UNIT -THREE

CLASSIFICATION OF COMPOUNDS

3.1 Introduction

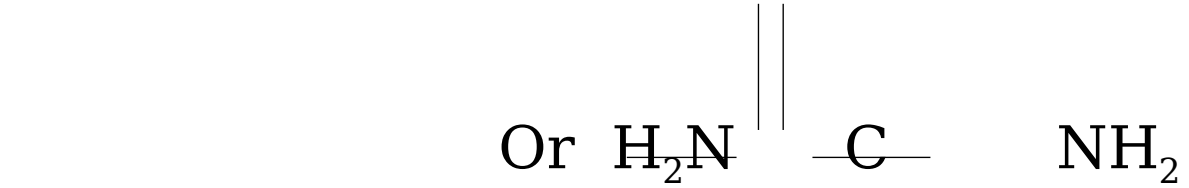
- ***Objective*: Explain the classification of compounds into organic and inorganic:**
- Define organic compounds as carbon containing compounds and give examples;
- Define inorganic compounds as compounds of elements other than carbon.

- During the latter part of the eighteenth century and the early part of the nineteenth century, chemists began to categorize compounds into two types:
- Organic and inorganic compounds obtained from living organisms were called organic compounds, and compounds obtained from mineral constituents of the earth were called inorganic compounds.
- During this early period, chemists believed that a special “vital force” supplied by a living organism was necessary for the formation of an organic compound.
- This concept was disproved in 1828 by the German chemist Friedrich Wohler.
- Wohler prepared urea, an organic compound, from the reaction between solutions of inorganic compounds **ammonium chloride** and **silver cyanate**.
- $NH_4Cl\ (aq) + AgCNO\ (aq) \rightarrow NH_4CNO\ (aq) + AgCl\ (s)$

Ammonium chloride Silver cyanate Ammonium cyanate Silver chloride

Soon other chemists had successfully synthesized organic compounds from inorganic starting materials. As a result, the vital-force theory was completely abandoned.

- $NH_4CNO\ (aq) \xrightarrow{Heat} (NH_2)_2CO\ (s)$ Urea



Or $H_2N-\overset{\overset{O}{\|}}{C}-NH_2$

- The terms organic and inorganic continue to be used in classifying compounds, but the definitions of these terms no longer reflect their historical origins.
- All organic compounds contain carbon and hydrogen, along with other possible elements such as **oxygen, nitrogen**, **Sulphur**, **halogens** and **phosphorus** except the oxides of carbon, carbonates, hydrogen carbonates, cyanides and cyanates.
- Inorganic compounds are the compounds consisting of mineral constituents of the earth or generally found in non-living things.
- The term inorganic compound refers to all compounds that do not contain carbon.
- Although, carbon dioxide, carbon monoxide, carbonates and hydrogen carbonates are carbon-containing compounds, which are classified as inorganic compounds.

Exercise 3.1

Classify each of the following compounds as organic or inorganic.

a. $C_{12}H_{22}O_{11}$

b. NaCl

c. CaO

d. C_2H_5OH

e. CH_3Cl

f. C_2H_4

Answers to Exercise 3.1

a. Organic

b. Inorganic

c. Inorganic

d. Organic

e. Organic

f. Organic

3. 2 Organic Compounds

- ***Objective:*** **Define hydrocarbons and mention source of hydrocarbons;**
- **Write the general formula of alkanes, alkenes and alkynes;**
- **Write the specific chemical formulas of the first ten members of alkanes, alkenes and alkynes;**
- **Describe a homologous series and its general characteristics;**
- **Name the first eight members of alkanes, alkenes and alkynes;**
- **Identify some common uses of organic compounds.**

Hydrocarbons

Activity 3.2

1. What is hydrocarbon?

- Hydrocarbons are compounds of carbon and hydrogen. Therefore, they are classified as organic compounds.

2. List the sources of hydrocarbons and indicate their location in Ethiopia.

Hydrocarbons

- A hydrocarbon is a compound that contains only carbon atoms and hydrogen atoms.
- Hydrocarbons divided into three large classes: **alkanes**, **alkenes** **and** **alkynes.**

Alkanes

- Alkanes are hydrocarbons that have the general formula C_nH_{2n+2}
- where, n is the number of carbon atoms present, n = 1, 2, 3…..
- For example, the molecular formulas of the first four alkanes are:
- $C_1H_{2\times1+2} = CH_4$,
- $C_2H_{2\times2+2} = C_2H_6$,
- $C_3H_{2\times3+2} = C_3H_8$, and
- $C_4H_{2\times4+2} = C_4H_{10}$, respectively.
- When we compare the formulas of CH_4 and C_2H_6 or C_2H_6 and C_3H_8,
- They differ by one carbon and two hydrogen atoms or – CH_2 – group called the **methylene group**.
- A family of compounds in which each member differs from the next by one methylene (-CH_2-) groupies called **homologous series** (homo is Greek for “the same as).
- **The members of a homologous series are called homologues.**

Exercise 3.2

1. Write the formulas of alkanes that contain 5, 7 and 9 carbon atoms.

- The general formula of Alkanes is C_nH_{2n+2}
- $C_5H_{2\times5+2} = C_5H_{12}$
- $C_7H_{2\times7+2} = C_7H_{16}$
- $C_9H_{2\times9+2} = C_9H_{20}$

Alkenes

- Alkenes are hydrocarbons that have the general formula C_nH_{2n}.
- Where, n is the number of carbon atoms present, n = 2, 3…..
- For example, the molecular formulas of the first three alkenes are:
- $C_2H_{2\times2} = C_2H_4$,
- $C_3H_{2\times3} = C_3H_6$, and

Exercise 3.3

1. Write the formulas of the alkenes that contain 6, 8 and 10 carbon atoms.

- The general formula of Alkenes is C_nH_{2n}.
- $C_6H_{2\times6} = C_6H_{12}$
- $C_8H_{2\times8} = C_8H_{16}$
- $C_{10}H_{2\times10} = C_{10}H_{20}$

Alkynes

- Alkynes are hydrocarbons that have the general formula C_nH_{2n-2}.
- Where n = 2, 3, 4, etc.
- For example, the formulas of the first three alkynes are:
- $C_2H_{2\times2-2} = C_2H_2$,
- $C_3H_{2\times3-2} = C_3H_4$, and
- $C_4H_{2\times4-2} = C_4H_6$, respectively.

Exercise 3.4

1. Write the formulas of the alkynes that contain five-eight carbon atoms.

- The general formula of Alkynes is C_nH_{2n-2}.
- $C_5H_{2\times5-2} = C_5H_8$ $C_7H_{2\times7-2} = C_7H_{12}$
- $C_6H_{2\times6-2} = C_6H_{10}$ $C_8H_{2\times8-2} = C_8H_{14}$

Additional Questions

*1. Classify each of the following compounds as alkane, alkene or alkyne.

a. C_9H_{20} c. $C_{12}H_{26}$

b. $C_{10}H_{20}$ d. $C_{10}H_{18}$

Answers to Additional Questions

a. alkane b. alkene c. alkane d. Alkyne

*a. An alkane containing **twenty two hydrogen** atoms.

a. $C_{10}H_{22}$

*b. An alkene containing **twenty six hydrogen** atoms.

b. $C_{13}H_{26}$

*c. An alkyne containing **twenty four hydrogen** atoms.

c. $C_{13}H_{24}$

d. An alkane containing **six carbon** atoms.

d. C_6H_{14}

Nomenclature (Naming) of Hydrocarbons

Activity 3.3

1. How do we give specific name to a hydrocarbon?

✓We give specific name to a hydrocarbon using a **prefix** that indicates the number of carbon atoms it contains and a **suffix** to show the group it belongs to or functional groups of molecules.

2. Are hydrocarbons named based on certain rules or randomly?

✓The names of hydrocarbons are given systematically. This means that we have to follow certain rules developed by chemists.

- The name of hydrocarbons is derived from the number of carbon atoms present (prefix) and the ending it contains (suffix).
- The names of **alkanes**,**alkenes and alkynes** end with the suffixes '-ane', '-ene' and '-yne', respectively.

i. a prefix- indicating the number of carbon atoms.

ii. a suffix indicating the type of the functional group present in the molecule or the type of hydrocarbon.

Table 3.1 Prefixes commonly used to indicate one to ten carbon atoms.

Number of carbon atoms	Prefix	Number of Carbon atoms	Prefix
1	Meth-	6	Hex-
2	Eth-	7	Hept-
3	Prop-	8	Oct-
4	But-	9	Non-
5	Pent-	10	Dec-

Table 3.2. a suffix indicating the type of the functional group present in the molecule or the type of hydrocarbon.

Type of hydrocarbon	suffix	Example
Alkane	**-ane**	Eth**ane**
Alkene	**-ene**	Eth**ene**
Alkyne	**-yne**	Eth**yne**

Example 1: Write the names of **alkanes**; CH_4 and C_3H_8.

***Solution*:**

✓**CH_4** contains one carbon atom.

✓So, we use the prefix '**meth-**' and adding the suffix '**-ane**' i.e. **meth + ane**.

✓Thus the name of **CH_4** becomes **methane.**

✓**C_3H_8** contains three carbon atoms.

✓So, we use the prefix '**prop-** 'and adding the suffix '**-ane**' i.e. **prop + ane**.

✓Thus the name of **C_3H_8** becomes **propane.**

Example 2: Write the names of alkenes; C_2H_4 and C_4H.

***Solution*:**

✓**C_2H_4** contains two carbon atoms.

✓So, we use the prefix '**eth-**' and adding the suffix '**-ene**' i.e. **eth + ene**.

✓Thus the name of **C_2H_4** becomes ethene.

✓**C_4H_8** contains four carbon atoms.

✓So, we use the prefix '**but-**' and adding the suffix '**-ene**' i.e**. but + ene**.

✓Thus the name of **C_4H_8** becomes **butene**.

Example 3: Write the names of alkynes; C_3H_4 and C_4H_6.

Solution:

- ✓ **C_3H_4** contains three carbon atoms.
- ✓ So, we use the prefix '**prop-** 'and adding the suffix '**-yne**' i.e. **prop + yne**.
- ✓ Thus the name of **C_3H_4** becomes **propyne**.
- ✓ **C_4H_8** contains four carbon atoms.
- ✓ So, we use the prefix '**but-**' and adding the suffix '**-yne**' i.e. **but + yne**.
- ✓ Thus the name of **C_4H_6** becomes **butyne.**

Exercise 3.5

1. Write the formulas and names of:

- alkanes,
- alkenes and
- alkynes containing **five** to **ten** carbon atoms.

Answers to Exercise 3.5

Number of carbon atoms	Formula of alkane	**Name of alkane**	Formula of alkene	**Name of alkene**	Formula of alkyne	**Name of alkyne**
5	C_5H_{12}	**Pentane**	C_5H_{10}	**Pentene**	C_5H_8	**Pentyne**
6	C_6H_{14}	**Hexane**	C_6H_{12}	**Hexene**	C_6H_{10}	**Hexyne**
7	C_7H_{16}	**Heptane**	C_7H_{14}	**Heptene**	C_7H_{12}	**Heptyne**
8	C_8H_{18}	**Octane**	C_8H_{16}	**Octene**	C_8H_{14}	**Octyne**
9	C_9H_{20}	**Nonane**	C_9H_{18}	**Nonene**	C_9H_{16}	**Nonyne**
10	$C_{10}H_{22}$	**Decane**	$C_{10}H_{20}$	**Decene**	$C_{10}H_{18}$	**Decyne**

Uses of Common Organic Compounds

- Many organic compounds are very useful in our daily life.
- Some important organic compounds and their uses are described in the following section.

Methane, CH_4

- Methane is used primarily as **fuel** for cooking, heating and generating electricity.
- Methane is the main constituents of **biogas** that is used as a **domestic fuel**.

Propane (C_3H_8) and Butane (C_4H_{10})

- The mixture of propane and butane is compressed at a moderate pressure and stored in steel cylinders.
- It is marked as bottled gas and commonly known as “butagas”.
- It is mainly used for cooking and heating.

Ethyne (C_2H_2)

- One of the main uses of ethyne is to produce oxyacetylene flame, which is used in the cutting and welding of steel and iron.



Figure 3.1 Oxyacetylene torch

Ethanol (Ethyl alcohol, C_2H_5OH)

- Ethanol is used in the intoxication ingredient of many alcoholic beverages such as **beer, wine, tella, ouzo, teji,** etc.
- Nowadays ethanol mixed with petrol is used as a fuel.
- It is also used in the production of acetic acid, and in hospitals and clinics for cleaning wounds.

Activity 3.4

- Why we add '**acheto**' or '**vinegar**' when we eat uncooked vegetables such as salad?

➢ We add vinegar to the salad for flavoring and disinfectant purposes.

Ethanoic Acid (Acetic acid,CH_3COOH)

- Table vinegar contains 4% to 8% acetic acid.
- Vinegar is used as food flavoring agent.
- It is also used as a disinfectant.
- For use in ickling) it typically ranges up to 18%



Figure 3.2Adding vinegar

Formalin (CH_2O)

- When formaldehyde is dissolved in water it is called formalin.
- Formalin contains 40%, by volume, of formaldehyde.
- Formalin is used for the preservation of biological specimens, because it makes proteins hard and insoluble.

Exercise 3.6

1. Classify each of the following hydrocarbons as **alkane**, **alkene** or **alkyne.**

a. C_5H_{10}

b. $C_{10}H_{22}$

c. C_8H_{14}

d. C_8H_{18}

e. $C_{10}H_{18}$

f. C_9H_{18}

Solution:

a. **Alkene**

b. Alkane

c. alkyne

d. Alkane

e. Alkyne

f. Alkene

3.3 Inorganic Compounds

- ***Objectives:*** **state that inorganic compounds are classified into oxides, acids, base and salts;**
- **classify oxides into metallic and nonmetallic;**
- **describe the properties of acidic oxides and basic oxides;**
- **predict the nature of common oxides;**
- **relate acidic properties to the presence of hydrogen ions and basic properties to the presence of hydroxide ions.**
- **name and write formulas for some common acids (HCl, HNO_3, H_2SO_4) and bases (NaOH, KOH, NH_4OH), using the periodic table, a list of ions, and rules for naming acids;**
- **describe how indicators can be used to classify solutions as acidic or basic;**

- Inorganic compounds can be classified into four groups according to their **composition** and their **properties.**
  - These include:

I. oxides,

II. acids,

III. bases and

IV. salts.

Oxides

- **Oxides** are **binary** compounds containing **oxygen** and **any other element**.
- Element + Oxygen → Oxide
- Some common examples of oxides are water (hydrogen oxide, H_2O), carbon dioxide (CO_2), lime (calcium oxide, CaO), rust (iron (III) oxide), etc.

Exercise 3.7

- Give the appropriate answers for the following questions.

1. Define oxides.

- Oxides are binary compounds containing oxygen with any other element.
- For example, SO_3, BaO, etc. are oxides.

2. Which of the following compounds are oxides?

a. $CaCO_3$

b. KOH

c. H_2O

d. rust

e. H_2CO_3

f. CaO

g. SO_3

h. CO_2

Answer

a. It is a salt.

b. It is base.

c. It is oxide.

d. It is oxide.

e. It is an acid.

f. It is oxide.

g. It is oxide.

h. It is oxide.

Types of Oxides

- Most oxides are classified as **metallic oxides** and **non-metallic oxides**.

i. **Metallic oxides** are binary compounds containing only **metals** and **oxygen**.

- Metal + Oxygen → Metallic Oxide
- Examples: CaO, Na_2O, Al_2O_3, MgO, etc.

ii. **Non-Metallic Oxides** are binary compounds containing only **non-metals** and **oxygen.**

- Non-metal + Oxygen → Non-metallic Oxide
- NO_2, H_2O, CO_2, SO_2, SO_3, etc are common example of non-metallic oxides.
- **Oxides** are also classified as **acidic** and **basic oxides** depending on their properties or behaviours.
- **Acidic oxides** are oxides that react with water to form acids or acidic solutions.
- They are mostly non-metallic oxides.
- Some examples of acidic oxides are SO_2, P_4O_6, CO_2, etc.
- **Basic oxides** are oxides that react with water to form bases or basic solutions.
- They are mostly metallic oxides.
- Some examples of basic oxides are Na_2O, Li_2O, CaO, MgO, etc.

Exercise 3.8: Give appropriate answers for the following questions.

1. Predict whether or not the oxide formed from each of the following elements is a basic oxide and an acidic oxide.

a. Calcium
b. Carbon
c. Sodium
d. Magnesium
e. Sulphur
f. Phosphorus

2. Classify the following oxides as metallic or non-metallic oxides.

a. CO_2
b. MgO
c. SO_3
d. CaO
e. NO_2
f. K_2O

Answer

1a. basic oxide.
b. An acidic oxide.
c. Basic oxide.
d. basic oxide.
e. an acidic oxide.
f. An acidic oxide.
2a. non-metallic oxide.
b. metallic oxide.
c. non-metallic oxide.
d. metallic oxide.
e. non-metallic oxide.
f. metallic oxide.

Properties of Oxides

Properties of Acidic Oxides

I. An acidic oxide or acid anhydride dissolves in water, to form acidic solution or an acid.

i.e. Acidic oxide + Water → Acid

- ***Examples:*** $SO_3 + H_2O \rightarrow H_2SO_4$
- $CO_2 + H_2O \rightarrow H_2CO_3$

II. Acidic oxides react with bases to form salts and water.

i.e. Acidic oxide + Base → Salt + Water

- ***Examples:*** $SO_3 + Ca(OH)_2 \rightarrow CaSO_4 + H_2O$
- $CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$

III. Acidic oxides react with basic or metallic oxides to form salt.

i.e. Acidic oxide + Basic oxide → Salt

- ***Examples:*** $CO_2 + Na_2O \rightarrow Na_2CO_3$

Properties of Basic Oxides

I. A basic oxide or basic anhydride reacts with water to produce a base or alkali.

i.e. Basic oxide + Water → Base (alkali)

- Examples: $CaO + H_2O \rightarrow Ca(OH)_2$
- $K_2O + H_2O \rightarrow 2KOH$

II. Basic oxides react with acidic oxides to form salts.

i.e. Basic oxide + acidic oxide → salt

- Examples: $CaO + CO_2 \rightarrow CaCO_3$
- $Na_2O + SO_3 \rightarrow Na_2SO_4$

III. Basic oxides react with acids to form a salt and water.

i.e. Basic oxide + Acid → salt + water

- Examples: $CaO + 2HCl \rightarrow CaCl_2 + H_2O$

Exercise 3.9

1. What are the missing products ‘X’, ‘Y’ and ‘Z’ in the following equations?

a. $CO_2 + H_2O \rightarrow X$

b. $CaO + H_2O \rightarrow Y$

c. $CaO + CO_2 \rightarrow Z$

Answer

a. $X = H_2CO_3$

b. $Y = Ca(OH)_2$

c. $Z = CaCO_3$

Laboratory Preparation of Sulphur dioxide and Magnesium Oxide

- Sulphur dioxide and magnesium oxide can be prepared in the laboratory by using direct synthesis method.
- Direct synthesis involves the combination of oxygen with active metals and non-metals.
- Non-metal + Oxygen → Non-metallic oxide
- Example: $S + O_2 \rightarrow SO_2$
- Metal + Oxygen → Metallic oxide
- Example: $2Mg + O_2 \rightarrow 2MgO$

Exercise 3.10

1. Describe how you could prepare each of the following oxides.

a. MgO b. SO_2

- We can prepare Sulphur dioxide and magnesium oxide by direct combination of elements (Sulphur and magnesium) with oxygen.

Acids and Bases

Acids

- Acids are a group of substances that release hydrogen ions (H+) when they are in aqueous solution.
- **Acids have sour taste.**
- Examples:lemonjuice,vinegar,sourtella and milk are some acidic substances in our daily life.
- HCl, H_2SO_4 and HNO_3 are common laboratory acids.
- They are also called mineral acids.

Bases

- A base is an oxide or hydroxide of a metal which neutralizes acid to form salt and water.
- Bases which are soluble in water are called alkalis.
- An alkali is a substance that releases hydroxide ion (OH–) when dissolved in water.

Naming and Writing Formula of Acids and Bases

Activity 3.9

1.Write the formulas of hydrochloric acid, sulphuric acid and nitric acid.

- The formulas of: hydrochloric acid = HCl
- Sulphuric acid = H_2SO_4
- Nitric acid = HNO_3

2. Write the formulas of sodium hydroxide, calcium hydroxide, potassium hydroxide and ammonium hydroxide.

- The formulas of sodium hydroxide = $NaOH$
- Calcium hydroxide = $Ca(OH)_2$
- Potassium hydroxide = KOH
- Ammonium hydroxide = NH_4OH

- When naming an acid, we can consider the acid to consist of an anion combined with as many hydrogen ions are needed to make the molecule electrically neutral.
- Therefore, the chemical formulas of acids are in the general form H_nX.
- where X is a monoatomic or polyatomic anion and n is a subscript indicating the number of hydrogen ions that are combined with the anion.
- The rules that used to named an acid with the general formula H_nX.

1. When the name of the anion (X) ends in –ide, the acid name begins with the prefix hydro-.

- The stem of anion has the suffix –ic and is followed by the word acid.

2. When the anion name ends in –ite, the acid name is the stem of the anion with the suffix –ous, followed by the word acid.

3. When the anion name ends in –ate, the acid name is the stem of the anion with the suffix –ic followed by the word acid.

Table 3.2 Naming of common acids

Anion ending	Example	Acid name	Example
-ide	Chloride, Cl^-	Hydro-(stem)-ic acid	HCl (Hydrochloric acid)
-ite	Sulfite, SO_3^{2-}	(Stem)-ous acid	H_2SO_3 (Sulfurous acid)
-ate	Nitrate, NO_3^- Sulphate, SO_4^{2-}	(stem)-ic acid (stem)-ic acid	HNO_3 (Nitric acid) H_2SO_4 (Sulphuric acid)

- Bases are named in the same way as other ionic compounds: the name of the cation is followed by the name of the anion i.e. hydroxide.
- **Examples:**
- NaOH (sodium hydroxide)
- Ca(OH)2 (calcium hydroxide)
- NH_4OH (ammonium hydroxide)

Exercise 3.11

- Give the appropriate answers for the following questions.

1. Define the following terms and give some examples for each.

   a. Acid b. Base

a. An acid is a substance that releases hydrogen ions (H+) when dissolved in water.

- For example, HCl, H_2SO_4, HNO_3,

b. A base is a substance that releases hydroxide ions (OH-) when dissolved in water.

- For example, NaOH, KOH, $Ca(OH)_2$,

2. Which ion is a characteristic of all acids in water solution?

- Hydrogen ion (H+)

3. Copy and complete the following table in your exercise book.

Name	Formula	Name	Formula
Hydrochloric acid		Calcium hydroxide	
	HNO_3		KOH
Sulfuric acid			NaOH

3. The answer is as shown below.

Name	Formula	Name	Formula
Hydrochloric acid	**HCl**	Calcium hydroxide	**$Ca(OH)_2$**
Nitric acid	HNO_3	**Potassium hydroxide**	KOH
Sulfuric acid	**H_2SO_4**	**Sodium hydroxide**	NaOH

Acid – Base Indicators

- Acid-base indicators are dyes extracted from plants that show the presence of an acid or a base by undergoing specific color changes when placed in a solution.
- **Litmus, methyl orange and phenolphthalein are common indicators.**

Properties of acids and bases

Properties of Acids

- Acids generally have the following properties:

1. **Acids have a sour taste.**
2. **Acids change the color of indicators**.

3. Acids react with metals

- Dilute acids react with active metals like **zinc**, **magnesium**, **iron** and **aluminum** to form salts and liberate hydrogen gas.
- i.e:Active Metal + Dilute Acid →Salt + Hydrogen
- Example: $Ca + 2HCl \rightarrow CaCl_2 + H_2$
- $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

4. Acids react with Carbonates and Hydrogen Carbonates

- Acids react with carbonates and hydrogen carbonates to form **salts, water and carbon dioxide gas.**
- Acid + Carbonate → Salt + Water + Carbon dioxide
- Example: $2HCl\ (aq) + CaCO_3\ (s) \rightarrow CaCl_2\ (aq) + H_2O\ (l) + CO_2\ (g)$
- Acid + Hydrogen carbonate →Salt + Water + Carbon dioxide
- Example: $H_2SO_4\ (aq) + Ca(HCO_3)_2\ (aq) \rightarrow CaSO_4\ (aq) + 2H_2O\ (l) + 2CO_2\ (g)$

5. Acids neutralize bases.

- Acids react with bases to form salts and water.
- Acid + Base →Salt + Water.
- Examples: $2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$

Properties of Bases

1. Bases have bitter taste.

2. Effect on acid-base indicators

- Alkalis change the color of indicators.

3. Bases neutralize acids.

- **Example: $NaOH + HCl \rightarrow NaCl + H_2O$**

4. Bases react with acids to form salt and water.

- Base + Acid →Salt + Water
- Example: $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$

Exercise 3.12

Give the appropriate answers for the following questions.

1. Define acid-base indicator.

- Indicators are substances that show the presence of an acid or a base by

undergoing specific color changes when placed in a solution.

2. Write the color of each of the following indicators in acidic and basic solution.

a.

Indicator	Color in acidic solution	Color in basic solution
Litmus paper	Red	Blue
Phenolphthalein	Colorless	Pink
Methyl orange	red	Yellow

3. Complete and balance the following reactions:

a. $2HNO_3 + Na_2CO_3 \rightarrow$

- **$2HNO_3 + Na_2CO_3 \rightarrow 2NaNO_3 + H_2O + CO_2$**

b. $2NaOH + H_2SO_4 \rightarrow$

- **$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$**

c. $2HCl + Zn \rightarrow$

- **$2HCl + Zn \rightarrow ZnCl_2 + H_2$**

4. What measures should you take if:

a. a base enters your eyes?

- Washing the eye with plenty of water and then seek medical treatment.

b. you accidentally drink an acid?

- Drinking a base such as $Mg(OH)_2$ and then seek medical treatment.

3.4 Neutralization Reaction and Salts

- The reaction of acids with bases to form salt and water is called **neutralization reaction**.

Applications of Neutralization in Daily Life

Activity 3.11

1. What are the important uses of neutralization in daily life?

- The uses of neutralization in different categories such as **at home**, **in health** and **in agriculture**.

2. Why our hairs get rough after applying shampoo and again turn shiny after we add conditioner?

- This is because our shampoo is basic in nature and conditioner is acidic in nature and that is why it neutralizes the effect of the shampoo.

- In our everyday life we come across many situations which involve neutralization reactions.

- The following examples will illustrate common neutralization reactions that occur around us.

Neutralization at Home

- **Toothpaste** contains bases that neutralize the acid produced by bacteria in our mouth.
- Baking powder is usually used to help the cake rise.
- Conditioner is used with shampoo to prevent small scales on hair which make your hair unmanageable.

Neutralization in Health

- Antiacids contains bases such as aluminum hydroxide ($Al(OH)_3$ and magnesium hydroxide ($Mg(OH)_2$ to neutralize the excess acid in the stomach.
- Vinegar is acidic in nature which is used to cure wasp stings that are alkaline in nature.
- Baking powder is alkaline which is used to cure bee stings and ant bites that are acidic in nature.

Neutralization in Agriculture

- Acidic soil is treated with powdered lime, CaO, limestone, $CaCO_3$ or ashes of burnt wood.
- The acidic gas from the decomposition of compost neutralizes the alkalis in basic soil.

Salts

- What are salts?
- The term ‘salt’ does not refer only to the table salt which we use to make our food.
- Salts are group of chemicals that are obtained by the reactions of acids and bases.
- These reactions are called neutralization reactions.
- Salt is defined as a compound consisting of the positive ion of a base and the negative ion of an acid.
- The positive ion in the salt can be that of a metal ion or ammonium ion.
- Sodium chloride (NaCl), calcium carbonate ($CaCO_3$), potassium nitrate (KNO_3), sodium bicarbonate ($NaHCO_3$), diammonium phosphate ($(NH_4)_2HPO_4$) are examples of salts.

Naming and Writing Formula of Salts

Activity 3.12

Write names and formulas of some common salts.

Name of salt	Formula of salt
Sodium chloride	NaCl
Sodium bicarbonate	NaHCO3
Calcium carbonate	CaCO3

The group names of salts are related to the names of the acids from which they are derived.

Table 3.5 Names of some acids and group names of their salts

Name of the acid	Group name of salt	Example of salt
Carbonic acid, H_2CO_3		Calcium carbonate, $CaCO_3$
Hydrochloric acid, HCl	Chlorides, Cl^-	Sodium chloride, NaCl
Sulphuric acid, H_2SO_4		Calcium sulphate, $CaSO_4$
Nitric acid, HNO_3	Nitrates, NO_3^-	Sodium nitrate, $NaNO_3$

- The name of a salt is derived from the names of two parts.

- The first part comes from the base. i.e: positive ion (cation)
- The second part comes from the acid. i.e: negative ion (anion)
- We can always work out the name of the salt by looking at the reactants.
- Example:Sodium hydroxide (base) + Hydrochloric acid (acid) → Sodium chloride (salt) + Water
- The name of the salt sodium chloride is obtained by taking the word ‘sodium’ from the name of the base and ‘chloride’ from the name of the acid by dropping the word ‘hydro’ and changing the ending ‘-ic acid’ to ‘-ide’.
- Follow the following simple rules to write the formula of salts.

1. Break the name of the salt up into the name of the cation (positive ion) which is derived from base and the name of anion (negative ion) which is derived from acid.

2. Use the cation’s name to determine the formula for the cation and anion’s name determine the formula for anion.

3. Now criss cross the charges and put the numbers below the formulas.

- Example: a. Write the formula of Calcium carbonate.

1. Name of cation is calcium and name of anion is carbonate.

2. Formula or symbol of cation is Ca^{2+} and anion is CO_3^{2-}

3. Ca^{2+} Co_3^{2-} $= Ca_2 (CO_3)_2$, Simplify and write the simplest formula of the salt.

- Thus, the formula of calcium carbonate is **$CaCO_3$**

Exercise 3.13

Give the appropriate answers for the following questions.

1. What are the applications of neutralization in everyday life?

- at home, in health and in agriculture.

2. Write the formula of the following salts.

A. Sodium chloride = NaCl

B. Potassium nitrate = KNO3

C. Calcium carbonate = CaCO3

Answers to Exercise 3.13

1. The uses of neutralization in different categories such as at home, in health and in agriculture.

2. a. NaCl

b. KNO_3

c. $CaCO_3$

Uses of Some Salts

Activity 3.13

Name of the salt	Formula of the salt	Uses
Sodium chloride		
Sodium bicarbonate		
Potassium nitrate		

Answer to Activity 3.13

Name of the salt	Formula of the salt	Uses
Sodium chloride	NaCl	✓ to prepare food ✓ for the manufacturing of sodium, sodium hydroxide and chlorine ✓ to make sodium hydrogen
Sodium bicarbonate	$NaHCO_3$	✓ to make baking powder ✓ in fire extinguishers
Potassium nitrate	KNO_3	✓ as a fertilizer ✓ to make gun powder

Key Terms

- Organic compound
- Hydrocarbon
- Alkane
- Alkene
- Alkyne
- Inorganic compound
- Oxide
- Basic oxide
- Acidic oxide
- Metallic oxide
- Non-metallic oxide
- Acid
- Base
- Alkali
- Indicator
- Neutralization
- Salt

SUMMARY

- ✓Chemical compounds can be broadly divided into two groups called **organic** and **inorganic compounds.**
- ✓Organic compounds contain primarily carbon and hydrogen atoms, plus nitrogen, oxygen, sulphur, and atoms of other elements except the oxides of carbon, carbonates, and hydrogen carbonates.
- ✓Hydrocarbons are compounds of carbon and hydrogen only.
- ✓Hydrocarbons are classified as alkanes, alkenes and alkynes.
- ✓Alkanes (paraffins) have the general formula C_nH_{2n+2} where n = 1, 2,3, …
- ✓Alkenes (olefins) have the general formula C_nH_{2n} where n = 2, 3, 4, ….
- ✓Alkynes have the general formula C_nH_{2n-2} where n = 2, 3, 4, ….
- ✓Inorganic compounds are non-carbon containing compounds except the oxides of carbon, carbonates, and hydrogen carbonates.
- ✓Inorganic compounds are classified as oxides, acids, bases, and salts.

- ✓ Oxides are binary compounds containing oxygen and any other element such as metal, non-metal or metalloid.
- ✓Oxides are classified as acidic and basic oxides depending on their properties.
- ✓Acidic oxides are non-metallic oxide that reacts with water to form acidic solution.
- ✓Basic oxides are metallic oxide that reacts with water to form basic solution.
- ✓Acids are compounds that release hydrogen ions (H+) when dissolved in water.
- ✓Alkalis are substances that release hydroxide (OH–) ions in aqueous solution.
- ✓Bases are compounds that neutralize acids to form salt and water.
- ✓An alkali is a substance that releases hydroxide ions in aqueous solution.
- ✓Acids and bases are dangerous and corrosive.
- ✓Therefore, they must be handled with great care and you have to avoid contact with your skin and other parts of your body while working with bases and acids.
- ✓Indicator is a substance that indicates whether a solution is acidic or basic by undergoing specific color changes when placed in a solution.

- ✓ Neutralization is the reaction of acids with bases to form salt and water.
- ✓ Neutralization is very important in our daily life.
- ✓ For example, at home, in health and in agriculture.
- ✓ Salts are compounds that contain positive ions derived from bases and negative ions derived from acids.
- ✓ The names of inorganic compounds can be deduced from a set of simple rules.
- ✓ The formulas can be written from the names of the compounds.

REVIEW EXERCISE ON UNIT-3

I. Choose the correct answer from the given alternatives for each of the following questions.

1. Which of the following is the first organic compound synthesized from inorganic compounds?

A. NH_4CNO B. $(NH_2)_2CO$ C. AgCNO D. NH_4Cl

✓**The correct answer is B**

2. All of the following compounds are hydrocarbons except:

A. ethane B. ethene C. ethyne D. alcohol

✓**The correct answer is D**

3. The general formula of alkene is:

A. C_nH_{2n} B. C_nH_{2n+2} C. C_nH_{2n-2} D.

4.Which one of the following formula represents an alkene containing eight carbon atoms?

A. C_8H_8 B. C_8H_{16} C. C_8H_{18} D. C_8H_{14}

✓**The correct answer is B**

5. Which of the following formula represents an alkane containing six carbon atoms?

A. C_6H_{12} B. C_6H_{14} C. C_6H_{10} D. C_6H_{13}

✓**The correct answer is B**

6. The general formula of alkyne is:

A. C_nH_{2n} B. C_nH_{2n+2} C. C_nH_{2n-2} D. C_nH_{2n+1}

✓**The correct answer is C**

7. Which of the following compound is found in all alcoholic beverages?

A. Ethanol B. Formalin C. Butanol D. Propanol

✓**The correct answer is A**

8. Which of the following compounds can be used for oxyacetylene torch?

A. Propane B. Ethene C. Ethyne D. Acetic acid

✓**The correct answer is C**

9. The characteristic property of a base is due to the presence of:

A. hydride ions B. hydroxide ions C. hydrogen ions D. all

✓**The correct answer is B**

10. Which of the following is an example of acidic oxide?

A. Sulphur dioxide B. Calcium oxide C. Barium oxide D. Sodium oxide

✓**The correct answer is A**

11. Which of the following is an example of basic oxide?

A. SO_3 B. N_2O_5 C. P_4O_6 D. Na_2O

✓**The correct answer is D**

12. Which of the following oxides reacts with water to form an acidic solution?

A. CaO B. Na_2O C. CO_2 D. NO

✓**The correct answer is C**

13. Which one of the following statements is true about oxides?

A. Oxides are binary compounds containing oxygen.

B. All non-metallic oxides are acidic oxides.

C. All metallic oxides are basic oxides.

D. All

✓**The correct answer is A**

14. What is the missing product ‘X’ and ‘Y’ in the following equation?

$$NaOH\ (aq) + H_2SO_4\ (aq) \rightarrow X + Y$$

A. Na_2SO_4, H_2O B. Na_2SO_4, H_2 C. NaCl, H_2O D. Na_2SO_4

✓**The correct answer is A**

15. Which of the following salts is used as making gun powder?

A. NaClB. $NaHCO_3$ C. $CaCO_3$ D. KNO_3

✓**The correct answer is D**

16. Which one of the following cannot be used for neutralizes the acidic soil?

A. CaO B. $CaCl_2$ C. $CaCO_3$ D. $Ca(OH)_2$

✓**The correct answer is B**

17. Nitrates are salts of:

A. Hydrochloric acid B. Sulphuric acid

C. Phosphoric acid D. Nitric acid

✓**The correct answer is D**

II. Give short answers for each of the following questions.

18. Give the name of:

a. **an alkyne** containing 10 hydrogen atoms

b. **an alkene** containing 10 carbon atoms.

c. **an alkane** containing 8 carbon atoms.

19. Write the molecular formula of:

b. Nonane

c. Heptene

d. Decyne

20. Define the following words:

a. Organic compound

b. Hydrocarbon

c. Inorganic compound

d. Acid

e. Base

f. Salt

18 **a. C_6H_{10}**

b. $C_{10}H_{20}$

c. C_8H_{18}

19 a. C_9H_{20}

b. C_7H_{14}

c. $C_{10}H_{18}$

20 a. Organic compounds contain primarily carbon and hydrogen atoms.

b. Hydrocarbons are compounds of carbon and hydrogen only.

c. Inorganic compounds are non-carbon containing compounds except the oxides of carbon, carbonates, and hydrogen carbonates.

d. Acids are compounds that release hydrogen ions (H+) when dissolved in water.

e. Bases are compounds that neutralize acids to form salt and water.

f. Salts are compounds that contain positive ions derived from bases and negative ions derived from acids.

21. Write the formulas of the following compounds.

a. Nitric acid

HNO_3

b. Sodium sulphate

Na_2SO_4

c. Potassium hydroxide

KOH

22. Write the names of the following compounds.

a. H_2SO_4

Sulphuric acid

b. $Ca(OH)_2$

Calcium hydroxide

c. KNO