \longrightarrow BaSO_4(s) + 2HCl(aq)$	(r) Endothermic
		(s) Decomposition
		(t) Double displacement
		(u) Precipitation

(1) A – (p, r), B – (q, s), C – (t, u)
(2) A – (p, q), B – (r, s), C – (t, u)
(3) A – (p, q), B – (r, t), C – (s, u)
(4) A – (p, t), B – (r, q), C – (t, u)

5.

Column-I	Column-II
(A) $C(s) + 2S(s) \rightarrow CS_2(l)$	(p) Exothermic reaction
(B) $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2\ (aq)$	(q) Redox reaction
(C) $NaCl(s) + AgNO_3(l) \rightarrow AgCl(s) + NaNO_3$	(r) Endothermic reaction
(D) $H_2S(g) + Cl_2(g) \rightarrow S(s) + 2HCl(l)$	(s) Double displacement reaction

(1) A – (r); B – (p); C – (s); D – (q)
(2) A – (q); B – (p); C – (s); D – (r)
(3) A – (p); B – (r); C – (s); D – (q)
(4) A – (r); B – (p); C – (q); D – (s)

Statement Based MCQ

6. Consider the following statements :
(a) It is possible to write a symbol equation even if we do not know the word equation.
(b) A chemical equation is always written under N.T.P conditions.
(c) In a chemical equation the diatomic gases must be written in the molecular form.
Which of these statement(s) is/are correct ?
(1) (a) and (b) (2) (a) and (c)
(3) Only (b) (4) Only (c)

7. Consider the following statements :
(a) For rusting of iron moisture and air are necessary conditions.
(b) The formula of rust is $Fe_3O_4.10H_2O$.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

8. Consider the following statements :
(a) Hydrogen gas can be collected over water.
(b) A balanced equation must be molecular.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

9. Consider the following statements :
(a) Oxidation is the loss of electrons from a substance.
(b) Reduction is the gain of electrons by a substance.
(c) The formation of Na^+Cl^- by the action of sodium and chlorine is an example of a redox reaction.
Which of these statement(s) is/are correct ?
(1) (a) and (b) (2) (a) and (c)
(3) (b) only (c) (4) All are correct

10. Consider the following statements :
(a) Rusting is a double decomposition reaction.
(b) Silver salt are generally sensitive to light.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

11. Consider the following statements :
(a) On mixing aqueous solution of silver nitrate and sodium bromide no precipitate is formed.
(b) Oxidation reaction always occurs in company of a reduction reaction.
(c) Rancidity of oils and fats is because of their oxidation.
Which of these statement(s) is/are correct ?
(1) (a) and (b) (2) (a) and (c)
(3) (b) only (c) (4) All are correct

12. Consider the following statements :
(a) Calcium carbonate is the product formed when calcium oxide reacts with carbon dioxide gas.
(b) The precipitate of zinc sulphide is black in colour.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

13. Consider the following statements :
(a) The number of atoms of each element is conserved in any chemical reaction.
(b) A complete chemical equation represents the reactants, products and their physical states symbolically.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

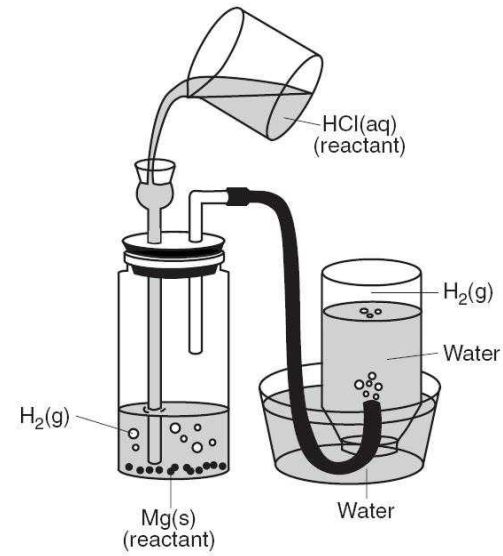
14. Consider the following statements :
(a) A magnesium ribbon burns with a dazzling flame in air (oxygen) and changes into a white substance, magnesium oxide.
(b) The reaction between nitrogen and hydrogen to give ammonia is an example of a combination reaction.
(c) Action of heat on ferrous sulphate is an example of decomposition reaction.
Which of these statement(s) is/are correct ?
(1) (a) and (b) (2) (a) and (c)
(3) (b) only (c) (4) All are correct

Passage Based MCQ

DIRECTIONS (Qs. 15 to 21) : Read the passage(s) given below and answer the questions that follow.

Carefully observe diagram given below which shows how hydrogen is prepared in laboratory and answers the questions that follows :

PASSAGE - 1



15. What type of chemical reaction occurs?
(1) Combination reaction
(2) Neutralisation reaction
(3) Displacement reation
(4) Decomposition reaction

16. Which of the following metal can be used in place of magnesium in above reaction?
(1) Ca (2) Zn
(3) Cd (4) Ni

17. Above phenomena represents
(1) physical change
(2) chemical change
(3) Both physical and chemical change
(4) None of these

18. Correct chemical equation for process
(1) $Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$
(2) $Mg(s) + HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$
(3) $Mg + 2HCl \longrightarrow MgCl_2 + H_2$
(4) None of these

PASSAGE - 2

Combination reactions has wide application in the manufacturing of some industrially important compounds.

- On a commercial scale, ammonia is manufactured by Haber's process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

- Ostwald process for manufacturing of nitric acid

$$4NO_2(g) + O_2(g) + 2H_2O(l) \longrightarrow 4HNO_3(aq)$$

- Similarly contact process for manufacturing of sulphuric acid involves following stages of combination reaction

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

$$H_2SO_4(l) + SO_3(g) \longrightarrow H_2S_2O_7(l)$$
(Conc)

$$H_2S_2O_7(l) + H_2O(l) \longrightarrow 2H_2SO_4(l)$$

- Manufacture of Ethylalcohol by acid catalysed hydration of ethylene

$$C_2H_4(g) + H_2O(g) \xrightarrow{H_3O^+} CH_3CH_2OH(l)$$

19. Which of the above process involves combination reaction of elements only?
(1) Ostwald process
(2) Haber's process
(3) Manufacture of C_2H_5OH
(4) Contact process

20. Which of the above process involves combination reaction of compounds with element ?
(1) Ostwald process
(2) Haber's process
(3) Manufacture of C_2H_5OH
(4) Contact process

21. Which of the above process involves combination reaction of compounds only?
(1) Ostwald process
(2) Haber's process
(3) Manufacture of C_2H_5OH
(4) Contact process

Assertion Reason Based MCQ

DIRECTIONS (Qs. 22 to 27) : Following questions consist of two statements, one labelled as the **'Assertion'** and the other as **'Reason'**. You are to examine these two statements carefully and select the answer to these items using the code given below.

Code :
(1) Both A and R are individually true and R is the correct explanation of A:
(2) Both A and R are individually true but R is not the correct explanation of A.
(3) A is true but R is false
(4) A is false but R is true.

22. **Assertion :** In electrolysis of water the volume of hydrogen liberated is twice the volume of oxygen formed.
Reason : It is because water has hydrogen and oxygen in the ratio of 1: 2.

23. **Assertion :** Copper sulphate can be stored in silver container.
Reason : Silver can't displace copper from copper sulphate as it is less reactive than copper.

24. **Assertion :** Respiration is exothermic in nature.
Reason : Oxygen inhaled in respiration causes the combustion of carbohydrates accompanied by release of energy.

25. **Assertion :** When carbon dioxide gas is passed through lime water, a white precipitate is initially formed.
Reason : White preciptate is of calcium carbonate which is formed during the reaction.

26. **Assertion :** A reduction occurs when a substance loses oxygen or gain hydrogen atom.
Reason : In a reaction of hydrogen with chlorine hydrogen serve as a reducing agent.

27. **Assertion :** The balancing of chemical of chemical equations is based on law of conservation of mass.
Reason : Total mass of reactants is equal to that mass of products.

Correct Definition Based MCQ

28. Chemical equation is
(1) qualitative representation of a chemical reaction in term of symbols and formulae
(2) quantitative representation of a chemical reaction in term of symbols and formulae
(3) qualitative and quantitative representation of a chemical reaction in term of symbols and formulae
(4) qualitative and quantitative representation of a chemical reaction in words.

29. Rancidity is
(1) unpleasant change in the colour, flavour and odour of food
(2) pleasant change in the flavour, colour and odour of food
(3) unpleasant change in the colour and odour of food
(4) unpleasant change in the flavour of food

30. Homogeneous reactions
(1) are those in which all reactants, products and catalyst are in different physical state
(2) are those in which all reactants and products are in different physical state
(3) are those in which all reactants and products are in same physical state.
(4) are those in which all reactants, products and catalyst are in same physical state

31. Decomposition reactions are
(1) those in which a compound breaks down into simpler compounds
(2) those in which a simple compound combine to form complex compounds
(3) those in which a compound breaks down into simpler compounds via electricity.
(4) those in which a compound breaks down into simpler compounds via heat

Feature Based MCQ

32. On the basis of following features identify the type of reaction
(I) One of the product obtained will be in aqueous form.
(II) One of the product formed is insoluble solid
(1) Displacement reaction
(2) Double displacement reaction
(3) Precipitation reaction
(4) Redox reaction

33. On the basis of following features identify the correct option
(I) The reaction occurs during corrosion
(II) This reaction occurs during respiration.
(1) Combustion reaction
(2) Redox reaction
(3) Oxidation reaction
(4) Exothermic reaction

34. On the basis of following features identify the correct option
(I) It is the primary means by which metals deteriorate
(II) Protective coatings are applied to prevent metals.
(1) Corrosion
(2) Chemical erosion
(3) Both (1) and (2)
(4) Neither (1) nor (2)

35. On the basis of following features identify the correct option
(I) A substance breaks down into simpler substances
(II) Electrolysis of water is example of this type of reaction.
(1) Electrolytic decomposition
(2) Thermal decomposition
(3) Photochemical decomposition
(4) Catalytic decomposition

Hints & SOLUTIONS

Exercise 1

1. **(4)** $Zn\,(s) + 2\,HCl\,(aq) \longrightarrow ZnCl_2\,(aq) + H_2$

2. **(2)** **3.** **(4)** **4.** **(3)**

5. **(4)** **6.** **(4)**

7. **(1)** Balanced equation is $2\,Fe + 3Cl_2 \longrightarrow 2FeCl_3$

8. **(2)**

9. **(4)** It is an example of displacement reaction. In it Al metal displaces iron from Fe_2O_3 when reaction is carried out in aqueous solution.

10. **(1)** $Fe(s) + 2HCl(dil) \rightarrow FeCl_2(aq) + H_2(g)$

11. **(3)** As iron is above copper in reactivity series.

12. **(4)** As in all above reactions complex substances decomposes to give simple subtances.

13. **(4)** This reaction is double displacement and precipitation as well because insoluble silver chloride gets precipitated.

14. **(4)** **15.** **(2)**

16. **(1)** As here H_2 gets oxidised and CuO reduced to Cu.

17. **(2)**

18. **(3)** Carbon reduces PbO to Pb.

19. **(4)**

20. **(2)** Here HNO_3 acts as an acid which on combining with base NaOH forms corresponding salt and water.

21. **(2)**

22. **(3)** Rusting is a process in which iron gets converted into hydrated iron oxide in presence of moisture.

$$2Fe + \frac{3}{2}O_2 + xH_2O \longrightarrow \underset{\text{rust}}{Fe_2O_3.xH_2O}$$

23. **(2)**

24. **(4)** A neutralization reaction is a double displacement reaction. In this reaction two reactants exchange their ions to form two new products. For example

$HCl\,(aq) + NaOH\,(aq) \longrightarrow NaCl(aq) + H_2O(l)$

25. **(1)** In a combination reaction only one product is formed.
For example : $N_2(g) + 3H_2\,(g) \longrightarrow 2NH_3(g)$

26. **(2)**

27. **(2)** Heat is required to decompose calcium carbonate. Thus this reaction proceeds with absorption of heat therefore it is endothermic reaction.

28. **(3)** Formation of NO involves all reactants and products in gaseous phase.

29. **(1)** $\underset{\text{(loss of electrons)}}{Fe^{++} \rightarrow Fe^{+++}}$

$\therefore$ Oxidation process

30. **(3)** The reactions which involve both reduction and oxidation are abbreviated as redox reactions.

$$\overset{\text{Oxidation}}{Cu + I_2 \longrightarrow CuI_2}\quad \overset{\text{Reduction}}{}$$

$$\overset{\text{Oxidation}}{Fe + S \longrightarrow FeS}\quad \overset{\text{Reduction}}{}$$

So, both are redox reactions.

31. **(2)** $\overset{\text{Oxidation}}{2FeCl_2 + Cl_2 \rightleftharpoons 2FeCl_3}$ (Reduction)

Oxidising agent is that substance which donate electrons while reducing agent is that substance which accepts electrons.

$\therefore$ Cl_2 is a oxidising agent.

32. **(3)**

33. **(3)** The substance which oxidises the other substances in a chemical reaction is known as an oxidising agent. Likewise, the substance which reduces the other substance in a chemical reaction is known as reducing agent.

34. **(3)** **35.** **(1)**

36. **(2)** $CaO + H_2O \longrightarrow Ca(OH)_2 + Q$

$Ca(OH)_2$ formed will be basic thus pH > 7.

37. **(4)**

38. **(2)** Lead sulphate being insoluble will not dissociate into Pb^{2+} ions.

39. **(4)** **40.** **(1)** **41.** **(2)** **42.** **(4)**

43. **(2)**

44. **(4)** $Na_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$

45. **(2)** **46.** **(2)**

47. **(1)** This is essential as a safety measure usually when an exothermic chemical reaction is carried out in a test-tube.

48. **(1)** Solid compounds do not show chemical reaction.

49. **(3)** $Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

50. **(3)** $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$

51. **(1)**

Exercise 2

1. **(2)** **2.** **(4)** **3.** **(3)** **4.** **(2)**

5. **(1)** **6.** **(4)**

7. **(1)** Formula of rust is $Fe_2O_3.xH_2O$.

8. **(3)** **9.** **(4)**

10. **(2)** Rusting of iron is an oxidation reaction.

11. **(3)** On mixing $AgNO_3(aq)$ and $NaBr(aq)$ the precipitate of AgBr is formed.

12. **(1)** **13.** **(3)** **14.** **(4)**

15. **(3)** Here magnesium displaces hydrogen from hydrochloric acid.

$Mg(s) + 2HCl\ (aq) \rightarrow MgCl_2(aq) + H_2(g)\uparrow$

16. **(2)** **17.** **(2)** **18.** **(1)**

19. **(2)** Haber's process for the manufacturing of ammonia. It involves combination of elements nitrogen and Hydrogen.

20. **(1)** Ostwald's process of manufacturing of nitric acid. It involves combination of compounds i.e. NO_2,H_2O with element oxygen.

21. **(3)** Manufacturing of ethylalcohol by combination of ethylene and water.

22. **(3)** 'A' is true but 'R' is false because hydrogen and oxygen in H_2O are in ratio of 2: 1.

23. **(1)**

24. **(1)** $C_6H_{12}O_6\ (s) + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(l) + heat$

Glucose (carbohydrate)

25. **(1)** Reason is the correct explanation of assertion. Lime water contains traces of calcium hydroxide dissolved in it. It reacts with carbon dioxide gas to form a white precipitate of calcium carbonate.

$Ca(OH)_2$ + $CO_2(g) \longrightarrow CaCO_3\ (s)$ + $H_2O\ (g)$

(In lime water) (White ppt)

26. **(2)** **27.** **(1)**

28. **(3)** **29.** **(1)** **30.** **(4)** **31.** **(1)**

32. **(3)** **33.** **(2)** **34.** **(3)** **35.** **(1)**