

4

Chemical Reaction

In this chapter we will be learning

- 4.1 Identify reactants and products
- 4.2 Count atoms and molecules in Chemical Reactions
- 4.3 Calculate amounts of reactants or products in chemical reactions
- 4.4 Describe energy changes in chemical reactions
- 4.5 Compare Physical and Chemical Changes
- 4.6 Explore chemical structure and properties : Soap making
- 4.7 Explore Chemical Structure and properties : food flavours



Being ignored causes the same chemical reaction in the brain as experiencing a physical injury!!!

WOW!!!!!!

4.1

Identify reactants and products

Reactants and Products in chemical Reaction

Chemical reaction is the reaction in which two or more substances combine to form new substances. During the reaction, the atoms of the original substances are arranged to form other substances.

E.g., Iron and Oxygen combines to make rust.

Reactant	Products
• Start with	• End with
• Go through a chemical change	• Produced by the reaction

e.g., Let us try to bake a cake, the cake is your product because that's what you have to produce or to make. Though we need certain things which are considered as reactants. Those things would be eggs, milk, flour, sugar etc.

The original substances in a chemical reaction are called **reactants**. These substances react, chemical change. The new substances that are formed in a chemical reaction are called **products**. These substances are produced by chemical reaction.

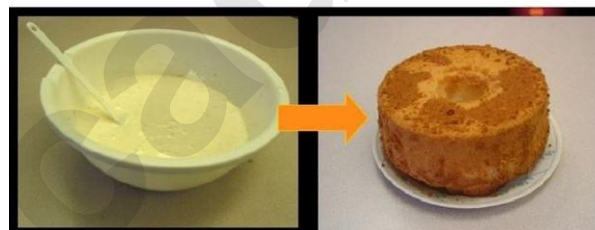
So, in a chemical reaction, reactants go through a chemical change to form products. E.g., Ozone forms when oxygen in the air combines with carbon monoxide and other chemical in polluted air.

Counting atoms and molecules in chemical reaction

To count atoms and molecules in a chemical reaction. The first thing we need to make sure that we are aware of law of conservation of matter.

It states that matter can neither be created nor be destroyed.

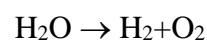
Masses should be equal before and after baking.



e.g., If we make a cake by putting like egg flour, sugar etc. Put all these into a bowl and then stuff in bowl pan. After you bake it, you will see it. baked up with same amount of mass and same weight.

Balancing of a chemical reaction

For a chemical reaction to take place, it is important that number of atoms on the reactant's side must be equal to number of atoms on the product's side. For example



In above reaction, number of oxygen atoms on reactant's side is 1 and number of oxygen atoms on product's side are 2. So, this chemical reaction doesn't take place.

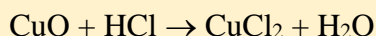
Identify reactants and products

4.1

There are various steps to count the atoms and balance a chemical reaction.

- 1) Write the chemical equation using the chemical formula.
- 2) List all the atoms and count the number of atoms in each element.
- 3) Multiply number of atoms of each by the coefficient.

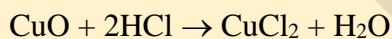
Example:



Atoms	Number of atoms in Reactants	Number of atoms in Products
Cu	1	1
O	1	1
H	1 × 2	2
Cl	1 × 2	2

The number of H and Cl atoms in reactants and products are unequal. For equating, we will multiply these by desired number. We multiply H and Cl atom in reactant by 2.

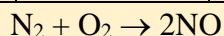
So, balanced equation will be



Example:

1 molecule of Nitrogen (N_2) reacts with 1 molecule of oxygen (O_2) to produce some amount of nitric oxide (NO).

Chemical element	Number of atoms in Reactants	Number of atoms in Products
N	2	2
O	2	2



Nitrogen oxygen Nitric oxide

During this reaction, two molecules of nitric oxide (NO) are produced.

Calculate amounts of Reactants or Products in Chemical Reactions.

During a chemical reaction, atoms in reactants are rearranged to form products. So, the products of a reaction are composed of the same number and type of atoms that were in the reactant.

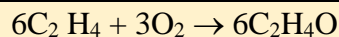
Example:

Acetaldehyde is a substance commonly used in chemical factories. It is often produced by combining ethylene gas and oxygen gas.

Consider the following reaction:

6 molecules of ethylene (C_2H_4) react with 3 molecules of oxygen (O_2) to produce some amount of acetaldehyde ($\text{C}_2\text{H}_4\text{O}$)

Chemical element	Number of atoms in the reaction
H	24
C	12
O	06



Ethylene oxygen acetaldehyde

During this reaction, 6 molecules of acetaldehyde $\text{C}_2\text{H}_4\text{O}$ are produced.

4.1

Identify reactants and products

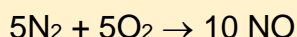
Example:

In the atmosphere, nitric oxide forms when a lightning strike causes nitrogen gas to react with oxygen gas.

Consider the following reaction:

5 molecules of Nitrogen (N_2) react with 5 molecules of oxygen (O_2) to produce some amount of nitric oxide (NO).

Chemical element	Number of atoms in the reaction
N	10
O	10



In total, 10 molecules of Nitric oxide are produced.

WORKSHEET 4.1

- Nitric oxide formed during lighting helps to provide nutrients to plants for their growth. The nitrogen and oxygen gas present in the atmosphere combine to form nitric oxide.
In this chemical reaction, nitric oxide is a _____
(a) Reactant (b) Product
- Gasoline is used to power car engines. In an engine, gasoline and oxygen combine to produce water vapor and carbon dioxide gas releasing energy to make the car move.
In the chemical reaction, gasoline is a _____
(a) Reactant (b) Product
- A common ingredient used in body washes and shampoos is sodium lauryl sulphate ($NaC_{12}H_{25}SO_4$) or SLS.
It produces foam or lather when used. It is prepared from lauryl alcohol ($C_{12}H_{26}O$) with sulphur trioxide (SO_3) and soda ash (Na_2CO_3). This results in the formation of sodium bicarbonate ($NaHCO_3$) and SLS.

Identify reactants and products

4.1

In the table mentioned below the reactants and the products in the chemical reaction which took place are: -

Reactants	Products

Select the correct option :

- a. Reactant: Soda ash (Na_2CO_3), Lauryl alcohol ($\text{C}_{12}\text{H}_{26}\text{O}$), Sulfur trioxide (SO_3)
Product: Sodium bicarbonate (NaHCO_3)
- b. Reactant: Sodium bicarbonate (NaHCO_3), Product: Soda ash (Na_2CO_3),
Lauryl alcohol ($\text{C}_{12}\text{H}_{26}\text{O}$), Sulphur trioxide (SO_3) _____
4. Banana flavoured candies are often flavoured with a substance called isoamyl ($\text{C}_7\text{H}_{14}\text{O}_2$). It is made by combining isopentane ($\text{C}_5\text{H}_{12}\text{O}$) with acetic acid ($\text{C}_2\text{H}_4\text{O}_2$). Also, water is formed in the process which is removed.
In the chemical reaction above mention the reactants.
Select the correct options.
(a) Isoamyl acetate ($\text{C}_7\text{H}_{14}\text{O}_2$) (b) Isopentane ($\text{C}_5\text{H}_{12}\text{O}$)
(c) Acetic acid ($\text{C}_2\text{H}_4\text{O}_2$) (d) Water (H_2O)
5. The satellites orbiting earth have small rockets on its sides. They are fuelled with hydrazine (N_2H_4). In this process, sodium hypochlorite (NaClO) and ammonia (NH_3) combine to form water (H_2O), Sodium chloride (NaCl) and hydrazine (N_2H_4).
In the chemical reaction above mention the reactants.
Select the correct options.
(a) Water (H_2O) (b) Sodium hypochlorite (NaClO) (c) Ammonia (NH_3)
(d) Sodium chloride (NaCl) (e) Hydrazine (N_2H_4)

Count atoms and molecules in Chemical Reactions

4.2

WORKSHEET 4.2

1. Consider the following chemical reaction:

1 molecule of carbon monoxide (CO) reacts with 1 molecule of chlorine (Cl_2) to produce some amount of phosgene (COCl_2). The table below shows the chemical element, and number of atoms in reactants. Calculate the number of atoms in products.

Chemical element	Number of atoms in reactants	Number of atoms in products
C	1	<input type="text"/>
O	1	<input type="text"/>
Cl	2	<input type="text"/>

Note: During a chemical reaction, atoms are not created, destroyed or changed from one chemical reaction to another.

2. In the chemical reaction mentioned in the above reaction, how many molecules of phosgene (COCl_2) are produced.

- (a) 3 (b) 2 (c) 1

3. Consider the following chemical reaction:

2 molecules of hydrogen (H_2) react with 1 molecule of oxygen (O_2) to produce some amount of water (H_2O). The table below shows the chemical element and number of atoms in reactants calculate the number of atoms in products.

Chemical element	Number of atoms in reactants	Number of atoms in products
H	4	<input type="text"/>
O	2	<input type="text"/>

4. In the chemical reaction mentioned in the above reaction, how many molecules of water (H_2O) are produced?

- (a) 1 (b) 2 (c) 3

5. Consider the following chemical reaction:

1 molecules of ethylene (C_2H_4) reacts with 1 molecule of water (H_2O) to produce some amount of ethanol ($\text{C}_2\text{H}_6\text{O}$). The table below shows the number of atoms in the reaction.

Chemical element	Number of atoms in reactants
H	6
C	2
O	1

How many molecules of ethanol ($\text{C}_2\text{H}_6\text{O}$) are produced?

- (a) 4 (b) 2 (c) 1

Calculate amounts of reactants or products in chemical reactions

4.3

WORKSHEET 4.3

1. Consider the following chemical reaction:

6 molecules of nitric oxide (NO) react with 3 molecules of oxygen (O_2) to produce some amount of nitrogen dioxide (NO_2). Complete the table below:

Chemical element	Number of atoms in the reaction
N	<input type="text"/>
O	<input type="text"/>

2. In the chemical reaction, mentioned in the above reaction, how many molecules of nitrogen dioxide are produced?

- (a) 8 (b) 6 (c) 4

3. Consider the following chemical reaction:

Some amount of hydrogen peroxide (H_2O_2) breakdown to produce 3 molecules of oxygen (O_2) and 6 molecules of water (H_2O)

Chemical element	Number of atoms in the reaction
H	<input type="text"/>
O	<input type="text"/>

4. In the chemical reaction, mentioned in the above reaction, how many molecules of hydrogen peroxide breakdown?

- (a) 4 (b) 5 (c) 6

5. Consider the following chemical reaction:

2 molecules of ethylene (C_2H_4) react with 2 molecules of water (H_2O) to produce some amount of ethanol (C_2H_6O).

Complete the table below:

Chemical element	Number of atoms in the reaction
H	<input type="text"/>
C	<input type="text"/>
O	<input type="text"/>

6. In the chemical reaction, mentioned in the above reaction, how many molecules of ethanol (C_2H_6O) are produced?

- (a) 3 (b) 2 (c) 1

Describe energy changes in chemical reactions

4.4

Chemical reactions often involve changes of energy due to the breaking and formation of bonds.

Thermal energy is a heat energy that is responsible for the temperature of a system for e.g., boiling water on a stove, the heat from a heater, baking in an oven etc. When hot and cold bodies are in thermal contact, they exchange heat energy until they reach equilibrium.

Exothermic reactions are those which release heat and light into their surroundings. For e.g., combustion reaction is usually exothermic. In exothermic reactions, the products have less enthalpy than the reactants, as a result, an exothermic reaction is said to have a negative enthalpy of reaction.

(a) When water freezes into ice cubes, the energy is released in the form of heat.

(b) We use hot packs in winters when we are in pain.

Endothermic Reactions are the reactions that absorb energy in the form of heat. These are the reactions in which heat is absorbed from the surrounding i.e. in endothermic reactions the temperature of surrounding decreases.

- (a) Melting of ice cubes absorb heat.
- (b) Evaporating water.
- (c) Cooking an egg absorbs heat.

WORKSHEET 4.4

1. A hand warmer contains powdered iron (Fe), salt and water. It is used by people on cold days to stay warm. The oxygen gas in the presence of salt and water quickly reacts with iron powder to form ferric oxide (Fe_2O_3). The reaction is accompanied with the release of a huge amount of thermal energy. Complete the statement. During the chemical reaction, the air around the reaction becomes _____.
(a) Warmer (b) Cooler

4.4

Describe energy changes in chemical reactions

2. In _____ the reaction above a huge amount of energy is released so the reaction will be _____.
- (a) Exothermic (b) Endothermic
3. Sal ammoniac a mineral made up of ammonium chloride (NH_4Cl) is found near the opening of active volcanoes. It rainwater falls on the mineral it quickly dissolves to form ammonium ions (NH_4^+) and chloride ions (Cl^-). The process of forming ions absorbs thermal energy from the surroundings and converts it to chemical energy. Complete the statement during the chemical reaction the solution becomes _____.
- (a) Warmer (b) Colder
4. In the reaction above a large amount of thermal energy is absorbed from the surroundings, so the reaction will be _____.
- (a) Exothermic (b) Endothermic
5. Thermite welding process is used to connect pieces of track. Thermite is a mixture of aluminium metal (Al) and ferric oxide (Fe_2O_3). The thermite is burnt between two pieces of track to form aluminium oxide (Al_2O_3) and iron (Fe). During the chemical energy a large amount of thermal energy is released. Complete the statement. During the chemical reaction, the air around the reaction becomes _____.
- (a) Warmer (b) Cooler
6. In the reaction, a huge amount of thermal energy is released so the reaction will be _____.
- (a) Exothermic (b) Endothermic

Physical and chemical changes

Physical change is a temporary change in which no new substance is formed. In physical changes, chemical composition remains same and physical properties like colour, state, shape etc might change.

- e.g.
- (a) Making a sugar solution
 - (b) Glowing of an electric Bulb
 - (c) Melting of ice cubes
 - (d) Boiling of water

Chemical change is a permanent change in which new substances are formed.

In chemical changes, both physical and chemical compositions are different from original substances.

- e.g.
- (a) Burning of coal
 - (b) Digestion of food
 - (c) Rusting
 - (d) Burning of paper

WORKSHEET 4.5

Select the correct options.

1. What do these two changes have in common.

Boiling water in a pan
Melting of butter

- (a) Both are only physical changes
- (b) Both are chemical changes
- (c) Both are caused by heating
- (d) Both are caused by cooling

2. What do these two changes have in common.

Deep frying of chicken
Baking a cake

- (a) Both are only physical changes
- (b) Both are chemical changes
- (c) Both are caused by heating
- (d) Both are caused by cooling

3. What do these two changes have in common.

Burning a match stick
Cellular respiration

- (a) Both are only physical changes
- (b) Both are chemical changes
- (c) Both are caused by heating
- (d) Both are caused by cooling

4. What do these two changes have in common.

Your breath condensing on a window pane on a cold day
Water evaporating from a lake

- (a) Both are only physical changes
- (b) Both are chemical changes
- (c) Both are caused by heating
- (d) Both are caused by cooling

5. What do these two changes have in common.

Melting of ice
Boiling water in a pan

- (a) Both are changes of state
- (b) Both are chemical changes
- (c) Both are caused by heating
- (d) Both are caused by cooling

Process of Saponification in Soap making

The process of preparing soap is called saponification. When an acid and base react with one another, it gets neutralized into salt or soap. This process is called saponification. In saponification, sodium hydroxide (NaOH) reacts with oil to form glycerol and soap. Saponification is a chemical reaction.

Chemical structure of soap

The chemical formula of soap is



Soap is basic in nature. It turns red litmus blue. Soap are sodium or potassium fatty acids salts, produced from the hydrolysis of fats in chemical reaction.

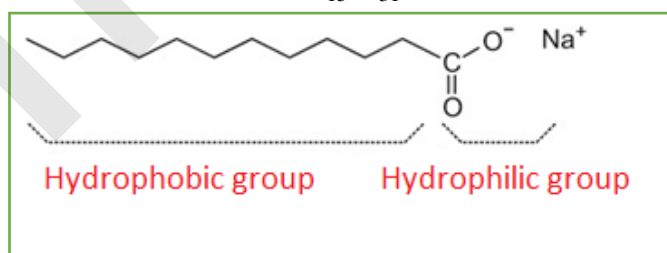
Each soap molecule has a long hydrocarbon chain, sometimes called its tail, with carboxylate 'head'.

In water the, sodium or potassium ions float free, leaving a negatively charged head.



Example of Soap

1. Sodium Stearate $C_{17}H_{35}COO^- Na^+$
2. Sodium Palmitate $C_{15}H_{31}COO^- Na^+$



Soap molecular structure

Chemical Properties of a substance

1. **Melting point** is the temperature at which solid changes to liquid. Higher the melting point of a substance stronger the bond is.
2. **Density** is characteristic property and is defined as the amount of mass in a given volume.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$
3. **Solubility** depends upon how much a substance is dissolved in given liquid at a particular temperature
4. **Emulsification** is a process in which two or more non-miscible liquids mix together by adding an emulsifier to it, like oil and water.

4.6

Explore chemical structure and properties : Soap making

WORKSHEET 4.6

1. A substance's properties do not depend on its chemical structure.
(a) True (b) False
2. The formation of soap during the process of saponification is a _____ change.
(a) Physical (b) Chemical
3. During the process of saponification, oil and sodium hydroxide are used to produce glycerol and soap, the sodium hydroxide is a reactant.
(a) True (b) False
4. A substance's melting point is higher when the attractions between its molecules are _____.
(a) Weaker (b) Stronger
5. The coconut oil used for making soap is _____ in water.
As a result, it _____ in water.
(a) Soluble, dissolves (b) Insoluble, does not dissolve
6. The coconut oil which is a liquid used for making soap after reacting with sodium hydroxide at $82^{\circ}F$ changes into a _____ (solid/gas). As a result, the melting point of coconut oil soap is _____ (higher/lower). Thus, the attractions between molecules of coconut oil soap are _____ (stronger/weaker) than attractions between molecules of coconut oil.
7. Coconut oil soap _____ in water. So, coconut oil soap is _____ in water
(a) does not dissolve, insoluble (b) dissolves, soluble
8. Why do coconut oil and coconut oil soap have different characteristic properties? Select all the correct options:
(a) Both coconut oil and coconut oil soap have different chemical structures.
(b) Coconut oil soap was formed due to a chemical change in the coconut oil.
(c) The attractions between coconut oil are stronger than the coconut oil soap molecules.

A substance's chemical structure determines its flavour. A flavour is the perceptual impression of food or other substance determined by chemical senses of the gustatory and olfactory system.

Its chemical structure depends upon number and types of atoms in each of its molecules, as well as on how these atoms are arranged.

e.g., Methyl anthranilate is used as a grape flavour to syrups, candy and other sweets. It is found naturally in certain types of grapes and also made in chemical factory.

Food flavour have different odour and taste. These are either natural or artificial.

WORKSHEET 4.7

1. A substance's physical and chemical properties are determined by its _____ structure.
(a) physical (b) chemical
2. The flavour of a substance is a property which combines both its odour and taste combined.
(a) True (b) False
3. Flavours are added to food to change or increase their flavour.
(a) True (b) False
4. Flavours are found in
(a) Only nature (b) In a chemical factory (c) Both in nature and a chemical factory

Answer key

WORKSHEET 4.1

1. b
2. a
3. a
4. b and c
5. b and c

WORKSHEET 4.2

1. C – 1, O – 1, Cl - 2
2. c
3. H – 4, O - 2
4. b
5. c

WORKSHEET 4.3

1. N – 6, O - 6
2. b
3. H – 12, O – 12
4. c
5. H – 12, C – 4, O – 2
6. b

WORKSHEET 4.4

1. a
2. a
3. b
4. b
5. a
6. a

WORKSHEET 4.5

1. a and c
2. b and c
3. b
4. a
5. a and c

WORKSHEET 4.6

1. b
2. b
3. a
4. b
5. b
6. (a) Solid (b) Higher (c) Stronger
7. b
8. a and b

WORKSHEET 4.7

1. b
2. a
3. a
4. c