14 Classification of Elements

There are pure and impure matters around us. They are in the form of elements, compounds, and mixtures. Till now 118 elements have been discovered so far, among which 92 are natural and 26 are artificial.

Think and discuss these questions: Are all the elements made up of same type of atoms? Are the physical and chemical properties of one element similar to that of the other element? How has it made the study of elements easier? What is classification of elements? Why are the elements classified? What is the basis of classification of elements? The elements having similar properties are kept in one group and the elements having different properties are kept in different groups for classification.

Activity 14.1

Classify the elements used in our daily life like oxygen, iron, silver, sodium, chlorine, aluminium, carbon, sulphur and nitrogen as metals and non-metals and fill in the table.

Metal	Non Metal

Do all metals have the same properties? Is there any relation between the atomic structure of elements with the similarity or differences between the properties of elements? Or how are the properties of elements related to the atomic structures?

Periodic table

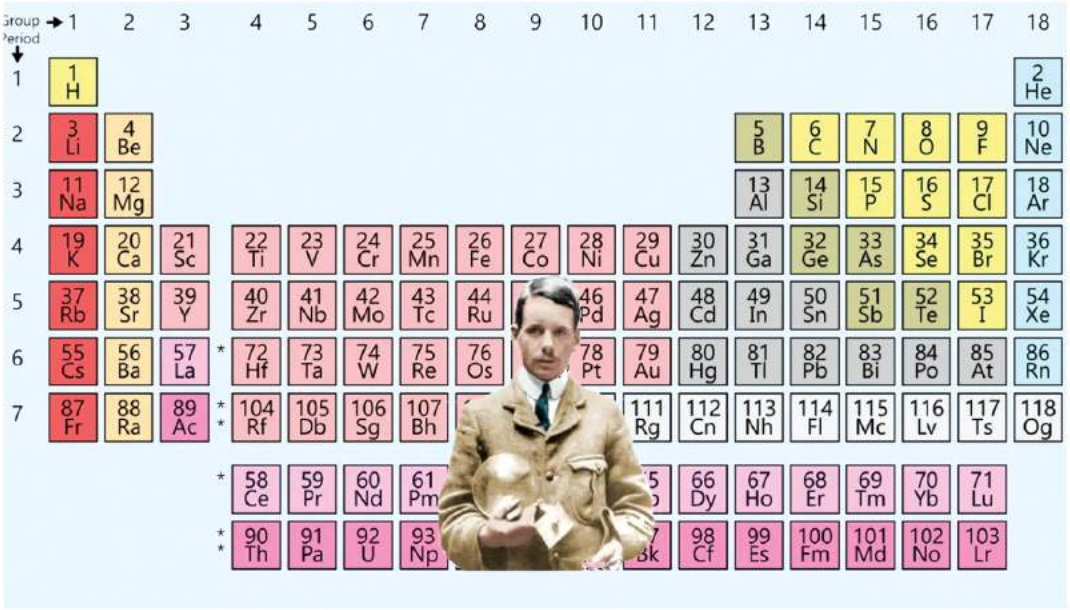
The scientific table made for the study of elements by keeping elements of similar properties in the same group and elements of different properties in different groups is called a periodic table.

Russian scientist Dmitri Mendeleev had created a periodic table for the classification of elements by the scientific study of elements on the basis of their atomic weight. He had formulated a periodic law for the classification of elements on the basis of his study. This law is known as Mendeleev's Periodic law. It states that "The physical and chemical properties of elements are the periodic functions of their atomic weight."

It means that when the elements are arranged according to the increasing order of their atomic weights then their physical and chemical properties recur periodically. Elements with similar properties lie in the same vertical column and the elements with different properties in between them lie in a horizontal row. In this way a classification table for elements is made which is known as periodic table. The vertical columns of a periodic table are called groups and the horizontal rows are called periods.

Modern Periodic Table

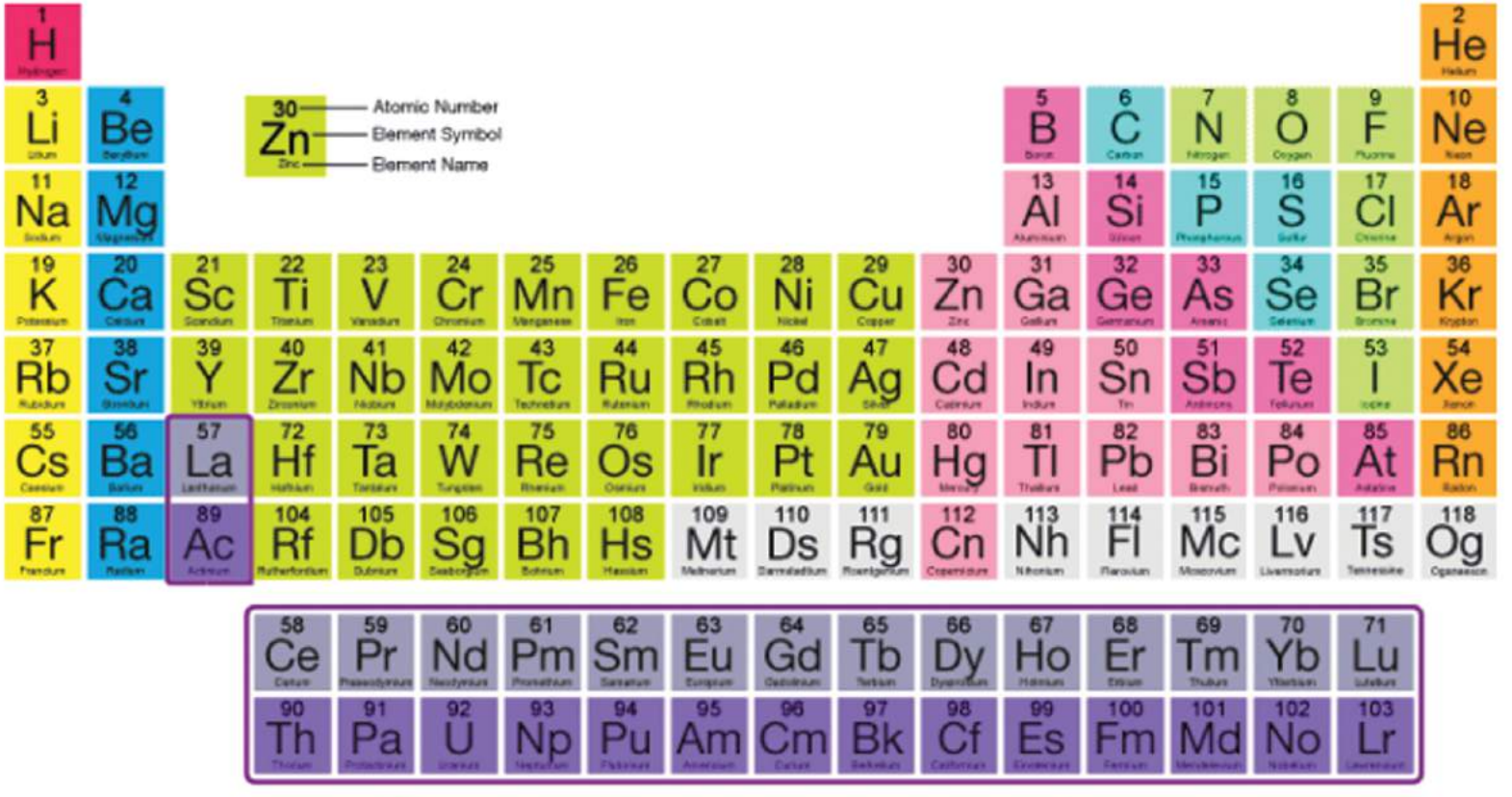
Mendeleev had considered atomic weight of elements as their fundamental property. Many complexities had been seen in the periodic table when the elements were classified on the basis of atomic weight. Some elements have more than one atomic weight, for example: C-12, C-13, and C-14 are the three forms or isotopes of carbon. Their atomic weights are 12, 13 and 14 respectively. The forms of the same element having different atomic weights are called isotopes. The number of protons in an atom is always constant whereas the number of neutrons may differ thus forming the isotopes. Mendeleev's periodic table was made on the basis of the atomic weight so separate spaces should be given for the isotopes of the same elements. However, he had allocated only one space for an element and had not given separate spaces for their isotopes. Similarly, his periodic law could not explain some other properties of the elements. After the detailed study, scientists went on to prove that atomic weight is not the fundamental properties of elements and kept searching for a new law for the periodic table.



Henry Moseley and Periodic Table

In this context, English scientist Henry Moseley in 1913 AD discovered that the properties of elements depend on atomic number rather than on atomic weight. He formulated modern periodic law on this basis. The modern periodic law can be stated as, "the physical and chemical properties of elements are the periodic function of their atomic number."

He had made a new periodic table on the basis of his periodic law. His periodic table is known as the modern periodic table or long form of periodic table. The elements have been arranged in the increasing order of their atomic number. In the modern periodic table also, the elements with similar properties are kept in the same vertical column which is known as a group. Similarly, elements with the increasing order of their atomic number are kept in horizontal row which is known as period.



Elements of the modern periodic table

Modern Periodic Table

Characteristics of modern periodic table

There are 7 periods in the modern periodic table. The elements in the same period have the same number of valence shells. The characteristics of modern periodic table can be listed as:

1. The elements are arranged in the increasing order of their atomic number in the modern periodic table.

2. There are 7 periods and 18 groups.

Period	Number of elements	Nature of period
First	2	Very short
Second	8	Short
Third	8	Short
Fourth	18	Long
Fifth	18	Long
Sixth	32	Very long
Seventh	32	Very Long

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
IA	IIA	IIIB	IVB	VB	VIB	VIIB		VIIIB		IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	AS	Se	Be	Kr

3. Modern periodic table has been divided into 18 groups according to the IUPAC system.

4. Metals are placed on the left side, non-metals are arranged on the right side and metalloids are kept in the middle of the modern periodic table.

5. There are alkali metals in group IA, alkaline earth metals in group IIA, transitional metals from group IIIB to IIB, halogens in group VIIA and noble gases in group 0 (18).

6. The group of 15 elements from Lanthanum (La), atomic number 57 to Lutetium (Lu), atomic number 71 are called lanthanides. Similarly, the group of 15 elements from Actinium (Ac), atomic number 89 to Lawrencium (Lr), atomic number 103 are called lanthanides. They are kept separately below the main block of the periodic table.

7. The elements from groups IB to VII B along with three columns of group VIII B (altogether 10 columns) are kept between metals and nonmetals. These are called transition metal.

8. The elements are classified as s, p, d or f blocks according to their electronic configuration based on sub-shell.

Activity 14.2

Study the modern periodic table. Prepare the periodic table in cardboard paper or chart paper. Keep separate colours for the groups and discuss the prepared table.

Activity 14.3

Prepare a periodic table as shown below and arrange the elements from atomic number 1 to 20. Show the alkali metals, alkaline earth metals, halogens and inert gases with different colours.

IA	IIA	IIIA	IVA	VA	VIA	VIIA	0

Electronic configuration of elements based on sub shells

Electronic configuration of elements based on sub shells

The path in which electrons revolve around the nucleus of an atom is called orbit or shell. A shell may be divided into one or more subshells. There are one or more orbitals in a subshell. Electrons are found in these orbitals.

As all the properties of elements could not be explained using the

electronic configuration of elements based on shells, scientists developed the electronic configuration of elements based on the subshells through their research. There are 1, 2, 3 and 4 subshells in K, L, M and N shells respectively. The subshell in K shell is denoted as 1s. Similarly, 2s and 2p are the subshells of L shell, 3s, 3p, and 3d are the subshells of M shell. 4s, 4p, 4d, and 4f are the subshells of N shell.

s, p, d, and f subshells can accommodate a maximum of 2, 6, 10, and 14 electrons respectively.

Example: 14.4 a

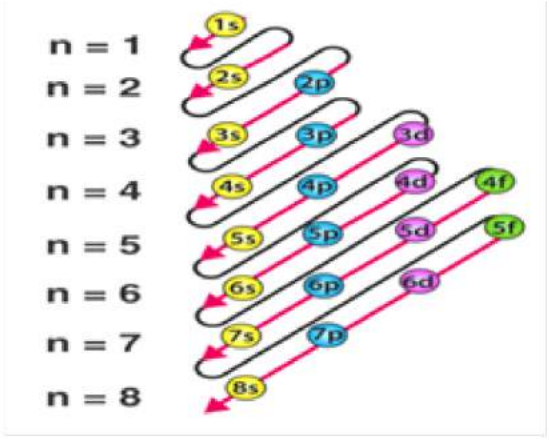
Subshell	Shell	Subshell	Total electrons in shell
1	K	$1s^2$	2
2	L	$2s^2$, $2p^6$	8
3	M	$2s^2$, $2p^6$, $3d^{10}$	18
4	N	$4s^2$, $4p^6$, $4d^{10}$, $4f^{14}$	32

Table 14.4 b electronic configuration of elements on the basis of their subshell

Atomic Number	Elements	Symbol	Electronic configuration				
			based on shells				based on sub shells
			K	L	M	N	
1	Hydrogen	H	1				$1s^1$
2	Helium	He	2				$1s^2$
3	Lithium	Li	2	1			$1s^2$, $2s^1$
4	Berylium	Be	2	2			$1s^2$, $2s^2$
5	Boron	B	2	3			$1s^2$, $2s^22p^1$
6	Carbon	C	2	4			$1s^2$, $2s^22p^2$
7	Nytrogen	N	2	5			$1s^2$, $2s^22p^3$
8	Oxygen	O	2	6			$1s^2$, $2s^22p^4$
9	Fluorien	F	2	7			$1s^2$, $2s^22p^5$

10	Neon	Ne	2	8			$1s^2, 2s^22p^6$
11	sodium	Na	2	8	1		$1s^2, 2s^22p^6, 3s^1$
12	magnesium	Mg	2	8	2		$1s^2, 2s^22p^6, 3s^2$
13	Alluminium	Al	2	8	3		$1s^2, 2s^22p^6, 3s^23p^1$
14	silicon	Si	2	8	4		$1s^2, 2s^22p^6, 3s^23p^2$
15	Phosphorus	P	2	8	5		$1s^2, 2s^22p^6, 3s^23p^3$
16	Sulphur	S	2	8	6		$1s^2, 2s^22p^6, 3s^23p^4$
17	Chlorine	Cl	2	8	7		$1s^2, 2s^22p^6, 3s^23p^5$
18	Argon	Ar	2	8	8		$1s^2, 2s^22p^6, 3s^23p^6$
19	Potsssium	K	2	8	8	1	$1s^2, 2s^22p^6, 3s^23p^6, 4s^1$
20	Calcium	Ca	2	8	8	2	$1s^2, 2s^22p^6, 3s^23p^6, 4s^2$

The electronic configuration of elements on the basis of subshells is guided by Aufbau's principle. Aufbau's principle states that electrons are filled in a subshell in the increasing order of energy of these subshells. The increasing order of energy of subshells or electrons are filled in subshells in the following order:



The order of subshells according to their increasing energies is:

1s< 2s< 2p < 3s < 3p < 4s < 3d < 4p<5s < 4d < 5p< 6s < 4f < 5d < 6p.....

The maximum number of electrons which s, p, d, and f subshell can accommodate are 2, 6, 10, and 14. The electrons could not be filled

in 2s subshell till 1s subshell is not completely filled. So, electrons should be filled serially in the order:

1s, 2s2p, 3s 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p....

Activity 14.4

Study the table and complete it:

shell	subshell	Maximum number of electrons accommodated in subshell	maximum number of electrons in the shell
K	1s	2	2
L	2s		2 + 6 = 8
	2p	6	
M	3s		
	3p		
	3d	10	
N	4s		
	4p		
	4d		
	4f	14	

Study the prepared table and explain the relationship between electronic configuration based on shell and subshell.

Classification of elements in modern periodic table

Study the prepared table and explain the relationship between electronic configuration based on shell and subshell.

The elements are classified in the modern periodic table on the basis of their properties.

Activity 14.5

1. Write the electronic configuration of hydrogen, alkali metal, and halogen.
2. Write the similarities between the electronic configurations of hydrogen, halogen, and alkali metals.

3. What are the differences between the electronic configurations of hydrogen, halogens and alkali metals?

4. Which group of the periodic table is suitable for hydrogen? Discuss and draw a logical conclusion.

Metals, nonmetals and metalloids

Elements are classified into three groups i.e., metals, nonmetals, and metalloids on the basis of their metallic characters.

Metal

Metals are placed on the left side of the modern periodic table. All the elements of group IA to IIIA (except boron) are metals. The metals of group IIA and IIIA are less reactive than the metals of group IA. The elements of group IIIB to IIB are less reactive transitional metals. For example: Fe, Co, Ni, Ag, Au, Hg, Zn etc. Their properties lie between the active metals and nonmetals so they are also known as transitional metals. Metals are the good conductors of heat and electricity.

The elements having one electron in their outermost shell lie in group IA. Elements like Li, Na, and K lie in this group. These are the reactive metals. They form a strong base or alkali when dissolved in water so they are also known as alkali metals. Their valence shell electronic configuration is ns1. Here 'n' denotes the shell. For example, the electronic configuration of sodium is $1s_2$, $2s_2$ $2p_6$, $3s_1$. The elements of this group are soft and have less density.

The elements having two electrons in their outermost shell lie in group IIA. The elements like Mg and Ca lie in this group. Their valence shell electronic configuration is ns2. For example, the electronic configuration of magnesium is $1s_2$, $2s_2$ $2p_6$, $3s_2$. The elements of this group are known as alkaline earth metals because the oxides of these metals are soluble in water and they are found on the earth's surface.

Non-metal

Nonmetals are kept on the right side of the periodic table. Group of elements of VA, VIA and VIIA along with elements of group VIIIA or 18 (0) are non-metals.

The elements having seven electrons in their valence shell are kept in

group VIIA (17) of the modern periodic table. Elements like F, Cl, Br, I lie in this group. These elements easily take part in reaction to gain one electron from others to fulfil their valence shell with eight electrons. So, they are very reactive. The outermost electronic configuration of these elements is given as ns^2np^5. For example, the electronic configuration of chlorine is $1s^2$, $2s^2$ $2p^6$, $3s^2$ $3p^5$. The elements of this group (F, Cl, Br, I) are called halogens. The elements of this group are soft and have less density. These are the most reactive nonmetals.

The elements having eight electrons in their valence shell and two electrons in their first shell which is also their valence shell are kept in group 0. The elements like He, Ne, Ar, Kr, Xe and Rn are kept in this group. The valence shell electronic configuration of these elements are denoted by ns^2 np^6. For example, the electronic configuration of Argon is $1s^2$, $2s^2$ $2p^6$, $3s^2$ $3p^6$. These elements are also known as noble gases or inert gases. Since they have octet state in their valence shell, they do not take part in chemical reactions so they are known as inert gases.

Metalloid

The elements which lie between metals and nonmetals in the periodic table and show some properties similar to metals and some properties similar to nonmetals are called metalloids. They are the poor/semiconductors of electricity. Their electrical conductivity is less than metals and more than nonmetals. Silicon (Si), Germanium (Ge), Bismuth (Bi) etc. are metalloids.

Activity 14.6

Study the modern periodic table. Fill the elements from atomic number 1 to 20 in groups IA to 0. Use different coloured inks for filling the names of metals, nonmetals and metalloids. Demonstrate the model of your periodic table in your classroom.

Characteristics of period and group in periodic table

The properties of elements depend on the group and period of that element in the periodic table. It is due to this fact that the periodic table is important to study the properties of the elements. Periods and groups have their own properties in the periodic table.

A. Valency

The outermost shell of an atom is called its valence shell. The electron present in the valence shell of an atom is called valence electron. There is change in the electronic configuration of elements as we move from left to right in a period. Although the number of shells is the same in a period, the number of valence electrons goes on increasing due to which the valency of elements changes even in the same period. So the valencies of elements in a period as we move from group IA to VIIA and group 0, are 1, 2, 3, 4, 3, 2, 1, and 0 respectively.

The valency of an element is determined by the number of valence electrons. All the elements of a group have the same valency. The valency of elements of group IA and VIIA is 1 and that of elements of group IIA and VIA is 2. Similarly, the elements of group IIIA and VA have their valency 3 generally.

Activity 14.7

Write the elements of group IA and 3rd period in vertical column and horizontal row respectively as in the periodic table and write their electronic configuration. Write similarities and differences in their properties on the basis of their number of shells and valencies.

What changes are seen in the valencies as we move from top to bottom of a group and left to right of a period in the periodic table? Draw a conclusion.

A. Atomic size

The atomic size of elements decreases from left to right of a period. The number of protons and electrons increases with the increase in atomic number while the number of shells remains the same. So, the increased electrons are filled in the same shell. Similarly, due to the increase in the number of protons, the positive charge of the nucleus also increases and the electrons in the shell are attracted with more force. As a result, the atom gets contracted. So, the size of atoms is decreased from group1 to 18 in a period.

Atomic size is determined by the distance of the valence shell from the nucleus of that atom. For example, Lithium atoms have K and L shells whereas sodium atoms have K, L, and M shells. So, the size of the sodium atom is more than the size of the Lithium atom in group IA.

Activity 14.8

1. Draw the atomic structure of Li, Be, B, N, and C.
2. Arrange these elements in the increasing order of their atomic size.
3. Draw the atomic structure of K, Li, and Na.
4. Arrange these elements in the increasing order of their atomic size.
5. What are the changes in atomic size as we move from left to right in a period and top to bottom in a group? Draw conclusions from it.

C. Electropositivity and electronegativity

The property of an element to lose its valence electrons and form positive ions (cations) is called electropositivity. The property of an element to gain electrons in its valence shell to form negative ions (anions) is called electronegativity. The atomic size of elements decreases from left to right of any period so their electron losing capacity decreases along the period whereas their capacity to gain electrons increases accordingly. Due to this, the electropositivity or metallic character of elements decreases from group 1 to 18 of any period whereas their electronegativity or nonmetallic character increases.

As we move from top to bottom of a group, the tendency of elements to lose electrons increases due to the increment in their atomic size. So, their electropositivity character also increases. But their capacity to gain electrons decreases due to the increase in distance from the nucleus. Hence, electronegativity decreases down a group.

Activity 14.9

1. Write the electronic configuration of Na, Mg, Al, Si, P, S, and Cl.
2. Arrange these elements in the increasing order of their electronegativity.
3. Similarly arrange them in the increasing order of their electropositivity.

4. Write the electronic configuration of Be, Mg, and Ca.

5. Arrange them in the increasing order of their electropositivity.

Draw conclusions from this activity by observing and studying the periodic table also and present it in the class.

d. Chemical reactivity

The chemical reactivity of metals decreases along a period whereas the chemical reactivity of nonmetals increases along a period. But the element in the extreme right of a period is inert. For example, let us study the second period of the modern periodic table:

Atomic number	11	12	13	14	15	16	17	18
Element	Na	Mg	Al	Si	P	S	Cl	Ar
Number of valence electron	1	2	3	4	5	6	7	8
Valency	1	2	3	4	3	2	1	0

As we can see, the atomic number increases from left to right in the third period. The number of protons and electrons also increases accordingly while the number of shells is the same. The electrons go on adding inthe same shell. The number of protons also increases inside the nucleus due to which the attraction force of the nucleus also increases. Hence, the electrons in the shell are attracted more towards the nucleus. Due to this, atoms contract. Thus, sodium has the largest size among the elements given above. And sodium is the most electropositive or the most reactive metal in the third period. Argon is the smallest among them but it is an inert gas so chlorine is the most electronegative or most reactive nonmetal among them.

The chemical reactivity of metals increases from top to bottom of a group whereas the reactivity of non-metals decreases. The size of elements increases down a group due to which they can easily lose their valence electrons so the reactivity of metals increases. For example, the reactivity of group IIA elements increases in the order of Be < Mg < Ca. The tendency of nonmetals to gain electrons decreases when their size increases. So, the chemical reactivity of nonmetals decreases down a group. For example, the reactivity order of nonmetals of group VIA is O > S > Se.

Project work

1. Make the atomic models of Lithium, Sodium and Potassium using clay or paper or any other suitable materials. Make the size of sodium larger than that of lithium and size of potassium larger than that of sodium. Observe these atomic models and discuss the properties of group IA of the periodic table.

2. Make the atomic models of elements of the second period like Lithium, Beryllium, Boron, Carbon, etc.using clay or paper or any other suitable materials. Discuss the properties of the second period on the basis of these models and present in the classroom.

Exercise

1. Choose the correct option for the following questions.

a. In which group do the elements having electronic configuration $1s^2$, $2s^2$ $2p^3$ lie?

(i) III A (ii) III B

(iii) V A (iv) V B

b. What are the elements between groups IIA and IIIA called in the modern periodic table?

(i) Alkali metals (ii) Transition metals

(iii)Alkaline earth metals (iv) Rare Earth metal

c. Which one of the given nonmetals are the most reactive?

(i) Fluorine (ii) Chlorine

(iii) Bromine (iv) Iodine

d. Which one of the given metals are the most reactive metals?

(i) Lithium (ii) Sodium

(iii) Potassium (iv) Cesium

e. Which group does the inert gases belong in the modern periodic table

(i) 0 (ii) IA

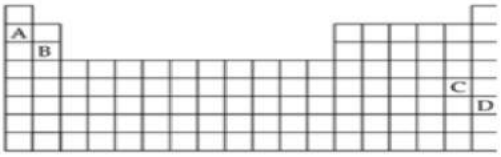
(iii) VIIB (iv) VIIA

f. Which one represents the correct order of increase in chemical reactivity of metals?

(i) Be < Mg < Ca (ii) Na < Li < K

(iii) Mg < Al< Si (iv) C < O < N

g. The position of elements A, B, C, and D are shown in the periodic table. Which of them can form acidic oxide?



(i) A (ii) B

(iii) C (iv) D

2. Give reason:

a. Classification of elements is necessary.

b. The size of atoms increases on going from top to bottom in a group of the periodic table.

c. The size of atoms decreases on going from left to right of a period in the periodic table.

d. Hydrogen is a non-metal but it is kept with metals in the modern periodic table.

e. Potassium is more reactive than sodium.

f. Fluorine is more reactive than chlorine.

g. The metallic characters of elements decrease and non-metallic characters increase on going from left to right of a period in the modern periodic table.

h. Inert gases are kept in group 0 of the modern periodic table.

i. A portion of the periodic table is shown below. The atomic size decreases from Li to Ne.

IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA
Li	Be	B	C	N	O	F	Ne

3. Write the differences between:

a. Group and period

b. Chlorine and Sodium

c. Elements of group IA and VIIA

d. Electronegativity and electropositivity

4. Answer the following questions:

a. State modern periodic law.

b. How many groups and periods are there in the modern periodic table?

c. Write the position of sodium in the modern periodic table. Why is it known as alkali metal?

d. Write the position of following elements in the periodic table: alkali metals, alkaline earth metals, inert gases, transition metals, lanthanides, and actinides.

e. Write the electronic configuration of sulphur and write its position in the modern periodic table.

f. On which basis do the group and period are separated in the modern periodic table?

g. In which group does Fluorine, Chlorine, and Bromine lie in the periodic table? Which one is more reactive among them?

h. If you are given a chance to make improvements in the modern periodic table, what changes would you make in it? Explain with reasons.

16 Gases

You might have heard of the death of people due to suffocation during the cleaning of deep wells. Similarly, you mighthave felt breathlessness inside caves. What might be the cause of suffocation inside the well? What might be the cause of breathlessness inside the cave? Which gas is used in refrigerators? Why is this gas used there? What may be the answers of these questions, let's think for some time! We will discussthe gases like carbon dioxide and ammonia related to these questions in this chapter.

16.1 Carbon dioxide gas

Carbon dioxide is produced when coal, wood, kerosene, fat, oil, wax etc. burns and gets mixed in air. This gas is also produced during the respiration process of plants and animals, volcanic eruption, and decaying process of organic matter. Atmospheric air contains about 0.03% carbon dioxide by volume. Deforestation, and burning of fuel are the artificial sources of carbon dioxide in the atmosphere. Van Helmont had discovered carbon dioxide in 1630 AD by burning wood. Similarly, in 1755 AD, Joseph Black had prepared this gas by burning magnesium carbonate. Later Lavoisier proved that carbon dioxide gas as a compound of carbon and oxygen.

Fact about Carbon dioxide gas

Symbol	Molecular weight
CO_2	44

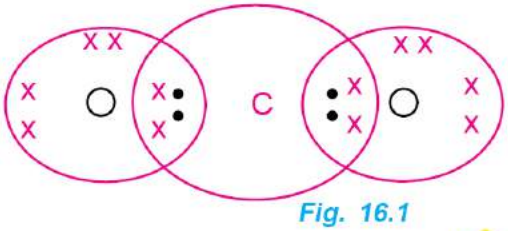


Fig. 16.1

Laboratory preparation of carbon dioxide gas

In laboratory carbon dioxide gas is prepared by the chemical reaction of limestone ($CaCO_3$) with dilute hydrochloric acid (dil. HCl).

Calcium Carbonate + dilute Hydrochloric acid → Calcium chloride + water + Carbon dioxide

$$CaCO_3(s) + 2HCl\ (aq) \rightarrow CaCl_2\ (aq) + H_2O\ (l) + CO_2(g)$$

Apparatus required

Wolfe's bottle, gas jar, thistle funnel, delivery tube, rubber cork, and some test tubes.

Chemicals required

Limestone or marble pieces or calcium carbonate powder or egg shells, dilute hydrochloric acid, phenolphthalein, lime water, sodium hydroxide solution, blue litmus paper.

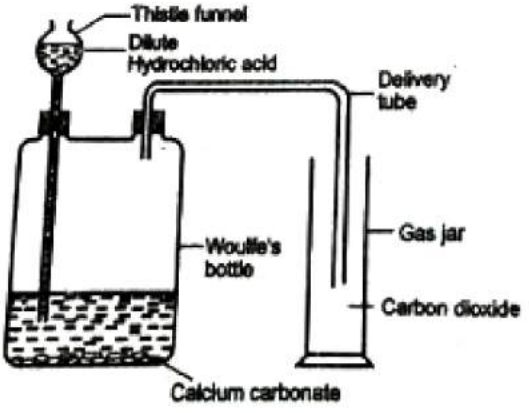
Method/Procedure

Practical activity: 1

a. Collect the apparatus and chemicals required for the preparation of gas.

b. Keep some pieces of limestone or marble pieces or calcium carbonate powder or egg shells into the Woulfe's bottle.

c. Arrange the delivery tube in one of the openings of the Woulfe's bottle and the delivery tube in another and make them airtight using rubber corks. Fix the delivery tube and thistle funnel in the opening of woulfe's bottle making it air tight with the help of rubber cork as shown in the figure.



Picture 16.2

d. Pour dilute hydrochloric acid into the Woulfe's bottle through the thistle funnel till it covers limestone or marble pieces or calcium carbonate powder or egg shells and opening of thistle funnel should be inside the acid layer.

e. Allow the gas to pass through the delivery tube and collect in the gas jar kept straight upright.

f. Observe the reaction between calcium carbonate and acid.

g. Carbon dioxide is formed during the reaction and the gas passes from Woulfe's bottle to the gas jar through the delivery tube. This gas being heavier than air, it is collected in the gas jar by the upward displacement of air.

Precautions

1. The end of the delivery tube should not be dipped into the acid.

2. The end of the thistle funnel should be dipped into the acid.

Test of gas

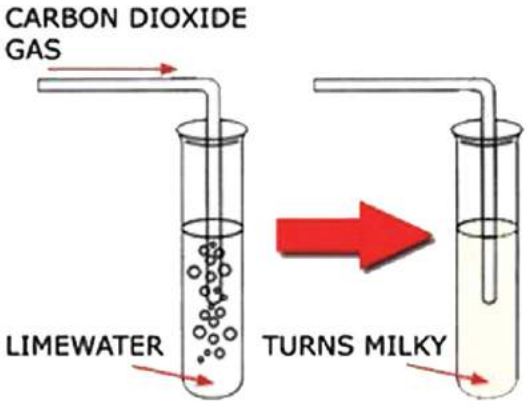
a. For a test of carbon dioxide, when a burning matchstick is brought near the mouth of the gas jar containing carbon dioxide, it extinguishes because carbon dioxide is neither combustible nor the supporter of combustion.

b. When a moist blue litmus is brought near the mouth of the gas jar containing carbon dioxide, it turns to blue. Similarly, when a few drops of phenolphthalein is put inside the gas jar, it remains colourless or unchanged. This proves that the gas inside the gas jar is carbon dioxide.

c. A little lime water is taken in a test tube and carbon dioxide is passed through it for some time, it changes to milky white. It is because of the formation of insoluble calcium carbonate as a result of the reaction of carbon dioxide and calcium hydroxide of the lime water. On passing carbon dioxide for a long time, the milky white colour disappears due to the formation of soluble calcium bicarbonate.

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s)\ (milky) + H_2O(l)$$

$$CaCO_3(s) + CO_2(g) + H_2O(l) \rightarrow Ca(HCO_3)_2(aq)\ (Colourless)$$



Picture 16.3

Properties of carbon dioxide gas

Physical properties

a. It is an acidic or non-metallic oxide which is colourless and odourless.

b. This gas dissolves in water to form carbonic acid, so it is sour in taste.

c. It is slightly soluble in water.

d. It is 1.5 times heavier than air.

e. It shows acidic properties and changes moist blue litmus paper red.

f. This gas is nontoxic, however, organisms die in the environment of carbon dioxide by suffocation due to lack of oxygen gas.

g. It can be changed to liquid at high pressure and low temperature.

h. When Carbon dioxide is cooled below -78°c, it changes to solid form which is known as dry ice.

i. This gas is neither combustible nor it supports combustion.

Chemical properties

1. Carbon dioxide is neither combustible nor a supporter of combustion.

It helps to extinguish the fire. But when a burning magnesium is inserted into the jar full of carbon dioxide, it burns brightly and produces white powder of magnesium oxide (MgO) and black carbon powder.This shows CO2contains carbon.

$$2Mg\ (s) + CO_2\ (g) \rightarrow 2MgO\ (s) + C\ (s)$$

2. Carbon dioxide dissolves in water to form carbonic acid. This gas is mixed in soft drinks at high pressure to bring a sour taste in them.

$$CO_2\ (g) + H_2O\ (l) \rightleftharpoons H_2CO_3\ (aq)$$

3. When carbon dioxide gas is passed into lime water for some time then lime water turns milky white due to the formation of insoluble calcium carbonate.

$$Ca(OH)_2\ (aq) + CO_2\ (g) \rightarrow CaCO_3\ (s) + H_2O\ (l)$$

Similarly, when this gas is passed into the lime water for a long time then the milky white colour disappears due to the formation of soluble calcium bicarbonate [$Ca(HCO_3)_2$].

$$CaCO_3\ (s) + H_2O\ (l) + CO_2\ (g) \rightarrow Ca\ (HCO_3)_2\ (aq)$$

4. When a few drops of KOH are added inside a test tube filled with CO_2 and inverted in water,the water level rises inside the test tube. During this process KOH absorbs CO_2 inside the test tube creating low pressure there rushing water into it.

$$2KOH + CO_2 \rightarrow K_2CO_3 + H_2O$$

5. Green plants prepare their food in the form of carbohydrates by the reaction of carbon dioxide absorbed from air and water absorbed by roots in the presence of sunlight trapped by chlorophyll in their leaves.

$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Solar energy}} C_6H_{12}O_6 + 6O_2$$

6. Carbon dioxide reacts with red hot coke at 900^{o} to form carbon monoxide.

$$CO_2 + C \rightarrow 2CO$$

Uses of carbon dioxide gas

1. Carbon dioxide is dissolved in soft drinks at high pressure.
2. Plants use carbon dioxide as a raw material for the preparation of their food.
3. This gas is used to extinguish fire. The device used to put off fire is called a fire extinguisher. Generally, a concentrated solution of sodium bicarbonate is placed inside the cylinder. A concentrated sulphuric acid is placed inside a glass vessel attached to a plunger near the mouth of the extinguisher. When the plunger is jerked, sulphuric acid gets mixed with sodium bicarbonate and carbon dioxide is produced which comes out with a very high speed and covers fire forming thick blanket. Due to this there will be a lack of oxygen and the fire gets extinguished.

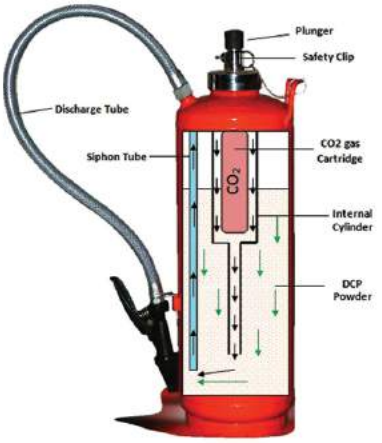


Fig. 16.4

$$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2$$

4. Carbon dioxide is used to prepare dry ice which is used to preserve fruits, vegetables, meat etc. in lower temperatures.
5. Liquid carbon dioxide is used in the purification of sugar by the carbonation process in sugar mills.
6. It is also used to prepare urea (NH_2CONH_2), washing soda (Na_2CO_3), and baking soda ($NaHCO_3$).

7. It is used to make carbogen. Carbogen is a mixture of 95% oxygen and 5% carbon dioxide. Carbogen is used to treat patients suffering from pneumonia for their artificial respiration.

8. Green plants use carbon dioxide for photosynthesis.

$$6CO_2 + 6H_2O + \frac{\text{Solar energy}}{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2$$

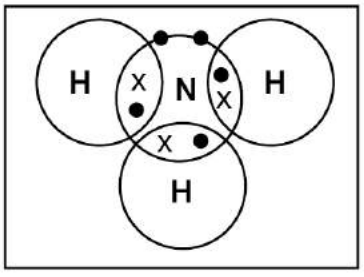
9. It is used in bakery products.

Ammonia

Ammonia is found in both free and combined states in nature. This gas is produced when nitrogenous substances decay in absenceof oxygen. Similarly, in combined form, ammonia gas is found in ammonium chloride and ammonium sulphate. Lavoiser had prepared this gas by heating the mixture of ammonium chloride and calcium hydroxide.

Fact about ammonia gas

Symbol	Molecular weight
NH_3	17



Picture 16.5

The molecular weight of ammonia is 17. The molecular weight of oxygen is 32, whereas the molecular weight of nitrogen is 28 and that of carbon dioxide is 44, so this gas is lighter than air.

Laboratory preparation of ammonia gas

In laboratory, ammonia gas is prepared by heating the mixture of ammonium chloride (NH4Cl) and calcium hydroxide [Ca(OH)2] in the ratio of 2:1 in a hard glass test tube.

Ammonium chloride + Calcium hydroxide → calcium chloride + water + ammonia

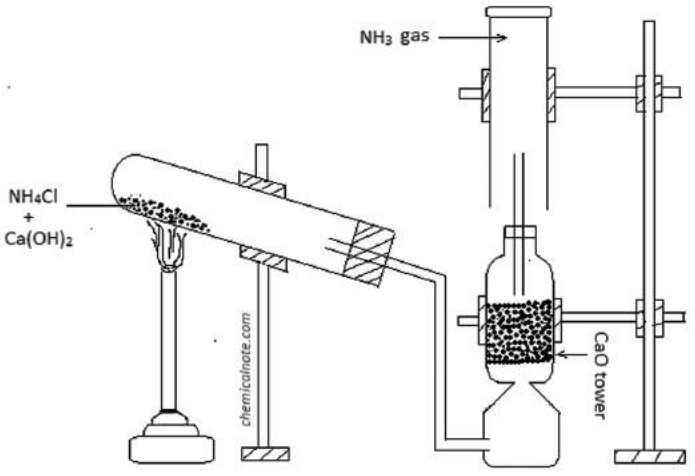
$$2NH_4Cl\ (s) + Ca(OH)_2\ (s) \rightarrow CaCl_2\ (s) + 2H_2O\ (l) + 2NH_3\ (g)$$

Apparatus required: Hardglass test tube, source of heat, gas jar, stand, lime tower, delivery tube, etc.

Chemicals required: Ammonium chloride andCalcium hydroxide

Method/ Procedure

1. Collect the apparatus and chemicals required for the laboratory preparation of ammonia gas.



Picture 16.6

2. Mix ammonium chloride and calcium hydroxide in the ratio of 2:1 and put the mixture into the hard glass test tube.

3. Fix a delivery tube in the mouth of the test tube with a rubber cork to make it airtight as shown in the figure. Arrange the hard glass test tube in a slightly inclined position with the help of a stand.Connect the other end of the delivery tube to the lime tower to obtain pure and dry ammonia gas.We can perform the experiment without lime tower to get impure ammonia.

4. Now heat the mixture gently and observe the formation of ammonia gas.

5. Lime tower filled with Calcium oxide (CaO) is used to obtain dry and pure ammonia. This gas is quite soluble in water so it is not obtained by the displacement of water. It is collected by the downward displacement of air as it is lighter than air.

Precautions

1. The mouth of the hard glass test tube should be slightly inclined downward so that the water vapour produced in this process passes to the lime tower through the delivery tube and prevents thehard glass tube from cracking.
2. The mouth of hard glass test tube should be airtight with the help of cork.
3. To obtain dry ammonia gas, the gas should be passed through a lime tower. Since the gas is highly soluble in water, it should not be collected by the displacement of water.

Do you know?

Calcium oxide absorbs moisture from ammonia. So, when ammonia is passed through the lime tower, we get pure and dry ammonia.

Test of the gas

1. The gas is basic so it changes moist red litmus to blue.
2. When a glass rod dipped to concentrated hydrochloric acid is brought near the mouth of a gas jar with ammonia, white fumes come out of it.

Picture 16.7

Properties of ammonia

Physical properties

1. It is a colourless gas. It has a strong and pungent odour like rotten egg.
2. It is lighter than air.
3. This gas is highly soluble in water.
4. It is a basic gas so it changes moist red litmus to blue.
5. Ammonia liquefies at -33.4°C and solidifies at -78° C.

Chemical properties

1. This gas is soluble in water. It forms ammonium hydroxide when dissolved in water.

   $NH_3\,(g) + H_2O\,(1) \rightarrow NH_4OH\,(aq)$

2. Ammonia reacts with acids to form ammonium salts.

   $NH_3\,(g) + HCl\,(aq) \rightarrow NH_4Cl\,(aq)$

   Ammonium chloride

   $2NH_3(g) + H_2SO_4\,(aq) \rightarrow (NH_4)_2SO_4\,(aq)$

   Ammonium sulphate

3. Ammonia solution (NH_4OH) reacts with acid to form salt and water.

   $2NH_4OH\,(aq) + H_2SO_4\,(aq) \rightarrow (NH_4)_2\,SO_4\,(aq) + 2H_2O\,(l)$

   $NH_4OH\,(aq) + HCl\,(aq) \rightarrow NH_4Cl\,(aq) + H_2O\,(1)$

4. Ammonia and carbon dioxide react at a high temperature of 1500° and at high pressure to form urea.

   $$NH_3\,(g) + CO_2\,(g) \xrightarrow[\text{pressure}]{1500\,^0C} NH_2 - CO - NH_2\,(s) + H_2O\,(1)$$

   Urea is an important chemical fertilizer.

5. When ammonia burns in the atmosphere of oxygen, it produces nitrogen gas and water.

   $4NH_3\,(g) + 3O_2\,(g) \rightarrow 6H_2O\,(1) + 2N_2\,(g)$

6. When a mixture of ammonia and oxygen is passed through the

platinum gauze at about 800°C, it produces nitric oxide.

$$4NH_3\,(g) + 5O_2\,(g) \xrightarrow[Pt]{800^0\,C} 6H_2O\,(1) + 2NO\,(g)$$

7. When ammonia is passed through the molten sodium then it forms sodamide and hydrogen gas.

$$2NH_3\,(g) + 2Na\,(S) \rightarrow 2NaNH_2\,(s) + H_2(g)$$

Uses of ammonia

1. This gas is used to make fertilizers like ammonium sulphate, ammonium nitrate, urea, ammonium phosphate, etc.
2. It is used in the manufacture of nitric acid, plastic, etc.
3. This gas is used to make washing soda.
4. It is used to make medicines of ammonium salts.
5. Ammonia is used to make the blue prints of maps.
6. It is used as a cooling agent in refrigerators.
7. It is used as a cleansing agent to remove the stains of oil, grease, etc.

Activity 16.1

Construction of fountain

Apparatus required: stand, dropper, rubber cork, round bottomed flask, glass tube

Chemicals required: dry ammonia gas, phenolphthalein

Method/Procedure:

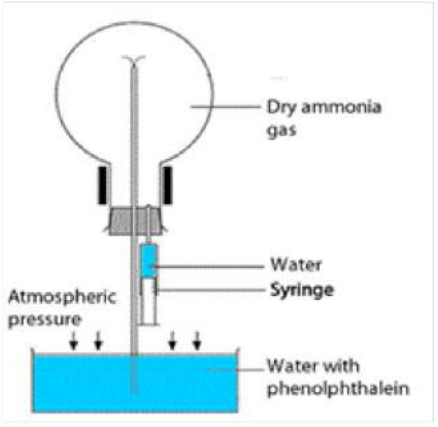
1. Collect the apparatus and chemicals required.

2. Set the apparatus as shown in the figure.

3. Fill a round bottom flask with ammonia gas and make it airtight.

4. Put a few drops of water inside the flask with the help of a syringe or a dropper.

5. This water combines with ammonia gas inside the flask creating vacuum.



Picture 16.8

6. The air pressure inside the flask becomes less due to which water with phenolphthalein from the beaker rushes upwards. The water mixes with ammonia and changes pink due to the formation of ammonium hydroxide which is basic in nature.

7. This experiment proves that ammonia is highly soluble in water.

Precautions

The bottle of liquid ammonia should be placed in cold water or ice before opening its lid. Ammonia is highly soluble in water.Due to the high pressure,ammonia solution may spill when its lid is removed.

Greenhouse effect

You might have felt hotter on cloudy nights than on clear nights. What may be the reason for it? Similarly, you might have seen plastic tunnels or glass houses in parks, botanical gardens, and agricultural farms. These are the examples of green houses. These houses, made of transparent glass or plastic, which stores the solar heat inside them and help in proper growth of plants and maintain greenery are called greenhouses. And the process of trapping solar energy inside a greenhouse increasing temperature inside them is called the greenhouse effect. Greenhouses may be artificial or natural. The earth is a natural greenhouse and the houses made of transparent glass and plastic are artificial greenhouses. What is the importance of greenhouses in our daily life? What happens if there are no greenhouses? What

are the advantages of greenhouses? Let's think about these questions.

Picture 16.9

The process of heating earth's surface is called the natural greenhouse effect. When the solar radiation reaches the earth's surface, some of it gets reflected back and some of it is absorbed by the earth. The earth's atmosphere consists of layers of greenhouse gases like carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chloro fluro carbons (CFCs), ozone (O_3), etc. These gases help to return some of solar radiation back to the earth's surface.

The layer of greenhouse gases is increasing in the atmosphere due to human activities, industrialization, and pollution. Due to this, more solar radiation is reflected back to the earth's surface and prevents the rays from escaping to space. Thus, human activities increase the greenhouse effect. It is necessary to have a layer of greenhouse gases in the atmosphere. If there were no greenhouse gases, the temperature of the earth would be very low. Due to which there would be no existence of life on the earth. The temperature of the earth has been increasing abnormally due to the increase of greenhouse gases in the atmosphere. As a result, we are facing climate change causing different negative impacts.

Question to think

What are the sources of carbon dioxide in the atmosphere?

Consequences of greenhouse effect

a. Increase in temperature

b. Change in water cycle

c. Negative impacts on human health

d. Decrease in agricultural productivity

e. Melting of snow in Himalayas and glaciers and decrease of snow

f. Increase in sea level causing sinking and flooding of coastal regions

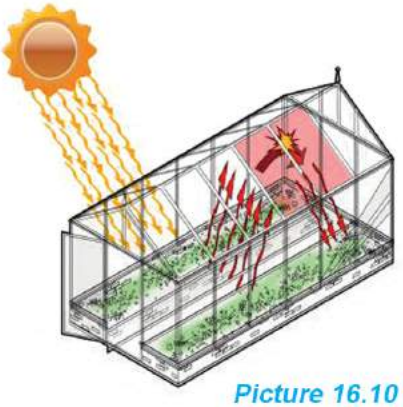
g. Degradation in biodiversity

h. Desertification

i. Imbalance in the ecosystem

Artificial greenhouse

Artificial greenhouses are made of transparent plastic or glass which allow solar radiation to enter into them. They are also known as hot houses. The structure made of glass and plastic to keep plants is called a greenhouse. The short waves of solar radiation can enter the greenhouse where some of the energy is absorbed by the greenhouse and they change to long waves. These waves with long wavelengths cannot escape from there. These long wavelength radiations changes into heat energy. As a result, heat is stored inside the greenhouse causing temperature to increase inside it. This is known as the artificial greenhouse effect.



Picture 16.10

Picture 16.11

Activity 16.2

Objective: To observe the temperature difference inside and outside of a plastic

Materials Required: a box made of a transparent plastic, thermometer

Method/ Procedure

1. Take a box made of transparent plastic.
2. Keep the box in sunlight for an hour.
3. Then measure the temperature of air inside and outside of the box with the help of a thermometer and note down on a table. Discuss the following questions based on the observation and draw a conclusion.

a. What difference is seen in the temperature of air inside and outside of the box?

b. What is the cause of the difference in temperature outside and inside of the box?

Importance and utility of artificial greenhouse

There is warm temperature inside a greenhouse so plants of any season can be grown inside it. We can earn money by growing unseasonal vegetables inside it. The existence of plants which are going to extinct due to extreme cold climate can also be protected. Similarly, we can also conserve rare plants found in cold places. The importance and utility of greenhouse can be listed below:

a. Plants of any season can be grown inside it throughout the year.

b. It helps thefood crops in very cold places.

c. Greenhouses are useful to produce flowers, green leafy vegetables, fruits, and different types of plants.

d. Plants inside the greenhouses can control environmental pollution.

e. Summer plants can be grown in the winter season as well.

f. Plants grown in summer season can be grown in cold places too.

How is the earth a natural greenhouse?

The earth is surrounded by the atmosphere of gases like carbon dioxide, ozone, water vapour, etc. These gases allow the solar radiation to enter the earth's surface but do not let them escape after reflection.

So, the rays are trapped inside the earth.

In this way the greenhouse gases increase the temperature of the earth. It plays the similar role as glass in an artificial green house. Thus, we can say that the earth is a natural greenhouse.

Ways to decrease greenhouse effect on the earth

To decrease the greenhouse effect, the production and use of greenhouse gases must be controlled. For this, we can adopt following methods:

1. The production and use of chloro fluoro carbons must be fully banned.
2. The use of petroleum products and coal should be decreased while use of renewable energy sources should be increased.
3. The use of alternate sources of energy like hydroelectricity, wind energy, solar energy etc. must be promoted.
4. Trees should be planted.
5. Production of carbon dioxide must be reduced.

Acid Rain

What would happen if acid is dropped on a leaf? The monuments as shown in the picture, are being faded day by day. What might be the cause of it? Why is this happening? What must be done to prevent it? Let's think about these questions.

Activity

Takehalf-filled glass bottle with hydrochloric acid. Dip a piece of bone into it and keep it for a day. Cautiously take out the bone after a day and observe it. What do you find? Discuss it and draw a conclusion.

Picture 16.12

Acid rain was first confirmed in 1960 AD. The gases like sulphur dioxide, carbon dioxide, nitrous oxide, chlorine,etc. produced from various industries and vehicles get mixed with water vapour in the atmosphere and form acids like, sulphuric acid, Carbonic acid, nitric acid, hydrochloric acids etc. These acids come down along with rain water which is known as acid rain. Generally, rain water is acidic. Its pH is 6. The pH value of acid rain ranges 3 to 5.

$2SO_2 + O_2 \rightarrow 2SO_3$

$SO_3 + H_2O \rightarrow H_2SO_4$

$CO_2 + H_2O \rightarrow H_2CO_3$

Effects of acid rain on the earth

1. The acid rain fades the monuments like temples, buildings, statues etc. made from marble.

$$CaCO_3\,(s) + H_2SO_4\,(aq) \rightleftharpoons CaSO_4\,(s) + CO_2\,(g) + H_2O\,(l)$$

2. It increases the acidity of soil thereby decreasing productivity.
3. The acid rain gets mixed to water sources and affects the aquatic animals.
4. It causes skin diseases in humans.
5. It causes negative effects on human health.

Methods to prevent acid rain

1. Less production of oxides of nitrogen and sulphur
2. Use of renewable sources of energy in place of fossil fuel
3. Awareness raising about the causes and effects of acid rain

Exercise

1. Choose the correct option for the following questions:

a. What products are formed on heating of limestone to a high temperature using coal?

i. Methane and lime

ii. Lime and carbon dioxide

iii. Acetylene and carbon dioxide

iv. Ammonia and lime

b. Which of the following statements is true?

i. Carbon dioxide is collected in the gas jar by the upward displacement of air.

ii. Carbon dioxide is collected in the gas jar by the downward displacement of air.

iii. Carbon dioxide is collected in the gas jar by the upward displacement of water.

iv. Carbon dioxide is collected in the gas jar by the downward displacement of water.

c. Which compounds are formed when carbon dioxide gas is passed through lime water for some time?

i. Calcium bisulphate ii. Calciumbicarbonate

iii. Calcium sulphate iv. Calcium carbonate

d. In what ratio should ammonium chloride and calcium hydroxide be mixed for the laboratory preparation of ammonia gas.

i. 3:1 ii. 2:3

iii. 1:2 iv. 2:1

2. Give reason

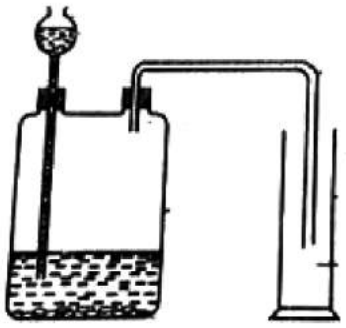
a. Carbon dioxide can be collected in an open glass jar.

b. The bottle of liquid ammonia should be placed in cold water or ice for some time before opening its lid.

3. Answer the following questions:

a. Describe the laboratory preparation of carbon dioxide with a labelled diagram.

b. Study the given figure and answer the following questions:



i. Which gas is being collected in the gas jar?

ii. Write a balanced chemical reaction for preparation of this gas.

iii. Which litmus paper is used to identify the gas?

iv. Why is this gas collected in the gas jar kept straight upright?

c. Write any three properties of carbon dioxide gas.

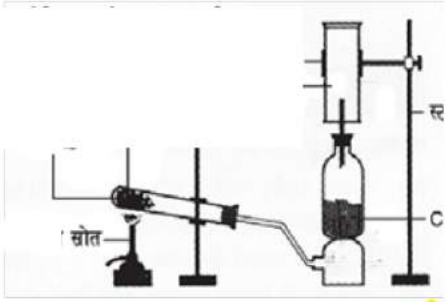
d. Write any four uses of carbon dioxide gas.

e. Describe the laboratory preparation of ammonia gas with a labelled diagram.

f. Study the given figure and answer the following questions.

i. Which gas is being collected in the gas jar?

ii. Write the balanc chemical equation for the preparation of this gas.



iii. Which litmus is used to identify this gas?

iv. Why the hard glass test tube is slightly inclined?

v. What is the use of the lime tower?

g. Write any four uses of ammonia gas.

h. What happens in the following processes? Write with a balanced chemical reaction.

i) Carbon dioxide is passed through lime water for some time.

ii) Carbon dioxide is passed through lime water for a long time.

iii) A burning magnesium is inserted into the jar full of carbon dioxide gas.

iv) The mixture of ammonium chloride and calcium hydroxide is heated.

v) Ammonia is mixed with water.

vi) Ammonia reacts with hydrochloric acid.

17 Metal and Not metals

Observe the pictures below and discuss the given questions:







a. Which of the given objects are metals and which of them are non-metals?

b. What type of materialsare used to make these substances?

c. Write the similarities and dissimilarities in the constituents of these objects?

d. From where and how are the raw materials required to make these objects obtained?

We use different types of matter in our daily life. These substances are classified into two types, pure and impure. Elements and compounds are the pure substances whereas mixture is the impure substance. Scientists have discovered 118 elements till now.

These elements are classified as metals, nonmetals and metalloids on the basis of their properties. Most of the elements are metals among the 118 elements in the modern periodic table whereas some are non-metals and only few are metalloids. We have already studied in previous class about the sources, properties and importance of metal, nonmetal and metalloid. In this unit, we will study about where and how these metals are found in nature as well as how these metals can be purified.

Minerals

Picture 17.2 potassium, sodium, and calcium rock

Almost all metals, except some, are found in the form of compounds on the earth's crust. These elements and compounds which are found naturally are called minerals. Minerals are the sources of metals. The rocks found on earth's surface are mainly made of metallic and nonmetallic matter. Some rocks are made of one or more types of minerals. Non-reactive metals like gold, silver, etc. are found in pure state in nature whereas reactive metals like sodium, potassium, calcium, iron, etc. are found in the form of compounds. Almost all minerals are inorganic, pure, solid and crystalline in nature. In this way, the pure, solid and crystalline compounds found in nature are called minerals. They have a fixed chemical formula. The earth's crust is composed of about 90% of silicate minerals. Besides this, sulphide, oxide, carbonate, sulphate, phosphate ores are also found on it. Minerals like hematite, cuprite, granite, limestone, talc, red clay, coal, etc. are found in different parts of Nepal. Dang, Salyan, Rolpa, Gulmi, Pyuthan, Lalitpur, Palpa, Nawalparasi are some places where minerals are found in Nepal.

Ore

A lot of impurities are found in the ores obtained from mines. Metals can be obtained from these ores only after removing these impurities.

The process of removing impurities from the ores depends upon the physical and chemical properties of the substances found in them.

Different amounts of metals are found in different minerals. Some minerals contain more amounts of metals from which the metals can be extracted easily and economically whereas some minerals contain less amount of metals and thus metals cannot be extracted easily and economically from them. The mineral from which a metal can be extracted in a large amount with low cost is called the ore of that metal. The minerals from which a metal cannot be taken out easily are not the ores. Thus all ores are minerals but all minerals are not ores. The metals used in our daily life are obtained from different ores.

Some ores of iron

Picture17.3 Ores of Iron

Some ores of iron are as follows:

a. Hematite (Fe_2O_3)

b. Magnetite (Fe_3O_4)

c. Siderite ($FeCO_3$)

d. Limonite ($2Fe_2O_3.3H_2O$)

e. Iron pyrite (FeS_2)

Among them hematite is the chief ore of iron. It contains a maximum amount of iron (about 75%).

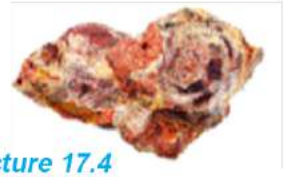
Some ores of aluminium

Some of the ores of aluminium are as given below:

a. Bauxite ($2Al_2O_3.2H_2O$)

b. Cryolite (Na_3AlF_6)

c. Corundum (Al_2O_3)



Picture 17.4

Among these ores, Bauxite is the chief ore of aluminium which contains about 40-60% of aluminium.

Some ores of copper

Cuprite

Chalcocite

Malachite
57,3% copper

Chalcopyrite
34,5% copper

Picture 17.5

Some ores of the copper are follows:

a. Chalcocite or copper glance (Cu_2S)

b. Copper pyrite or chalcopyrite ($CuFeS_2$)

c. Cuprite (Cu_2O)

d. Malachite [$Cu_2(OH)_2CO_3$]

Copper pyrite or chalcopyrite is the main ore of copper which contains about 34.5% of copper.

Some ores of Silver

a. Argentite (Ag_2S)

b. Horn silver (AgCl)

c. Ruby silver ($Ag_2Sb_2S_3$)

d. Silver copper glance ($Ag(Cu)_2$ S)

fig 17.6 Argentite

Among these the chief ore of silver is the argentite which consists of about 87% silver.

Some ores of gold

Gold is found in pure state in nature or the ores of gold contain it in pure form. Gold is a non-reactive metal so it is found in pure state. It is found mainly in rocks and alluvial soil formed from rocks.

Activity 17.1

Collect the pictures and name of ores of iron, aluminium, copper, and silver and paste them on a chart paper. Present it group wise in your class.

Metallurgy

Mining

For extracting metals, the ores of metals are first taken out from their mines by digging the earth's surface. This process of extracting useful substances and minerals from the earth's geological surface is called mining. Mining is done to take out coal, petroleum, gold, and ores of different metals from the Earth's crust. Then metals are extracted from their ores through different steps.

Metallurgy is the science which deals about the properties, production and purification of metals. It also includes the stepwise extraction process of metals from their respective ores. Generally, five main steps are to be adopted for extracting pure metal from their ores.

General steps of metallurgy

Grinding

This is the first step of metal extraction. The process of crushing the ores into small particles form with the help of rollers of the machines is called grinding.

1. Concentration

The grounded or crushed ores contain impurities like mud, sand, rocks, etc. which is known as gangue. So these impurities must be removed first. Concentration is done to remove the impurities from ores. Thus the process of removing impurities from the ores thereby increasing the percentage of metals in them is called concentration. A specific method is used to remove these impurities from the ores according to their properties. For example, if the density of ore and impurities is different than hydraulic or gravity separation method is used. Similarly, magnetic separation is used if one of them is magnetic and the other is non-magnetic substance. If either ore or impurities are hydrophilic and other being hydrophobic, a froth floatation process is used to concentrate the ore.

Activity 17.2

Use of magnetic method to separate the mixture of magnetic and non-magnetic substances.

Materials required: Iron dust, aluminium dust, sand, and a magnet

Method/Procedure: Make a mixture of iron dust, aluminium dust, and sand.Bring a magnet near to the mixture.

Observation: What do you see? Why does it happen?

In this way magnet attracts iron dust (magnetic substance) but does not attract aluminium and sand (non-magnetic substance) and they get separated.

Conclusion .....

3. Oxidation

It is easier to obtain metals from their oxides, so the concentrated ores are changed to metal oxide. There are two processes for the oxidation of metals.

a. Roasting

It is the process of strongly heating the ore to their oxides by passing air or in presence of oxygen. This process is done for non-oxide ores. Generally roasting is done to convert sulphide ores to their oxide ores. For example, Zinc sulphide (ZnS) is converted to Zinc oxide (ZnO) by the process of roasting.

b. Calcination

It is the process of strongly heating the ores to their oxides in the absence of air or without passing oxygen. Calcination is done to convert carbonate ores to their oxides. For example, calcium carbonate is converted to calcium oxide by using a calcination process.

4. Reduction

It is the process of removing oxygen from metal oxide. The metal oxides like copper oxide, lead oxide,and iron oxide are treated with reducing agents like carbon, carbon monoxide, hydrogen, etc. which removes oxygen from these metal oxides.

But zinc oxide can be reduced by carbon only. Silver oxide and mercury oxide are unstable and they are reduced when heated. The oxides of reactive metals like sodium, potassium, calcium, magnesium, aluminium, etc. are very stable and they can be reduced only by the electrolysis method.

Smelting

After oxidation, metal oxides are reacted with reducing agents like carbon, coke, or hydrogen above the melting point of the metals.

In this process, metals are separated from their oxides in the molten form and the remaining impurities are separated in the

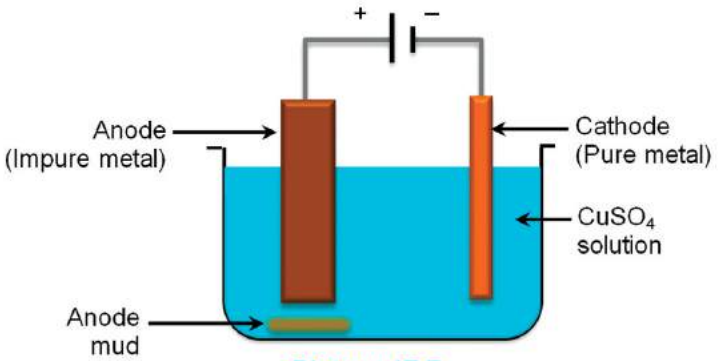
form of gases or slag. This process of heating metals beyond their melting points along with a reducing agent is called smelting.

5. Refining

The metals obtained after the reduction process may still contain some impurities. So to obtain metals in pure state, refining is done. Metals can be refined through various processes like distillation, electro refining, etc. In this way, pure metals can be obtained after refining through various methods.

a. Distillation

In this method, the impurities present in metals are removed by boiling. This process is done when either the metals or impurities would change to vapour when heated. It is used for the purification of metals which poses a low boiling point and gets vaporized such as mercury.



Picture 17.7

B. Electro-refining

Electro-refining is one of the processes of refining metals obtained from the reduction process. For electro-refining, the electrolysis method is used. This process is used to obtain metals like iron, silver, copper, gold,etc. in pure state. The metals obtained by this process are about 99% pure. In this method, a voltameter (vessel to perform electrolysis) is taken and impure metal is connected to anode (positive terminal of cell) whereas pure metal is connected to the cathode (negative terminal of cell). In this method, one of the salt of metal to be refined is used as

an electrolyte. For example, do the activity of purifying impure copper by the method of electro-refining.

Activity 17.3

Purifying impure copper by the method of electro-refining.

Materials required: voltameter, impure copper, pure copper plate, battery, copper sulphate solution, or solution of any other copper salts.

Method:

Take the solution of copper sulphate in the voltameter. Connect impure copper to the positive terminal of the battery and the pure copper plate to the negative terminal of the battery as shown in figure 17.7 thus by making impure copper an anode and pure copper as cathode. Now pass electricity into the voltameter.

Observation

What do you see? Why and how does it happen?

The impure copper plate in anode erodes and pure copper gets deposited on the cathode.

Conclusion

In this way, we can get the pure copper from its impure form by the process of electrolysis.

Activity 17.4

Make a flowchart showing different steps of metallurgy in a chart paper and present it in the class.

Project work

Search the internet and observe an audio visual materials on the extraction of metals. Prepare a report on metallurgy and present it in the classroom.

Exercise

1. Choose the correct option for the following questions:

a. Which is the main ore of iron?

i) Bauxite ii) Argentite

iii) Hematite iv) Pyrite

b. Which metal is found in pure state in nature?

i) Aluminium ii) Iron

iii) Copper iv) Gold

c. Which is the primary step of purifying metal?

i) Smelting ii) Roasting

iii) Concentration iv) Grinding

d. Which of the following ore is oxidised by roasting method?

i) Hematite ii) Siderite

iii) Bauxite iv) Cuprite

e. In which process is smelting included?

i) Grinding ii) Refining

iii) Oxidation iv) Reduction

2. Give reason:

a. All ores are minerals but all minerals are not ores.

b. Ores are oxidised after concentration.

3. Write the differences between:

a. Mineral and ore

b. Roasting and calcination

c. Oxidation and reduction

4. Answer the following questions:

a. What are the sources of metals?

b. Make a list of ores of iron, copper, aluminium, and silver.

c. How is metallurgy a stepwise process? Explain.

d. How pure metals are obtained from electro-refining? Explain it with an activity.

18 Hydrocarbon and its Compounds

There are different types of compounds around us. These compounds can be classified as carbonic and non-carbonic or organic and inorganic. The compounds obtained from minerals are called non-carbonic compounds or inorganic compounds and the compounds obtained from plant and animal sources are called carbonic compounds or organic compounds. All the compounds of carbon except its oxides, carbonates, bicarbonates, and carbides are the organic compounds. The carbonic compounds composed of only carbon and hydrogen are called hydrocarbons.

Hydrocarbon

Activity 18.1

Collect locally available materials like wood pieces, sugar, stone, water, cooking oil, ghee, rice, maize, glass, iron pieces, etc. Make fire using the wood pieces in an open place. Then put the above materials in the fire one by one and observe. Classify the objects which burn in fire and which do not burn and fill the given table.

S.N.	Name of the object	Combustible	Non combustible

Conclusion: On this basis, all combustible substances are organic and non-combustible substances are inorganic.

All the combustible substances consist of carbon and hydrogen. Hydrocarbons are made of carbon and hydrogen. Kerosene lamps are lit in the villages where there is no hydroelectricity. Similarly, firewood is used to cook food. Spirit lamps are used in laboratories as a source of heat. Charcoal is used to heat and melt metals while making utensils. All of these combustible substances contain carbon and hydrogen. These substances are obtained from plants and animals.

Those substances which are obtained from plants and animals and are combustible are called organic compounds.

The substances found in the human body like protein, hormone, carbohydrate, fat, enzyme, protoplasm, etc. all are organic compounds.

Organic compounds

Generally, the compounds of carbon covalently bonded to other carbon atoms or hydrogen atoms are called organic compounds. Besides hydrogen, the carbon may also form covalent bonds with other elements like oxygen, nitrogen, halogens, sulphur, and phosphorus. However, CO_2, CO, HCO_3-, CO_3- - , are not organic compounds although they contain carbon atoms. Generally organic compounds are composed of elements like carbon, hydrogen, oxygen, nitrogen, halogen, sulphur, and phosphorus. Some organic compounds may also contain metal bonded to them. The examples of organic compounds are methane, ethane, ethene, acetylene, methanol, chloroform, urea, insulin, protein, oil, etc. The branch of chemistry which deals with the study of these compounds is called carbonic chemistry or organic chemistry.

Petroleum is the main source of hydrocarbons. The hydrocarbons are classified as saturated and unsaturated on the basis of types of bonds between the carbon atoms.

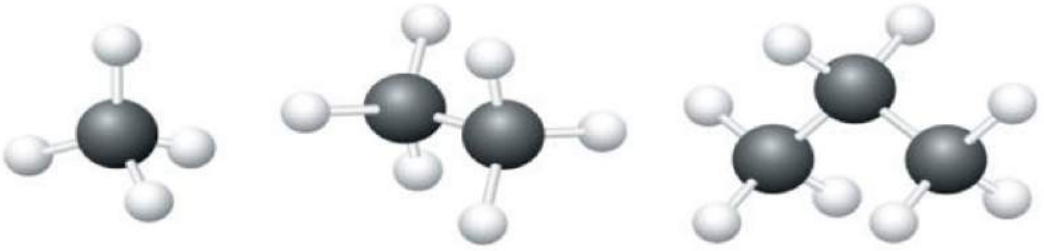
Activity 18.2 Model of a hydrocarbon molecule

Objective: To make a model of a hydrocarbon molecule

Materials required: clay dough or flour dough, colour, matchstick or toothpick

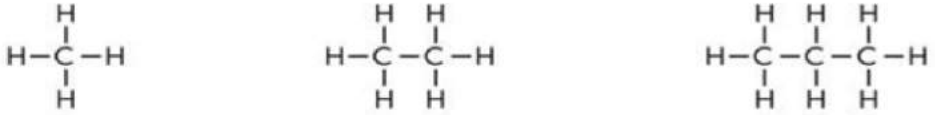
Method/ Procedure:

1. Make some spherical shapes from the clay or flour dough of different sizes.
2. Paint bigger spherical shapes red and assume them to be carbon atoms and paint smaller spherical shapes white and assume them to be hydrogen atoms.
3. Then prepare a model of hydrocarbon as shown in figure with the help of toothpick or matchstick. Now, have a discussion in your classroom.



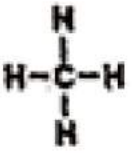
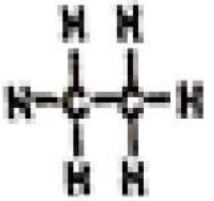
CH_4 C_2H_6 C_3H_8

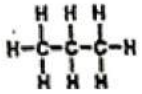
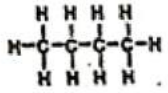
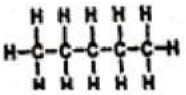
Methane Ethane Propane



Saturated hydrocarbon

The hydrocarbons having a single covalent bond between the carbon atoms are called saturated hydrocarbons. They are very stable and less reactive so they are known as paraffin. They are also called alkanes. The general formula of these compounds is C_nH_2n+2 where 'n' is the number of carbon atoms. Here n= 1, 2,3,4.....

Name	Molecular formula	Condensed formula	Structural formula
Methane	CH_4	CH_4	
Ethane	C_2H_6	H_3CCH_3	

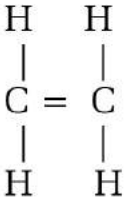
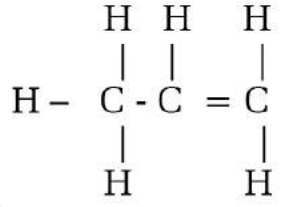
Propane	C_3H_8	$H_3CCH_2CH_3$	
Butane	C_4H_{10}	$H_3C(CH_2)_2CH_3$	
Pentane	C_5H_{12}	$H_3C(CH_2)_3CH_3$	

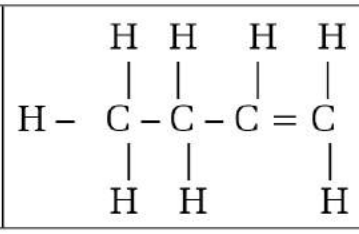
Unsaturated hydrocarbon

The hydrocarbons having double or triple covalent bond between the carbon atoms are called unsaturated hydrocarbons. They are less stable and are very reactive so they are known as olefins.They are also known as alkene and alkyne.

Alkene

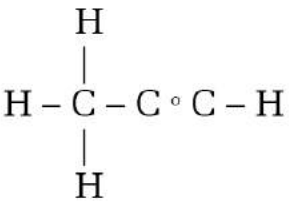
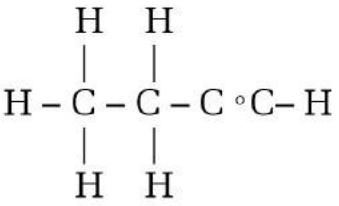
The hydrocarbons having a double covalent bond between the carbon atoms are called alkene. Example ethene, propene, butene, etc. The general formula of these compounds is C_nH_{2-n} where 'n' is the number of carbon atoms.

Name	Molecular formula	Condensed formula	Structural formula
Ethene	C_2H_4	$H_2C = CH_2$	
propene	C_3H_6	$H_3C\text{-}CH= CH_2$	

Butene	C_4H_8	$H_3C - CH_2 - CH=CH_2$	

Alkyne

The hydrocarbons having a triple covalent bond between the carbon atoms are called alkyne. Example ethyne, propyne, butyne, etc. The general formula of these compounds is C_nH_{2n-2} where 'n' is the number of carbon atoms.

Name	Molecular formula	Condensed formula	Structural formula
Ethyne	C_2H_2	$HC \circ CH$	$H - C \circ C - H$
Propyne	C_3H_4	$H_3C- C \circ CH$	
Butyne	C_4H_6	$H_3C- CH_2 - C \circ CH$	

The process of making Vanaspati ghee from vegetable oil is called hydrogenation. In hydrogenation, the unsaturated fatty acids change to saturated fatty acids.

$$H_2C=CH_2 + H_2 \longrightarrow C_2H_6$$

Alkene Alkane

Differences between saturated and unsaturated hydrocarbons

Saturated Hydrocarbon	Unsaturated Hydrocarbon
1. The Hydrocarbon having a single covalent bond between the carbon atoms is called saturated hydrocarbon.	1. 1. The Hydrocarbon having double or triple covalent bond between the carbon atoms is called unsaturated hydrocarbon.
2. Saturated hydrocarbons are stable.	2. Unsaturated hydrocarbons are unstable or they are chemically reactive.
3. They are also known as alkane (C_nH_{2n+2}). For example, CH_4, C_2H_6, C_3H_8	They are also known as alkene (C_nH_2n) and alkyne (C_nH_{2n-2}). For example, C_2H_4, C_2H2, C_3H_4

Homologous series

The series of hydrocarbons which can be represented by the same general formula is called a homologous series. Each member of this series is called a homologue. All the members of the series can be represented by a common formula and the adjacent homologue of the series differs by CH2 group. Similarly, the molecular weight of adjacent members of the series or homologue differs by 14.

Name	Molecular Formula
Methanol	CH_3OH
Ethanol	CH_3CH_2OH
Propanol	$CH_3CH_2CH_2OH$

Alkyl radical

The group of atoms formed by removing one hydrogen atom from an alkane molecule is called an alkyl radical. It can be represented by a general formula C_nH_{2n+1}. For example $-CH_3+$, $-C_2H_5^+$, etc.

for example : CH_3^+, $CH_3CH_2^+$

Functional group

An atom or a group of atoms which determines the structure and chemical reactivity of a certain group of organic compounds is called a functional group. The functional groups get attached to the alkyl groups to form different groups of organic compounds.

Example of functional groups -O-, -CHO, -COOH

Nomenclature of hydrocarbons

IUPAC means International Union of Pure and Applied Chemistry. It is a system established by scientists to make uniformity in the names of organic and inorganic compounds all over the world. According to this system, a compound has the same or only one name. This removes the mistake while naming or understanding the compounds.

Common system of nomenclature of hydrocarbons

i. Find the word rooton the basis of number of carbon atoms as:

No of carbon atoms	Word root	notation
C-1	Meth	C_1
C-2	Eth	C_2
C-3	Prop	C_3
C-4	But	C_4
C-5	Pent	C_5
C-6	Hex	C_6
C-7	Hept	C_7
C-8	Oct	C_8
C-9	Non	C_9
C-10	Dec	C_{10}

ii. In this way after finding the word root, add the suffixes like ane, ene and yne according to the number of bonds between the carbon atoms.

For example,

$CH_3 - CH_3$

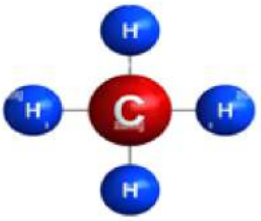
There are two carbon atoms so the word root is eth and there is only one covalent bond between the carbon atoms, so we should add ane as the suffix.

So, its name is eth+ane = ethane

Some important hydrocarbons and their compounds.

Methane

This gas is found in marshy places so it is also known as marsh gas. Its molecular formula is CH_4. This gas is generally found above the minerals oil. It is also found in gobar gas or bio gas, and sewage gases. It is colourless, odourless, and tasteless. It is not soluble in water but soluble in organic solvents like ether, alcohol, etc.



Methane CH_4

Uses of methane

1. Methane is used for cooking food as gobar gas or biogas and as a fuel in industries.
2. It is used to prepare carbon black which is used to make printing ink, shoe polish and paint.
3. Methane is also used to prepare chloroform, carbon tetrachloride, methyl alcohol, formaldehyde, etc.
4. It is also used in the industrial preparation of hydrogen gas.

Ethane

Ethane is a saturated hydrocarbon having two carbon atoms bonded with a single covalent bond. Its molecular formula is C_2H_6. It is found along with methane gas in natural gas, coal gas, and petroleum mines. It is also colourless, odourless, and tasteless as methane. It is also insoluble in water but soluble in organic solvents like ether, alcohol, etc.

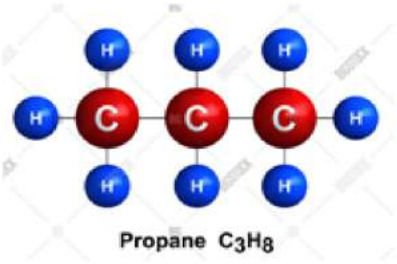
Uses of ethane

1. It produces heat on combustion so it is used in metal welding.

2. It is also used to prepare carbonic compounds like ethyl chloride, nitro ethane, etc.

Propane

Propane is also a saturated hydrocarbon. Its molecule consists of three carbon atoms and its molecular formula is C3H8. This gas is also found in natural gas and petroleum mines. It is a colourless and odourless gas. It is insoluble in water but soluble in organic solvents.



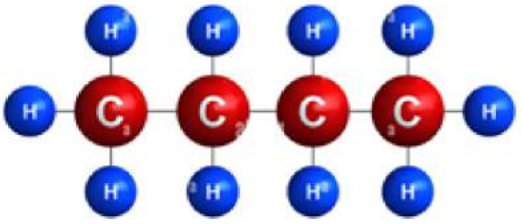
Propane C_3H_8

Uses of propane

1. It is a highly flammable gas so it is used as a fuel.
2. It is used to make different types of carbonic compounds.
3. It is used as a coolant in petroleum industries.

Butane

Butane is also a saturated hydrocarbon. Its molecule consists of four carbon atoms and its molecular formula is C4H10. This gas is also found in natural gas and petroleum mines. It is a colourless and odourless gas. It is insoluble in water but soluble in organic solvents.



Butane C_4H_{10}

Uses of Butane

1. It is used as a raw material for making synthetic rubber.
2. It is mixed with methane in LPG (Liquefied Petroleum Gas) which is used as fuel. It easily changes to liquid on applying pressure.

Alcohol

Do you know?

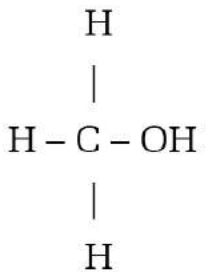
Generally, alcohol refers to ethyl alcohol (C_2H_5OH) in our daily life. It has the functional group -OH and it is also known as ethanol. It is colourless liquid and soluble in water.

The compounds of alcohol are produced from alkanes. The compounds formed by the replacement of one or more hydrogen atoms of alkanes by the -OH group are alcohols. Its general formula is $C_nH_{2n+1}OH$. Hydroxyl group (-OH) is the functional group of alcohols.The alcohol with only one hydroxyl group is known as monohydric alcohol.The alcohol with two hydroxyl groups is known as a dihydric alcohol. Similarly, the alcohol that consists of three hydroxyl groups is known as a trihydric alcohol.

Some important alcohol compounds

Methyl Alcohol

Methyl alcohol is a monohydric alcohol. Its IUPAC name is methanol. Its molecular formula is CH_3OH, and it is represented by the following structural formula:



Uses of methyl alcohol

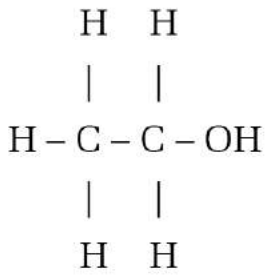
1. It is used to prepare methylated spirit.
2. It is used as a solvent for paints and varnishes.
3. Methanol is also used to prepare perfumes, paints, medicines and synthetic clothes.

4. It is also used to manufacture formaldehyde.

5. It is also used in dry cleaning.

Ethyl alcohol

Ethyl alcohol is also a monohydric alcohol. Its IUPAC name is ethanol. Its molecular formula is C_2H_5OH, and its molecular structure is as follows:



Uses of ethyl alcohol

1. Ethyl alcohol is used to prepare hard drinks like whisky, wine, beer, etc.

2. It is used to sterilize syringes and wounds in hospitals, health posts, and nursing homes.

3. It is used to preserve biological specimens in laboratories.

4. It is also used in thermometers.

5. It is used in the manufacture of polyethylene, terylene, soaps, paints, dyes, etc.

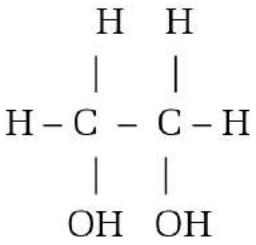
6. It is also used as an organic solvent.

Activity 18.3

Ask a person in your locality who could prepare alcohol and observe the alcohol making process and prepare a report. Present your report in the class.

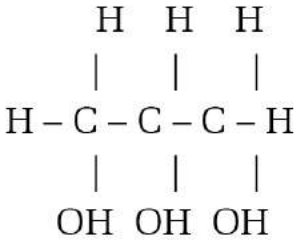
Glycol

It is a dihydric alcohol. in which two hydroxyl groups are attached to each of the carbon atoms of hydrocarbons. In glycol, each carbon contains one hydroxyl group. Different types of glycols are used in industrial and food stuff. One of the common glycols is ethane diol. Its IUPAC name is ethane-1, 2-diol. Its molecular formula is CH_2OHCH_2OH and its structural formula is:



Glycerol

The compound formed by replacing three hydrogen atoms of propane with three hydroxyl groups is called glycerol. Glycerol is a trihydric alcohol which is also known as glycerine. Its name is derived from a Greek word glycerol which means sweet. It is a colourless and sweet viscous liquid. It is soluble in water and alcohol but insoluble in ether. Its IUPAC name is propane-1, 2, 3- triol. Its molecular formula is $C_3H_5(OH)_3$ and its structural formula is



Uses or glycerol

1. It is used to protect skin by trapping moisture and prevent its dryness.

2. It is used as a sweetening agent in food.
3. It is used to make good quality soap, lotion, cosmetics, shaving creams, etc.
4. It is used to keep the tobacco moist and it also prevents the dryness of fruits and foods as well as prevents them from decaying.

Project work

Enlist the hydrocarbons and their compounds used in your house. Also write how they are used at your home.Present your report in the class.

Exercise

1. Choose the best option for the following questions.

a. Which hydrocarbon is included in the alkane group?

i. Methane ii. Ethene

iii. Acetylene iv. Propyne

b. Which one is the correct formula of glycerol?

i. $C_3H_6(OH)_2$ ii. $C_3H_5(OH)_2$

iii. $C_3H_4(OH)_4$ iv. $C_3H_5(OH)_3$

c. Which of the following is the IUPAC name of the alcohol used as a beverage?

i. Methanol ii. Ethanol

iii. Propanol iv. Butanol

d. Which of the following is used to protect skin from dryness?

i. Methyl alcohol ii. Ethyl alcohol

iii. Glycerol iv. Glucose

e. Which hydrocarbon is used to prepare glycerol?

i. Methane ii. Ethane

iii. Propane iv. Glucose

2. Write differences between

a. Saturated and unsaturated hydrocarbon

b. Alkane and alkene

c. Monohydric alcohol and dihydric alcohol

3. Give reason

a. Ethane is known as a saturated hydrocarbon.

b. Glycerol is called a trihydric alcohol.

4. Answer the following questions:

a. What are hydrocarbons? Write any four examples.

b. What do you mean by a saturated hydrocarbon? Write with examples.

c. Introduce methane gas along with its two uses.

d. What is alcohol? Write its types on the basis of the hydroxyl group? Also write their examples along with their molecular formula and the structural formula.

e. Write the molecular formula, condensed formula, and the structural formula of the following compounds.

Ethylene, propene, acetylene, ethyl alcohol, glycerol

f. Name the alcohol used for following purposes:

i. to make formaldehyde

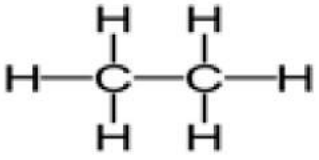
ii. used in thermometer

iii. used as an antiseptic

iv. to prepare alcoholic beverages

g. Write the structural formula of ethylene. What type of bond is found between its hydrogen and carbon? Why is the bond between its carbon atoms weak?

h. Study the following structural formula of a hydrocarbon and answer the given questions.



i. Write the name of this compound.

ii. Is it a saturated hydrocarbon?Write with reason.

iii. Which compound will form if one of the hydrogen atoms is replaced with a -OH group in the given compound?

i. Write any three uses of methane gas.

j. Write major uses of each of ethane and propane.

k. Define the following terms.

   i. Saturated hydrocarbon

   ii. Unsaturated hydrocarbon

   iii. Alkane

   iv. Alkene

   v. Alkyne

   vi. Functional group

   vii. Homologous series

l. Write the molecular formula of the following compounds

   Glycerol, methane, ethanol, butane, propane, acetylene, ethene, ethane, propyne, methyl alcohol

m. Write the name and structural formula of the alcohol used in spirit lamps.

n. Name the compound formed by the replacement of three hydrogen atoms with three hydroxyl groups (-OH) from propane. Also write its IUPAC name along with its structural formula. Write its three uses.

o. Rama has a problem of dry skin in her hands, feet, and face. Which compound can be used to solve her problem? Write the IUPAC name and the structural formula of that compound.

19 Chemicals used in Daily Life

Different types of chemicals are used in our daily life. Among them some are natural and some are manufactured in industries. For example, chemicals used for cleaning purposes, food preservatives, pesticides, chemicals used for the preservation of fruits and vegetables, chemical fertilizers, etc. are the chemicals used in our daily life. The branch of chemistry in which we study about the different aspects of transformationof matter to manufacture materials useful to mankind through chemical processes is called industrial chemistry.

Picture 19.1 materials used in our daily life

Some of the chemicals given above are used for cleaning, some are used to kill harmful pests, while some are used as food and food preservatives. Prepare a list of other chemicals used in our daily life and fill the given table and then, discuss in the classroom.

Chemicals used as food	Chemicals used as food preservatives	Chemicals used for cleaning	Chemicals used as pesticides
Salt, sugar	Salt, sugar	Soap	Rat poison (Rodenticides)

Food preservatives

Activity 19.1

Topic: Use of salt and oil in pickle

Objective: To observe the effect of salt and oil in pickle

Materials required: seasonal vegetables like carrot, radish, cabbage or fruits and vegetables which can be used to make pickle, two plastics or glass bottles, salt, oil

Method

1. Cut the vegetables or fruits into small pieces.
2. Dry them in sunlight for some time.
3. Divide them into two parts.
4. Mix oil and salt in one part and put in one of the bottles with little pressing. Put the next part into another bottle without mixing salt and oil.
5. Observe the pickles in both bottles after a week.

Conclusion

The pickle made by mixing oil and salt would be preserved whereas the pickle in another bottle would be decayed. Salt and oil prevent food from decaying so they are known as food preservatives.

The food gets decayed due to the growth of bacteria, yeast, mold, etc. on it. In this way, the substances used to protect food from decaying are called food preservatives. They are used to prevent food from decaying for a long time like cereals, legumes, vegetable products, fruits and vegetables, and animal products like meat, milk and milk products, etc. These food preservatives check the growth of bacteria, yeast and mold in the food stuff.

Preservatives are classified as first class and second class.

First Class preservatives: They belong to natural sources and can be used in necessary amounts in food. Sugar, salt, vinegar, honey, spices, edible oils, etc. are the examples of first class preservatives.

Second Class preservatives:

They are obtained by chemical derivation of compounds and can be used in a certain or limited amount only. For example, sodium or potassium nitrate, benzoic acid and its salts, sulphur dioxide, etc. We should not use more than one type of second class preservatives in any food.

Different traditional and modern methods are used to preserve food materials, like drying, keeping them in the fridge, mixing with salt and sugar solution, etc. Similarly, different chemicals are used to ripen the fruits quickly. But such chemicals used in food are very harmful to human health and the environment. We should wear masks and gloves while using them. Similarly, we should wash our hands with soap and water after using them. They should not be used in excess and we should use natural preservatives as much as possible instead of them.

Discuss the traditional and modern methods of preservation of food materials.

Food preservatives are used to preserve the nutrients of fruits, vegetables, milk, curd, meat, and fish, and prevent food spoilage. Food preservatives are of three types: chemical food preservatives, natural food preservatives, and the preservatives which induce ripening of fruits.

1. Chemical food preservatives

figure 19.2 a

figure 19.2 b

Salt and oil are the chemicals which control the growth of microscopic germs and organisms. Similarly, the chemicals like sodium benzoate sorbate, Sulphur dioxide, nitrates and nitrites,

butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), calcium propionate, sodium metabisulfite are used as food preservatives.

2. Natural food preservatives

Food materials are being used continuously and within a short interval of time in our daily life. Natural food preservatives come from organic matter and they prevent food materials from decaying. We can get the natural preservatives from plants, animals, fungi and algae. Use of mugwort (Titepati), neem oil, lemon concentrate (Chuk) etc. are some examples of natural food preservation. Similarly, the traditional methods of food preservation like drying in sun, keeping in cold places or above water, use of wood ash, mixing of turmeric and oil, etc. are the natural methods to preserve food. Nowadays new methods of food preservation have been developed in both urban and rural areas like pasteurization, freezing, keeping food in cold stores, etc. All of these technologies control the elements required for the growth of microbes and preserve food materials.

3. Food preservatives as inducing ripening of fruits/ Artificial ripening food preservative

Fruits like mango, banana take a long time to ripen even after maturation. So to induce the ripening of these fruits, different chemicals are used. The chemicals used for fast ripening of fruits are called ripening agents. Calcium carbide, ethylene gas, ethephon, etc. are the ripening agents.

Picture 19.3Chemicals used to ripen the mango

There are many traditional methods of fruit ripening like wrapping the fruits in a jute sac, using leaves of Asuro (Malabar nut), keeping

the sac of fruits inside a pit or hole and covering with soil from top, wrapping them inside a thick layer of husk or hay, etc.

But nowadays calcium carbide is used excessively to ripen the fruits as it is an easier and cheaper method. We should be careful while using this chemical and while consuming the fruit ripened with it. Different health problems like skin irritation, skin burning, appearance of red blisters in skin, lung effusion, eye irritation may appear due to the overuse of these chemicals. So we must be very careful while consuming these fruits. Similarly, these chemicals should not be used in excess.

Introduction and use of chemicals used in cleansing

Natural materials used in cleansing

We use different types of natural substances for cleansing. Reetha (soapberry), mustard seed cake (Peena), wood ash, lemon juice, Sajiban, etc. are the natural materials used for cleansing purposes.

Picture 19.4Natural materials used in cleansing

Reetha (Soapberry)

Reetha contains saponin which acts as a foaming agent so it can be regarded as a soft natural soap. It has been in use for centuries to clean our body and wash clothes. It is a traditional medicinal tree found in Nepal, India, and China. It is generally used to make ayurvedic medicine. The powdered form of its fruit is used in shampoo as a foaming agent.

Peena (Mustard seed cake)

Peena (Mustard seed cake) has been in use in our country for a long time to wash hair and make it soft and strong. It consists of necessary nutrients for the healthy growth of hair and make it strong like folate,

niacin, thymine and vitamin B6 which are the forms of vitamin B complex. Its use can control hair fall to a large extent. It also makes hair soft and healthy.

Wood ash

Wood ash is being used for cleaning purposes. It can be mixed with a small amount of water to form a paste, this paste can then be used as an abrasive cleaner. It can brighten metals and clean dirty utensils.It even removes sticky residue and adhesive. Wood ash is also a good source of potassium, phosphorus, and magnesium for the plants so it can also be used as a fertilizer.

Sajiban

Sajiban is a very useful plant found naturally in different regions of Nepal. It has been used in various ways. Animals do not eat this plant, so it can be used as a fence in our fields. Its leaves are used to make compost manure and its juice is used to cure the burns. Similarly, it can be used as an anticancer medicine and its twigs can be used for brushing teeth. It is also a good source of nitrogen, phosphorus, and potash.Therefore, it is also used as an organic fertilizer.

Let's know the importance of Sajiban

The juice and oil of Sajiban can be applied on cattle to kill lice on their body. Its oil can also be applied to cure skin diseases and infections and to relieve muscular and joint pains. Its oil can also be used to make soaps and lit lamps. Its twig can be used to clean teeth. Its oil can also be used to produce glycerin. Its leaves are used to make compost and its seed cake can be used as manure. The oil obtained can be refined to get bio diesel.

Jatropha curcas or Sajiban found in Nepal has been referred to as an excellent source of biodiesel by scientists. Generally, a seed of Sajiban consists of about 30 to 48% of oil. About one liter of oil can be produced from 3 kilograms of Sajiban seeds.

Lemon Juice

Lemon juice consists of citric acid in high concentration. It is a good natural cleaner due to its low pH value and antibacterial properties. It also works as a natural bleach. It has a good smell and does not destroy materials like wood and clotheswhen used to clean them. It also cleans copper surfaces efficiently and makes them shiny. Lemon juice has been used as a medicine for decades.

Chemicals used in cleansing

Soap

The sodium or potassium salts of long chain fatty acids are called soap. Generally, animal fat or vegetable oil, sodium hydroxide, and sodium chloride are the raw materials for making soap. For making soap, vegetable oil (olive, coconut or cotton seeds) or animal fat is heated with sodium hydroxide and sodium chloride. This process of making soap by the hydrolysis of vegetable oil or animal fat with alkali is known as saponification. Soap produces insoluble scum with the hard water so it is not an efficient cleaner in hard water. However, it is biodegradable so it does not cause chemical pollution.

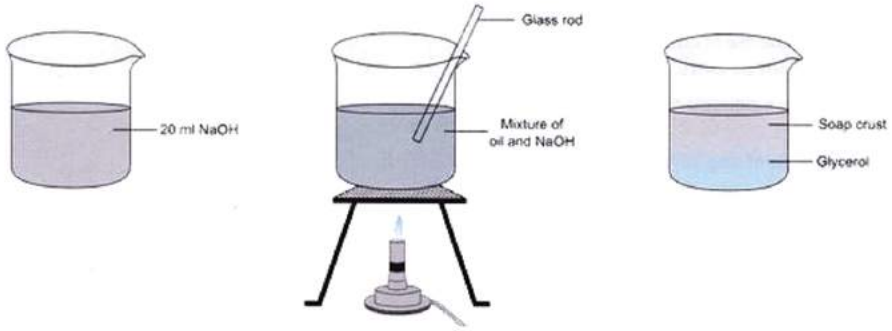
Activity 19.2

Objective: To make soap

Materials required: vegetable oil or animal fat, sodium hydroxide solution, edible salt or sodium chloride, a beaker, funnel, filter paper, source of heat

Method/ procedure

1. Take about 40 ml of vegetable oil in a beaker.
2. Make about 50 ml mixture of sodium hydroxide by dissolving 15 grams of sodium hydroxide in50 ml water.
3. Mix both of them and heat the mixture. On heating for some time, it forms a thick paste. Add a little soda and common salt. The salt helps to separate soap from the mixture.



Picture 19.5: Soap making process

4. Now filter the mixture by using a filter paper. The residue left on the filter paper is the soap. Now pour the soap in a desired shape vessel.

5. Keep the soap untouched for a day and we would get a soap of desired shape. The remaining solution or the filtrate contains glycerin.

Detergent

Picture 19.6: ditergent

Detergent is a substance used to clean clothes. It is more soluble than soap. It is a chemical obtained from hydrocarbons which is more soluble in water than soap. It is also known as soapless soap. It cleans clothes like soap.However, its chemical nature is different from that of soap. It can be used with hard water as well. Sodium lauryl sulphate, alkyl benzene sulphonate, sodium pyrophosphate, etc. are some examples of detergents. It is a chemical so it is non-biodegradable. Due to which it can cause chemical pollution.

They are found in powder or liquid form. Most of the perfumed soaps in the market are also made from petroleum rather than natural oils. However, its use can cause problems like skin irritation or skin burn. Similarly, it can cause soil and water pollution. It can also fade the colour of clothes on its long use.

Chemical pesticides

Activity 19.3

What type of insecticides are being used in the agricultural land and garden of your locality? observe and search,and then discuss on the following questions:

a) What are the advantages of using insecticides?

b) What local methods have been used to control pests and insects in your area?

c) Are there any negative effects of using insecticides?

Let's study a case

Picture 19.7Spraying insecticide in crops

According to the news published on 15th Shrawan 2079 BS, in the 'The Kathmandu Post', a farmer in Haripur Municipality was burnt badly at his back due to the leakage of insecticide, which he was carrying while spraying the chemical in his field. Similarly a study shows that 22 persons had already died of cancer in Ghurkauli, a main area of growing vegetables in Hariban Municipality. The number of people suffering from blood and skin cancer is also more in that area. These are only some examples in the case of Nepal. In fact, there is an excessive and unscientific use of pesticides in vegetables, fruits, and agricultural products in different regions of Nepal.

Discuss the following questions in groups in your classroom based onyour experience, observation, or the news you might have heard about.

a. What effects are seen on the health of people and the environment due to the excessive and unscientific use of pesticides?

b. What situation have you seen or felt in your family or locality due to the overuse of pesticides?

c. Is it right to spray pesticides as shown in the above figure?

The poisonous substances used to remove, destroy, kill, and control harmful pests from seeds, plants, trees, birds, animals, human health, and construction areas are called pesticides. According to the 'Pesticide Management Act 2076 (B.S.)',"pesticide" means any organic, vegetation, biological and chemical material which is used to protect plants, agricultural products, forest and forest products, living beings, livestock, human health, storage, packaging, and construction works from any harmful disease, insect, mite, nematode, weed grass, and rodents.

DDT was at first imported to Nepal in 1952 AD to control malaria. Currently the average use of pesticides in our country is 396 grams per hectare. About 80% of the used pesticides get mixed to the soil which takes a long time to get diffused. Due to this, the microorganisms in soil are destroyed and there is a high risk of pollution of surface and underground sources of water.

Types of pesticides

On the basis of effect on the environment, the pests they affect, and mode of action, the pesticides are classified to different groups as follows.

1. Pesticides on the basis of effect on the environment

According to the nature of effect on the environment, pesticides are of two types as:

a) Environmentally biodegradable or non-persistent

Biodegradable pesticides are those that can be broken down into harmless compounds by microbes and other living organisms within a shorter period of time when they come in contact with water, air, light, or heat. For example: dimethoate (Nugor, Rugor, Dimet), Malathion, etc.

b) Environmentally non-biodegradable or persistent

These types of pesticides do not decompose easily in the environment and remain in our food chain for a long time. This type of pesticides are banned in most of the countries. In Nepal also, the use, export, and import of these pesticides are banned. For example: DDT, Aldrin, etc.

2. Pesticides on the basis of the pests they affect

a) Insecticides:

Pesticides used to kill and control harmful insects, example: Malathion, Cypermethrin, Fenvalerate, Nitenpyram, etc.

b) Fungicides:

They are used against fungi and the diseases caused due to them. For example: Dimethomorph, Sectin, Mancozeb, Carbendazim, etc.

c) Herbicides:

They are used to destroy or control unwanted herbs and plants in our crop fields. For example: Butachlor, isoproturon, atrazine, etc.

d) Rodenticides:

The pesticides used to kill rats and rodents like mice, squirrels, hamsters, porcupines, etc. are rodenticides. For example: Zinc phosphide, bromadiolone, Coumatetralyl, etc.

e) Miticides:

They are used to kill mites. For example: bifenazate, fenazaquin,

propargite, fenpyroximate, etc.

3. Pesticides on the basis of mode of action

a) Contact pesticides:

They kill pests like aphids (lahi), larva, thrips, white house fly, etc. when their body comes in direct contact with these pesticides. Malathion, Chlorpyrifos, etc. are the contact pesticides.

b) Internal pesticides:

When the pests consume the leaves, flowers and fruits of plants with these pesticides, then they are killed due to the effect of poison. Pesticides like Malathion, Cypermethrin, Fenvalerate, etc. lie in this group.

c) Systemic pesticides:

The parts of plants like roots, leaves, etc. absorb the pesticides due to which the plant itself becomes poisonous. So when insects suck its juice or eat the plant part, they are also killed. For example pesticides used to kill aphids, larva, thrips, white house fly, leaf miner, stem borer, such as ;Thiamethoxam, Dinotefuran, etc. are some systemic pesticides.

d. Fumigants pesticides:

These pesticides produce poisonous gases or fumes when they come in contact with air due to which pests are killed. These pesticides are generally used to kill pests during the storage of agricultural products. For example: Aluminium phosphide, Methyl bromide, etc.

Activity 19.4

What alternative methods are used to control pests in your house or locality besides using excessive chemical pesticides? Discuss in groups. Then preparea list of suggestions to give to your family members or people of your locality and present it in the class.

Safety precautions in the use and storage of pesticides

figure19.8

Following precautions must be followed strictly during the storage and use of chemical pesticides:

a) Only the pesticides permitted by 'Pesticides Management Act, 2076' must be imported, produced, traded, or used.

b) The pesticides should be bought under the suggestion of agricultural technicians only. Similarly, the remaining pesticides after use must be stored and managed in a safe place.

c) The labels of pesticides must be clear and intact.

d) Pesticides should not be stored in the places where children could easily reach or near the food storage.

e) The pesticides must be stored in an airtight container with no leakage.

f) The carelessness or a small mistake of the user can cause accident and harm so, the instructions given in the label should be read and followed strictly.

g) Only less harmful, but effective pesticides should be used. And while using them, protective suits which cover the whole body, along with masks to cover nose and mouth, goggles to cover eyes, andthe gloves should be used.

h) The utensils used for spraying pesticides should be cleaned immediately after their use and stored in a safe place. However, they should not be cleaned near the water sources.

i) We should wash our hands and take a bath immediately after spraying the pesticides.

j) We should follow the integrated pest management method as far as possible.

k) The vegetables, fruits and crops should not be sold or consumed immediately after using pesticides.

l) The most dangerous pesticides enlisted as Group IB pesticides must be bought only under the direction of the crop protection officer.

m) We should not forget the saying that,"all pesticides are poisons, they are not medicines".

Project work

Ask an expert to find the pesticides which could be used in Nepal and the time to be awaited after using them. Prepare a report and present it in class for discussion.

Chemical pollution

figure 19.9 Pollutants produced from the industry

Environment pollution is the problem which causes trouble for humans and all living beings in their survival. It causes the degradation in quality of components of the environment like air, water, soil thereby causing imbalance in the ecosystem. It causes negative impacts to all living beings such as the transmission of airborne disease due to air pollution, transmission of waterborne diseases due to water pollution, etc. The amount of carbon dioxide in the atmosphere is also increasing as a result of air pollution due to which the average temperature of the earth is increasing. It has a direct impact on all living beings.

Different pesticides are used to kill insects, pests, and rodents. They contain poison in different amounts. They not only kill the harmful insects but also kill the useful insects. It creates imbalance in the ecosystem of that place. The use of DichloroDiphenylTrichloroethane (DDT) powder causes physical and biological environment pollution. The polluted water causes negative impacts on aquatic and terrestrial animals. It also affects the reproductive system of the organisms. Similarly, it causes different respiratory diseases. The reproductive capacity and growth of fishes and birds are also affected. Birds lay less eggs and all of them will not be fertile. Similarly, some of the fertile eggs will not hatch to babies as their shells will be very thin and will get destroyed. Similarly, pesticides like benzene hexachloride (BHC), methoxychloride, aldrin, dieldrin, etc. also cause similar effects on the organisms.

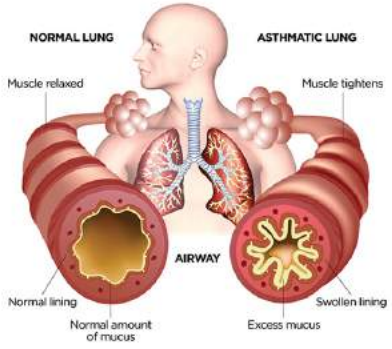


Figure 19.10

Different types of insecticides like DDT, BHC, aldrin, dieldrin, etc. are being used in the name of modernization in agriculture. Similarly, chemical fertilizers are also being used excessively. These insecticides and fertilizers reach the sources of water on getting mixed with the rain water and affect the ecosystem there. This destroys aquatic animals.

The agricultural products are destroyed by different harmful pests thus pesticides must be used in order to kill and control them. Although they protect agricultural products from harmful pests, they pollute soil. Chemicals like insecticides, fungicides, or weedicides are regarded as a main source of pollution. Substances like DDT, aldrin, dieldrin, and parathion like chemicals degrade the quality of soil.

Let's know

Aldrin,Dieldrin, DDT, BHC, Chlordane, Lindane, Endosulfan, etc. are the insecticides which are all banned in Nepal. The production, buying, selling, export, and import of Dichlorvos insecticide has been restricted in Nepal.

The haphazard use and disposal of industrial chemicals like cement, ceramics, glass, plastic, fiber, chemical fertilizers, soap, detergent has degraded the quality of different components of the environment like air, water, soil, etc. which causes imbalance in the ecosystem. So, this type of pollutants must be used and managed properly. They should not be disposed directly in the sources of water and agricultural land.

Figure19.11Ceramics, glass, plastic, fiber etc. in Sisdole dumping site

Observe the above picture and answer the following questions:

a) What effects are seen in the environment due to the haphazard disposal of such waste materials?

b) In your opinion, what measures can be taken to control such pollution?

Following measures can be adopted for the proper management of industrial chemicals like cement, glass, ceramics, plastic, fiber, chemical fertilizers, soap, detergents, pesticides, etc.

a) Glass, ceramics, plastic and fiber pieces should not be thrown haphazardly and should be managed in proper places.

b) Cement sacs should be tied and covered properly to prevent the dust blow.

c) Organic or compost fertilizer should be used instead of the chemical fertilizers.

d) Chemical fertilizers and pesticides should be used only as suggested by the agriculture expert.

e) The waste water after the use of soap and detergent should not be directly mixed to water sources or agricultural land but should be collected in separate places.

Project work

Get divided into into four groups (A, B, C and D).Each group will be assigned one topic given below. Visit the related places and do the project work on that basis to present in your class.

Group A : Chemical pollution due to soap and detergent and diseases caused by it.

Group B : Chemical pollution due to pesticides and diseases caused by it.

Group C : Effects of chemical fertilizers and ways to manage them.

Group D : Pollution due to cement, glass, ceramics, fiber, plastic, and chemical fertilizer, their effects and management.

According to the feedback you receive after the presentation in class, write a report onthe project.Include a proper conclusion with suggestions. Submit it to your subject teacher.

Exercise

1. Choose the correct optionfor the following questions:

a. Why is detergent called a soapless soap?

i. It does not give lather with hard water as a soap.

ii. It has the same chemical composition as of soap.

iii. It has cleaning properties like soap and it can be used with hard water.

iv. It has cleaning properties like soap but its chemical nature is different.

b. Identify the group of insecticides?

i. Potassium chloride, aldrin, benzene hexa chloride

ii. DDT, sodium chloride, aldrin

iii. Dieldrin, DDT, methoxychloride

iv. Potassium chloride, aldrin, malathion

c. In which group does sodium stearate lie?

i. Soap ii. Detergent

iii. Insecticide iv. Food preservative

d. What is the main use of detergents?

i. To clean hands and foot ii. To take bath

iii. To wash clothes iv. Tocleantoilet

e. Which of the following compounds is used to ripen fruits?

i. Calcium carbide ii. Calcium carbonate

iii. Sodium sulphate iv. Sodium carbonate

2. Write differences between:

a. Chemical pesticides and biological pesticides

b. Chemical food preservative and organic food preservative

c. Soap and detergent

3. Give reason

a. Use of DDT powder causes imbalance in the ecosystem.

b. The use of chemical pesticides should be decreased.

c. Salt is used in the process of making soap.

d. Pickles can be preserved for a long time.

4. Answer the following questions:

a. Write the full forms of DDT and BHC.

b. What do you mean by food preservatives? Why are they used?

c. What chemicals are used as food preservatives?

d. What are the natural methods used to preserve the nutrients of food?

e. What do you mean by natural food preservatives? Why are they good in comparison to the chemical food preservatives? Analyze it.

f. How can fruits be ripened artificially? Write methods and processes for it.

g. What precautions should be taken while using chemical pesticides?

h. Make a list of chemicals used for cleaning purposes in your house and locality? Write the effects of these substances in the environment.

i. Explain the soap making process.

j. What is detergent? Write its two examples. What effects are seen on the human health and environment due to the use of detergent? Present your argument.

k. There has been an excessive use of chemical pesticides in Hari's village due to which complex problems have been observed in the health of people and the environment. What may be the alternatives to solve these problems? Give some suggestions.

l. What do you mean by chemical pollution? What are its effects? Write practical ways to minimize it.

m. Write about the pollution caused by industrial products like cement, glass, ceramics, plastic, fiber, chemical fertilizers, soap, detergent,etc. in your locality. Write its causes and suggest proper ways for management.