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Chemical Reactions and Equations



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Rusting of iron objects like this car is one of the most common chemical reactions. Chemistry happens everywhere inside and around you, not just in a laboratory. Matter interacts to form new products through a chemical reaction. Every time you cook or clean, it's chemistry in action. There are reactions when you breathe, light a match or take medications.

Topic Notes

- *Chemical Reactions*
- *Chemical Equations*
- *Types of Chemical Reactions*
- *Effects of Oxidation Reactions in Everyday Life*

CHEMICAL REACTIONS

We come across a variety of changes which take place around us in our daily life. These changes may be physical changes or chemical changes.

In this chapter we will study about chemical reactions and their characteristics, balancing chemical equations, various types of chemical reactions such as combination reactions, decomposition reactions, displacement reactions, double decomposition reactions, exothermic and endothermic reactions, redox reactions and effects of oxidation reactions in our daily life.

Physical changes are the changes which bring about changes in physical characteristics of a substance without changing the chemical composition of the substance.

Examples: Melting of ice to form water, boiling of water to form water vapour, dissolving salt or sugar in water, mixing carbon dioxide gas in soda etc.

Chemical changes are the changes in which new substances are formed having properties entirely different from the original substance(s).

Examples: Cooking of food, digestion, respiration, burning of coal, rusting of iron, souring of milk etc.

Chemical reactions are the processes involving a chemical change in which new substances having new properties are formed from original substances.



Important

→ Chemical reactions involve breaking of old bonds and formation of new bonds.

Reactants and Products

The substances which take part in a chemical reaction are called reactants while the new substances produced as a result of chemical reaction are called products.

Examples:

Reactants	Products
$2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$	$2\text{H}_2\text{O}(\text{l})$
$2\text{Al}(\text{s}) + \text{Fe}_2\text{O}_3(\text{s})$	$\text{Al}_2\text{O}_3(\text{s}) + 2\text{Fe}(\text{l})$

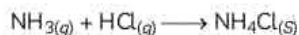
Characteristics of Chemical Reactions

A chemical reaction is characterized by any of the following observations:

Change in State

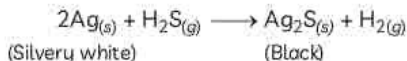
Consider the reaction between ammonia gas with

hydrogen chloride gas to produce solid ammonium chloride. Change of state takes place in this reaction.



Change in Colour

In the reaction between silver (silvery white in colour) and hydrogen sulphide to form silver sulphide (black) and hydrogen gas, change of colour takes place.



Evolution of a Gas

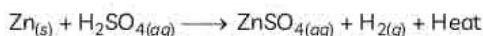
The reaction between zinc and dilsulphuric acid is characterized by the evolution of hydrogen gas.



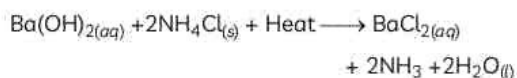
Change in Temperature

A chemical reaction can be exothermic or endothermic in nature.

The reaction between zinc and dil. sulphuric acid to form zinc sulphate and hydrogen gas is an exothermic reaction as heat is evolved.

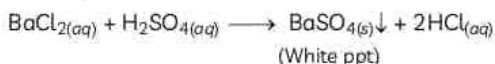


However, the reaction between ammonium chloride and Barium hydroxide is an endothermic reaction as heat is absorbed.



Formation of a Precipitate

When barium chloride solution reacts with sulphuric acid, barium sulphate is formed which is an insoluble white substance also known as precipitate, along with hydrochloric acid.



Example 1. Case Based:

A 2 cm long thin ribbon of a metal 'X' was taken and first cleaned with a sandpaper. It was then burnt using a spirit lamp or burner by holding it with a pair of tongs. The ribbon burnt with a dazzling white flame and formed a powder 'Y' which was collected in a watch glass.

[NCERT Activity 1.1]

(A) Which option correctly identifies both X and Y?

(a)	Magnesium	Magnesium carbonate
(b)	Aluminium	Aluminium oxide
(c)	Magnesium	Magnesium oxide
(d)	Iron	Iron oxide

(B) The colour of powder or ash formed when a magnesium ribbon is burnt in air is:

- (a) grey (b) black
(c) white (d) yellow.

(C) Why should a magnesium ribbon be cleaned before burning in air? [NCERT]

(D) Is burning of magnesium ribbon a physical change or a chemical change? Justify your answer.

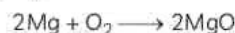
(E) Assertion: Magnesium ribbon burns with a dazzling white flame.

Reason: When magnesium ribbon burns in air only heat is evolved.

- (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.

oxide.

Explanation: When magnesium ribbon is burnt, it forms a white powder of magnesium oxide (MgO) due to the reaction between magnesium and oxygen present in the air.



(B) (c) white

Explanation: When a magnesium ribbon is burnt in air, it forms magnesium oxide, which is a white coloured powder.

(C) Magnesium ribbon should be cleaned before burning in air to remove the layer of magnesium oxide that may have formed on the ribbon due to the reaction of magnesium with oxygen.

(D) Burning of ribbon is a chemical change as magnesium burns in air to form a new substance magnesium oxide. Moreover, it also involves change in temperature as a lot of heat and light is produced during this change.

(E) (c) (A) is true, but (R) is false.

Explanation: Magnesium ribbon burns in presence of air to form magnesium oxide. A large amount of heat and light are produced due to which we see a dazzling white flame.

TOPIC 2

CHEMICAL EQUATIONS

Chemical equations are the symbolic representation of chemical reactions where the reactants and products are written in the form of symbols and formulae on the left hand side and right hand side of an arrow respectively.

Example of a chemical equation:

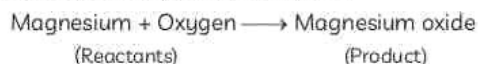


In the above equation, the reactants calcium chloride and silver nitrate react to form the products calcium nitrate and silver chloride.

Word Equations

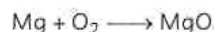
One way of representing chemicals reaction is word equation which is a short and simplest way of writing chemical reaction as compared to the description of a chemical reaction in a sentence form which is quite long.

The word equation for the reaction between magnesium and oxygen gas would be:



Representation of Chemical Reactions

To make chemical equations more concise and useful we use chemical formulae instead of words. A chemical equation represents a chemical reaction. The word equation shown above can be written as:



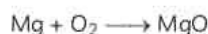
Balanced and Unbalanced Chemical Equations

A balanced chemical equation has an equal number of atoms of different elements in the reactants and products in accordance with the law of conservation of mass.

= Number of atoms of each element in product side

An unbalanced chemical equation has an unequal number of atoms of one or more elements in the reactants and products because the mass is not the same on both sides of the equation. Such a chemical equation is a skeletal chemical equation for a reaction.

The equation



is a skeletal chemical equation as the number of atoms of oxygen is not equal in reactant side (2 atoms) and product side (1 atom).

Balanced Chemical Equations

We need to balance chemical equations to satisfy the law of conservation of mass in chemical reactions.

The process of making the number of different types of atoms equal on both the sides of an equation is called balancing of equation.

Hit-and-trial Method of Balancing Chemical Equations

Consider the chemical equation for the reaction between methane and oxygen to yield carbon dioxide and water:



The above equation is an unbalanced equation as the number of atoms of both hydrogen and oxygen are not equal on reactant side and product side.

Step I: First draw boxes around each formula or put a bracket around each formula. Do not change anything inside the boxes or brackets while balancing the equation.



Step II: List the number of atoms of different elements present in the unbalanced equation

Element	Number of Atoms in Reactants (LHS)	Number of Atoms in Products (RHS)
C	1	1
H	4	2
O	2	3

Step III: Start balancing with the compound that contains the maximum number of atoms. It may be a reactant or a product. In that compound, select the element which has the maximum number of atoms.

hydrogen in it.

Atoms of Hydrogen	In Reactants	In Products
(i) Initially	4 (in CH ₄)	2 (in H ₂ O)
(ii) To balance	1 × 4	2 × 2

To make the number of atoms of hydrogen equal, we put the coefficient '2' as '2H₂O'

Important

→ To equalise the number of atoms, we cannot alter the formulae of the compounds or elements involved in the reactions.



This is a partly balanced equation as the number of oxygen atoms are not balanced.

Step IV: Pick any of those elements whose atoms are still not balanced to proceed further.

As number of oxygen atoms are not equal on reactant and product sides, we will balance O atoms now.

Atoms of Oxygen	In Reactants	In Products
(i) Initially	2 (in O ₂)	Total 4 ...2 (in H ₂ O) + 2 (in CO ₂)
(ii) To balance	2 × 2	4



Step V: Count atoms of each element on both sides of the equation to check the correctness of the balanced equation.



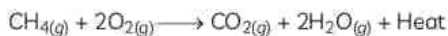
Element	Number of Atoms in Reactants (LHS)	Number of Atoms in Products (RHS)
C	1	1
H	4	2
O	2	3

The numbers of atoms of elements on both sides of above equation are equal. This equation is now balanced.

Step VI: Writing Symbols of Physical States:

To make a chemical equation more informative, the physical states of the reactants and

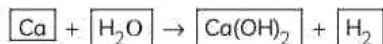
chemical formulae. For example, the burning of methane in oxygen can be written as:



Example 2. Balance the chemical equation
 $\text{Ca} + \text{H}_2\text{O} \longrightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$.

Ans. Steps to balance the equation are as follows:

Step I: First draw boxes around each formula or put a bracket around each formula.



Step II: List the number of atoms of different elements present in the unbalanced equation

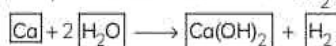
Element	Number of Atoms in Reactants (LHS)	Number of Atoms in Products (RHS)
Ca	1	1
H	2	4
O	1	2

We note here that both H and O atoms are not equal on both sides.

Step III: We first equalize atoms of H.

Atoms of Hydrogen	In Reactants	In Products
(i) Initially	2 (in H_2O)	4 (2 in $\text{Ca}(\text{OH})_2$ and 2 in H_2)
(ii) To balance	2×2	4

To make the number of atoms of hydrogen equal, we put the coefficient '2' as $2\text{H}_2\text{O}$



By putting the coefficient 2 before H_2O , the atoms of both H and O get multiplied by 2.

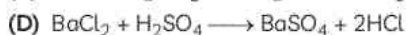
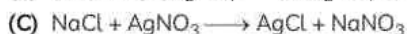
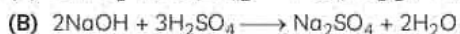
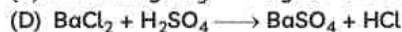
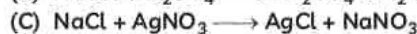
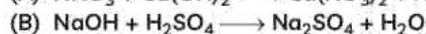
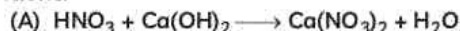
We now count atoms of each element on both sides of the equation to check the correctness of the equation.

Element	Number of Atoms in Reactants (LHS)	Number of Atoms in Products (RHS)
Ca	1	1
H	4	4
O	2	2

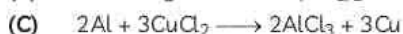
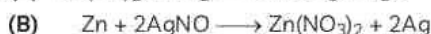
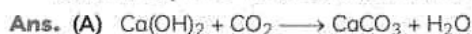
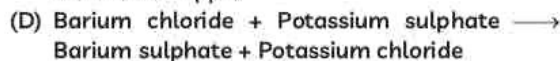
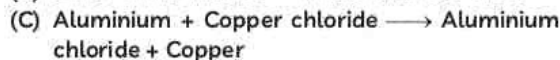
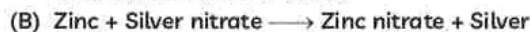
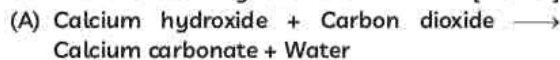
This is a balanced equation as the number of hydrogen and oxygen atoms are now balanced.



Example 3. Balance the following chemical equations. [NCERT]



Example 4. Write the balanced chemical equations for the following reactions. [NCERT]



⚠ Caution

Students should not alter the formulae of compounds or elements involved in the reactions to equalize the number of atoms while balancing a chemical equation.]

For example, for balancing the equation



we observe that number of Chlorine atoms are not equal on both sides. But we cannot balance the equation by writing NH_4Cl_3 in place of NH_4Cl as in



Instead, we have to balance as:



We should write the formulae of each compound by using their correct symbols and valencies. If the formula of even a single compound is incorrect, the entire equation will be incorrect.

For example, for writing a balanced equation for the reaction: when copper oxide is heated with magnesium powder, magnesium oxide and copper are formed as magnesium displaces copper from its oxide, if we write formula of copper oxide as CuO_2 or Cu_2O instead of CuO , the equation will be incorrect.

The correct equation is:



In order to write and balance the equation correctly, it is important to remember the seven elements that exist in nature as diatomic molecules (H_2 , N_2 , O_2 , F_2 , Cl_2 , Br_2 , and I_2)

Whenever word equations are given along with the physical states of reactants and products, the same should also be written in the chemical equations.

Products in an Equation

- (1) Solid state is indicated by the symbol (s). Formation of precipitate is indicated by writing (s) or downward pointing arrow (\downarrow)
- (2) Liquid state is indicated by the symbol (l)
- (3) Aqueous state (solution made in water) is indicated by the symbol (aq)
- (4) Gaseous state is indicated by the symbol (g) or an upward pointing arrow (\uparrow).

For example, in the chemical equation



Fe is in solid state, CuSO_4 is in aqueous state, FeSO_4 is in aqueous state and Cu is in solid state.

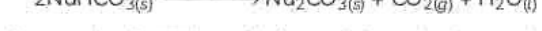
Indicate the Heat Changes in an Equation

- (1) An exothermic reaction (reaction in which heat is evolved) is indicated by writing "+ Heat" on the products side of an equation.
- (2) An endothermic reaction (reaction in which heat is absorbed) is indicated by writing "+ Heat" on the reactants side of an equation.

Indicate the Conditions under which the Reaction Takes Place

The reaction conditions, such as temperature, pressure, catalyst, etc., for the reaction may be indicated above and/or below the arrow in the equation.

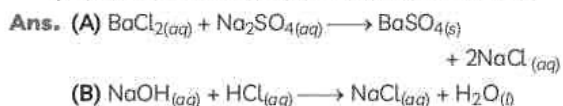
For example, the temperature at which sodium hydrogen carbonate is heated to obtain sodium carbonate, carbon dioxide and water can be represented by the chemical equation,



Example 5. Write a balanced chemical equation with state symbols for the following reactions.

[NCERT]

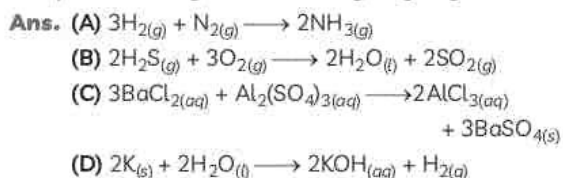
- (A) Solutions of barium chloride and sodium sulphate in water react to give insoluble barium sulphate and the solution of sodium chloride.
- (B) Sodium hydroxide solution (in water) reacts with hydrochloric acid solution (in water) to produce sodium chloride solution and water.



Example 6. Translate the following statements into chemical equations and balance them.

[NCERT]

- (A) Hydrogen gas combines with nitrogen to form ammonia.
- (B) Hydrogen sulphide gas burns in air to give water and sulphur dioxide.
- (C) Barium chloride reacts with aluminium sulphate to give Aluminium chloride and a precipitate of barium sulphate.
- (D) Potassium metal reacts with water to give potassium hydroxide and Hydrogen gas.



TOPIC 3

TYPES OF CHEMICAL REACTIONS

Chemical reactions involve the breaking of bonds present in reactant atoms and forming new bonds in products. Some of the important types of chemical reactions are described next:

Combination Reaction ($A + B \longrightarrow AB$)

Those reactions in which two or more reactants combine to form a single product are known as combination reactions. In a combination reaction:

- (1) Two or more elements can combine to form a compound.
- (2) Two or more compounds can combine to form a new compound.
- (3) An element and a compound can combine to form a new compound.

Examples of Combination Reactions

S. No.	Example of Combination Reaction	Chemical Equation
(1)	Burning of hydrogen in air to form water	$2\text{H}_{2(g)} + \text{O}_{2(g)} \longrightarrow 2\text{H}_2\text{O}_{(l)}$
(2)	Burning of carbon (coal) in air to form carbon dioxide	$\text{C}_{(s)} + \text{O}_{2(g)} \longrightarrow \text{CO}_{2(g)}$
(3)	Reaction of hydrogen with chlorine to form hydrogen chloride	$\text{H}_{2(g)} + \text{Cl}_{2(g)} \longrightarrow 2\text{HCl}_{(g)}$

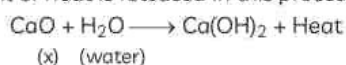
S. No.	Combination Reaction	Chemical Equation
(4)	Burning of sodium metal in chlorine to form sodium chloride	$2\text{Na}_{(s)} + \text{Cl}_{2(g)} \longrightarrow 2\text{NaCl}_{(s)}$
(5)	Heating of iron with sulphur to form iron sulphide	$\text{Fe}_{(s)} + \text{S}_{(s)} \longrightarrow \text{FeS}_{(s)}$

Example 7. A solution of a substance 'X' is used for white washing. [NCERT]

- (A) Name the substance 'X' and write its formula.
 (B) Write the reaction of the substance 'X' named in above with water.

Ans. (A) The substance 'X' which is used in whitewashing is quick lime or Calcium Oxide. Its chemical formula is CaO.

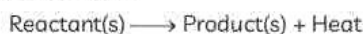
(B) Calcium oxide reacts with water to form slaked lime or calcium hydroxide and a large amount of heat is released in this process.



Exothermic and Endothermic Reactions

Chemical reactions are accompanied with change in temperature of the reaction mixture. There can be either a rise in temperature or a fall in temperature.

Exothermic Reactions:

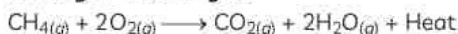


Those reactions in which heat is evolved are known as exothermic reactions. Some examples of exothermic reactions are:

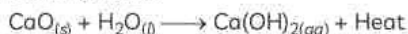
- (1) **Burning of carbon in air to form carbon dioxide:**



- (2) **Burning of natural gas:**

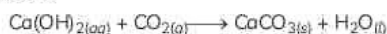


- (3) **Reaction between calcium oxide with water to form slaked lime:**



Important

➤ The reaction between calcium oxide with water to form slaked lime is used for white washing walls. The reaction taking place is:

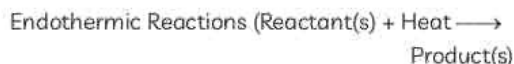


- (4) **Respiration:** It is the release of energy by the oxidation of glucose in the cells of our body.



compost.

- (6) All combustion reactions.



Those reactions in which heat is absorbed are known as endothermic reactions. Some examples of endothermic reactions are:

- (1) Formation of nitrogen monoxide by heating nitrogen and oxygen to a temperature of about 3000°C.

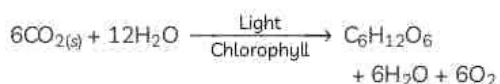


- (2) All decomposition reactions are endothermic reactions since the decomposition reactions require energy either in the form of heat, light or electricity for breaking down the reactants.

For example, when calcium carbonate is heated, it decomposes to form calcium oxide and carbon dioxide:



- (3) Photosynthesis is an endothermic process as sunlight is absorbed by green plants during photosynthesis resulting in the formation of glucose, water and oxygen.



Decomposition Reaction (AB \longrightarrow A + B)

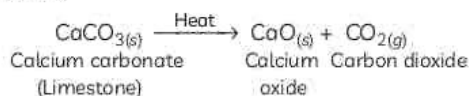
Those reactions in which a compound splits up into two or more simpler substances are known as decomposition reactions.

Depending upon the form of energy required for the reaction, there are three types of decomposition reactions:

Thermal Decomposition Reactions

When a decomposition reaction is carried out by heating, it is called thermal decomposition.

For example, decomposition of calcium carbonate to calcium oxide and carbon dioxide on heating is an important decomposition reaction used in various industries.



Example 8. Case Based:

Two boiling tubes were taken, about 2 grams of a green coloured metal salt 'A' was taken in the first tube and 2 grams of a white coloured metal salt 'B' was taken in the second tube. Both the tubes were heated by holding them with a pair of tongs. Smell

whereas brown gas was emitted in the second test tube. [NCERT Activity 1.5, 1.6]

- (A) The salts 'A' and 'B' are:
- Ferrous nitrate and lead sulphate respectively
 - Ferric oxide and lead nitrate respectively
 - Ferrous sulphate and lead nitrate respectively
 - Ferric oxide and lead sulphate respectively
- (B) During the experiment of heating of ferrous sulphate, four students recorded their observation as
- Green colour changes to brown black colour.
 - Brownish yellow gas is evolved.
 - Blue colour changes to green colour.
 - Smell of burning sulphur is observed.
- Which of the above observations are incorrect?
- Both (I) and (II)
 - Both (I) and (IV)
 - Both (II) and (III)
 - Both (III) and (IV)
- (C) What are the products formed when ferrous sulphate is heated?
- $\text{SO}_3, \text{SO}_2, \text{FeO}$
 - $\text{SO}_3, \text{Fe}_2\text{O}_3$
 - $\text{SO}_3, \text{SO}_2, \text{Fe}_2\text{O}_3$
 - SO_2, FeO
- (D) On heating lead nitrate, two gases are evolved, one is colourless and the other is brown in colour. Which gases are they?
- Oxygen and nitrogen dioxide
 - Hydrogen and lead oxide
 - Hydrogen and oxygen
 - Oxygen and nitrous oxide
- (E) In which of the following category will you put the reaction of heating of ferrous sulphate and lead nitrate?
- Decomposition Reaction
 - Combination Reaction
 - Endothermic Reaction
 - Exothermic Reaction
- Only (I)
 - Only (II)
 - Both (I) and (III)
 - Both (II) and (IV)

Ans. (A) (c) Ferrous sulphate and lead nitrate respectively

Explanation: The green coloured metal salt 'A' in the first test tube is ferrous sulphate as it is green in colour and when heated decomposes to form ferric oxide, sulphur dioxide and sulphur trioxide, which smell of burning sulphur.

Equation for the reaction taking place is:



test tube is lead nitrate as brown fumes of a gas is emitted when it is heated, which are of nitrogen dioxide.

Equation for the reaction taking place is:



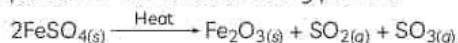
(B) (b) Both (I) and (IV)

Explanation: Ferrous sulphate crystals are green in colour. When they are heated, they lose their molecules of water of crystallization and form ferric oxide, sulphur dioxide and sulphur trioxide gases. The green colour of ferrous sulphate crystal changes to brown black and smell of burning sulphur is observed.

(C) (c) $\text{SO}_3, \text{SO}_2, \text{Fe}_2\text{O}_3$

Explanation: When ferrous sulphate crystals are heated, it undergoes decomposition reaction to form ferric oxide, sulphur dioxide and sulphur trioxide.

Equation for the reaction taking place is:



(D) (a) Oxygen and nitrogen dioxide

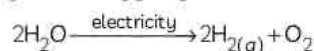
Explanation: When lead nitrate is heated, it undergoes decomposition reaction to form lead oxide, along with the evolution of gases nitrogen dioxide and oxygen.

(E) (c) Both (I) and (III)

Explanation: As both ferrous sulphate and lead nitrate absorb heat and undergo decomposition, the reactions are endothermic reactions and are also known as thermal decomposition reactions.

The decomposition reactions that are carried out by using electricity are known as electrolytic decomposition reactions.

For example, the electrolysis of water to form hydrogen and oxygen gas.



Example 9. Why is the amount of gas collected in one of the test tubes in Activity 1.7 double of the amount collected in the other? Name this gas.

[NCERT Activity 1.7]

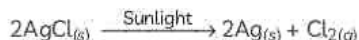
Ans. When water undergoes electrolysis, it decomposes to form hydrogen gas and oxygen gas as per equation below:



As the electrolysis of water produces 2 volumes of hydrogen gas and 1 volume of oxygen gas, it can therefore be concluded that the ratio of hydrogen and oxygen elements in water is 2 : 1 by volume.

The decomposition reactions that occur in the presence of sunlight are known as photo decomposition reactions or photolysis.

For example, silver chloride (white) decomposes into silver (grey) and chlorine in the presence of sunlight.



A brief summary of some decomposition reactions is given below:

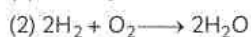
S.No.	Examples of Decomposition Reaction	Chemical Equation
(1)	Heating of potassium chlorate in presence of manganese dioxide (catalyst) to give potassium chloride and oxygen	$2\text{KClO}_{3(s)} \longrightarrow 2\text{KCl}_{(s)} + 3\text{O}_{2(g)}$
(2)	Decomposition of molten sodium chloride on passing electric current to form sodium metal and chlorine gas	$2\text{NaCl}_{(l)} \longrightarrow 2\text{Na}_{(s)} + \text{Cl}_{2(g)}$
(3)	Decomposition of hydrogen peroxide (H_2O_2) in the presence of light to water (H_2O) and oxygen gas (O_2)	$2\text{H}_2\text{O}_2 \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$

Example 10. Why are decomposition reactions called the opposite of combination reactions? Write equations for decomposition reactions.

[CBSE 2010, NCERT]

Ans. In a decomposition reaction, a single substance (reactant) splits into two or more products whereas in a combination reaction, two or more reactants combine to form a single product. Thus, decomposition reaction is the opposite of combination reaction.

Consider the reactions:

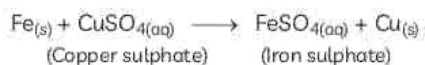


Reaction (1) is a decomposition reaction as a single reactant (ZnCO_3) splits into two products ZnO and CO_2 .

Reaction (2) is just the opposite of reaction (1) as two reactants H_2 and O_2 combine to form a single product (H_2O).



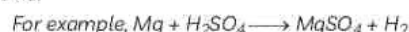
Those reactions in which one element takes the place of another element in a compound, are known as displacement reactions. In general, a more reactive element displaces a less reactive element from its compound.



In this reaction, iron has displaced or removed another element, copper, from copper sulphate solution. This reaction is known as displacement reaction.

Important

➤ The reaction between most metals and acids is also a displacement reaction as the metal displaces hydrogen from the acid.



➤ The hydrogen gas is collected by the downward displacement of water as it is lighter than water. Moreover, it is also insoluble in water.

Other examples of displacement reactions:

S.No.	Examples of Displacement Reaction	Chemical Equation
(1)	When a strip of lead metal is placed in a solution of copper chloride, the green colour of copper chloride solution fades due to the formation of colourless solution of lead chloride. Lead is able to displace copper from copper chloride solution because lead is more reactive than copper.	$\text{CuCl}_{2(aq)} + \text{Pb}_{(s)} \longrightarrow \text{PbCl}_{2(aq)} + \text{Cu}_{(s)}$
(2)	When iron (III) oxide is heated with aluminium powder, then aluminium oxide and iron metal are formed as a more reactive metal aluminium displaces a less reactive metal iron from its oxide	$\text{Fe}_2\text{O}_{3(s)} + 2\text{Al}_{(s)} \longrightarrow \text{Al}_2\text{O}_{3(s)} + 2\text{Fe}_{(l)}$

sulphate solution change when an iron nail is dipped in it? [NCERT]

Ans. When an iron nail is dipped in copper sulphate solution, iron displaces copper from copper sulphate solution as iron is more reactive than copper. Therefore, the colour of the copper sulphate solution changes from blue to green.

The reaction taking place is:



Example 12. What happens when dilute hydrochloric acid is added to iron filings? Tick the correct answer. [NCERT]

- (a) Hydrogen gas and iron chloride are produced.
 (b) Chlorine gas and iron hydroxide are produced.
 (c) No reaction takes place.
 (d) Iron salt and water are produced.

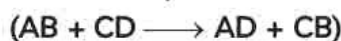
Ans. (a) Hydrogen gas and iron chloride are produced

Explanation: As iron is more reactive than hydrogen, it displaces chlorine from dil hydrochloric acid and forms hydrogen gas and a salt, iron chloride.

The equation for the reaction taking place is:



Double Displacement Reaction



Those reactions in which there is exchange of ions between two compounds to form two new compounds are called double displacement reactions. For example, when silver nitrate solution is added to sodium chloride solution, a white precipitate of silver chloride is formed alongwith sodium nitrate solution.



Precipitation Reaction

Any reaction in which an insoluble solid (called precipitate) is formed that separates from the solution is called a precipitation reaction.

For example, when ammonium hydroxide solution is added to aluminium chloride solution, a white precipitate of aluminium hydroxide is formed alongwith ammonium chloride solution.



Neutralization Reactions

The reactions in which acids or acidic oxides (oxides of non-metals) react with bases or basic oxides (oxides of metals) to form salt and water are called neutralization reactions. For example,



S.No.	Example of Double Displacement Reaction	Chemical Equation
(1)	Lead (II) nitrate reacts with sodium chloride to produce sodium nitrate and a white precipitate of lead (II) chloride	$\text{Pb}(\text{NO}_3)_{2(aq)} + 2\text{NaCl}_{(aq)} \longrightarrow 2\text{NaNO}_{3(aq)} + \text{PbCl}_{2(s)}$
(2)	Aluminium sulphate reacts with calcium hydroxide solution to produce a white precipitate of aluminium hydroxide and calcium sulphate solution.	$\text{Al}_2(\text{SO}_4)_{3(aq)} + 3\text{Ca}(\text{OH})_{2(aq)} \longrightarrow 2\text{Al}(\text{OH})_{3(s)} + 3\text{CaSO}_{4(aq)}$

Example 13. Write the balanced chemical equation for the following and identify the type of reaction in each case. [NCERT]

- (A) Potassium bromide_(aq) + Barium iodide_(aq) → Potassium iodide_(aq) + Barium bromide_(s)
 (B) Zinc carbonate_(s) → Zinc oxide_(s) + Carbon dioxide_(g)
 (C) Hydrogen_(g) + Chlorine_(g) → Hydrogen chloride_(g)
 (D) Magnesium_(s) + Hydrochloric acid_(aq) → Magnesium chloride_(aq) + Hydrogen_(g)

Ans. (A) $2\text{KBr}_{(aq)} + \text{BaI}_{2(aq)} \longrightarrow 2\text{KI}_{(aq)} + \text{BaBr}_{2(s)}$

(It is a double Displacement reaction as there is an exchange of K^+ and Ba^{2+} ions between the reactants)

(B) $\text{ZnCO}_{3(s)} \longrightarrow \text{ZnO}_{(s)} + \text{CO}_{2(g)}$

(It is a decom-position reaction as a single reactant splits to form two products)

(C) $\text{H}_{2(g)} + \text{Cl}_{2(g)} \longrightarrow 2\text{HCl}_{(g)}$

(It is a combination reaction as two reactants combine to form a single product)

(D) $\text{Mg}_{(s)} + 2\text{HCl}_{(aq)} \longrightarrow \text{MgCl}_{2(aq)} + \text{H}_{2(g)}$

(It is a displacement reaction as Mg displaces hydrogen from HCl as it is more reactive than H)

Example 14. What is the difference between displacement and double displacement reactions? Write relevant equations for the above.

[CBSE 2012, 11, 10, NCERT]

Ans. In a displacement reaction a more reactive substance displaces a less reactive substance from its compound or salt solution whereas

of ions takes place between the two reactant compounds. In a displacement reaction, only a single displacement takes place whereas in a double displacement reaction, two displacements take place between the molecules.

For example,

In the reaction,



Mg displaces hydrogen from HCl as Mg is more reactive than H. It is therefore an example of Displacement reaction

In the reaction,



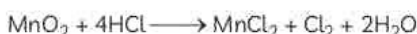
Both K and Ba displace each other from their compounds by exchanging ions. It is therefore an example of double displacement reaction.

Oxidation and Reduction

Those reactions in which addition of oxygen to a substance or removal of hydrogen from a substance takes place or the loss of electron from an element, are called oxidation reactions.

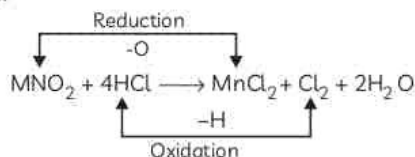
Those reactions in which addition of hydrogen to a substance or removal of oxygen from a substance takes place or the gain of electron in an element are called reduction reactions.

For example, in the reaction



Hydrochloric acid is oxidized to chlorine (as hydrogen is removed from HCl) and Manganese dioxide is reduced to manganese dichloride (as oxygen is removed from MnO_2).

HCl is the reducing agent and MnO_2 is the oxidizing agent.



Oxidising Agent

The substance which provides oxygen for oxidation or the substance which removes hydrogen.

Reducing Agent

The substance which gives hydrogen for reduction or the substance which removes oxygen.



Important

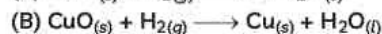
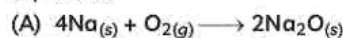
→ The substance which gets oxidised is the reducing agent.

→ The substance which gets reduced is the oxidising agent.

gets reduced during a reaction. Such reactions are called oxidation-reduction reactions or Redox reactions.

Chemical Equation	Substance Oxidized	Substance Reduced
$\text{H}_2\text{S} + \text{Cl}_2 \longrightarrow \text{S} + 2\text{HCl}$	Hydrogen sulphide to Sulphur	Chlorine to HCl
$\text{ZnO} + \text{C} \longrightarrow \text{Zn} + \text{CO}$	Carbon to carbon monoxide	Zinc oxide to zinc
$\text{PbS} + 2\text{H}_2\text{O}_2 \longrightarrow \text{PbSO}_4 + 4\text{H}_2\text{O}$	Lead sulphide is oxidized to lead sulphate	Hydrogen peroxide is reduced to water
$2\text{PbO} + \text{C} \longrightarrow 2\text{Pb} + \text{CO}_2$	Carbon to carbon dioxide	Lead oxide to lead

Example 15. Identify the substances that are oxidized and that are reduced in the following equation. [NCERT]



Ans. (A) In the equation $4\text{Na}_{(s)} + \text{O}_{2(g)} \longrightarrow 2\text{Na}_2\text{O}_{(s)}$ Na is oxidized to Na_2O as there is addition of oxygen and O_2 gets reduced.

(B) In the equation,



CuO gets reduced to Cu by losing oxygen and H_2 gets oxidized to H_2O by gaining oxygen.

Example 16. Which of the statements about the reaction below are incorrect? [NCERT]



(I) Lead is getting reduced

(II) Carbon Dioxide is getting oxidised

(III) Carbon is getting oxidised

(IV) Lead oxide is getting reduced

(a) (I) and (II)

(d) (I) and (III)

(c) (I), (II) and (III)

(e) all

Ans. (a) (I) and (II)

Explanation: In the given reaction, PbO loses oxygen to form Pb . Therefore, PbO (Lead oxide) is reduced.

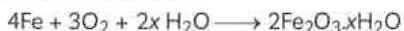
Moreover, C is oxidized to CO_2 by addition of oxygen. Therefore, (III) and (IV) are correct and (I) and (II) are incorrect.

EFFECTS OF OXIDATION REACTIONS IN EVERYDAY LIFE

Corrosion

The process in which metals are eaten up gradually by the action of air, moisture or a chemical such as acids on their surface is called corrosion.

For example, rusting of iron metal is the most common form of corrosion.



The rusting of iron is a redox reaction.

The black coating on silver and the green coating on copper are other examples of corrosion.

Effects of corrosion: Damage to bridges, iron railings, bodies of vehicles, ships and all objects made of metals like iron.

Example 17. Why do we apply paint on iron articles? [NCERT]

Ans. If iron articles are left exposed, their surface comes in contact with the atmospheric oxygen and in the presence of moisture it forms Iron(III) oxide or rust. They are therefore painted to prevent them from rusting as the paint does not allow the surface to come in contact with oxygen and moisture and thus prevents rusting.

Rancidity

The slow oxidation of fats and oils in foods marked by unpleasant smell and taste is called rancidity.

Prevention of Rancidity

- (1) By adding anti-oxidants to foods containing fats and oils: Usually substances which prevent oxidation (antioxidants) are added to foods containing fats and oil. The two common anti-oxidants are BHA (Butylated Hydroxy-Anisole) and BHT (Butylated Hydroxy-Toluene).
- (2) Keeping food in air tight containers helps to slow down oxidation.
- (3) By packaging fat and oil containing foods in nitrogen gas : Chips manufacturers usually flush bags of chips with gas such as nitrogen to prevent the chips from getting oxidized.
- (4) By keeping food in a refrigerator.
- (5) By storing foods away from light.

Example 18. Oil and fat containing food items are flushed with nitrogen. Why?

[CBSE 2014, NCERT]

Ans. Fried food items containing oil and fat get oxidized and become rancid in the presence of air or oxygen. As nitrogen is a comparatively unreactive gas as compared to oxygen, it prevents the oxidation of food items and hence prevents food from becoming rancid. That is why oil and fat containing food items are flushed with nitrogen gas.

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. Which of the following is not a physical change?

- (a) Boiling of water to give water vapour.
- (b) Melting of ice to give water.

(c) Dissolution of salt in water.

(d) Combustion of Liquefied Petroleum Gas (LPG). [NCERT Exemplar]

(LPG).

Explanation: Since combustion of Liquefied Petroleum Gas (LPG) produces new substances, a lot of heat is produced along with carbon dioxide and water vapour. It is also irreversible in nature. So it is a chemical change.

However, boiling of water to give water vapour, melting of ice to give water and dissolution of salt in water are physical changes, as here no new substance is formed, only the physical state of the substance changes.



Related Theory

- A physical change does not produce a new substance although the initial and final substances appear different and it is reversible.
- During a chemical change, the chemical composition of the substance changes and new substances with new properties are formed. Energy is either released or absorbed during a chemical change and it is irreversible.

2. Which of the following is (are) an endothermic process(es)?

- (I) Dilution of sulphuric acid
- (II) Sublimation of dry ice
- (III) Condensation of water vapours
- (IV) Evaporation of water

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

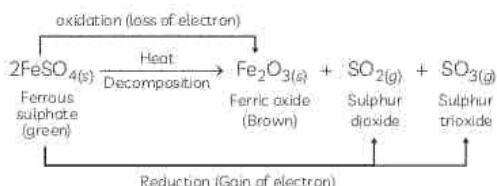
3. Strong heating of ferrous sulphate leads to the formation of a brown solid and two gases. This reaction can be categorised as:

- (a) displacement and redox.
- (b) decomposition and redox.
- (c) displacement and endothermic.
- (d) decomposition and exothermic.

[CBSE 2020]

Ans. (b) decomposition and redox reaction.

Explanation: When FeSO_4 is heated strong, it decomposes to form a brown solid ferric oxide, sulphur dioxide and sulphur trioxide.



forms new products so it is a decomposition reaction. Here FeSO_4 is oxidised to Fe_2O_3 by loss of electrons. So this part of the reaction is oxidation reaction FeSO_4 is also reduced to SO_2 and SO_3 by gain of electrons.

Hence, Heating of FeSO_4 is both decomposition and Redox reaction.



Related Theory

A reaction is called redox when both oxidation and reduction are taking place simultaneously.

Oxidation process involves:

- (1) Gain of oxygen
- (2) Loss of hydrogen
- (3) Loss of electrons

Reduction process involves:

- (1) Loss of oxygen,
- (2) Gain of hydrogen
- (3) Gain of electrons

The substance which loses electrons i.e. gets oxidised, acts as a reducing agent and the substance which gains electrons, i.e. it gets reduced and acts as an oxidising agent.

4. Which among the following is (are) double displacement reaction(s)?

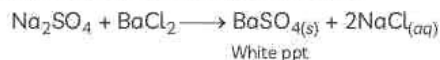
- (I) $\text{Pb} + \text{CuCl}_2 \longrightarrow \text{PbCl}_2 + \text{Cu}$
- (II) $\text{Na}_2\text{SO}_4 + \text{BaCl}_2 \longrightarrow \text{BaSO}_4 + 2\text{NaCl}$
- (III) $\text{C} + \text{O}_2 \longrightarrow \text{CO}_2$
- (IV) $\text{CH}_4 + 2\text{O}_2 \longrightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

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

[NCERT Exemplar]

Ans. (b) only (II)

Explanation: A double displacement reaction involves a displacement of two ions of two different compounds that results in the formation of new compounds. Here, only in reaction (II), ions of both reactants are exchanged and two entirely different compounds are formed. For example,



In a double displacement reaction, exchange of ions takes place i.e., SO_4^{2-} exchange place with Cl^- ion. It is also called precipitation reaction as BaSO_4 is precipitated as insoluble salt in the solution.

(LPG).

Explanation: Since combustion of Liquefied Petroleum Gas (LPG) produces new substances, a lot of heat is produced along with carbon dioxide and water vapour. It is also irreversible in nature. So it is a chemical change.

However, boiling of water to give water vapour, melting of ice to give water and dissolution of salt in water are physical changes, as here no new substance is formed, only the physical state of the substance changes.



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- (I) Dilution of sulphuric acid
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- (a) (I) and (III) (b) Only (II)
 (c) Only (III) (d) (II) and (IV)

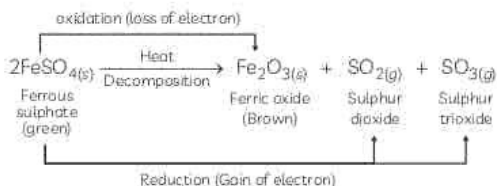
3. Strong heating of ferrous sulphate leads to the formation of a brown solid and two gases. This reaction can be categorised as:

- (a) displacement and redox.
 (b) decomposition and redox.
 (c) displacement and endothermic.
 (d) decomposition and exothermic.

[CBSE 2020]

Ans. (b) decomposition and redox reaction.

Explanation: When FeSO_4 is heated strong, it decomposes to form a brown solid ferric oxide, sulphur dioxide and sulphur trioxide.



forms new products so it is a decomposition reaction. Here FeSO_4 is oxidised to Fe_2O_3 by loss of electrons. So this part of the reaction is oxidation reaction FeSO_4 is also reduced to SO_2 and SO_3 by gain of electrons.

Hence, Heating of FeSO_4 is both decomposition and Redox reaction.



Related Theory

A reaction is called redox when both oxidation and reduction are taking place simultaneously.

Oxidation process involves:

- Gain of oxygen
- Loss of hydrogen
- Loss of electrons

Reduction process involves:

- Loss of oxygen,
- Gain of hydrogen
- Gain of electrons

The substance which loses electrons i.e. gets oxidised, acts as a reducing agent and the substance which gains electrons, i.e. it gets reduced and acts as an oxidising agent.

4. Which among the following is (are) double displacement reaction(s)?

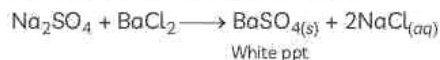
- (I) $\text{Pb} + \text{CuCl}_2 \longrightarrow \text{PbCl}_2 + \text{Cu}$
 (II) $\text{Na}_2\text{SO}_4 + \text{BaCl}_2 \longrightarrow \text{BaSO}_4 + 2\text{NaCl}$
 (III) $\text{C} + \text{O}_2 \longrightarrow \text{CO}_2$
 (IV) $\text{CH}_4 + 2\text{O}_2 \longrightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

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

[NCERT Exemplar]

Ans. (b) only (II)

Explanation: A double displacement reaction involves a displacement of two ions of two different compounds that results in the formation of new compounds. Here, only in reaction (II), ions of both reactants are exchanged and two entirely different compounds are formed. For example,



In a double displacement reaction, exchange of ions takes place i.e., SO_4^{2-} exchange place with Cl^- ion. It is also called precipitation reaction as BaSO_4 is precipitated as insoluble salt in the solution.

ammonium sulphate forms barium sulphate and ammonium chloride. Which of the following correctly represents the type of reaction involved?

- (I) Displacement reaction
 - (II) Precipitation reaction
 - (III) Combination reaction
 - (IV) Double displacement reaction
- (a) Only (I) (b) Only (II)
 (c) Only (IV) (d) (II) and (IV)

[NCERT Exemplar]

6. When copper turnings are added to silver nitrate solution, a blue coloured solution is formed after some time. It is because copper:

- (I) Displaces silver from the solution
 - (II) Forms a blue colored complex with AgNO_3
 - (III) Is oxidized to Cu^{2+}
 - (IV) Is reduced to Cu^{2+}
- (a) (I) and (II) (b) (II) and (III)
 (c) (I) and (III) (d) (II) and (IV)

Ans. (c) (I) and (III)

Explanation: Copper is placed above silver in electrochemical series and thus reaction occurs



7. One of the following does not happen during a chemical reaction. This is:

- (a) Breaking of old bonds and formation of new bonds
- (b) Formation of new substances with entirely different properties
- (c) Atoms of one element change into those of another element to form new products
- (d) A rearrangement of atoms takes place to form new products

Ans. (c) atoms of one element change into those of another element to form new products.

Explanation: It is not atoms but the bonds between these atoms break and form during chemical reactions. Atoms of elements can rearrange but cannot change into other elements.

8. You are given the solution of lead nitrate. In order to obtain a yellow precipitate you should mix with it a solution of:

- (b) potassium nitride
- (c) potassium sulphide
- (d) potassium iodide

Ans. (d) potassium iodide

Explanation: Potassium iodide on reacting with lead nitrate gives yellow precipitate of lead iodide.



9. In which of the following chemical equations do the abbreviations represent the correct states of the reactants and products involved at reaction temperature?

- (a) $2\text{H}_{2(l)} + \text{O}_{2(l)} \longrightarrow 2\text{H}_2\text{O}_{(g)}$
- (b) $2\text{H}_{2(g)} + \text{O}_{2(l)} \longrightarrow 2\text{H}_2\text{O}_{(g)}$
- (c) $2\text{H}_{2(g)} + \text{O}_{2(g)} \longrightarrow 2\text{H}_2\text{O}_{(l)}$
- (d) $2\text{H}_{2(g)} + \text{O}_{2(g)} \longrightarrow 2\text{H}_2\text{O}_{(g)}$

[NCERT Exemplar]

10. Dilute hydrochloric acid is added to granulated zinc taken in a test tube. The following observations are recorded. Point out the correct observation:

- (a) The surface of metal becomes shiny.
- (b) The reaction mixture turns milky.
- (c) Odour of a pungent smelling gas is recorded.
- (d) A colourless and odourless gas is evolved.

[Diksha]

Ans. (d) A colourless and odourless gas is evolved.

Explanation: The chemical reaction between dilute hydrochloric acid and granulated zinc is represented as follows:



The product, zinc chloride, does not turn the reaction milky. Hydrogen gas evolved is colourless and odourless and released by the formation of bubbles. Hence, option (d) is correct.

11. On heating a blue coloured powder of copper (II) nitrate in a boiling tube, a black substance X, oxygen gas and a brown gas Y was formed.

Select the option which identifies the products correctly:

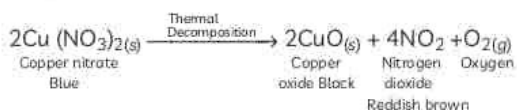
Option	Black Substance X	Brown Gas Y
(a)	Copper	Nitrogen dioxide
(b)	Copper oxide	Nitrogen oxide

(c)	Copper oxide	Nitrogen dioxide
(d)	Copper	Nitrogen oxide

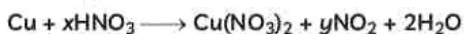
Ans. (c) X is Copper Oxide and Y is Nitrogen Dioxide

Explanation: When blue coloured powder of copper (II) nitrate is heated, it decomposes to form black coloured substance which is copper oxide, oxygen gas and brown gas nitrogen dioxide.

The chemical equation for the reaction taking place is:



12. In the equation:

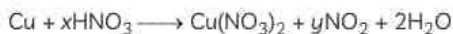


The values of x and y are :

- (a) 3 and 5 (b) 8 and 6
(c) 4 and 2 (c) 7 and 1

Ans. (c) $\text{Cu} + 4\text{HNO}_3 \longrightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$

Explanation: In order to find the values of x and y, we need to balance the chemical equation by equating the number of atom of each element on both sides in the given equation.



Element	Number of atoms	
	Reactant side	Product side
Cu	1	1
H	x	4
N	x	y + 2
O	3x	2y + 2

Equating the number of H atoms on both sides as per the law of conservation of mass,

$$x = 4.$$

Putting this value in either the no. of atoms of N or O,

$$x = y + 2 \text{ means } y = x - 2 = 4 - 2 = 2.$$

Therefore, x = 4 & y = 2 is the correct answer

13. In which of the following chemical equations, the abbreviations represent the correct states of the reactants and products involved at reaction temperature?

- (b) $\text{AlCl}_3(\text{aq}) + 3\text{NH}_4\text{OH}(\text{l}) \longrightarrow \text{Al}(\text{OH})_3(\text{aq}) + 3\text{NH}_4\text{Cl}(\text{s})$
(c) $\text{AlCl}_3(\text{l}) + 3\text{NH}_4\text{OH}(\text{aq}) \longrightarrow \text{Al}(\text{OH})_3(\text{s}) + 3\text{NH}_4\text{Cl}(\text{aq})$
(d) $\text{AlCl}_3(\text{aq}) + 3\text{NH}_4\text{OH}(\text{aq}) \longrightarrow \text{Al}(\text{OH})_3(\text{aq}) + 3\text{NH}_4\text{Cl}(\text{s})$

Ans. (a) $\text{AlCl}_3(\text{aq}) + 3\text{NH}_4\text{OH}(\text{aq}) \longrightarrow \text{Al}(\text{OH})_3(\text{s}) + 3\text{NH}_4\text{Cl}(\text{aq})$

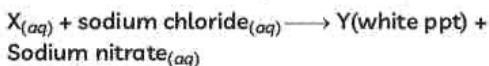
Explanation: When ammonium hydroxide solution is added to aluminium chloride solution, a white precipitate of aluminium hydroxide is formed alongwith ammonium chloride solution.

14. (a) The reaction $2\text{HNO}_3 + \text{Ca}(\text{OH})_2 \longrightarrow \text{Ca}(\text{NO}_3)_2 + 2\text{H}_2\text{O}$ is an example of:

- (I) displacement reaction.
(II) double displacement reaction.
(III) neutralisation reaction.
(IV) combination reaction.

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

15. (a) Consider the following chemical equation:



	X	Y
(a)	Silver Nitrate	Silver Chloride
(b)	Potassium Chloride	Silver Nitrate
(c)	Potassium Nitrate	Silver Nitrate
(d)	Silver chloride	Silver Nitrate

Assertion-Reason Questions

For the following questions, two statements are given: one labeled Assertion (A) and the other labeled 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 the 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.

chemical equation for the action of steam on iron:



Reason (R) : The law of conservation of mass holds good for a chemical equation.

[CBSE 2020]

Ans. (b) Both (A) and (R) are true but (R) is not the correct explanation of (A).

Explanation: Iron (Fe) metal does not react with cold or hot water but it reacts with steam to form metal oxide and hydrogen.

The law of conservation of mass holds good for a chemical reaction. The statement is true but it does not explain about the equation given in Assertion.

17. (A) Assertion (A): Magnesium ribbon burns with a dazzling white flame.

Reason (R) : Magnesium ribbon undergoes physical change on burning and melts.

18. Assertion (A): While equalizing the number of atoms to balance a chemical equation, we alter the formula of the compounds or elements involved in the reaction.

Reason (R) : Chemical equation is balanced by making the number of atoms of each element equal on both sides of the arrow.

Ans. (d) (A) is false, but (R) is true.

Explanation: A chemical equation is balanced by making the number of atoms of each element equal on both sides of the arrow without altering the formula of the compounds or elements involved in the reaction. It is balanced by putting coefficients in front of the compounds or elements.

19. Assertion (A): The reaction of calcium oxide with water to produce slaked lime releasing a large amount of heat is a combination reaction.

Reason (R) : Double displacement reactions are the reactions in which there is exchange of ions between the reactants.

Ans. (b) Both (A) and (R) are true but (R) is not the correct explanation of (A).

with water to produce slaked lime releasing a large amount of heat is a combination reaction as the two reactants combine to form a single product.

Whereas, in a double displacement reaction, there will be two reactants and two products which are formed by the exchange of ions between the reactants.

20. (A) Assertion (A): The decomposition reaction of silver chloride into silver and chlorine is an exothermic process.

Reason (R) : Reactions in which energy is absorbed are known as endothermic reactions.

21. (A) Assertion (A): Zinc and lead displace copper from its compounds.

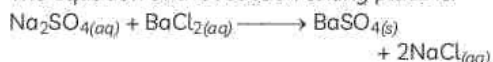
Reason (R) : Zinc and lead are more reactive than copper.

Very Short Answer Type Questions

22. What happens when sodium sulphate solution is added to barium chloride solution?

Ans. When sodium sulphate solution is added to barium chloride solution, a white precipitate of barium sulphate is formed.

The equation of the reaction taking place is:



23. An aqueous solution of metal nitrate P reacts with sodium bromide solution to form yellow ppt of compound Q which is used in photography. Q on exposure to sunlight undergoes decomposition reaction to form metal present in P along with reddish brown gas. Identify P & Q.

Ans. As the compound Q is formed by the reaction between P (metal nitrate solution) and sodium bromide solution, Q is silver bromide which is used in photography.

Further Q undergoes decomposition in the presence of sunlight to form silver and bromine gas. As silver is formed above, the metal nitrate is silver nitrate.

P - silver nitrate (AgNO_3)

Q - silver bromide (AgBr).

24. What can be seen when a strip of copper metal is placed in a solution of silver nitrate? [CBSE 2015]

Ans. When a strip of copper metal is placed in a solution of silver nitrate, copper displaces silver

reactive metal than silver. Copper nitrate is formed with a shiny greyish white deposit of silver on the copper strip.



25. Name and state the law which is kept in mind when we balance chemical equations. [CBSE 2012]

Ans. The law which is kept in mind when we balance chemical equations is the law of conservation of mass which states that "Matter can neither be created nor be destroyed". It means that the total mass of atoms of reactants = total mass of atoms of products, as atoms can neither be created nor be destroyed.

26. Hydrogen being a highly inflammable gas and oxygen being a supporter of combustion, yet water, a compound made up of hydrogen and oxygen is used to extinguish fire. Why? [CBSE 2011]

Ans. The compound made up of hydrogen and oxygen is water (H_2O) which has properties that are different from properties of H_2 and O_2 as it is formed by the chemical reaction

While hydrogen and oxygen are gases at room temperature, water is a liquid at room temperature.

27. If copper metal is heated over a flame, it develops a coating. What is the colour and composition of coating? [CBSE 2011]

28. Write a balanced chemical equation to represent the following reaction: carbon monoxide reacts with hydrogen gas at 340 atm to form methyl alcohol. [CBSE 2011]

29. Write a balanced chemical equation for the reaction between sodium chloride and silver nitrate indicating the physical state of the reactants and the products. [CBSE 2011]

Ans. When silver nitrate solution is added to sodium chloride solution, a white precipitate of silver chloride is formed along with sodium nitrate solution.

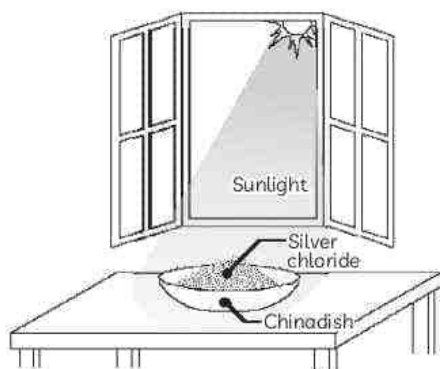


30. Complete and balance the following: $\text{Fe}_2\text{O}_3 + \text{Al} \longrightarrow$ [CBSE 2011]

COMPETENCY BASED Questions (CBQs)

[1, 4 & 5 marks]

31. ④



During a chemical reaction atoms of one element do not change into those of another element. Nor do atoms disappear from the mixture or appear from elsewhere. Actually, chemical reactions involve the breaking and making of bonds between atoms to produce new substances.

To demonstrate a reaction, 2 g of silver chloride is taken in a china dish and placed in sunlight.

- (A) What will you observe after some time?
(B) What is this reaction known as?
(C) Write the balanced chemical equation for this reaction.
(D) Give reasons for the observations.
32. Whitewash is a very low cost type of paint made from slaked lime (calcium hydroxide) and chalk (whiting). Chalk is calcium carbonate. Slaked lime turns into chalk by reacting with carbon dioxide in the air over several days. This causes crystallization, which binds and strengthens the coating. Various other additives can be used.



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 a solution called lime water.

Which among the following is (are) true about slaking of lime and the solution formed?

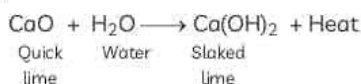
- (I) It is an endothermic reaction.
 (II) It is an exothermic reaction.
 (III) The pH of the resulting solution will be more than seven.
 (IV) The pH of the resulting solution will be less than seven.
- (a) (I) and (II) (b) (II) and (III)
 (c) (I) and (IV) (d) (III) and (IV)

[NCERT Exemplar]

Ans. (b) (II) and (III)

Explanation: Slaking of lime is an exothermic reaction because a large amount of heat is produced during the reaction. The heat can be felt by touching the beaker from the outside.

The resulting compound $\text{Ca}(\text{OH})_2$, which is also called slaked lime, turns red litmus solution to blue and hence, proves it to be a basic solution. Thus, the pH of this solution will be more than seven.



33. Shalini was quite interested in observing the changes that take place during chemical reactions but was always afraid of entering the chemistry lab. When she spoke to her chemistry teacher regarding this, the teacher suggested that she should perform a simple experiment under her guidance to overcome her fear and at the same time she could observe the changes that take place during a chemical reaction.

She took about 2 g of ferrous sulphate crystals in a dry boiling tube and heated it over the

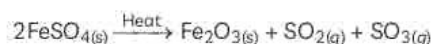
colour of the ferrous sulphate crystals and could also smell the characteristic odour of burning sulphur.

- (A) What change in colour did Shalini observe?
 (B) Why did Shalini get the characteristic odour of burning sulphur?
 (C) What type of reaction takes place when ferrous sulphate is heated?
 (D) Give another example of such type of reactions.

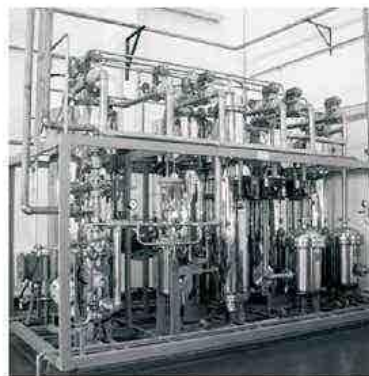
Ans. (A) Shalini observed that the green colour of ferrous sulphate crystals changed to white as it loses water when heated.



- (C) The type of reaction taking place is thermal decomposition reaction. The chemical equation for the reaction taking place is:



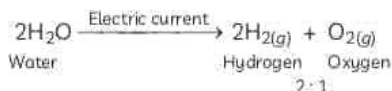
34. The production of hydrogen from water via electrolysis is a clean process, resulting in only oxygen being produced as a by-product. If the electricity required to split the water into hydrogen and oxygen is supplied via a renewable energy source then the process is environmentally benign. The water electrolysis hydrogen (oxygen) plant is equipment that electrolyzes water to produce hydrogen and oxygen by using lye as an electrolyte.



Electrolysis of water is a decomposition reaction. The mole ratio of hydrogen and oxygen gases liberated during the electrolysis of water is:

- (a) 1:1 (b) 2:1
 (c) 4:1 (d) 1:2 [CBSE 2013]

Explanation: The balanced chemical equation for the electrolysis of water is:



The mole ratio of hydrogen and oxygen gases liberated during electrolysis of water is 2:1 by volume.

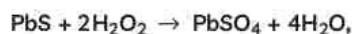
In a decomposition reaction, a compound is broken down into its simpler forms. During electrolysis, water is broken down into oxygen gas and hydrogen gas due to the passage of electric current through it.

- 35.** Redox reactions are an important class of reactions. The oxidation and reduction reactions always occur simultaneously, such class of chemical reactions is named as the redox reaction or Oxidation-Reduction reaction.

The substance getting reduced in a chemical reaction is known as the oxidizing agent, while a substance that is getting oxidized is known as the reducing agent. The activity in which copper powder is taken in a china dish and heated helps in understanding redox reactions.

- (A) What happens when copper powder is heated in a china dish? Explain your observation.
- (B) What will you observe if hydrogen gas is passed over the heated material obtained in (A) above?
- (C) Identify the substance oxidized and substance reduced in the reaction at (B) above.
- (D) Identify the correct statement:

In the reaction between lead sulphide and hydrogen peroxide shown by the equation below,

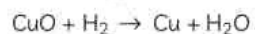


- (a) Lead sulphide is reduced and Hydrogen peroxide is oxidized.
- (b) Lead sulphide is oxidized and Hydrogen peroxide is reduced.
- (c) Lead sulphate is oxidized and water is reduced.
- (d) Lead sulphate is reduced and water is oxidized.

china dish, the surface of copper powder is coated with black copper oxide as oxidation of copper takes place by addition of oxygen to copper.



- (B) When hydrogen gas is passed over heated material CuO, the black coating on the surface turns brown as reverse reaction takes place and copper is formed.



- 36.** Rancidification is the process of complete or incomplete oxidation or hydrolysis of fats and oils when exposed to air, light, or moisture or by bacterial action, resulting in unpleasant taste and odor. Specifically, it is the hydrolysis or autoxidation of fats into short-chain aldehydes and ketones, which are objectionable in taste and odor. When these processes occur in food, undesirable odors and flavors can result.



Which of the following gases can be used for the storage of fresh sample of an oil for a long time?

- (a) Carbon dioxide or oxygen
- (b) Nitrogen or oxygen
- (c) Carbon dioxide or helium
- (d) Helium or nitrogen [NCERT Exemplar]

- Ans.** (d) Helium or nitrogen

Explanation: Inert gases like helium or nitrogen both can be used for the storage of fresh sample of oil for a long time, as they do not react with most elements, including oxygen. Thus these gases create an inert environment for the oil and prevent its reaction (oxidation) with any element in the environment. Hence, stopping it from becoming rancid.

- 37.** A student takes two test tubes. In the first test tube, he takes lead nitrate solution and in the second he takes a few zinc granules. He adds potassium iodide solution to lead nitrate solution in the first test tube. He adds dilute sulphuric acid in the second test tube containing zinc granules. [NCERT Exemplar]

on adding potassium iodide solution?

Option	Formula of Precipitate Formed	Colour of Precipitate
(a)	KNO_3	Yellow
(b)	KNO_3	Brown
(c)	PbI_2	Yellow
(d)	PbI_2	Brown


(B) Select the correct observations:

When dilute sulphuric acid is added to a few zinc granules in the second test tube,

- (I) Bubbles of hydrogen gas can be seen around the zinc granules.
 - (II) Bubbles of carbon dioxide can be seen around zinc granules.
 - (III) The flask becomes hot
 - (IV) Colour of solution changes to blue.
- (a) Only (I) (b) Both (I) and (III)
(c) Both (II) and (III) (d) (I), (III) and (IV)

(C)  Select the incorrect statement(s):

- (I) Both the reactions are accompanied by change in colour.
 - (II) A precipitate is formed in the first test tube only.
 - (III) Gas is evolved in the second test tube only.
 - (IV) Both the reactions are examples of double displacement reactions.
- (a) Both (I) and (III) (b) Both (I) and (IV)
(c) Both (II) and (III) (d) Both (I) and (II)

(D)  Suppose we add dil hydrochloric acid in place of sulphuric acid in the second test tube. Select the correct observation:

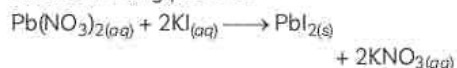
- (a) Chlorine gas will be evolved.
- (b) The test tube will become cold as heat is absorbed during this reaction.
- (c) Hydrogen gas will be evolved.
- (d) A precipitate of zinc chloride will be formed

when water is added slowly to a small amount of calcium oxide in a beaker is:

- (I) Combination Reaction
 - (II) Displacement reaction
 - (III) Exothermic reaction
 - (IV) Endothermic reaction
- (a) Both (I) and (III)
(b) Both (II) and (III)
(c) Both (I) and (IV)
(d) Both (II) and (IV)

Ans. (A) (c) Both (II) and (III)

Explanation: When potassium iodide solution is added to lead nitrate solution in a test tube, a yellow precipitate of lead iodide is formed. The equation of the reaction taking place is:



(B) (b) Both (I) and (III)

Explanation: When dilute sulphuric acid is added to zinc granules in a conical flask, the equation of the reaction taking place is:



38. You must have seen that your mother stores fried food items such as boondi raita, chips, mixture, banana chips and other such items properly. This is because their smell and taste changes due to oxidation of fried food items and food becomes unfit for human consumption.



Why are anti-oxidants added to fat and oil-containing food items?

Ans. Anti-oxidants are added to fat and oil containing food items to prevent their oxidation which is known as rancidity which makes food smell bad and changes its taste.

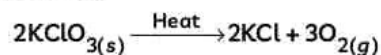
more substances, the reactants, are converted to one or more different substances, the products. Substances are either chemical elements or compounds. A chemical reaction rearranges the constituent atoms of the reactants to create different substances as products.

Chemical reactions must be distinguished from physical changes. Physical changes include changes of state, such as ice melting to water and water evaporating to vapour. If a physical change occurs, the physical properties of a substance will change, but its chemical identity will remain the same. However, if water, as ice, liquid, or vapour, encounters sodium metal (Na), the atoms will be redistributed to give the new substances molecular hydrogen (H₂) and sodium hydroxide (NaOH). By this, we know that a chemical change or reaction has occurred.

- (A) Which of the following are physical changes?
- (I) Melting of wax
 - (II) Burning of wax
 - (III) Rusting of iron
 - (IV) Evaporation of water
- (a) Both (I) and (III) (b) Both (II) and (III)
(c) Both (I) and (IV) (d) Both (II) and (IV)
- (B) Ⓐ A chemical reaction does not involve:
- (a) Formation of new substances having entirely different properties than that of the reactants
 - (b) Breaking of old chemical bonds and formation of new chemical bonds
 - (c) Rearrangement of the atoms of reactants to form new products
 - (d) Changing of the atoms of one element into those of another element to form new products
- (C) Ⓐ Quick lime is used in whitewashing because
- (a) It is cheap
 - (b) It forms lime stone with water which has a nice color.
 - (c) It forms slaked lime with water which reacts with atmospheric carbon dioxide to form limestone.
 - (d) It is easy to use

endothermic processes?

- (I) Burning of natural gas
 - (II) Dilution of an acid
 - (III) Evaporation of water
 - (IV) Sublimation of camphor (crystals)
- (a) (I) and (II) (b) (II) and (III)
(c) (IV) and (IV) (d) (III) and (IV)
- (E) The following reaction is used for the preparation of oxygen gas in the laboratory



Which of the following statement about the reaction is correct?

- (a) It is a displacement reaction and endothermic in nature.
- (b) It is a decomposition reaction and exothermic in nature.
- (c) It is a decomposition reaction and endothermic in nature.
- (d) It is a photochemical decomposition reaction and exothermic in nature.

Ans. (A) (c) Both (I) and (IV)

Explanation: Melting of wax and evaporation of water are physical changes as they undergo only change in their physical states without any change in their chemical composition. Whereas, burning of wax is a chemical change as carbon dioxide and water are formed when wax is burned. Rusting of iron is also a chemical change as iron undergoes oxidation in the presence of moisture to form rust or iron oxide.

- (E) (c) It is a decomposition reaction and endothermic in nature.

Explanation: It is a decomposition reaction as a single reactant splits up into two products, namely, KCl and O₂, by absorbing energy in the form of heat.

It is an endothermic reaction as heat is absorbed in this reaction.

40. Many materials over time can be prone to corrosion and wear. Iron is one such metal. Having a protective later and proper preparation can certainly help materials last longer and have other properties integrated into it.



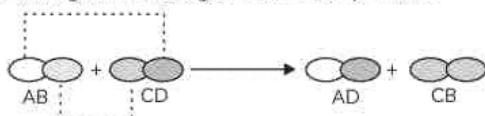
A substance X used for coating iron articles is added to a blue solution of a reddish brown metal Y, the colour of the solution gets discharged. Identify X and Y and also the type of reaction.

Ans. We are given that the metal Y is reddish brown in colour. This metal is copper and the blue solution of Y is copper sulphate. Also, zinc is used in protecting iron articles and this process is called galvanisation. As Zinc is more reactive than copper it displaces copper from its salt solution, copper sulphate.



So, X is zinc, while Y is copper.

41. Double displacement reactions may be defined as the chemical reactions in which one component each of both the reacting molecules is exchanged to form the products. During this reaction, the cations and anions of two different compounds switch places, forming two entirely different compounds.



Double displacement reactions generally take place in aqueous solutions in which the ions precipitate and there is an exchange of ions.

Double displacement reactions can be further classified as neutralization and precipitation reactions.

(A) What is the precipitate formed on mixing the solution of barium chloride and sodium sulphate?

- (a) Barium sulphate
- (b) Sodium chloride
- (c) Barium sulphite
- (d) Sodium sulphite

(B) When Potassium iodide solution is added to lead(II) nitrate solution,

- (I) lead (II) iodide precipitates out of the solution as a yellow solid

of the solution as a yellow solid

(III) Potassium displaces lead from lead nitrate solution.

(IV) Exchange of lead and potassium ions takes place

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

(C) Identify the precipitate obtained by the reaction between lead nitrate and sodium sulphate.

- (a) PbS
- (b) Pb(SO₄)₂
- (c) PbSO₄
- (d) NaNO₃

(D) Which one of the following is true about a double displacement reaction?

- (I) Electrolysis of water is an example of this reaction.
- (II) Two compounds exchange ions to form new compounds.
- (III) Only a single product is formed.
- (IV) Reaction between magnesium oxide and dilute hydrochloric acid is an example for this reaction.

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

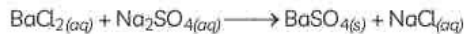
(E) Identify the incorrect statement regarding double displacement reactions:

- (a) All double displacement reactions are precipitation reactions.
- (b) All neutralization reactions between acids and bases are double displacement reactions
- (c) The reaction between vinegar and baking soda is an example of double displacement reaction.
- (d) Reaction between silver nitrate solution and sodium chloride solution is an example of double displacement reaction.

Ans. (A) (a) Barium Sulphate

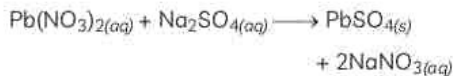
Explanation: When a solution of barium chloride is mixed with a solution of sodium

is formed along with sodium chloride.



(C) (c) PbSO_4

Explanation: Lead nitrate reacts with sodium sulphate solution to form a precipitate of lead sulphate and sodium nitrate.

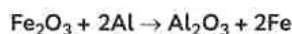


This is a double displacement reaction as exchange of lead and sodium ions is taking place.

42. Thermite is a pyrotechnic composition of metal powder fuel and metal oxide. When ignited by heat, thermite undergoes an exothermic oxidation-reduction reaction. Most varieties are not explosive but can create brief bursts of high temperature in a small area. Its form of action is similar to that of other fuel-oxidizer mixtures, such as black powder. Thermites have diverse compositions. Fuels include aluminium, magnesium, titanium, zinc, silicon, and boron. Aluminium is common because of its high boiling point. Oxidizers include boron(III) oxide, silicon(IV) oxide, chromium(III) oxide, manganese(IV) oxide, iron(III) oxide, iron(II,III) oxide, copper(II) oxide, and lead(II,IV) oxide.



In this reaction mention the substance getting oxidized and the substance getting reduced.



- Ans.** Oil and fat containing food items are flushed with nitrogen while packing them as nitrogen is an inert gas and prevents fried food materials from getting rancid.
43. A synthesis or combination reaction is a reaction in which simple compounds combine to make a more complex one. The opposite of combination reaction is a decomposition reaction in which a single substance splits into two or more substances. We also have single displacement reaction (in which a more reactive element displaces a less reactive element

reaction (in which exchange of ions takes place between two compounds). Having a thorough understanding of the types of reactions will be useful for predicting the products of an unknown reaction.

- (A) ④ A student performed several experiments and then noted down his observations in a tabular form as given below:

S. No.	Observation	Conclusion Regarding type of Reaction Taking Place
(I)	When copper powder is heated in a china dish, the surface of copper powder turns black	Combination Reaction
(II)	Hydrogen gas is evolved when Iron reacts with dil. HCL.	Decomposition Reaction
(III)	A black precipitate is formed along with sulphuric acid solution when hydrogen sulphide gas is passed through copper sulphate solution	Double Displacement Reaction
(IV)	When electricity is passed through molten aluminium chloride aluminium metal is formed along with a gas.	Displacement Reaction

Select the option that correctly describes the conclusions made by the student regarding type of reaction taking place:

- (a) Both (I) and (II)
 (b) Both (I) and (III)
 (c) Both (II) and (III)
 (d) (I), (III) and (IV)
- (B) ④ When a metal X, which is used for coating iron articles, is added to a blue solution of a reddish brown metal Y, the color of the solution gets discharged.

identifies the metals X and Y and the type of reaction taking place.

Option	Metal X	Metal Y	Type of Reaction
(a)	Zinc	Iron	Double displacement
(b)	Copper	Zinc	Double displacement
(c)	Copper	Zinc	Displacement
(d)	Zinc	Copper	Displacement

(C) The type of reaction taking place when barium chloride solution is added to copper sulphate solution is:

- (I) Combination reaction
- (II) Displacement reaction
- (III) Double Displacement reaction
- (IV) Precipitation reaction
- (a) Only (I)
- (b) Only (II)
- (c) Both (II) and (IV)
- (d) Both (III) and (IV)

(D) Identify the incorrect statement:

- (a) Burning of natural gas is a decomposition reaction.
- (b) Burning of hydrogen gas in air is a combination reaction
- (c) Reaction between most metals and dilute hydrochloric acid is a displacement reaction.
- (d) Reaction between an acid and a base is an example of double displacement reaction.

(E) Which of the following statement(s) are correct?

insoluble salts.

- (II) Neutralization reactions are single displacement reactions.
- (III) Decomposition reactions can be carried out only in presence of heat or light.
- (IV) Displacement reactions are opposite of combination reactions.
- (a) Only (I)
- (b) Only (II)
- (c) Both (I) and (III)
- (d) Both (II) and (IV)

Ans. (C) (d) Both (III) and (IV)

Explanation : When barium chloride solution is added to copper sulphate solution, a white precipitate of barium sulphate is formed alongwith copper chloride solution.

This is an example of precipitation reaction as a precipitate of barium sulphate is formed. It is also a double displacement reaction as the Ba^{2+} and Cu^{2+} ions form new compounds by exchanging their ions.

The equation of the reaction taking place is:



(E) (a) Only (I)

Explanation: Precipitation reactions are the reactions in which an insoluble substance or precipitate is formed.

Neutralization reactions are the reactions between an acid and a base and are double displacement reactions.

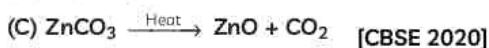
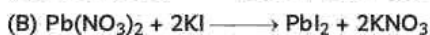
Decomposition reactions require energy in the form of heat, light or electricity.

Decomposition reactions are the opposite of combination reactions.

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

44. Identify the type of each of the following reactions stating reason for your answers :



Ans. (A) $Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe + \text{Heat}$

Single Displacement Reaction Aluminium (Al) being more reactive than iron (Fe) displaces less reactive metal Fe from its compound Fe_2O_3 . This reaction is highly exothermic and releases a lot of heat.

Related Theory

This reaction is also known as thermite reaction. The amount of heat evolved is so large that Fe metal produced in the molten state is used to join railway tracks or cracked machine parts.



Double Displacement Reaction

In this double displacement reaction, two compounds $\text{Pb}(\text{NO}_3)_2$ and KI react by exchange of ions to form two new compounds, lead iodide and potassium nitrate. In this reaction PbI_2 is formed as a precipitate (an insoluble solid) which separates out from the solution so this reaction is also precipitation reaction.



Thermal Decomposition Reaction

When a decomposition reaction is carried out by heating, it is called Thermal decomposition reaction. In this reaction a single compound zinc carbonate (ZnCO_3) when heated breaks down into two compounds zinc oxide (ZnO) and carbon dioxide (CO_2).

45. Identify the reducing agent in the following reactions:

- (A) $4\text{NH}_3 + 5\text{O}_2 \longrightarrow 4\text{NO} + 6\text{H}_2\text{O}$
(B) $2\text{H}_2\text{O} + 2\text{F}_2 \longrightarrow 4\text{HF} + \text{O}_2$
(C) $\text{Fe}_2\text{O}_3 + 3\text{CO} \longrightarrow 2\text{Fe} + 3\text{CO}_2$
(D) $2\text{H}_2 + \text{O}_2 \longrightarrow 2\text{H}_2\text{O}$

[NCERT Exemplar]

46. When hydrogen sulphide gas is passed through a blue solution of copper sulphate, the colour of the solution fades and a black precipitate is obtained.

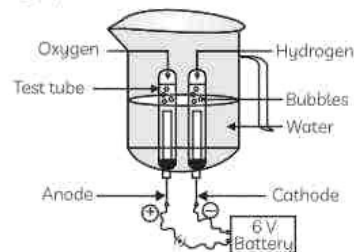
- (A) Name the type of reaction mentioned above.
(B) Why does the colour of the solution fade away?
(C) Write the chemical name of the black precipitate formed.
(D) Give the balanced chemical equation for the reaction involved. [CBSE 2020]

Ans. When hydrogen sulphide gas is passed through a blue solution of copper sulphate, the blue colour of the solution fades and a black precipitate of copper sulphide is formed along with sulphuric acid.

is double displacement reaction.

- (B) The blue colour of copper sulphate fades due to its reaction with hydrogen sulphide gas and results in the formation of colourless solution of sulphuric acid.
(C) The chemical name of black precipitate is copper sulphide.
(D) $\text{H}_2\text{S}_{(g)} + \text{CuSO}_{4(aq)} \longrightarrow \text{CuS}_{(s)} \downarrow + \text{H}_2\text{SO}_{4(aq)}$
Hydrogen sulphide gas Copper sulphate solution (Blue) Copper sulphide (Black) Sulphuric acid

47. Study the figure given below and answer the following questions:



- (A) Name the process depicted in the diagram.
(B) Write the composition of gases collected at anode and the cathode.
(C) Write the balanced chemical equation of the reaction taking place in this case.
(D) The reaction does not take place if a few drops of dilute sulphuric acid are not added to water. Why? [CBSE 2020]

Ans. (A) Electrolytic decomposition of water/ electrolysis of water.
(B) The gas collected at cathode is hydrogen which is double the volume of oxygen collected at anode.
(C) $2\text{H}_2\text{O}_{(l)} \xrightarrow[\text{Current}]{\text{Electric}} 2\text{H}_{2(g)} + \text{O}_{2(g)}$
(D) Water is not a good conductor of electricity sulphuric acid is added in the water to make, it a good conductor of electricity.



Related Theory

- **Decomposition reaction**-the reaction in which a single compound breaks down to give two or more simpler substances. The decomposition reaction which takes place when electricity is passed through the compound in the molten state or in aqueous solution, then this reaction is called electrolytic decomposition reactions or electrolysis.
→ **Hydrogen gas collected is twice the volume of oxygen gas collected. It is 2 : 1 (by volume)**

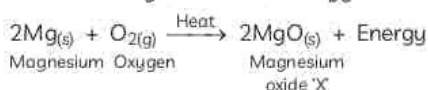
with dilute hydrochloric acid, the following observations were made:

- Silver metal does not show any change.
- The temperature of the reaction mixture rises when aluminium (Al) is added.
- The reaction of sodium metal is found to be highly explosive.
- Some bubbles of a gas are seen when lead (Pb) reacts with the acid. Explain these observations giving suitable reasons. [NCERT Exemplar]

49. A magnesium ribbon is burnt in oxygen to give a white compound X accompanied by emission of light. If the burning ribbon is now placed in an atmosphere of nitrogen, it continues to burn and forms a compound Y.
- Write the chemical formulae of X and Y.
 - Write a balanced chemical equation for when X is dissolved in water.

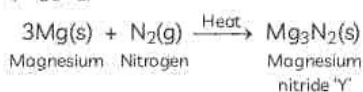
[CBSE 2013]

- Ans. (A) When magnesium ribbon is burnt in oxygen, it forms magnesium oxide with emission of light and heat energy.



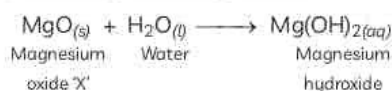
The chemical formula of X is MgO.

If the burning ribbon is placed in a nitrogen gas chamber, magnesium reacts with nitrogen and forms magnesium nitride (Mg₃N₂).



The chemical formula of compound Y is Mg₃N₂.

- (B) If magnesium oxide is dissolved in water, it forms magnesium hydroxide.



50. What happens when food materials containing fats and oils are left for a long time? List two observable changes and suggest three ways by which this phenomenon can be prevented. [CBSE 2020]

51. Answer the following questions:

- (A) In the following reactions, name the

reduction:



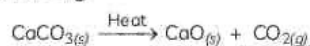
- (B) Also state one industrial application of reduction.

52. (A) Mention any four information given by a chemical equation.
(B) State the law of conservation of mass as applicable in a chemical reaction.

- Ans. (A) A balanced chemical equation tells:
- number of atoms and molecules of reactants and products involved.
 - chemical formula of reactants and products involved.
 - catalyst involved in the reaction if any.
 - physical state of reactants and products involved.



Related Theory

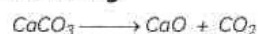


- 1 molecule of CaCO₃ decomposes into 1 molecule of CaO and 1 molecule of CO₂.
- CaCO₃ decomposes in the presence of heat.
- Physical state of CaCO₃ and CaO is solid whereas CO₂ is gas.
- Calcium carbonate upon heating decomposes to give calcium oxide and carbon dioxide.

- (B) The Law of Conservation of Mass states that "matter can neither be created nor destroyed in a chemical reaction. The mass of the products in a chemical reaction is equal to the mass of the reactants."



Related Theory



$$\begin{aligned} \text{Molecular Mass of CaCO}_3 \\ &= 1 \times 40 + 1 \times 12 + 3 \times 16 \\ &= 100 \text{ g} \end{aligned}$$

$$\begin{aligned} \text{Molecular Mass of CaO} \\ &= 1 \times 40 + 1 \times 16 \\ &= 56 \text{ g} \end{aligned}$$

$$\begin{aligned} \text{Molecular Mass of CO}_2 \\ &= 1 \times 12 + 2 \times 16 \\ &= 44 \text{ g} \end{aligned}$$

$$\begin{aligned} \text{LHS} &= \text{RHS} \\ 100 &= 56 + 44 \end{aligned}$$

Hence, it follows the law of conservation of mass.

in a dry boiling tube:

- (A) List any two observations.
- (B) Name the type of chemical reaction taking place.
- (C) Write the chemical equation for the reaction.
- (D) Name the products obtained.

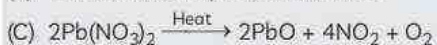
54. (A) A solution of potassium chloride when mixed with silver nitrate solution forms an insoluble white substance. Write the chemical reaction involved and also mention the type of the chemical reaction.

[NCERT Exemplar]

- 55. (A) Write two observations when lead nitrate is heated in a test tube.
- (B) Name the type of reaction.
- (C) Write a balanced chemical equation to represent the above reaction.

Ans. (A) It turns yellow due to formation of lead oxide and reddish brown fumes evolve.

(B) Thermal decomposition reaction.



[CBSE Marking Scheme 2019]

56. (A) P, Q and R are 3 elements which undergo chemical reactions according to the following equations:



Answer the following:

- (A) Which element is most reactive?
- (B) Which element is least reactive?
- (C) State the type of reaction listed above.

57. (A) Translate the following statements into chemical equations and balance them (if needed):

- (A) Quicklime combines with carbon dioxide to form calcium carbonate.
- (B) Aluminium metal granule is added in sulphuric acid to form aluminium sulphate and hydrogen gas. [Diksha]

reaction:



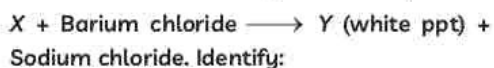
- (A) Identify the type of reaction.
- (B) Write a balanced chemical equation of another example of this type of reaction. [CBSE 2015]

Ans. (A) It is a combination reaction as the two reactants, namely, hydrogen gas and chlorine gas, combine to form a single product, hydrogen chloride.

(B) Another example of this type of reaction is the reaction of calcium oxide (lime or quicklime) vigorously with water to form calcium hydroxide (slaked lime).



59. (A) Consider the following chemical equation:



(A) 'X' and 'Y'.

(B) The type of reaction. [CBSE 2015]

60. (A) A zinc plate was put into a solution of copper sulphate kept in a glass container. It was found that the blue colour of the solution gets fader and fader with passage of time. After few days when zinc plate was taken out of the solution, a number of holes were observed on it.

(A) State the reason for the changes observed on zinc plate.

(B) Write the chemical equation for the reaction involved. [CBSE 2011]

Ans. (A) When a zinc plate was put into a solution of copper sulphate, the blue colour of the solution got fader and a number of holes were observed on the zinc plate. This was because zinc displaced copper from copper sulphate solution as zinc is more reactive than copper.

(B) The chemical equation for the reaction taking place is:



[3 marks]

61. Write balanced chemical equations for the following reactions:

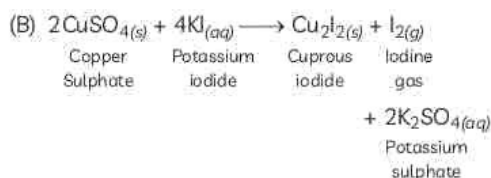
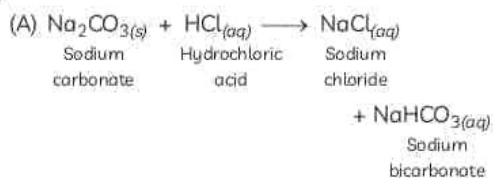
(A) Sodium carbonate on reaction with hydrochloric acid in equal molar concentrations gives sodium chloride and sodium hydrogen carbonate.

[CBSE 2010]

(B) Copper sulphate on treatment with potassium iodide precipitates cuprous iodide (Cu_2I_2), liberates iodine gas and also forms potassium sulphate.

[NCERT Exemplar]

Ans.



62. A substance X, which is an oxide of a group 2 element, is used intensively in the cement industry. This element is present in bones also. On treatment with water, it forms a solution which turns red litmus blue. Identify X and also write the chemical reactions involved. [NCERT Exemplar]

63. Grapes hanging from the plant do not ferment but after being plucked from the plant can be fermented. Under what conditions do these grapes ferment? Is it a chemical or a physical change?

[NCERT Exemplar]

Ans. When the grapes are attached to the plants, they are still considered as living. Thus oxygen reaches in the cell leading to aerobic respiration taking place and no fermentation is possible under aerobic conditions.

After plucking grapes from plants, fermentation of sugar is carried out in the presence of yeast, which changes sugar to ethanol

and carbon dioxide. This process occurs in the absence of oxygen, i.e., in anaerobic conditions.

Here, fermentation is a chemical change as it results in the formation of new substances: alcohol and carbon dioxide.

64. Why do we store silver chloride in dark coloured bottles? [NCERT Exemplar]

65. A silver article generally turns black when kept in the open for a few days. The article when rubbed with toothpaste again starts shining.

(A) Why do silver articles turn black when kept in the open for a few days? Name the phenomenon involved.

(B) Name the black substance formed and give its chemical formula.

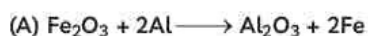
[NCERT Exemplar]

Ans. (A) The metal surface of silver articles reacts with atmospheric sulphur compounds like hydrogen sulphide and forms black layer of sulphides. This phenomenon is called as corrosion or tarnishing of silver.

(B) The black substance that is formed by the reaction of hydrogen sulphide and atmospheric oxygen is silver sulphide (Ag_2S).



66. What is a reduction reaction? Identify the substances that are oxidized and the substances that are reduced in the following reactions.



67. An aqueous solution of metal nitrate 'P' reacts with sodium bromide solution to form yellow precipitate 'Q' which is used in photography. 'Q' on exposure to sunlight undergoes decomposition reaction to form metal present in 'P' along with reddish brown gas. Identify 'P' and 'Q'. Write the balanced chemical equation for the chemical reaction. List the two categories in which the reaction can be placed. [CBSE 2012]

with sodium bromide to form a yellow precipitate 'Q' which is used in photography. Q is a bromide salt as it undergoes double displacement reaction and since silver bromide is used in photography, Q is silver bromide, AgBr. Therefore, 'P' is silver nitrate, AgNO₃.

The balanced equation for the reaction between silver nitrate and sodium bromide is:



When silver bromide is exposed to sunlight, it undergoes decomposition reaction and forms silver metal (present in silver nitrate) along with bromine gas, which is reddish brown in colour.

The balanced chemical equation for the reaction taking place is:



68. (A) Why is it necessary to balance a chemical equation?
 (B) Write the balanced chemical equation for the following reactions:
 (i) Natural gas burns in air to form carbon dioxide and water.
 (ii) During respiration, glucose combines with oxygen and forms carbon dioxide and water along with the release of energy. [CBSE 2013]

equation because a chemical reaction is just a rearrangement of atoms. Atoms are neither created nor destroyed during a chemical reaction. The chemical equation needs to be balanced to follow the law of conservation of mass which states that mass can neither be created nor be destroyed.

- (B) The balanced chemical equation is given below:
 (i) As methane is the main component of natural gas, the equation for burning of natural gas is:

$$\text{CH}_4(g) + 2\text{O}_2(g) \longrightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(g)$$

 (ii) The equation for the oxidation of glucose to form carbon dioxide and water along with release of energy is:

$$\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \longrightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{Heat}$$

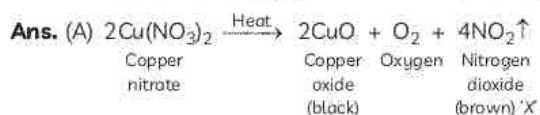
69. (A) Why is respiration considered an exothermic reaction?
 (B) Define the term oxidation and reduction.
 (C) Identify the substance that is oxidized and reduced in the following reaction:

$$\text{CuO} + \text{Zn} \longrightarrow \text{Cu} + \text{ZnO}$$
 [CBSE 2011]

LONG ANSWER Type Questions (LA)

[5 marks]

70. On heating blue coloured powder of copper (II) nitrate in a boiling tube, copper oxide (black), oxygen gas and a brown gas X is formed.
 (A) Write a balanced chemical equation of the reaction.
 (B) Identify the brown gas X evolved.
 (C) Identify the type of reaction.
 (D) What could be the pH range of aqueous solution of the gas X? [NCERT]

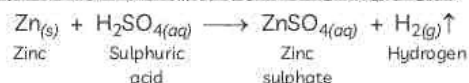


- (B) X is nitrogen dioxide gas (NO₂) that has evolved as brown, choking fumes.

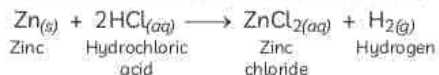
- (C) A thermal decomposition reaction.
 (D) Nitrogen dioxide dissolves in water to form an acidic solution because it is an oxide of non-metal. Therefore, the pH level of this solution is less than 7.

71. What happens when zinc granules are treated with dilute solution of H₂SO₄, HCl, HNO₃, NaCl and NaOH. Also write their chemical equations, if reaction occurs. [NCERT Exemplar]

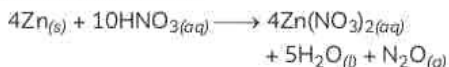
Ans. Dilute H₂SO₄: Zn reacts with dilute sulphuric acid to form zinc sulphate and hydrogen gas.



chloride with the evolution of hydrogen gas.

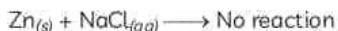


Dilute HNO₃: Reaction with dilute HNO₃ is different as compared to other acids because nitric acid is an oxidizing agent and it oxidizes H₂ gas, evolved to H₂O.

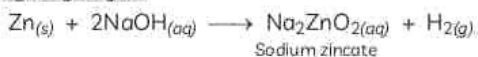


Zinc reacts with cold and dilute nitric acid and forms zinc nitrate, water and nitric oxide.

NaCl solution: No reaction will take place as sodium is more reactive than Zn.



NaOH solution: Zinc reacts with NaOH solution and forms sodium zincate and hydrogen gas.



Related Theory

In the case of the reaction of zinc granules with sulphuric acid or hydrochloric acid, a salt is formed.

72. (A) Design an activity to demonstrate the decomposition reaction of lead nitrate.
- (B) Draw labelled diagram of the experimental set-up. List two main observations.
- (C) Write balanced chemical equation for the reaction stating the physical state of the reactant and the products. [CBSE 2019]
73. (A) Hydrated ferrous sulphate crystals are heated in a boiling tube for a few seconds. Water droplets are seen in the inner sides of test tube and the colour of the crystals changes. On continuous heating, a colourless gas X with the smell of burning sulphur is evolved and a residue Y is obtained.
- (i) What is the colour of the crystals before and after mild heating?
- (ii) Identify gas X and the residue Y formed.
- (iii) Write a balanced chemical equation for the above reaction.
- (B) Write balanced chemical equations for the following reactions:
- (i) Barium chloride reacts with aluminium sulphate to give

of barium sulphate.

- (ii) Sodium metal reacts with water to give sodium hydroxide and hydrogen gas. [Diksha]

74. Identify the type of reaction taking place in each of the following cases and write the balanced chemical equation for the reactions.

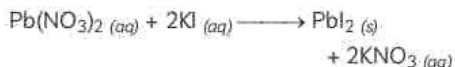
- (A) Zinc reacts with silver nitrate to produce zinc nitrate and silver.
- (B) Potassium iodide reacts with lead nitrate to produce potassium nitrate and lead iodide. [CBSE 2019]

Ans. (A) When zinc reacts with silver nitrate solution, it forms zinc nitrate and silver.



This is a displacement reaction which occurs because zinc is more reactive than silver due to which zinc displaces silver from silver nitrate solution to give zinc nitrate and silver.

- (B) When potassium iodide is added to lead nitrate solution, a yellow precipitate of lead iodide is formed alongwith potassium nitrate solution.



This is a double displacement reaction in which two compounds react by an exchange of ions to form two new compounds. This is also called precipitation reaction as an insoluble solid (precipitate) is formed.

75. (A) Classify the following reactions into different types:

- (i) $\text{AgNO}_{3(aq)} + \text{NaCl}_{(aq)} \longrightarrow \text{AgCl}_{(s)} + \text{NaNO}_{3(aq)}$
- (ii) $\text{CaO}_{(s)} + \text{H}_2\text{O}_{(l)} \longrightarrow \text{Ca}(\text{OH})_{2(aq)}$
- (iii) $2\text{KClO}_{3(s)} \longrightarrow 2\text{KCl}_{(aq)} + 3\text{O}_{2(g)}$
- (iv) $\text{Zn} + \text{CuSO}_4 \longrightarrow \text{ZnSO}_4 + \text{Cu}$

(B) Translate the following statement into a balanced chemical equation:

“Barium chloride reacts with aluminium sulphate to give aluminium chloride and barium sulphate.” [CBSE 2019]

76. (A) Arrange the following metals in the increasing order of their reactivities: Copper, Zinc, Aluminium and Iron

in your notebook

30 minutes after adding iron filings to copper sulphate solution. [CBSE 2019]

- Ans.** (A) Metals arranged in increasing order of reactivity: $\text{Cu} < \text{Fe} < \text{Zn} < \text{Al}$.
- (B) When iron filings are added to copper sulphate solution we will observe:
- (1) Colour of the solution changes from blue to green.
 - (2) Deposition of brown colour on iron filings.

77. Give characteristic tests for the following gases:

- (A) CO_2 (B) SO_2
(C) O_2 (D) H_2

[NCERT Exemplar]

78. What is observed after about 1 hour of adding the strips of copper and aluminium separately to ferrous sulphate solution filled in two beakers?

Name the reaction if any change in colour is noticed. Also, write chemical equation for the reaction. [CBSE 2019]

Ans. When strip of copper is added to ferrous sulphate solution taken in a beaker, no change is observed.

On adding a strip of aluminium to ferrous sulphate solution taken in another beaker, we observe that the greenish colour of ferrous sulphate solution starts fading and it becomes colourless after about an hour.

Reaction taking place is Displacement reaction.

Equation of the reaction taking place is:



79. A student wants to study a decomposition reaction by taking ferrous sulphate crystals. Write two precautions he must observe while performing the experiment. [CBSE 2019]

80. 2 g of silver chloride is taken in a china dish and the china dish is placed in sunlight for sometime. What will be your observation in this case? Write the chemical reaction involved in the form of a balanced chemical equation. Identify the type of chemical reaction. [CBSE 2019]

Ans. When 2 g of silver chloride is taken in a china dish and the china dish is placed in sunlight for sometime, we will observe that silver chloride turns grey.

chloride into silver and chlorine by sunlight.

The balanced chemical reaction involved is:



Type of chemical reaction taking place here is decomposition reaction.



Related Theory

- Decomposition reactions are those reactions in which a compound splits up into two or more simpler substances.
- A decomposition reaction is the opposite of a combination reaction.
- Decomposition reactions may be carried out by heat, electricity or light and are known as thermal decomposition, electrochemical decomposition and photochemical decomposition reaction respectively.

81. You are provided with two containers made up of copper and aluminium. You are also provided with solutions of dilute HCl, dilute HNO_3 , ZnCl_2 and H_2O . In which of the containers can these solutions be kept?

[NCERT Exemplar]

82. A student mixes sodium sulphate powder in barium chloride powder.

What change would the student observe on mixing the two powders?

Justify your answer and explain how he can obtain the desired change. [CBSE 2019]

Ans. No reaction takes place when sodium sulphate and barium chloride powders are mixed as no ions are formed in their solid state.

He can get the desired change by taking aqueous solutions of both the reactants as ionic compounds dissociate into ions only in presence of water and then exchange of ions takes place.

The equation for the chemical reaction taking place is:



83. While Abhi was about to burn magnesium ribbon in the chemistry laboratory, the teacher asked him to clean the ribbon with a sandpaper before burning it.

What could be the reason for the above instruction by the teacher? After burning the magnesium ribbon, Abhi obtained a white coloured residue. Name this residue. What type of chemical reaction has occurred? Write a balanced chemical equation to explain the reaction. [Diksha]

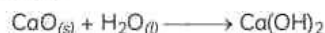
for the following:

- (A) Silver chloride is decomposed in presence of sunlight to give silver and chlorine gas.
- (B) Calcium oxide reacts with water to give lime water.
- (C) Sodium hydroxide reacts with hydrochloric acid to give sodium chloride and water.
- (D) Dilute hydrochloric acid is added to copper oxide to give green coloured copper chloride and water.
- (E) Solution of barium chloride and sodium sulphate in water reacts to give insoluble barium sulphate and solution of sodium chloride.

Ans. (A) Silver chloride is decomposed in presence of sunlight to give silver and chlorine gas.



(B) Calcium oxide reacts with water to give lime water.



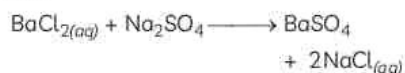
(C) Sodium hydroxide reacts with hydrochloric acid to give sodium chloride and water.




(D) Dil. hydrochloric acid is added to copper oxide to give green coloured copper chloride and water.



(E) Solution of barium chloride and sodium sulphate in water reacts to give insoluble barium sulphate and solution of sodium chloride.



85.  Answer the following:

- (A) Define oxidizing agent.
- (B) Translate the following statements into chemical equations and balance them.
 - (i) Hydrogen gas combines with nitrogen to form ammonia.

give water and sulphur dioxide.

- (iii) Potassium metal reacts with water to give potassium hydroxide and Hydrogen gas.

86. (A) Samarth brought an iron pipe but forgot to use it. After 2 months he observed that the surface of the pipe was covered with red coloured flaky substance and even red coloured powder was collected where the pipe was kept. His friend Sumit asked him to rub that pipe with sandpaper and then to colour it.

Why was the metal pipe changed to red in colour? Why did Sumit advise Samarth to colour that pipe?


(B) Rupali bought silver jewellery and she used it regularly. After some days, jewellery lost its shine and became black in colour. Her friend Swapna advised her to clean it with toothpaste.

Why does silver jewellery turn black after use? How does toothpaste clean the silver jewellery?

Ans. (A) Iron pipe reacts with oxygen in presence of moisture in the air to form a red coloured layer of rust. This process is called corrosion (rusting).

By colouring the iron pipe, the contact between the iron and oxygen can be prevented. Hence, to avoid further corrosion of the iron pipe, Sumit advised Samarth to color the pipe.

(B) Silver jewellery turns black due to formation of black coating of silver sulphide on jewellery. Toothpaste reacts with a layer of silver sulphide and removes it.

87.  Define chemical reaction. State four observations which helps to determine whether a chemical reaction has taken place or not. Write one example of each observation with a balanced chemical equation. [CBSE 2015]



SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

1. What would you observe on adding zinc granules to freshly prepared ferrous sulphate solution? Give reason for your answer.

Ans.

$$\text{FeSO}_4(aq) + \text{Zn}(s) \xrightarrow{\text{displacement}} \text{ZnSO}_4(aq) + \text{Fe}(s)$$

Ferrous sulphate
Zinc Granules
Zinc sulphate
Ferrous metal

The green colour of the solution changes to greyish - white on there is a displacement ~~the~~ reaction occurring. Zinc being more reactive than iron displaces it from its salt solution.

∴ Fe powder can be observed

[CBSE Topper 2019]

2. You might have noted that when copper powder is heated in a china dish, the reddish brown surface of copper powder becomes coated with a black substance.
- (A) Why has this black substance formed?
 (B) What is this black substance?
 (C) Write the chemical equation of the reaction that takes place.
 (D) How can the black coating on the surface be turned reddish brown?

Ans.

a) This black substance has been formed due to the oxidation of copper powder.

b) This black substance is copper oxide (CuO).

c)

$$2\text{Cu}(s) + \text{O}_2(g) \xrightarrow{\text{Heat}} 2\text{CuO}(s)$$

Copper (reddish brown)
(from air)
Copper oxide (black)

d) This black coating can be removed by heating the black compound with hydrogen.

$$\text{CuO}(s) + \text{H}_2(g) \xrightarrow{\quad} \text{Cu}(s) + \text{H}_2\text{O}(l)$$

Copper oxide (black)
Hydrogen
Copper metal (shiny brown)
water

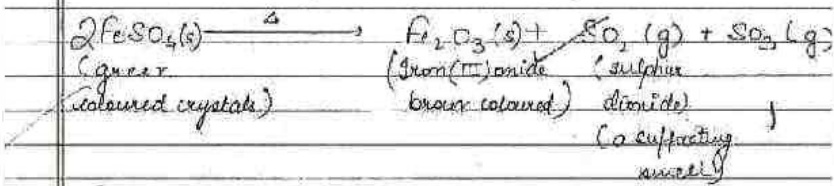
[CBSE Topper 2019]

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

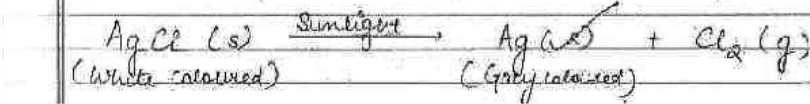
3. Decomposition reactions require energy either in the form of heat or light or electricity for breaking down the reactants. Write one equation each for decomposition reactions where energy is supplied in the form of heat, light and electricity.

(i) Thermal decomposition reaction

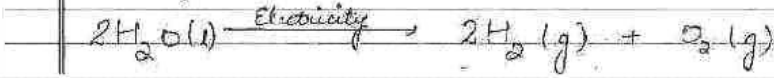


=> Green coloured crystals change to brown coloured Fe_2O_3 along with gases like SO_2 & SO_3 .

(ii) Photo decomposition reaction



(iii) Electrolytic decomposition reaction



[CBSE Topper 2018]

