9 Matter

There are various types of objects around us, such as bags, books, pens, pencils, desks, benches, water, air etc. All these objects have mass and volume. Similar to this, observe the items that have mass and volume around you and those that do not. Based on that, complete the given table below and discuss it in class.

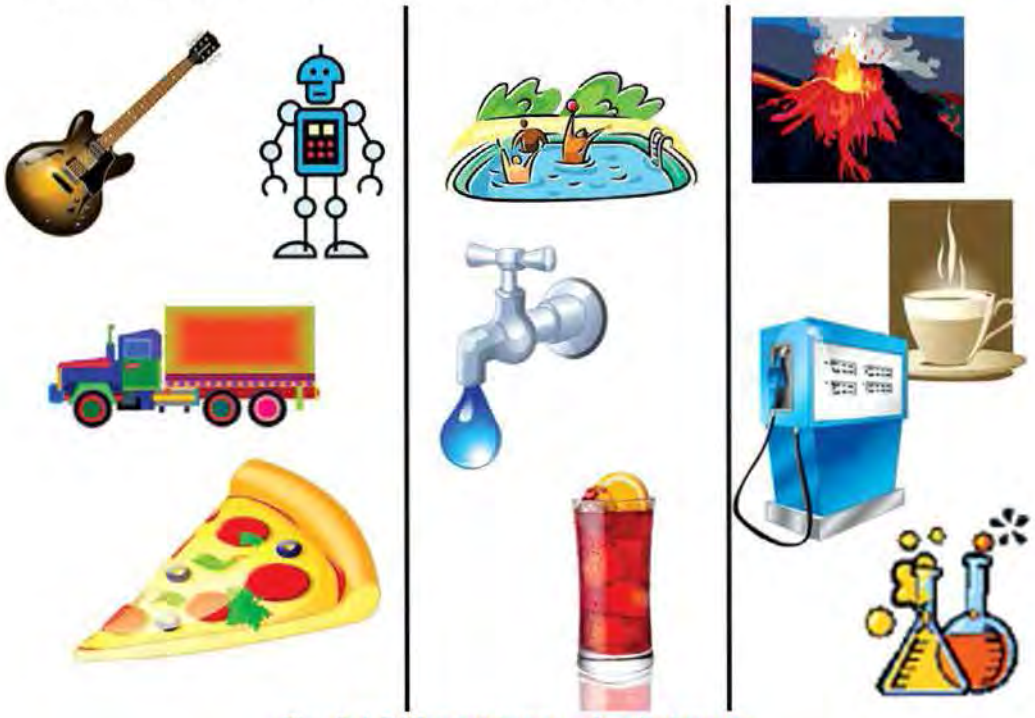


Fig. 9.1 Different types of substances

Objects with mass and volume	Objects without mass and volume

In contrast to heat, light, shadow etc. which do not have mass and volume, the objects around us such as books, copies, desks, benches, houses, and trees all have these properties.

All objects which have mass and volume are called matter. The matter is made up of the same or different types of atoms. The matteris categorized into pure and impure substances. Elements and compounds are pure substances whereas mixtures are impure substances. In addition, the substances around us are found in solid, liquid and gaseous states.

Atom

Activity: 9.1

Match the symbol and atomic number of the given element.

Element	Atomic Number
H	13
Li	15
N	1
Al	10
P	3
Ne	7
	9

Activity9.2

Look at the picture and discuss the questions given below.

a. What is called the central part of an atom?

b. What are the sub-atomic particles of an atom?

c. Which sub-atomic particles remain in the central part of the atom?

d. What is the sub-atomic particle that revolves around the nucleus?

e. Atomic structure of which element is shown in the figure?

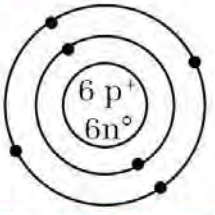


Figure 9.2: Atomic structure

The smallest particle of an elementis systematically composed of subatomic particles. An atom may take part in a chemical reaction. An atom is an extremely minute particle of matter that cannot be seen

with the naked eye. Elements are made up of the same type of atoms. An atom of an element is different from the atom of other elements.

The structure of an atom determines the physical and chemical behavior of an element.

Structure of an atom

An atom is composed of three subatomic particles. There are two types of sub-atomic particles in the central part of an atom. The central part of an atom is called the nucleus. Another sub-atomic particle revolves around the nucleus in a fixed path. Such a fixed path is called a shell or orbit. Neutrons and protons are the sub-atomic particles in the nucleus whereas the electrons revolve around the nucleus in their shells.

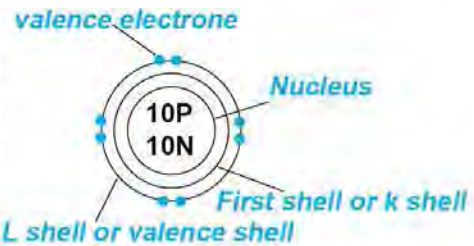


Figure: 9.3 Atomic Structure

Proton

A positively charged sub-atomic particle in the nucleus of an atom is called a proton. It is denoted by p+. The mass of a proton is equal to the mass of a hydrogen atom. The mass of a proton is called 1 atomic mass unit (a.m.u.).

Neutron

The chargeless sub-atomic particles in the nucleus of an atom are called neutrons. It is denoted as n^0. The mass of a neutron is equal to the mass of a proton. Therefore, the mass of a neutron is 1 atomic mass unit (amu).

Electron

A negatively charged sub-atomic particle that revolves around the nucleus of an atom is called an electron. It is denoted as e-. The mass of an electron is very less than that of a proton and neutron. The mass of a proton is equal to the mass of about 1837 electrons or the mass of an electron is equal to 1/1837 amu.

Comparative study of the sub-atomic particles of an atom

Sub-atomic particles	Symbol	Location	Charge	Mass
Proton	p^+	nucleus	positive	1amu
Neutron	n^o	nucleus	chargeless	1amu
Electron	e^-	shells or orbit	negative	1/1837amu

Name of element, symbol and number of sub-atomic particles in an atom

Atomic number	Element	Symbol	Number of protons	Number of neutrons	Number of electrons
1	Hydrogen	H	1	0	1
2	Helium	He	2	2	2
3	Lithium	Li	3	4	3
4	Beryllium	Be	4	5	4
5	Boron	B	5	6	5
6	Carbon	C	6	6	6
7	Nitrogen	N	7	7	7
8	Oxygen	O	8	8	8
9	Fluorine	F	9	10	9
10	Neon	Ne	10	10	10
11	Sodium	Na	11	12	11
12	Magnesium	Mg	12	12	12
13	Aluminium	Al	13	14	13
14	Silicon	Si	14	14	14
15	Phosporous	P	15	16	15
16	Sulphur	S	16	16	16
17	Chlorine	Cl	17	18	17
18	Argon	Ar	18	22	18
19	Potassium	K	19	20	19
20	Calcium	Ca	20	20	20

Nitrogen has seven electrons in its shell. Are these all electrons in the same shells or different shells? The number of electrons in an atom

of an element can be found by Bohr and Bury's $2n^2$ Rule.

Bohr and Bury's $2n^2$Rule

The electrons in the atoms of an element are located in its shells. The innermost shell of an atom is called the K shell and the other shells are called L, M, and N respectively. Shells are also called energy levels. K shell is the first energy level of an atom, while the second, third and fourth energy levels are L, M and N shells respectively.

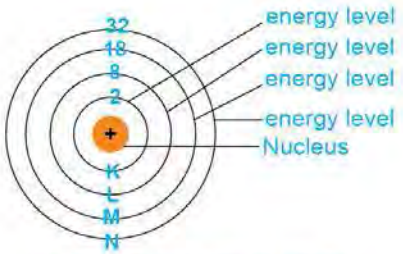


Fig. 9.4 energy of atom

The rule that tells how many electrons are located in the shell of an atom is called the $2n^2$rule of Bohr and Bury where 'n' is the number of shells. According to this rule, the K shell has 2 electrons. Similarly, L, M and N shells have 8, 18 and 32 electrons respectively.

For example:

For K shell (n=1), the number of electrons that can be accommodated

$= 2n^2 = 2 \times 1^2 = 2.$

Atomic structure of the first 20 elements

 Hydrogen (1)	 Helium (2)	 Lithium (2.1)	 Beryllium (2.2)	 Boron (2.3)
 Carbon (2.4)	 Nitrogen (2.5)	 Oxygen (2.6)	 Fluorine (2.7)	 Neon (2.8)
 Sodium (2.8.1)	 Magnesium (2.8.2)	 Aluminium (2.8.3)	 Silicon (2.8.4)	 Phosphorus (2.8.5)
 Sulphur (2.8.6)	 Chlorine (2.8.7)	 Argon (2.8.8)	 Potassium (2.8.8.1)	 Calcium (2.8.8.2)

Project work 9.1

Prepare an atomic model of any five elements among the first 20 elements by using materials such as different colored threads or iron wire, different colored pulses or any locally available materials and demonstrate it in the class.

Valence shell, Valence electron and Valency

The outermost shell of an atom is called the valence shell. The electrons in the valence shell are called valence electrons. Atom always tries to attain stability by attaining two (elements from atomic number 1 to 5) or 8 electrons in their valence shell. Atoms loose or gain or share electrons to attain stability. An atom of an element with valence electrons 1 to 3 loses electrons, an atom with 4 valence electrons shares electrons and an atom with 5 to 7 valence electrons gains electrons to attain stability. Valency is the number of electrons donated, shared or gained by an atom of an element to attain stability. An atom of an element with valence electron 8 does not donate, share or lose any electron. Therefore, the valency of such elements is 0 and do not take part in the generalchemical reaction.

Activity 9.3

Complete the electronic configuration and valency of the elements in the given table.

Atomic number	Element	Electronic configuration	Valency
1	Hydrogen	1	
2	Helium		
3	Lithium		
4	Beryllium		
5	Boron	2, 3	
6	Carbon		

7	Nitrogen		
8	Oxygen		
9	Fluorine		
10	Neon		
11	Sodium		
12	Magnesium	2, 8, 2	
13	Aluminium		
14	Silicon		
15	Phosphorous		
16	Sulphur		
17	Chlorine	2, 8, 7	
18	Argon		
19	Potassium		
20	Calcium	2, 8, 8, 2	

Molecular formula

The symbolic representation of a molecule of an element or a compound is called molecular formula. Molecules of an element have the same type of atoms while the molecules of the compounds have different types of atoms. While writing the molecular formula of a compound, it is necessary to know the type of elements and their valency involved in the formation of the compound. Then the molecular formula of the compound can be written using the criss-cross method. For this following method should be used serially.

(a) At first, write the name of the compound. Eg: Magnesium oxide

(b) Write the symbol of the elements involved in the molecule of the compound.

Mg O

(c) Write the valency of the elements above their symbol.

2 2

Mg O

(d) Now exchange the valency with the help of arrow symbols.

(e) Write the exchanged valency number as a subscript in the symbol of elements.

Mg_2 O_2

= MgO

Valency 1 is not written. If the valency of two elements is divisible by a common number, then divide the number and write the remaining number only.

Mg_2O_2 = MgO

Other examples of molecular formulas

(a) Potassium Chloride

Potassium Chloride

1 1

K Cl

K_1 Cl_1

= KCl

(b) Calcium Chloride

Calcium Chloride

2 1

Ca Cl_1

Ca_1 Cl_2

= $CaCl_2$

(c) Ammonia

3 1

N H

N_1 H_3

= NH_3

(d) Carbon dioxide

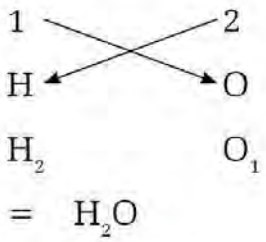
4 2

C O

C_2 O_4

= CO_2

(f) Water



Atomic weight of elements

The sum of the number of protons and neutrons in the nucleus of an atom is called the atomic weight of the element. For example, there are 12 protons and 12 neutrons in the nucleus of a magnesium atom. So the sum of protons and neutrons is 24, which is the atomic weight of magnesium.

Atomic weight of an element = number of protons + number of neutrons

Examples

Find the atomic weight of calcium which has 20 protons and 20 neutrons.

Number of protons of calcium = 20

Number of neutrons of Calcium =20

Atomic weight of Calcium =?

Atomic weight= number of protons + number of neutrons

=20+20

= 40 amu

Question to think about:

Although the sub-atomic particles of elements are protons, neutrons and electrons but the atomic weight of elements is calculated by the sum of protons and neutrons only, why?

Molecular weight of molecule

The molecular weight of any element or compound is the sum of the atomic weights of the elements present in the molecule of the element or compound. For example, the molecular formula of water is H_2O. This means that there are two hydrogen atoms and one oxygen atom in the water molecule. The atomic weight of hydrogen and oxygen are 1 and 16 respectively. So the molecular weight of water is 18 amu.

For examples:

(a) What is the molecular weight of Calcium Carbonate?

Molecular weight of Calcium Carbonate = atomic weight of calcium + atomic weight of Carbon + 3×atomic weight of oxygen × 3

$= CaCO_3$

$= Ca + C + 3 \times O$

$= 40 \times 1 + 12 \times 1 + 16 \times 3$

$= 100$ amu

(b) What is the molecular weight of Magnesium Chloride?

Molecular weight of Magnesium Chloride =?

Molecular weight of Magnesium Chloride = atomic weight of magnesium + atomic weight of Chlorine × 2

$= MgCl_2$

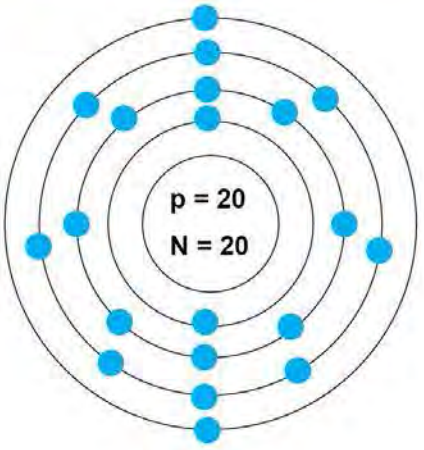
$= Mg + 2 \times Cl$

$= 24 \times 1 + 35 \times 2$

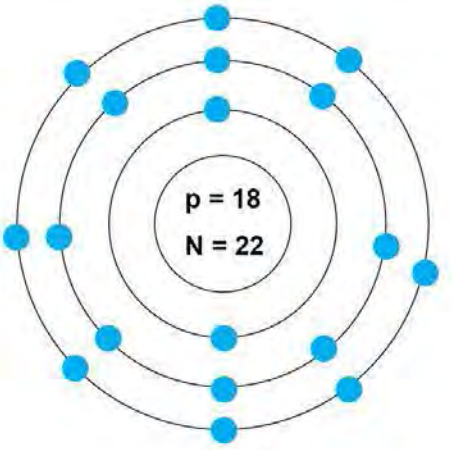
$= 94$ amu

Activity 9.4

Compare the atomic structures of elements and complete the table given below.



Atom A



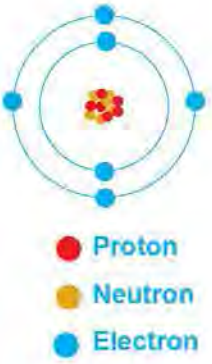
Atom B

	Element name	Atomic number	No. of proton	No. of neutron	No. of electron	Atomic weight	No. of shells	Valence electron	Valency
Atom A									
Atom B									

Exercises

1. Choose the best alternatives:

(a) What is the symbol of the element given in the figure?



(अ) S (आ) Si

(इ) Na (ई) C

(b) Which of the following elements has zero valency?

(i) Hydrogen (ii) Sodium

(iii) Neon (iv) Calcium

(c) What is the atomic weight of Argon?

(i) 40 amu (ii) 42 amu

(iii) 44 amu (iv) 46 amu

(d) Which of the following is the mass of negatively charged subatomic particles of an atom?

(i) 1/1834 amu (ii) 1/1835 amu

(iii) 1/1836 amu (iv) 1/1837 amu

(e) What are the subatomic particles in the nucleus of an atom?

(i) Proton and Electron (ii) Electron and Neutron

(iii) Neutron and proton (iv) Proton, Neutron and Electron

(f) What is the molecular formula of calcium oxide?

(i) CaO (ii) CaO_2

(iii) Ca_2O (iv) $CaCO_3$

(g) The number of protons (p+), electrons (e-) and neutrons (n^0) of various elements are given in the table below.

Element	No. of proton	No. of electron	No. of neutron
Potassium	19	19	20
Carbon	6	6	6
Oxygen	8	8	8
Argon	18	18	22

Which of these has the highest atomic weight?

(i) Potassium (ii) Carbon

(iii) Oxygen (iv) Argon

2. Differentiate between:

(a) Proton and electron (b) K shell and M shell

(c) Valence shell and valence electron

(d) Atomic weight and molecular weight

3. Give reasons:

(a) An atom is electrically neutral.

(b) The valency of Chlorine is 1.

4. Answer the following questions:

(a) What is an atom?

(b) Write the name, symbol and charge of sub-atomic particles in an atom.

(c) Write the molecular formula of the given compound by the crisscross method.

(i) Magnesium oxide (ii) Sodium Chloride

(iii) Potassium oxide (iv) Aluminium Chloride

(v) Ammonia

(d) What is a shell?

(e) What isthe $2n^2$ rule used for?

(f) What is a valence shell? What is called the electron in the valence shell?

(g) What is valency? What are the factors on which the valency of an element depends?

(h) What is meant by the valency of an element being zero?

(i) What will be the valency of an element if the electronic configuration of an element is 2,8,8,1? Write with reasons.

(j) What is the molecular formula? What arethe information required to write the molecular formula of a compound?

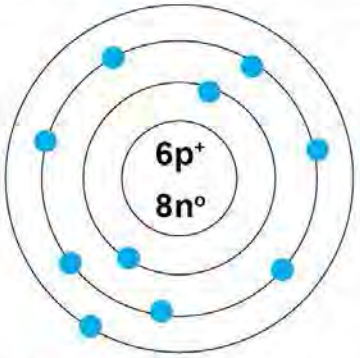
(k) What is the atomic weight of Potassium? Calculate the molecular weight of Calcium Chloride.

(l) Complete the table given below:

Element	Symbol	Atomic number	Atomic mass	No. of proton	No. of neutron	No. of electron
Oxygen			16			
	C			6		
		11			12	
			24			12
Chlorine				17		
	K				20	
		14				14
Argon			40			

(m) Can an atom exist without electrons? Give reasons.

(n) Anju has drawn the atomic structure of Sodium as follows. Find any three mistakes in the atomic structure drawn by her.



(o) What is the element to which the given nucleus of an atom belongs? Draw the atomic structure of an atom of the elements given below. What are the information required to calculate the atomic weight of the elements? Write with reasons.

Proton=19

Neutron=20

(p) Complete the table by the number of atoms in a molecule of Sulphuric acid (H_2SO_4)

Element	Number of atoms
Hydrogen	.....
Sulphur	.....
Oxygen	.....

Activity 9.5

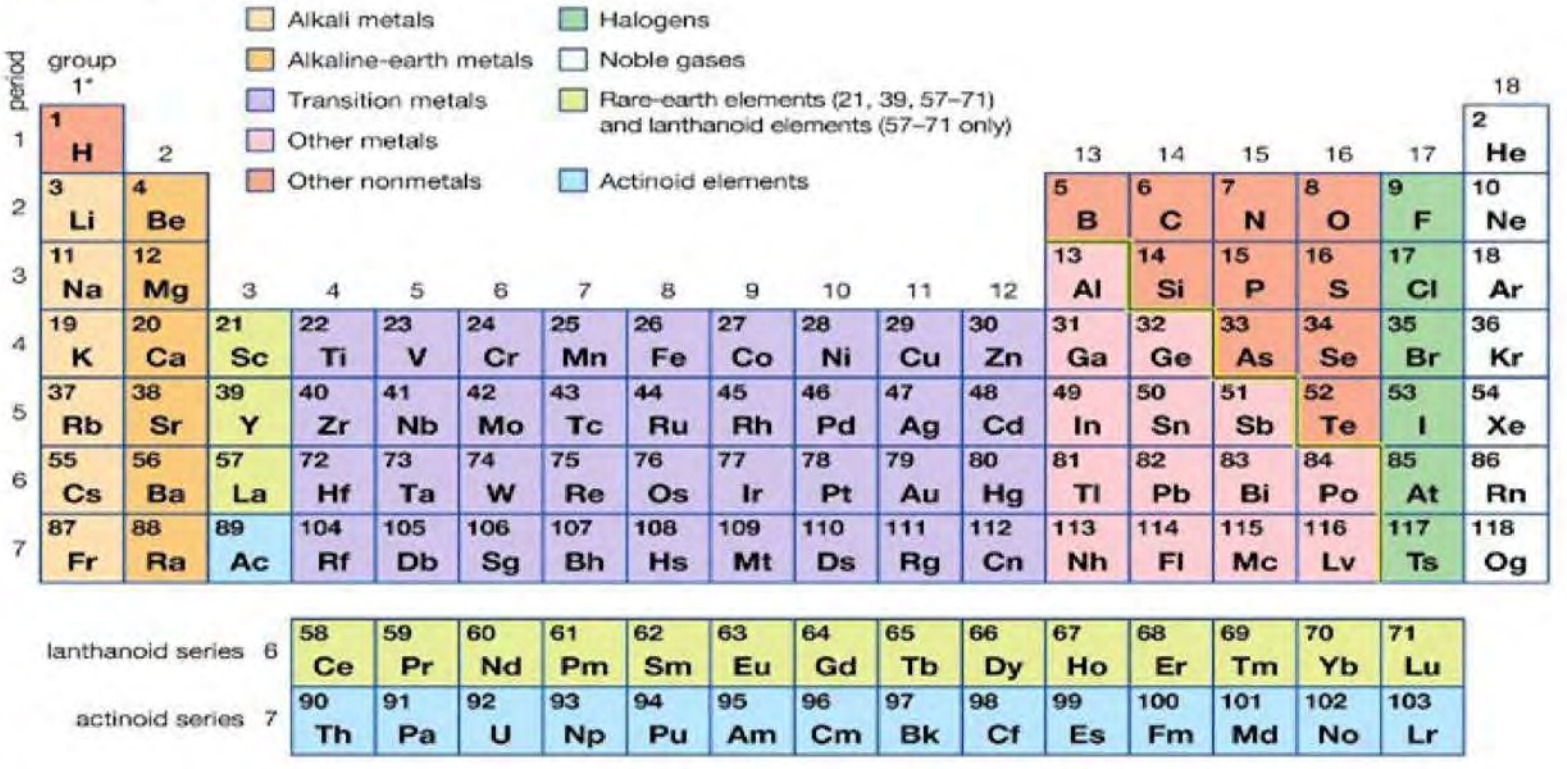
Write the names of at least 20 objects around us. Try to memorize these items by reading them once or twice. Check how many of them you can remember. Now classify these objects based on similar properties and try to remember them. Discuss whether it was easier to remember the names of objects before or after categorizing them. By classifying the elements in this way, the study of the elements would be easier and faster to memorize for a long time.

Along with the development of science, more and more elements were discovered. It became difficult to study them one by one. Therefore, it is needed to classify the elements based on their similar and dissimilar characteristics. While classifying the elements, they were arranged in a table having rows and columns which is called the periodic table. Along with the development of different types of the periodic table, the modern periodic table was developed which is still in practice.

Modern Periodic Table

While classifying elements, many scientists tried to classify the elements in their own way, but the modern periodic table created by Henry Moseley in 1913 is considered the most scientificclassification. It is accepted all over the world so being used currently in scientific works. Henry Moseley discovered that the properties of the elements repeated at certain intervals while arranging them in increasing order of their atomic number. Elements with similar properties fell inthe same vertical column and different elements with different properties lie in a horizontal row. Henry Mosely put forward the modern periodic law based on the periodic function of the atomic number of elements.

Periodic table of the elements



*Numbering system adopted by the International Union of Pure and Applied Chemistry (IUPAC).

Modern Periodic Law

'The physical and chemical properties ofelements are the periodic function of their atomic number". The physical and chemical properties of elements change as their atomic number increases and a similar property repeats itself at a certain interval.

Activity 9.6

Make a blank periodic table on a piece of chart paper. Write the symbol of the elements from hydrogen to calcium clearly on separate pieces of paper as big as the room made in the periodic table. Now paste the pieces of paper serially from hydrogen to calcium in the periodic table. Every student should perform this activity and present it in the classroom turn-wise.

Position of Hydrogen in the modern periodic table

Hydrogen has only one electron in its outermost shell. Therefore, it is placed in group 1 of the modern periodic table.But hydrogen does not have metallic properties like other elements of group 1.

Position of metals in the modern periodic table

Elements that donate electrons during a chemical reaction are called metals. Metals are good conductors of heat and electricity. If there are 1 to 3 electrons in the outer shell of an element, the elements show their reactivity by donating electrons. There are metals from groups 1 to 13. Elements in group 1 have one valence electron which they easily donate during a chemical reaction to attain stability. Hence elements of this group are very reactive. They are also called alkali metals. Group 2 elements are called alkaline earth metals.

Position of non-metals in the modern periodic table

Elements that gain electrons during a chemical reaction are called non-metals. Non-metals are poor conductors of heat and electricity. If there are 5 to 7 electrons in the outermost shell of an element, the elements show their reactivity by gaining electrons. Elements in groups 15, 16 and 17 of the modern periodic table have the properties of non-metals.

Since there are seven valence electrons in the outermost shell of an atom of group 17, they attain stability by gaining one electron. Therefore, the elements of this group are called very reactive non-metals. They are also called halogens.

Position of inert gases in the modern periodic table

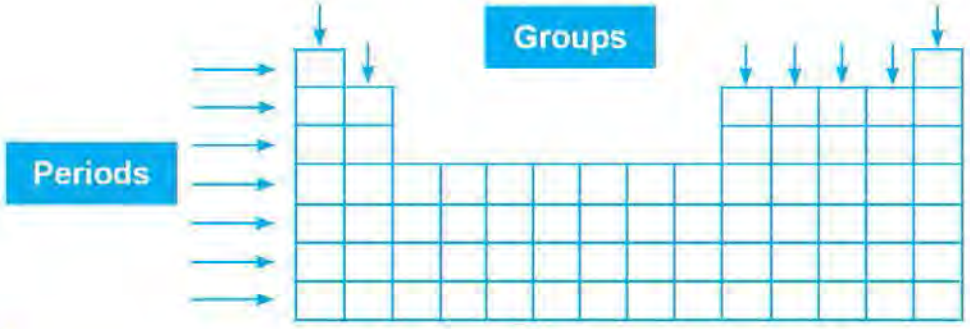
Elements that neither gain nor donate any electrons nor participate in a chemical reaction are called inert gases. If there are two electrons (helium) and 8 electrons (neon, argon) in the outermost shell of an element, these elements do not gain or donate electrons because they have already attained stability. The inert gases are placed in group 18 of the modern periodic table.

Activity 9.7

In the class, students from roll numbers 1 to 20 are given the name hydrogen, helium, lithium ..... calcium respectively according to atomic number. Make a blank periodic table with chalkor lime in the school hall, courtyard or open space. Now, students who are named hydrogen, helium, lithium..... calcium have to occupy their respective places in the empty periodic table one by one. Discuss the reason for falling in group 1 by the students in that group. Similarly, the students in other groups also discuss the reasons for falling into their respective groups.

The concept of groups and periods in the modern periodic table

In the modern periodic table, elements with similar properties are placed in the same vertical columns called groups, where as elements having different properties are placed in horizontal rows called periods. The modern periodic table has 18 groups and 7 periods.



Characteristic of groups in the modern periodic table

Activity 9.8

Make atomic structures of Group 1 elements by using locally available materials such as yarn, cotton, wool, fine metal wire etc.and keep them serially. Study their atomic structure and answers the following questions:

(a) What happens to the atomic sizes of Group 1 elementsas we move from top to bottom?

(b) What change occurs in the number of shells of elements of group 1 on moving from top to bottom?

(c) What change is observed inthe electron-donating capacity of group 1 elements as we move from top to bottom?

(d) Is the valency changed in the elements of group 1 as we move from top to bottom and why?

Characteristics of Groups

1. The physical and chemical properties of elements in the same group are similar.
2. Elements in the same group have different numbers of shells but the number of electrons in the valence shell isthe same. Therefore, their valency is also the same.
3. As we move from top to bottom in any group, the atomic size of the elements increases because the number of shells in their atom increases one by one.
4. When we move fromthe top to the bottom in any group, the electron-donating ability or metallic character of the elements increases whereas the electron-gaining capacity or non-metallic character decreases.

Periods in the modern periodic table

Activity 9.9

Make atomic structures of period 3 elements using locally available materials such as yarn, cotton, wool, fine metal wire, etc. and keep them serially.

Study the atomic structure carefully and answer the following questions:

a) What change occursin the atomic size of the elements in period 3 as we move from left to right?

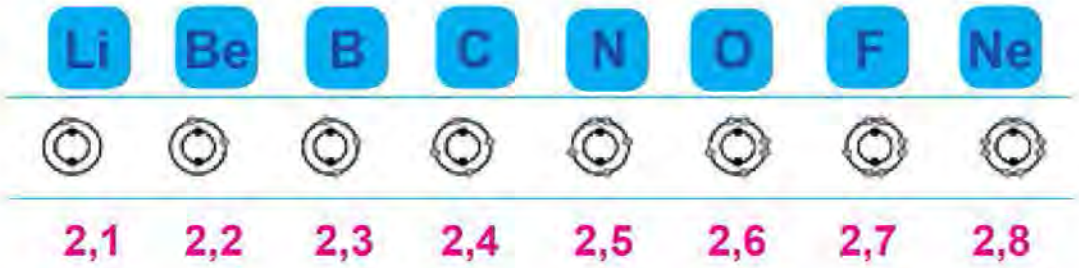
b) What change occurs in the number of shells ofelements as we move from left to right in period 3?

c) What change occurs in the ability of elements of period 3 to accept electrons as we move from left to right?

d) Why is the valency of the element in period 3 changed as we move from left to right?

Properties of Period

1. The physical and chemical properties of the elements gradually change in the same period.



2. Elements in the same period has an equal number of shell, whereas the number of valence electrons is different. Therefore, the valency varies in a period.

3. Atomic size of elements decreases as we go from left to right in any period except inert gas.

4. While moving from left to right in any period, the electron donating capacity of the elements or metallic character decreases, whereas the electron gaining capacity or the non-metallic character increases.

Project work 9.2

Prepare a model of a modern periodic table using locally available materials like wood, thermocol, cardboard etc. and demonstrate it in your class.

Chemical Reaction

Various changes are taking place around us. A change that does not alter the composition of the substance is called a physical change. Physical change can be reversed to its original state. The changes in which the composition of the substance varies and cannot be reversed directly to its original state is called a chemical change. Combination, dissociation and exchange of atoms take place during the chemical change. Thus, the chemical change in which combination, dissociation and exchange of atoms take place to form new substances is called a chemical reaction.

A chemical equation is the symbolic representation of a chemical reaction in the form of symbols and chemical formulas.The substances that take part in a chemical reaction are called the reactants, whereas the new substances formed at the end of the chemical reaction are called the products. While writing a chemical equation, the reactants are written on the left and the products on the right of the arrow symbol.

Chemical Equation

Chemical equations in which reactants and products are expressed in words are called word equations. Likewise, chemical equations in which reactants and products are expressed inmolecular formulae are called formula equations. The number of atoms of every element on the left and right sides of the formula equation must be equal. So the reactants and products are balanced by placing coefficients in front of reactants and products as per necessity.The number of atoms on the left and right sides of the formula equation is equal in a balanced chemical equation. The formulae equation before balancing is called the skeletal equation. Therefore, chemical equations can be expressed as word equations, skeletal and balanced chemical equations

For example, the chemical reaction between sodium and chlorine to form sodium chloride can be expressed into a balanced chemical equation as:

Sodium + Chlorine $\longrightarrow$ Sodium chloride

$2Na + Cl_2 \longrightarrow 2NaCl$

The reaction between nitrogen and hydrogen to form ammonia can be expressed ina balanced chemical equation as:

Nitrogen+ Hydrogen $\longrightarrow$ Ammonia

$N_2 + 3H_2 \longrightarrow 2NH_3$

When calcium carbonate is heated, calcium oxide and carbon dioxide are formed. This chemical reaction can be expressed in the form of a chemical equation as:

Calcium carbonate $\longrightarrow$ Calcium oxide + Carbon dioxide

$CaCO_3 \longrightarrow CaO + CO_2$

The chemical reaction between zinc and dilute hydrochloric acid produces zinc chloride and hydrogen gas which can be expressed in the form of a balanced chemical equation as:

Zinc + Hydrochloric acid $\longrightarrow$ Zinc Chloride + Hydrogen

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

Exercise

1. Choose the correct alternative:

(a) Who discovered the modern periodic table?

(i) Dmitri Mendeleev (ii) Henry Moseley

(iii) John Dalton (iv) Bohr

(b) On which basis are the elementsarranged in the modern periodic table?

(i) atomic weight (ii) atomic mass

(iii) molecular mass (iv) atomic number

(c) Which of the following statements is true regarding the characteristics of the group?

(i) Elements in the same group have different chemical and physical properties.

(ii) Atomic size of elements decreases from top to bottom of the group.

(iii) Elements in the same group have the same valency.

(iv) The non-metallic properties of the elements increase from top to bottom of the group.

(d) Which metal is found in the liquid state at normal room temperature?

(i) Sodium (ii) Magnesium

(iii) Aluminum (iv) Mercury

(e) Which of the following elements belongs to group 18 of the modern periodic table?

(a) Sodium (ii) Magnesium

(iii) Phosphorus (iv) Argon

(f) What are the similarities between argon and chlorine?

(i) Both elements are inert gases.

(ii) Both elements belong to the same period.

(iii) Chemical reactivity of both elements isthe same.

(iv) Both elements lie in the same column

(g) Which of the following statements is correct about the characteristics of groups in the periodic table?

(i) The physical properties of the elements are different in the same group.

(ii) Elements belonging to the same group have the same chemical properties.

(iii) Elements belonging to the same group have the different physical and chemical properties.

(iv) Elements belonging to the same group have the same physical properties but different chemical properties.

2. Differentiate between:

(a) Group and period

(b) Metals and non-metals

(c) Group 1 and Group 17 elements

(d) Word equation and formula equation

(e) Reactants and products

3. Give reason:

(a) Classification of elements is necessary.

(b) Sodium and Chlorine belong to different groups but they have valency 1.

(c) The study of elements becomes easier using a periodic table.

(d) The products are different from the reactants.

(e) Metals and non-metal sare kept separately in the periodic table.

4. Answer the following questions:

(a) What is periodic table?

(b) Write the modern periodic law.

(c) Explain the position of metals in the modern periodic table.

(d) What change in the metallic properties of the elements occurs while moving from top to bottom in any group of the modern periodic table?

(e) What change in metallic properties of elements occurs while moving from left to right in any period of the modern periodic table?

(f) What is a chemical reaction?

(g) What is a chemical equation?

(h) How can we balance the formula equation? Write with examples.

(i) Express the given chemical reaction into a balanced chemical equation:

(i) Magnesium oxide + Hydrogen $\longrightarrow$ Magnesium + water

(ii) Calcium carbonate + Hydrochloric acid $\longrightarrow$ CalciumChloride + Water + Carbon dioxide

(iii) Potassium + Chlorine $\longrightarrow$ Potassium chloride

(iv) Sodium + Oxygen $\longrightarrow$ Sodium oxide

(vi) Hydrogen + Oxygen $\longrightarrow$ Water

(j) The chemical equation for the chemical reaction between Zinc and hydrochloric acid is given below:

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

Write the chemical equation if sulfuric acid is used instead of hydrochloric acid.

(k) Part of a group of the periodic table is given below:

Be
Mg
Ca

Write any four characteristics of this group.

10 Materials Used in Daily Life

Observe the given figure below and discuss:

Figure no. 10.1

Questions:

(i) Which objects are shown in the figure?

(ii) Which of the items shown in the figure have you used?

(iii) What items have you used other than those shown in the figure?

(iv) Which of the substances shown in the figure have acidic, alkaline and salt properties?

We use different types of substances in our daily life. Among them, some are acids, some alkalis and some salts. Fruits, vegetables, soaps, shampoos, conditioners, sanitizers, and cleansing agents contain different kinds of acids, alkalis or salts.

Acid

Activity 10.1

Make a list of the sour foods that you have eaten. Discuss why these foods are sour.

Activity 10.2

Match the given acids with figures.

Formic acid

Oxalic acid

Citric acid

Hydrochloric acid

Acetic acid

Lactic acid

Carbonic acid

Discuss which organic acids are found in the foods based on the above matching exercise.

The sour substances around us are acids. Acids are soluble in water and give hydrogen ions (H+) when dissolved. Therefore, the substances that give hydrogen ions when dissolved in water are called acids. All the acids are not edible. Generally, acids found in plants and animals are edible but the acids made in the laboratory are not edible. Thus the acids can be divided into two types based on sources. They are organic and inorganic acids. Acids that are found in plants and animals naturally are called organic acids. For example, acids found in fruits, animals etc. Those acids which are prepared in the laboratory by using minerals are called inorganic acids. For example hydrochloric acid, sulphuric acid, nitric acid etc. Similarly, acids are divided into two types i.e. hard acids and soft acids depending upon the liberation of hydrogen ions when dissolved in water. Those acids which give more hydrogen ions when dissolved in water are called strong acids whereas those acids which giveless hydrogen ions are called weak acids. Mostly, inorganic acids are called strong acids and organic acids are weak acids.

Questions to think:

Hydrochloric acids are found in the stomach of our body. Is hydrochloric acid organic or inorganic? Why?

Physical properties of an acid

Activity 10.3

Take a lemon and complete the table by doing the following activity.

Activities	Experience/ Observation
Taste a little lemon juice.	
Dissolve lemon juice in water.	
Dip red litmus in lemon juice.	
Dip blue litmus in lemon juice.	
Mix lemon juice with a little methyl orange.	
Mix lemon juice with a little phenolphthalein.	

Based on the above activity, write the physical properties of the acids on chart paper and paste it into the classroom.

Physical properties of acids

a. The taste of acid is sour.

b. Acids are soluble in water.

c. Acids turn blue litmus to red but do not change colour to red litmus.

d. Acids turn methyl orange into red colour.

e. Phenolphthalein remains colourless in acids.

Chemical properties of acids

(a) Ionization when dissolved in water

Acids give hydrogen ions when dissolve in water.

Hydrochloric acid $\rightleftharpoons$ Hydrogen ion + Chloride ion

$HCl \rightleftharpoons H^+ + Cl^-$

Activity 10.4

Observation of chemical reaction between metal and dilute acid.

Objective: To observe the chemical reaction between acid and metal.

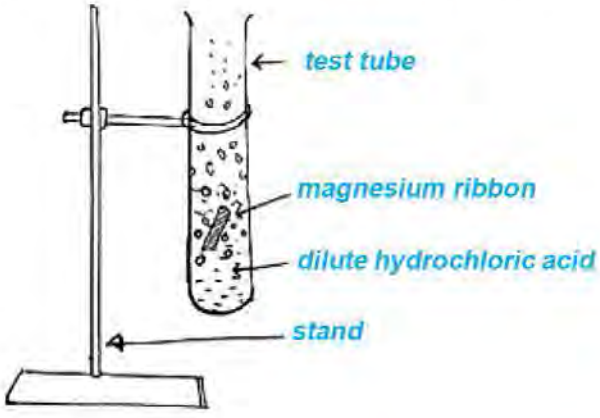


Fig 10.2

Materials required: Magnesium ribbon, dilute hydrochloric acid, match stick.

Method

Take a little dilute hydrochloric acid in a test tube and keep a small piece of magnesium ribbon on it. What happens? Observe it. Bring a burning matchstick close to the mouth of the test tube after bubbles appear in the test tube. Is the 'pop' sound produced or not?

Write a conclusion based on the activity.

(b) Chemical Reaction with metals

Acids react chemically with metals to form metallic salt and hydrogen gas.

Magnesium + Hydrochloric acid ⟶ Magnesium chloride + Hydrogen

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

Activity 10.5

The chemical reactionbetween acids and metallic carbonates.

Objective: To observe the chemical reaction between acids and metallic carbonate.

Materials required: Calcium carbonate, dilute hydrochloric acid, lime water.

Fig 10.3

Method: Take some pieces of calcium carbonate in a test tube. Now put some dilute hydrochloric acid in it. What happens? Observe it. Why did bubbles appear in the test tube? Observe, what happens when that colourless gas is passed intoclean lime water.

Conclusion:

(c) Chemical reaction of dilute acids with metallic carbonate

Acids react chemically with metallic carbonates to form metallic salts, water and carbon dioxide gas.

Calcium carbonate + Hydrochloric acid → Calcium chloride + Carbon dioxide +Water

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

Activity 10.6

The chemical reaction between acids and bases.

Objective: To observe the chemical reaction between acid and base.

Fig. 10.4

Material Required: Dilute hydrochloric acid, a few pellets of sodium hydroxide, a test tube, a porcelain basin, a sprint lamp or bunsen burner, a spatula, a glass rod, a tripod stand, and wire gauzes.

Method: Take a half-test tube of dilute hydrochloric acid and pour a few drops of phenolphthalein. Make the aqueous solution of sodium hydroxide in another test tube. Now mix the sodium hydroxide solution drop by drop in the test tube containing acids. When the colour of the mixture becomes faint pink, stop mixing. Now pour the solution into a porcelain basin and evaporate it. Observe what is left after heating for some time.

Conclusion:

(d) A chemical reaction between an acid and a base Salt and water are formed when a chemical reaction occurs between an acid and a base. This is also known as the neutralization reaction.

Hydrochloric acid + Sodium hydroxide→ sodium chloride + water

$$HCl + NaOH \rightarrow NaCl + H_2O$$

Uses of acids

Activity 10.7

Cut radish or carrot into small pieces. Now divide those radishes or carrots into two parts and put them in two glass bottles. Do not put anything in one bottle whereas put vinegar in the other bottle making all the radishes or carrots sink. Within a week to two weeks, observe both bottles and discuss the changes that have occurred with reasons.

Acids	Uses
Organic acids	
Citric acid	To preserve food for a long time. To make food sour.
Ascorbic acid	To make medicine for various diseases as a source of vitamin C.
Acetic acid	To make pickles.
Tartaric acid	To make baking powder.
Inorganic acids	
Hydrochloric acid	Hydrochloric acid produced in the human body help to digest food, clean bathrooms and make polyvinyl chloride.
Nitric acid	To make nitrogenous fertilizer, explosive materials.
Sulphuric acid	To use in batteries, make chemical fertilizers, dyes, detergent, artificial silk, manufacture hydrochloric acid.

Base

Metallic oxides and hydroxides are called bases. Sodium oxide, sodium hydroxide, potassium oxide, potassium hydroxide, magnesium oxide etc. are examples of bases. Some metallic oxides are soluble in water whereas some are not soluble. Bases that dissolve in water are called alkalis. Bases give hydroxide ions when dissolved in water such as sodium hydroxide, potassium hydroxide etc. Bases are divided into hard and soft based on the number of hydroxide ions they give when dissolved in water.

Strong bases give more hydroxide ions whereas weak bases give less hydroxide ions when dissolved in water. Sodium hydroxide and potassium hydroxide are strong basesand ammonium hydroxide is a weak base.

Activity 10.8

Take little amount of ashes. Perform the following activities and fill in the observations in the given table.

Activities	Experiences / Observations
Taste a little ash water.	
Dissolve little ash in water and filter.	
Touch the ash water with your hand.	
Dip red litmus paper in ash water.	
Dip the blue litmus in the ash water.	
Mix the ash water with a little methyl orange.	
Mix the ash water with a little phenolphthalein.	

Share your experiences or observations of the above activities with your friends. Then, write the physical properties of bases on the sample chart paper and paste it into the classroom.

Sample Chart

a. Bases turn red litmus paper to blue.

b. Most of the bases are bitter.

c. Most of the bases are slippery like soapy water.

d. Bases change methyl orange to yellow colour.

e. Bases change phenolphthalein to pink colour.

Chemical properties of bases

(a) Bases ionize in water and give hydroxide ions(OH^-).

Sodium hydroxide $\rightleftharpoons$ Sodium ion + Hydroxide ion

$$NaOH \rightleftharpoons Na^+ + OH^-$$

Activity 10.9

Objective: To observe the chemical reaction between base and ammonium salt.

Materials required: Sodium hydroxide, ammonium sulphate, test tube and litmus paper.

Method: Take a little amount of ammonium sulphate in a test tube. Now mix a little amount of sodium hydroxide solution in it. What happens? Observe it. Then after, bring a moist red litmus paper near the mouth of the test tube. What happens? Observe it.

Conclusion:.....

(b) Chemical reaction with an ammonium salt.

Ammonia gas is produced when ammonium salt reacts with a base.

Ammonium sulphate + Sodium hydroxide $\rightarrow$ Sodium sulphate+ Ammonia + Water

$$(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2NH_3 + H_2O$$

(c) Chemical reaction with acids

Bases react with acids to give salt and water. This is called an acid-base reaction or a neutralization reaction.

Sulphuric acid + Potassium hydroxide $\rightarrow$ Potassium sulphate + Water

$$H_2SO_4 + KOH \rightarrow K_2SO_4 + H_2O$$

Uses of base

Bases	Uses
Calcium hydroxide	To makebleaching powder, use it as a white primer before painting the house (to whitewash), to reduce the acidity of the soil.
Magnesium hydroxide	As an antacid to neutralize hyperacidity (gastric).
Sodium hydroxide	As an antacid to neutralize hyperacidity (gastric).
Ammonium hydroxide	To manufacture soap, clothes, and paper. For processing petroleum products.
	As a laboratory reagent, to manufacture chemical fertilizer, rayon cloth, plastic and dyes.

Salt

A neutral compound formed after the chemical reaction between an acid and a base is called a salt. According to the nature of acids and bases, salts can be acidic, basic or neutral. Salts are mainly of three types which are as follows:

(a) Neutral Salts

Salts formed after the chemical reaction between a strong acid and a strong base or a weak acid and a weak base are called neutral salts. For example:

sodium chloride (NaCl) is a neutral salt.

(b) Acidic Salts

Salts formed after the chemical reaction betweena strong acid and a weak base is called acidic salts. Ammonium chloride (NH_4Cl) is an example of an acidic salt.

(c) Basic Salts

Salts formed after the chemical reaction between astrong base and a weak acid are called basic salts. Sodium carbonate (Na_2CO_3) is an example of basic salt.

Activity 10.10

Take a little amount of table salt or copper sulphate. Perform the following activities and fill in the observations in the table given below:

Activities	Observations
Taste the table salt or examine copper sulphate properly.	
Dissolve a little table salt or copper sulphate in water.	
Dip red litmus paper in table salt or copper sulphate solution	
Dip blue litmus in table salt or copper sulphate.	
Mix a little amount of methyl orange in table salt or copper sulphate.	
Mix a little amount of phenolphthalein in table salt or copper sulphate solution.	

Write the physical properties of salts on a chart paper based on the above activities and paste it in the classroom.

Sample:

Although table salt is salty, most salts are tasteless and some are bitter.

Most salts are soluble in water.

They are colourless or white and some are colourful.

Neutral salts do not react with indicators.

The boiling and melting points of salts are high.

Chemical properties of salt

(a) Ionization when dissolve in water

When salts dissolve in water, they produce positive ions of metals and negative ions of non- metals.

Sodium chloride $\rightleftharpoons$ Sodium ion + Chloride ion

$$NaCl \rightleftharpoons Na^{+} + Cl^{-}$$

(b) Chemical reaction with acids

Sometimes salts react chemically with acids to form new salts and acids.

Sulfuric acid + Sodium chloride $\rightarrow$ Sodium sulfate + Hydrochloric acid.

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

(c) Chemical reaction with bases

Sometimes salts react chemically with bases to form new salts and bases.

Ammonium chloride + Calcium hydroxide $\rightarrow$ Calcium chloride + Ammonia + Water

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

Activity 10.11

Objective: To observe the chemical reaction wherea more reactive metal displaces a less reactive metal of a salt.

Materials Required: Test tube, Copper sulphate, iron powder.

Method: Take a half test tube of copper sulphate solution. Now keep some iron powder in it. What happens after some time?
Observe and write a conclusion based on the activity.

(c) Displacement reaction

The more active metal displaces the less active metal of salt and forms a new salt.

Iron + Copper sulphate $\rightarrow$ Ferrous Sulphate + Copper

$$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$$

Uses of salt

Salt	Uses
Table salt or Sodium Chloride	To make food tasty. To use as a food preservative. To manufacture sodium hydroxide, sodium carbonate, soap, baking soda etc.
Sodium carbonate or washing soda	For cleansing action. To remove the permanent hardness of the water. For industrial production of glass, paper, and soap.
Sodium bicarbonate or Baking soda	To make baking powder. To make antacid. To use in fire extinguishers.

10.2 Acid rain

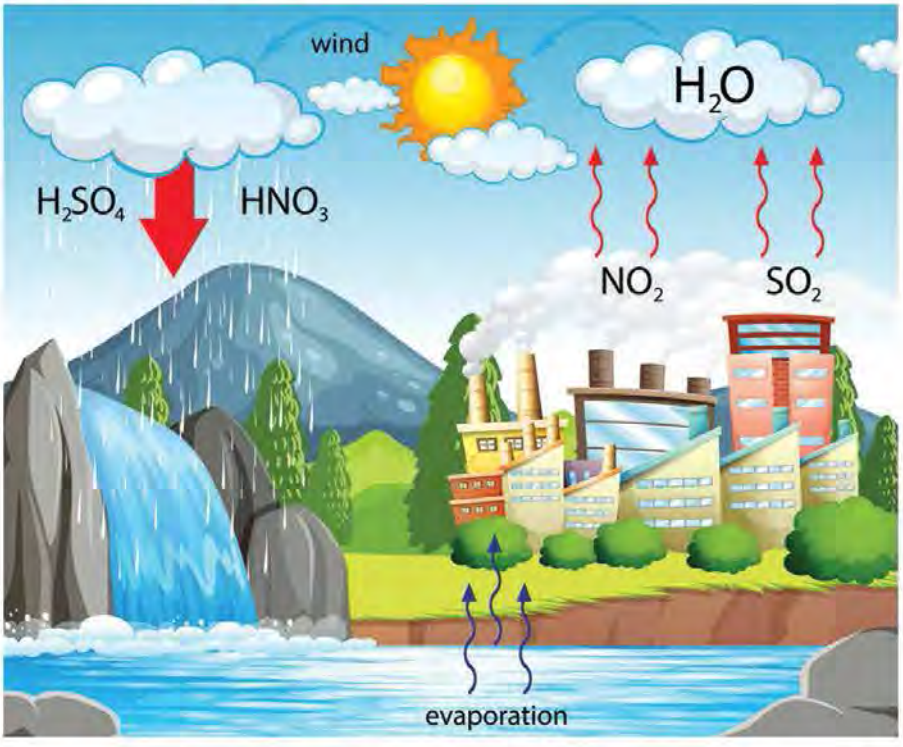


Fig 10.5

Study the picture and discuss it in the classroom based on the given questions:

Questions

i. What is coming out from the factories and industries in the given figure?

ii. How are the sulphuric acid and nitric acid formed as shown in the figure?

iii. What is called when these acids fall with rain water?

iv. What is the effect of these acids when they are mixed with rainwater?

v. How is acid rain prevented?

The rain that has become acidic by mixing various acids formed in the atmosphere is called acid rain. Generally, rainwater is acidic because carbonic acid is formed by the chemical reaction of carbon dioxide and water in the atmosphere. It will reach the earth's surface with rainwater. The pH value of this water is around 6 which is not very harmful. In addition to this, strong acids come with rainwater of low pH value is harmful to animals and plants. Acids are formed in the atmosphere in two ways.

(a) By natural means

Natural events such as the decay of animals and plants, volcanic eruptions, and the mixing of oxides of nitrogen and sulphur inthe atmosphere, chemically react with water to form acids such as sulphuric acid and nitric acid. These acids mix with rainwater and fall on the earth's surface in the form of acid rain.

(b) Byartificial means

Mostly acid rain is caused by human activities. Oxides of nitrogen and sulphur are present in the atmosphere by burning fossil fuels, use of unnecessary vehicles and harmful chemicals produced by factories and industries. These harmful chemicals are mixed into the atmosphere and react with the water to form acids such as sulphuric acid, nitric acid, and carbonic acid reach the surface of the earth along with rainwater.

Activity 10.12

Take rainwater and find out whether it is acidic, basic or neutral with the help of litmus paper or any other indicator. Discuss the result in the classroom.

Effects of Acid Rain on the Environment

Rainwater is a major component of the environment. Living beings need water to survive. Rainwater is the main source of water recharge on Earth. Water mixed with acid reaches the surface of the ground and affects living organisms as well as other environmental elements. Some of the effects are given below.

1. Acid rain will make water sources such as rivers, lakes, and ponds acidic which is harmful to aquatic life.
2. Acid rain damages the leaves of plants and also reduces the quality of the soil.
3. The forest will be destroyed if the acid rain exists for a long time.
4. Acid rain also destroys temples, monuments and idols of archaeological importance.

Measures to prevent acid rain

1. Reducing the use of fossil fuels.
2. Reducing air pollution by using renewable sources of energy like hydroelectricity, solar energy etc.
3. Establishing industries and factories away from residential areas.

Project work

Create a poster which indicates them easures that can be taken to prevent acid rain artistically and paste it on the notice board of the school.

Exercises

1. Choose the correct alternatives.

(a) Which of the following is a property of an acid?

(i) Bitter (ii) Slippery

(iii) Sour (iv) Colorless

(b) Which of the following turns red litmus blue?

(i) Curd (ii) Tomato

(iii) Coca- Cola (iv) Shampoo

(c) Which of the following liquid will be in the test tube if bubbles come out as soon as zinc pieces are placed?

(i) Water (ii) Acid

(iii) Base (iv) Salt

(d) What is the reason for using ash to reduce soil acidity?

(i) Ash is cheap (ii) Ash is available at home

(iii) Ash is alkaline (iv) Ash is salt

(e) Which salt is used in fire extinguishers?

(i) Sodium carbonate (ii) Potassium carbonate

(iii) Sodium bicarbonate (iv) Potassium sulphate

2. Differentiate between:

(a) Organic acid and inorganic acid.

(b) Strong acid and weak acid.

(c) Bases and alkalis.

3. Givea reason :

a. Generally, rainwater is acidic.

b. Ammonium chloride is an acidic salt.

c. Both lemon juice and sulfuric acid are acidic, sulfuric acid corrodes cloth but lemon does not.

d. Gastritis patients are cured by consuming magnesium hydroxide.

4. Answer the following questions:

a) What is an acid?

b) Show in a table the reaction of an acid with indicators.

c) Define bases.

d) Make a table to show the reaction of a base with indicators.

e) What is salt?

f) Make a table to show the reactions of salts with indicators.

g) List out the reasons for acid rain.

h) How do you know that acid rain is harmful?

i) What can be done to prevent acid rain?

j) What suggestion do you give to improve the declining agricultural production due to acid rain?

k) Results obtained by reacting two samples with a different indicator are shown in the table below:

Sample	Methyl orange	Litmus paper	Phenolphthalein
A	Red	Red	X
B	Y	Blue	Pink

(i) Which colour do X and Y represent?

(ii) Among A and B, which will produce carbon dioxide gas when reacts with calcium carbonate?

10.3 Hardness of water

Activity 10.13

Collect water from different sources and keep it in a different beaker. Write down the name in the beaker from where the water is collected. Now put two drops of liquid soap on all the water samples and stir them. Observe which beaker water produces more lather and less lather. Discuss the results obtained in the classroom.

The water that gives more lather with soap is called soft water and that gives less lather is called hard water. Mostly, surface water is soft while groundwater is hard. In this way, water can be divided into two types i.e. soft water and hard water based onthe formation of lather.

Soft water

Water which does not contain soluble salts of calcium and magnesium is called soft water. Soap gives more lather in soft water and more water is needed to wash clothes. Rainwater, boiled water and surface water are some examples of soft water.

Hard water

Water which contains soluble salts of calcium and magnesium is called hard water. Hard water contains sulphate, chloride and bicarbonate of calcium and magnesium which produces less lather with. Clothes washed in hard water will gradually get dull and whitish matter accumulates in the pipes and boilers. Generally, groundwater is hard. There are two types of hardness of the water.

Temporary hardness of water

The water which contains dissolved bicarbonate salts of calcium and magnesium is called temporary hardness of the water. The temporary hardness of water can be removed by boiling or using calcium hydroxide (lime).

Method for removing temporary hardness of water

(a) By Boiling Method

The temporary hardness of water can be removed by boiling. The calcium and magnesium bicarbonate salts dissolved in the water are converted into insoluble carbonates after boiling and it settles. The remaining water becomes soft.

(b) Clark method

The method of removing the temporary hardness of water using calcium hydroxide is called the Clark method. In this method, calcium hydroxide is added to the required amount of water. Calcium hydroxide converts the bicarbonate salts of calcium and magnesium into insoluble carbonates. It gets precipitate at the bottom of the crucible and can be separated by filtration.

Activity 10.14

Objective: To remove the temporary hardness of water

Materials Required: Well water, beaker, test tube, bunsen burner or spirit lamp, calcium hydroxide, soap etc.

Method

a) Place the sample of well water in three test tubes.

b) Put a small amount of liquid soap powder in the first test tube and stir it.

c) Boil the water in the second tube and adda few drops of liquid soap and stir it.

d) Pour a small amount of calcium hydroxide into the third test tube and add a few drops of liquid soap with stirring.

e) Now, which of the following three test tubes of water produces more lather? Conclude by observing.

Permanent hardness of water

The water that contains sulphate and chloride salts of calcium and magnesium is called permanent hardness of the water. The permanent hardness of water cannot be removed by boiling but can be removed by using washing soda or zeolite (crystalline solids of aluminium silicate)

Method for removing permanent hardness of water

(a) Using washing soda

Washing soda converts calcium and magnesium sulfate and chloride salts dissolved in water into insoluble carbonates, which are separated by filtration.

(b) By permutit method

The method of removing the permanent hardness of water using zeolite is called the permutit method. In this method, layers of small stones, sand and sodium zeolite are placed together as shown in the figure. When hard water is passed, the sodium in sodium zeolite is replaced by calcium or magnesium ions. Hence the hardness of the water is removed and soft water is obtained.

Read the following story and discuss the questions given below:

Ramila went to the jewellery with her mother. Mother wanted to make a gold bangle. In the jewellery, she chose the design which she liked and started discussing with the goldsmith about the carats and tolas of gold required. Mother told her plan to the goldsmith to make two tolas of 24 carats. The goldsmith asked whether she would wear bangles daily or occasionally. Mother said that she would wear it daily. Then the goldsmith advised her to make a 22-carat gold bangle instead of a 24-carat.

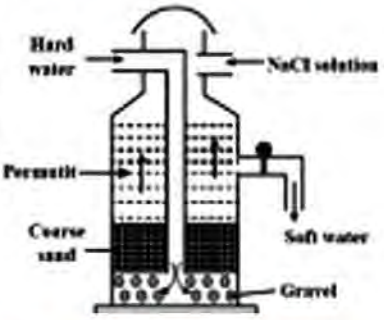


Fig: 10.6 Permutit method

Questions

(i) Which gold among 24-carat and 22-carat is pure and mixed?

(ii) Why did the goldsmith advice Ramila's mother to make a bangle 22-carat for daily use?

A homogenous substance formed by the combination of metals with metals or with non-metals is called an alloy. In our daily life, we use alloys instead of pure metals due to various reasons. Making alloys from metals further improves the properties of the metal and increases its utility. Aluminium is a light metal and is used to make the body of aeroplanes but to make it strong it is mixed with copper, manganese and magnesium which is duralumin.

Properties of Alloys

1. Alloys are harder than metals from which it is made up. They are less ductile and malleable.

2. Alloys do not rust easily.

3. An alloy has a melting temperature lower or higher than that of the pure metals it is composed of.

4. An alloy has a different colour than the metals it is composed of. For example, silver and zinc both are white but an alloy made of these two metals is pink in colour.

5. The properties of alloys are improved than the properties of the constituent metals.

Some Alloys used in daily life

Activity 10.15

Make a list of materials made of pure metals and alloys in your kitchen and discuss them in the classroom.

(a) Steel

Figure No. 10.7

A homogenous mixture of carbon and iron is called steel. Pure iron is very soft when heated and is difficult to work with. So a little carbon is added to it which makes it hard. Similarly, pure iron rusts, but an alloy made up of iron, chromium and nickel (stainless steel) does not rust easily. Therefore, steel and stainless steel are used more than pure iron these days. Steel is used to make buildings, bridges, railings, etc. Similarly, stainless steel is used to make kitchen utensils and surgical instruments in hospitals.

Brass

Figure No. 10.8

A homogenous mixture of copper and zinc is called brass. It is used to make various materials used in daily life like pooja items, gagri, idols etc and is also used to make different nuts, bolts plumbing and machinery items.

(c) Bronze

Figure No. 10.9

A homogenous mixture of copper and tin is called bronze. Bronze is used to make dinner plates, bowls, tumblers etc. In addition, bronze is also used to make medals, coins, ships, and statues.

Activity 10.16

Prepare a list of the names and uses of items made of steel, brass and bronze available at your home and present them to the class.

Exercise

1. Choose the correct alternatives.

(a) Hard water contains which of the following salts?

(i) Magnesium sulphate (ii) Magnesium oxide

(iii) Magnesium nitrate (iv) Magnesium sulphide

(b) Which method should be used to remove the permanent hardness of water?

(i) By boiling (ii) Clark's method

(iii) Permutit method (iv) Using calcium hydroxide

(c) Which of the following water has the lowest hardness?

(i) Rain water (ii) Well water

(iii) Tube bell water (iv) River water

(d) What is the reason for the increment in the use of alloys instead of pure metals?

(i) Alloys are cheaper.

(ii) The properties of metals are improved in the alloy.

(iii) Alloys are easily available in the market

(iv) The use of alloy is good for health.

(e) Which metals are mixed to make brass?

(i) Copper and zinc (ii) Copper and tin

(iii) Copper and carbon (iv) Copper and nickel

(f) Which property of iron is lost when carbon is mixed with iron?

(i) Becomes black after ageing (ii) Becoming heavy

(iii) Rusting properties (iv) Shining properties

(g) Which alloy is formed when copper is mixed with tin?

(i) Steel (ii) Stainless steel

(iii) Brass (iii) Bronze

(h) Which of the following sentences is true?

(i) An alloy is harder than the metal it is made of.

(ii) An alloy is more flexible than its constituents metal.

(iii) An alloy is dull than the metal it is made up of.

(iv) The alloy is more ductile than the metal it is made of.

(2) Differentiate:

(a) Soft water and hard water

(b) Temporary hardness of water and permanent hardness of the water.

(c) Clark's method and Permutit method

(d) Pure metals and alloys

(e) Steel and stainless steel

(3) Give reasons:

(a) Steel is used more than iron in making household kitchen utensils.

(b) rainwater produces more lather with soap while washing clothes.

(c) Well water is hard.

(d) The use of alloys is increasing day by day than pure metals.

4. Answer the following questions:

(a) Define the hardness of the water.

(b) What are the causes of the hardness of water?

(c) Roshan took out water from the well to wash his school uniform on Saturday. Sufficient lather is not produced while applying soap to it. What would you suggest to produce sufficient lather even in well water?

(d) Riya always washes her clothes in tubewell water. White clothes became dull instead of shiny. What is the reason for this dullness of white clothes? What do you suggest to her to solve this problem?

(e) How can the hardness of water be removed by the permutit method? Describe with the necessary diagram.

(f) What is an alloy?

(g) Whichmetals are mixed in the following alloys?

(i) Steel (ii) Stainless steel

(iii) Brass (iv) Bronze

(h) What are the causes for the increasing popularity of alloys? Prepare a list.

(i) Rama won a bronze medal in a competition. Which metals are mixed to make the medal she has received?

11 The Earth and Universe

Observe the diagrams and discuss the given questions :

Fig 11.1

(a) What is the surface of the earth shown in Figure A made of up?

(b) How are the masses shown in Figure B formed in your opinion?

(c) Are all living beings shown in Figure C evolved at the same time?

All heavenly bodies including Earth are part of the universe. The universe is made of nebulas, stars, planets, asteroids, meteors etc. Although there are different hypotheses about the origin of the universe, the most acceptable one is the Big Bang theory which is based on scientific facts and evidence.

In the beginning, the earth was too hot for living beings, but later on, it gradually cooled to normal temperature and the living beings started evolving one after another.

The surface of the earth is composed of rock, soil, stones, sand, minerals, water etc. These substances and the different gases present in the atmosphere have provided a suitable environment for living beings. At the very beginning of organic evolution, the formation of various biomolecules like carbohydrates, proteins, nucleic acids, etc led to the evolution of very simple and unicellular creatures. Their continuous evolution resulted in the present biodiversity on Earth.

11.1 Minerals

Discuss after observing the given figure :

(a) Are all stones shown here similar in composition and quality?

(b) What is a stone composed of ?

Fig 11.1 different types of stones

The outer surface or crust of the earth is composed of rock, soil, sand, rock, metals, and water-like substances. If deeply examined, all these rocks, soil, sand, and stones are found to be formed of various particles of elements and compounds. According to geology (earth science), a naturally made solid and pure substance is a mineral. Minerals are found either in elementary or in compound forms and the combination/mixing of which has formed earth's crust having all rocks, soil, stones etc. Water parts of the earth also contain some minerals in dissolved form. Simply, a mineral is a substance obtained from mines and some economic importance. According to this explanation, useable substances like coal, petroleum, limestone, marble, diamond and other gemstones, granite, quartzite, slate, red clay, white clay etc are all minerals. The branch of geology which deals with the study of minerals is called Mineralogy.

Types of Minerals

Based on composition and characteristics, minerals can be divided into three groups :

(a) Metallic minerals, (b) Non-metallic minerals, (c) Energy Minerals

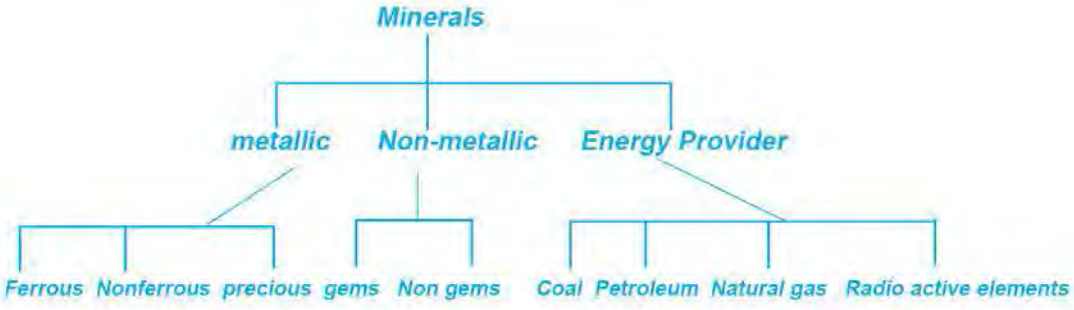


Fig. 11.3 Flow chart of elements

(a) Metallic minerals

Normally hard, lustrous, and good conductors of heat and electricity, relatively denser minerals are metallic minerals or ores. The ores can exhibit some metallic characteristics. The ores of iron, tin, nickel, copper, gold, silver, zinc, cobalt etc are some examples of metallic minerals. These metallic minerals are again divided into three types: Ferrous, Non-ferrous and Precious minerals. Hematite, magnetite, limonite, siderite, pyrite etc are ferrous minerals and iron can be extracted from them. The ores of copper, lead, tin, aluminium etc have no iron or very less iron, so they are called non-ferrous. The minerals which have comparatively very less deposition but great economic value and are chemically very less reactive are called precious minerals. They are the minerals of gold, silver, platinum, palladium etc.

Fig. 11.4 Various metalic minerals

(b) Non-metallic minerals

The non-metallic mineral has properties like that of non-metals though they may contain some metals or metalloids in their molecules. they are bad conductors of heat and electricity and light in density. Because of their being light, they are found on the upper part of the crust. Most of them are found in the form of rocks but some are in the pure state. They can be further divided into two types: gems and non-gems. Diamonds, emeralds, sapphire, topaz, garnet, etc are gem minerals and silica, feldspar, mica, sulphur, graphite, gypsum, talc, etc examples of non-gem minerals.

Fig. 11.5

Fig. 11.5 b

(c) Energy Minerals

The fuels used in industries and daily life that are obtained from mines are called energy minerals. These minerals are found under the ground and used as a non-renewable source of energy. Coal, petroleum, natural gas and radioactive elements like uranium are examples of energy minerals

Fig. 11.6

Project work 11.1

Visit some natural places in your surroundings. Take photos of minerals found there or collect them from other sources. Present the photographs of minerals in your class with their characteristics.

Properties of Minerals

(a) Minerals exist in various colours. The minerals/ores of iron are black or reddish brown and that of gold and copper are light yellow or red. Some minerals are colourless too. Muscovite is a colourless mineral.

(b) Most of the minerals have fixed geometric shapes so they exist in crystalline forms. Very few are in an amorphous form which does not make any crystal naturally. Minerals usually exist in cubical or prismatic forms. For example, pyrite is cubical and tourmaline is a prismatic mineral. Opal is an amorphous mineral.

(c) Minerals are usually hard, bright and lustrous.

(d) Metallic minerals are usually good conductors of electricity and heat, but non-metallic minerals are insulators.

(e) Minerals are found in a solid state and they are homogeneous solids having definite chemical composition.

Activity: 11.1

Collect some minerals from your surrounding and fill the given table making separately on a chart paper and exhibit in your class.

Name of mineral	Colour	Shape	Lustre	State

Uses of minerals

Many minerals are used as raw materials in industries. The importance and uses of some minerals in various sectors are given below :

(a) Uses in agricultural sectors

Minerals are essential to maintain the fertility of the soil and to increase crop productivity. Calcium, potassium, nitrogen, iron, and phosphorus minerals are necessary for the proper growth, greenery, and blooming of plants. These elements are supplied in the soil through minerals. Chemical fertilizers, pesticides, micronutrients etc are manufactured from minerals which support farming, pisciculture, animal husbandry, and poultry farming. Nitrogen, potash, phosphorus, gypsum, sulphur etc are the minerals used in the agriculture sector.

(b) Uses in the industrial sector

Minerals are used in industries as raw materials or as a source of energy. Industries like cement, glass, paint, ceramics, detergent etc are based on minerals. Silica, mica, gypsum, limestone, magnesite, granite etc are some minerals being used in various industries. Many limestone-based cement factories like Udaypur Cement, Hetauda Cement and many others factories are running in Nepal. Electric cables, iron rods, tools, machinery, weapons etc are produced from metallic minerals.

Fig. 11.7

(c) Uses in the construction sector

Minerals are also used in the construction sector. Rocks, sand, gravel, and gypsum-like substances are used to construct houses, bridges, and roads like infrastructures. There is a tradition of making slate-roof in many parts of Nepal where slate is naturally available. Limestone and marble are used to make images, idols, and stone inscriptions. Decorative items like marble, granite, talc, slate etc are also minerals.

Fig. 11.8

(d) Uses in the energy sector

Coal, graphite, zinc, petroleum, lithium, lead, manganese etc are used as the source of thermal or electrical energy. Petroleum is used to run vehicles, cook food and generate electricity. Coal is used in cement factories, brickkilns, blast furnaces, etc to generate very high temperatures. Lead, graphite, lithium, manganese, zinc etc are used in dry cells to generate electricity.

Project work: 11.2

Visit the local community near your school. Prepare a report of minerals with their utility the people of the community are using traditionally for a long time and present it in your class.

Minerals in Nepal

More than 60 types of minerals are identified in Nepal among which 21 types are metallic, 23 types are related to chemical fertilizer and insulating material, 6 types are gems, 9 types of constructing material and 4 types of minerals are related to fuel and geothermal energy. The plane land of the Terai region is likely to be enriched in construction material, underground water, petroleum and natural gas, the Himalayan region is for construction material, radioactive minerals, petroleum and natural gas, the lower of the Himalayan region is likely to bear iron, zinc, lead, copper, gold, magnesite, phosphorite, limestone, dolomite, slate, garnet etc. Despite great potentiality, not enough research has been made to explore such valuable minerals which could uplift the economic status of the country more rapidly than any other resources. The Himalayas and its periphery hold about 83% of the total minerals. Nepal has all metallic, non-metallic, energy minerals as well as constructional, decorative stones in considerable volume. Limestone, dolomite, silica, coal, gold, iron, gypsum, and mica, as well as radioactive uranium, are also found in Nepal. From very ancient times mines of iron, coal, and copper mines are being used in Nepal from pre-historical times. The iron mine of Ramechhap and the coal mine of Dang were in use in the past time. The prime minerals found in Nepal are given in the table below.

Table 11.1 A Glimpse of Minerals in Nepal

SN	Name of minerals	Places of potentiality
1	Iron	Fulchoki (Lalitpur), Those (Ramechhap), more than 88 places
2	Copper	more than 107 places
3	Zinc and Lead	Ganesh Himal and surrounding. More than 57 places
4	Gold	The sand of Rapti, Sunkoshi, Kaligandaki, Bishnumati and many other rivers
5	Limestone	Udaipur, Makwanpur, Chobhar (Kathmandu)
6	Dolomite	Mahabharat mountain range
7	Phosphorite	Dang, Pyuthan, Baitadi
8	Magnesite	Dolkha, Udaipur, Palpa
9	Ceramics clay	Makwanpur, Kathmandu Valley
10	Silica	Sand of rivers
11	Rock salt	Mustang, Dolpa
12	Quartz crystal	Dailekh, Taplejung, Rasuwa
13	Marble and Granite	Godawari (Lalitpur), Sindhuli
14	Slate	Dhankuta, Achham, Gorkha, Benighat (Dhading)
15	Coal	Dang, Palpa, Pyuthan
16	Radioactive Uranium	Upper Mustang

11.2.1 Origin and Age of Earth

From the study of the age of rocks and fossils, the earth is estimated to be originated about 4.6 billion years ago. Stars, planets, and satellites like heavenly bodies are formed after the origin of the universe. Some hypotheses related to the origin of the earth are as follows :

(a) Kant's and Laplace's Nebular hypothesis

(b) George Buffon's Planetesimal hypothesis

(c) Chamberlin's and Moulton's Binary hypothesis

(d) Jean's and Jeffrey's Tidal hypothesis

(a) Nebular Hypothesis

German scientist Immanuel Kant proposed the Nebular hypothesis in 1755 based on Newton's law of gravitation. According to this hypothesis, there was a super big, nearly circular and flat nebula spinning slowly in the present site of the solar system. The dust and gas particles of the nebula gradually came closer in the central part due to mutual gravitation among those particles. The formation of eddy current by the collecting particles accelerated the rate of collection and the central mass started to grow and rotate more rapidly. Due to the eddy current, more particles were collected in the centre and it became a very big ball of matter (protostar) rotating more rapidly. Tremendous pressure in the core of the protostar resulted in millions of degrees of temperature which started thermonuclear fusion in the core and the big ball became the sun. Because of comparatively high spinning speed and less consistency, the outer part of the ball started to be flat from the equator due to centrifugal force keeping their motion continuing around the central sun. The substances present in the flattening part of the protostar also started collecting nearby particles at many places and gradually converted into planets and the materials around them became satellites. The remaining particles of the spinning nebula became asteroids, comets and meteoroids.

In 1796, a French scientist Pierre Simon Laplace slightly corrected Kant's hypothesis saying that planets originated from the equator of the newly formed sun by sudden ejection of rings of some of its mass

one after another due to strong centrifugal force just like the drops of water ejecting all around if a wet cloth is spun rapidly. And, satellites were also formed from the planet in the same way.

The speciality of the nebular hypothesis

i) According to this hypothesis, all planets, satellites and other heavenly bodies of the solar system are solid and cold from the very beginning of their origin. But due to the powerful collision of substances during the formation of planets and satellites, they might have been molten partially and cooled time and again.

ii) As heavenly bodies of the solar system have originated from the flattening and spinning of the central part of the protostar/sun, all the planets and satellites revolving around the central sun from more or less the same plane and same direction.

(b) Planetesimal hypothesis

This hypothesis is presented by French scientist George Buffon in 1745 before the nebular hypothesis of Kant. According to this, there was only the sun before the formation of other heavenly bodies of the solar system. Long ago, a giant comet collided forcefully making a very low angle and splashed away some solar mass in space among which, some parts escaped into space, some fell again on the sun and the remaining parts which can be called 'Planetesimal' started to revolve round the sun. Later on, the revolving parts cooled down and became planets and other members of the solar system.

The speciality of the Planetesimal hypothesis :

(a) According to this hypothesis, earth and all other members of the solar system were extremely hot in the beginning and started cooling slowly due to the distance maintained between them and the sun.

(b) Because the total mass of all planets, satellites, asteroids etc of the solar system is only about 1% of the solar mass, the event that happened in the sun long ago as he claimed cannot be ignored completely.

(c) Binary hypothesis

The binary hypothesis was forwarded in 1905 by two American scientists Thomas Crowder Chamberlin and Forest Ray Moulton. According to this, our sun had a very big co-partner star of the binary system and they were revolving around each other. Once, the partner star, became very close to our sun and some solar mass was pulled out due to its strong gravitation. The binary star continued its way swiftly before the separated solar mass could fall on its surface. Later on, the separated solar mass started revolving sun, gradually cooled down, and became planets, satellites and other members of the solar system.

Criticism of the Binary hypothesis

Still, it is not in anyone's knowledge that our sun has any binary star.

(d) Tidal hypothesis

English scientists Sir James Jeans and Harold Jeffrey put forward their Tidal hypothesis in 1919. They claimed that there was only one sun in this galactic region and a very big star swiftly passed away by the sun. The strong gravitation of that heavier star pulled a big lump of hot matter from the sun's surface in the form of a tide and started revolving the sun. The separated tidal mass somewhat looked like a cigar. Later on, smaller planets Mercury and Pluto at the two ends and bigger planets Jupiter, Saturn etc formed at the middle portion of the lump due to mutual gravitation and cooling process.

The speciality of the Tidal hypothes

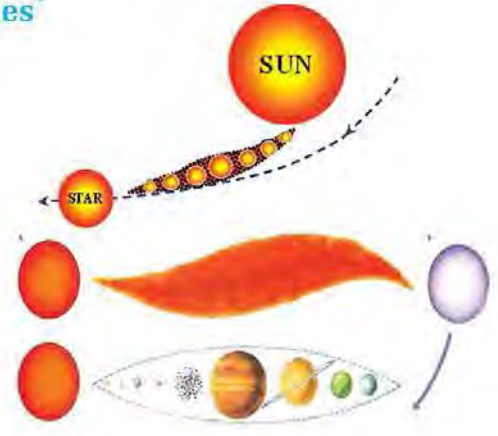


Fig. 11.9

(a) As the shape of the tidal mass of the sun was spindle having tapering ends and swollen middle part, the planets formed from it at two ends are much smaller. In the middle, the size of the planets gradually grows bigger and central Jupiter has become the biggest one.

(b) Mars, which is farther than the Earth should be bigger but due to some reason, it must have been broken into pieces forming thousands of Asteroids lying between the orbits of Mars and Jupiter. Due to this breaking, Mars has become smaller than Earth.

Activity: 11.2

Objective: To construct the model of the Nebular hypothesis.

Material required: Knife, thermocol sheet, different colours, pencil and compass.

Procedure :

(a) Take the thermocol sheet. Draw an outline figure of the solar system on the thermocol with the pencil and compass based on the Nebular hypothesis.

(b) Inscribe the sheet with a knife carefully to represent the sun, planets, orbits, satellites etc and apply suitable colour.

(c) Present your model in class and arrange a talk program on the various hypothesis about the origin of the solar system.

11.2.2 History of Evolution of Living Beings on Earth

At the beginning of formation, because of the collision of big boulders of rocks from every direction with tremendous velocity, the particular part of the earth had melted many times. Everything here was unstable. The molten heavy metals like iron, nickel, gold etc gradually sank into the core and the lighter silicon, magnesium, aluminium etc. accumulated towards the surface. In the process of repeated expansion and contraction, the surface of the earth turned into various topography like mountains, valleys, planes, anticlines & synclines. The thermal decomposition reaction among various molecules of rocks originated various volatile gases including water

vapour, carbon dioxide, sulphur dioxide, nitrogen, oxygen, ammonia, methane etc. which gradually formed the atmosphere. Condensation of water vapour caused heavy rain which filled all lowlands and created oceans, seas, and ponds like water bodies. In this way, the environment of the earth gradually became suitable for living beings. Similarly, the reaction between hydrogen, oxygen, nitrogen, carbon etc formed different biomolecules like nucleic acids and proteins and with this, very simple prokaryotes evolved. All present lives on earth are developed from those simplest means of life through a gradual and continuous process of organic evolution.

To make the study of organic evolution easy, the total history of the earth has been divided into different units called Geological time scales. The longest time scale is called Eon. There are two Eons: Cryptozoic and Phanerozoic. Both of the Eons are further divided into three Eras each.

(a) Cryptozoic Eon

Cryptozoic Eon simply means the Eon of false life. It is very long in comparison to the Phanerozoic Eon and covers almost 88% of the total life of earth till now. It is further divided into Archeozoic, Proterozoic and Eozoic Eras. Archeozoic Era spent its tenure creating a suitable physical environment i.e. atmosphere, hydrosphere and lithosphere, for life, Proterozoic Era evolved the first primitive unicellular lives in water and in Eozoic Era, some soft-bodied unicellular and multicellular aquatic animals, algae were evolved in water.

Fig. 11.10

Cryptozoic Eon is the first part of the earth's history. It started 4.6 billion years ago and ended just 570 million years ago. Many geologists call Cryptozoic Eon as Precambrian or Azoic Era. We don't have much information about this Eon.

(b) Phanerozoic Eon

This Eon is running for 570 million years to till now. Although its duration is only about 12% of total life, it is much important because of the evolution and existence of a very vast diversity of life. Based on the origin and destruction of lives, this Eon is also divided into Palaeozoic, Mesozoic and Cenozoic Eras.

i) Palaeozoic Era

Fig. 11.11

Palaeozoic Era, with a duration of 330 million years is the longest among the rest two later Eras. It started 570 million years ago and ended 240 million years ago. During this Era, the evolution of varieties of multicellular animals and plants took place in water and some of them gradually dwelled on the land. Almost all invertebrates like arthropods, mollusks, echinoderms and pieces, amphibians and small reptiles evolved including Cryptogams or non-flowering plants.

Main Events and Lives

Continuous geological disturbances took place in this Era. In its first Cambrian period, maximum varieties of aquatic arthropods and algae evolved more than in any other geological period. Trilobites, crustaceans, mollusks, lung-fishes, snails, corals, marine

scorpions and four-legged amphibians along with algae, bryophytes and pteridophytes (lycopodium, dense forest of tree-fern etc) are the creation of this period. Due to the occurrence of immense geological and tectonic disturbances at the end of this era, most lives went extinct forever.

ii) Mesozoic Era

The total duration of this Era is 175 million years from 240 million years ago to 65 million years ago. In this Era, many geological and climatic changes took place and many further advanced organisms evolved. Due to the evolution of vast floral and faunal biodiversity, this Era has great importance in the history of organic evolution.

Main Events and Lives

The climate became dry and the effects of season change started to take place in this eara. The shallow sea became further deeper and the area of land expanded. Occurrences of physical activities like storms, the formation of clouds, heavy thundershowers, and considerable differences in day and night temperature were some important events of this Era. Replacing the pteridophytes, a coniferous forest of large gymnosperms like cycas, pines, ginkgo, juniper, ephedra etc occupied almost all moist land. therefore, this Era is also called the Era of Gymnosperms or Era of Conifers. At the end of this Era, some least-developed flowering plants also evolved.

Fig. 11.12

Fig. 11.13

evolution and extinction of many big reptiles including crocodiles and dinosaurs the noticeable events of the Mesozoic Era. Dinosaurs were dominant in all habitats (water, land and air). They were herbivores, omnivores as well as the top carnivores. Dinosaurs evolved in the first Triassic period, became dominant in the second Jurassic period and they were extinct at the end of the third Cretaceous period. It is said that heavy meteor-shower took place on earth along with devastating volcanic eruptions which spread flames of fire and poisonous gas everywhere enough to kill every organism that dwelt on the surface and in the shallow sea. Because of the abundance of reptiles and their dominance, Mesozoic Era is also called the Era of Creepers. Toothed birds, mosquitoes, fruit-feeding insects and small mammals also evolved at the end before the deadly devastation had occurred suddenly.

iii) Cenozoic Era

Cenozoic is the name of the current Era in the history of the earth. This Era started about 65 million years ago and still running. All mammals including human beings and phanerogams (seed-making plants) have evolved in this Era so it is also called the Era of Mammals and Era of Angiosperms.

Fig. 11.14

Main Events and Lives

In this modern era, all seven continents separated from each other due to the tectonic movement of the earth's crust and developed their own climatic conditions. The increase in height of the Himalayas, the formation of many mountains, rivers, lakes, planes, plateaus, valleys, regular changes in season etc caused the evolution of many kinds of modern animals and plants. Many giant mammals including elephants, horses, cats, monkeys, rhinos, primates, whales, entelodon wild boar, monocot and dicot plants evolved and most of them extinct in this Era. First wild human beings evolved about 6 million years ago from primates and they started using two hind limbs for walking only about 4 million years ago. Modern human beings called Cro-Magnons or Homo sapiens evolved only 56,800 years ago. Spending a long time as wild animals, the Homo sapiens started social life by cultivating plants, rearing animals, keeping faith in God in the name of various religions, practising married life etc. only 10,000 to 12,000 years ago, and this recent time frame is called Holocene epoch.

Exercise

1. Choose the correct alternative from the given options :

(a) What is called the branch of science that deals with the study of minerals?

i) Geology ii) Paleontology

iii) Mineralogy iv) Archeology

(b) Which mineral is necessary for the proper growth of plants?

i) Nitrogen ii) Dolomite

iii) Uranium iv) Gypsum

(c) Which of the following statement resembles the tidal hypothesis?

i) Earth originated from the splashed mass due to the collision of two stars.

ii) Earth originated from a hot lump of a star projected due to the strong force of gravitation when another giant star passed quickly by it.

iii) Earth originated from nebular dust.

iv) Earth originated from the explosion of a big heavenly mass.

(d) In which Era has the given organism evolved?

i) Precambrian ii) Palaeozoic

iii) Mesozoic iv) Cenozoic

2. Differentiate :

(a) Metallic minerals and Non-metallic minerals

(b) Palaeozoic Era and Cenozoic Era

3. Give reason :

(a) Minerals are said to be pure chemicals.

(b) Mesozoic Era is also called the era of coniferous.

(c) Living beings have evolved after a very long time on Earth's evolution.

4. Answer the following questions :

(a) What is a mineral? Give examples

(b) What are the hypotheses about the origin of the earth? Explain any one of them.

(c) Explain the importance of minerals for Nepal.

(d) Make a flowchart of minerals showing their types.

(e) Which Era was inappropriate for the evolution of life and why? Explain with an example.

(f) When did mammoths with long tusks and fish with lungs evolve?

(g) Make a list of places in Nepal for any five minerals with their uses.

(h) Name the Era in the following organisms to be evolved :

Tree-fern, entelodon wild boar, dinosaur, frogs, monocot plants, bacteria, mosquito, trilobites, jellyfish.

(i) Read the given passage and answer the following questions:

"Various types of minerals are found in Nepal. Recently, very precious uranium-like minerals are also reported to be found in Nepal. Some minerals like iron, copper, coal, gold etc. are being extracted and used traditionally but the effective exploring, extracting and commercial use of minerals is yet to be done. Such minerals are not being extracted sustainably."

i) What may be the reason that minerals are not being explored, extracted and utilized sustainably in Nepal?

ii) Which minerals are being extracted traditionally in Nepal? What should be done to extract and use such minerals sustainably?

(j) Study the given figure and answer the following questions:

i) In which Era did these animals evolve and extinct?

ii) What are the reasons for their extinction?

iii) If these animals were still roaming on earth, what impact, in your opinion would be occurred in biological balance?

11.3 The Universe

What are the heavenly bodies seen if observed in the sky at clear night? How far is this sky extended? Guess and discuss with your friends.

Planets, satellites, stars, meteors, asteroids, comets etc seen in the sky are all heavenly bodies. Except these, universal substances like dust particles, clouds, air molecules, ordinary matter, dark matter, leptons, and photons and the energy contained in them also exist in the sky. They all are very far from Earth.

Fig. 11.15

Boundless view of the sky is called space. No one can predict or even imagine the region up to which the space is expanded. The limitless expansion of visible space is called the sky. The aggregate form of limitless space, time, matter and energy is the universe. In another word, the universe stands for total existence. Earth, moon, sun, stars and all other celestial bodies are only parts of the universe. The extension and demarcation of the universe are infinite. The coverage of a powerful telescope is called the observable universe. The diameter of the observable universe is estimated to be 46 billion light years. The distance travelled by light in one year through the vacuum is called 1 light year (l.y.) which is equivalent to 9.46×10^{12} km. The branch of science, that deals with the study of the universe is called Astronomy.

Origin of the Universe and the Big-Bang Theory

The universe is estimated to be originated about 13.8 billion years ago. Although there is no factual evidence about its origin and age, various research about the expansion of the universe has established the theory of the Big Bang. In 1924, an American scientist Edwin Powell Hubble found a spiral nebula that was going farther from the earth at a very high speed, which developed a new concept about the theory of the origin of the universe. Three years later in 1927, a Belgium

scientist George Lemaitre described that the universe is expanding continuously with a great speed and if this rate of expansion is imagined to be reversed, all the matter and energy of the universe (which exist in different forms of heavenly bodies), will crunch to be a single point (he called it as 'Primeval atom') after 13.8 billion years. It means the present universe has been initiated from the primaeval atom 13.8 billion years ago.

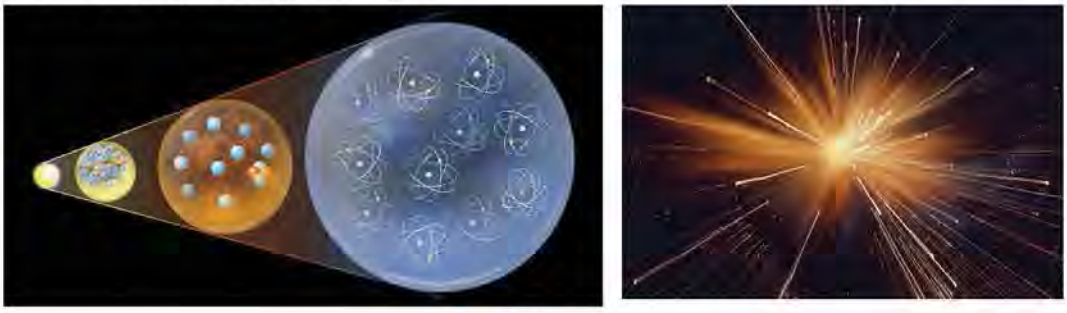


Fig11.16

According to him, the unimaginably dense and pressurized primaeval atom exploded 13.8 billion years ago. This explosion is called Big Bang. After the Big Bang, the primaeval atom started to expand at a very high speed forming the pre-matter at first and then subatomic particles. With their combination, atoms were formed followed by the formation of molecules. From atoms and molecules, the formation of all heavenly bodies of the universe including galaxies, nebulas, stars, planets etc. could be possible with time. Stephen Hawking has redescribed the origin of the universe from a mathematical singularity in the book "A brief history of Time: From the Big Bang to Black Holes".

Project work 11.3

Search the findings and facts about the theory of the Big Bang by Hubble, Lemaitre and Hawking on the internet and prepare a chart of their short biography and contribution to the origin of the universe with their photos on cardboard paper and present it in your class.

Fig11.17

Asteroids

Different types of objects exist in the solar system. The heavenly body whether they are bigger or smaller, which revolves around the sun is a member of the solar system. Asteroids are also members of the solar system. The smaller masses of rocks without any specific shape that revolve around the sun along their orbits are called Asteroids or baby planets. There are too many asteroids in our solar system. Their orbits around the sun are somewhat irregular so while revolving around the sun, they hit and collide with each other.

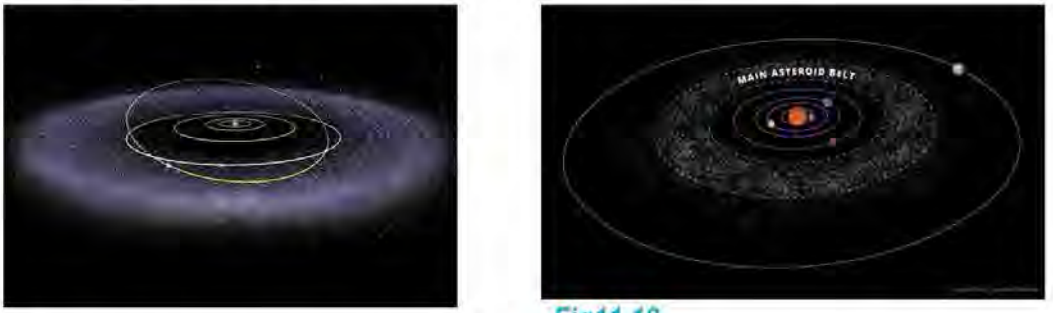


Fig11.18

Many Asteroids revolve around the sun and lie between the orbits of Mars and Jupiter. This region is called the Asteroid belt. Similarly, many asteroids revolve around the sun lying far away from the orbit of Neptune. This region is called the Kuiper Belt. the dwarf planet Pluto also lies within the Kuiper belt. The frozen icy particles of the Kuiper belt are the remnant of the substance with which our solar system has been formed. Some Asteroids revolve around the sun using the orbits of Jupiter, and Mars and they are called Trojans.

Many of the asteroids revolve around the sun intersecting the orbit of our Earth and they are called 'Near Earth Asteroids'. Some times. some of them fall into the earth and cause great devastation.

Asteroids have various sizes and most of them are irregularly shaped. Because of less mass contained, their gravity is not strong enough to shape them around. They are found to have 1 km to about 1000 km in diameter. Ceres, the largest asteroid is nearly round with a diameter of 940 km. Eros, another asteroid, is elongated and its diameter is only 16.8 km.

Asteroids are composed of rocks, minerals, metals, clay etc.

Activity: 11.3

Objective: To prepare a model of an asteroid

Materials required: Clay, water, colour, knife, cardboard & chart paper, glue, pencil, compass

Procedure:

(a) Make a hard paste of clay mixing it with water little by little and leave for some time.

(b) Paste chart paper on the cardboard paper to outline the solar system.

(c) Draw all planets around the sun showing their orbits with pencil and colour them.

(d) Cut the paste of clay into small irregular pieces and cling them indicating Asteroid Belt and Kuiper Belts.

(e) Let the model dry in the sun and colour. Now the model is ready to present in your class.

Comet

The smaller members of the solar system that appear with the long bright tail when coming closer to the sun are called Comets. Their orbits are highly elliptical and most of them are extended up to the Kuiper Belt. Once they come very close to the sun and go very far away from the sun while revolving. Many comets do not go outside the Kuiper belt and they are called Endocomets and some come to revolve sun from outside the solar system and they are called Exocomet. Comets are composed of ice, dust particles, fragments of rocks and gases. The central core of a comet is an icy solid called Nucleus. When they come closer to the sun, most of the substance present in them gets evaporated and makes a bright and spherical cloud around the nucleus which is called Coma. Similarly, strong solar wind makes the evaporated particles fly away from them in the opposite direction of the sun which appears as a long and bright tail due to the reflection of sunlight. If observed, two distinct tails can be seen in the opposite direction of the sun. The thicker and whiter tail is composed of dust particles and another thinner and bluish tail is composed of

ions or plasma. As is already mentioned that the orbits of comets are highly elliptical and the distance between them and the sun goes on increasing and decreasing regularly, a comet when becomes closer to the sun starts producing its tail. The length of the tail gradually increases as it comes further closer but when it goes away from the sun, its tail also starts shortening and gradually disappears due to decreasing effect of solar energy. When the distance between them and the sun further increases, they seem to be lost in the dark space. Comets take 2 to 2,50,000 years to make a complete revolution around the sun. Hyakutake comet, identified in 1996, had spent 70,000 years making a revolution. It means it will be seen from the earth only after 70,000 years. Encke, another comet, takes only 3.3 years for a revolution.

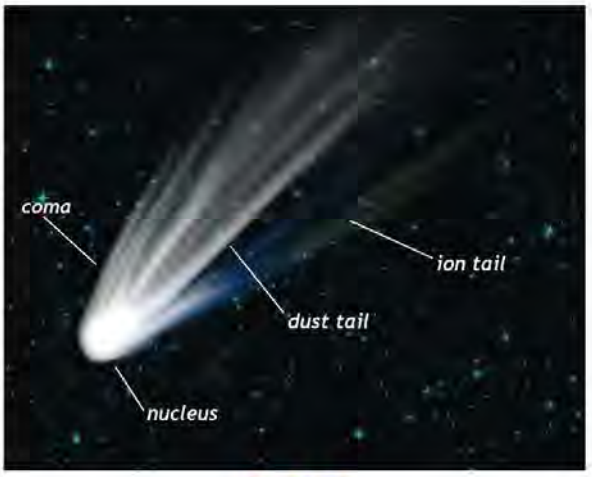


Fig11.18

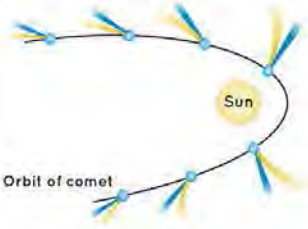


Fig11.19

Some comets revolve around the sun being very close to the earth and may bang down very forcefully. At the end of the Cretaceous period of the Mesozoic Era, many such comets and meteors fell like a shower which destroyed almost all life on Earth including dinosaurs within a few minutes. Similarly, Shoemaker-Levy in 1994 had fallen into Jupiter. About 4584 comets are identified and provided names till now. At every revolution, a comet losses some of its mass in space due to evaporation, so after making many revolutions, a comet is turned

into an asteroid by losing all its volatile substances and gases. Such comets are called Extinct comets.

Examples of some comets with their revolutionary period are given in the table:

Comet	Discovered by	Orbital period (year)	Finding Date (AD)
Halley	Ed. Halley	75.32	1758
Encke	J. Encke	3.3	1786
Tempel Tuttle	H. Tuttle	`13.61	1858

Meteoroid, Meteor and Meteorite

Small irregular fragments of rocks and metals roaming randomly within the solar system are called Meteoroids. They range the size from dust grains to a small asteroids. They may enter into the gravitational field of planets and satellites and fall on them at very high speed. Sometimes they also enter into the earth's gravitational field at the rate of 20 km/s to 80 km/s. Due to this very high speed, they cause great friction with air particles in the Mesosphere by which they burn to leave a streak of light behind within a few seconds. Such streak lo light caused by falling meteoroids is called Meteors and is seen only at night due to the absence of sunlight. Some people say such meteors as falling stars or shooting stars. Most the meteor completely burn before they reach the troposphere, but some bigger meteors can reach the surface of the earth causing great destruction. Remnants of fallen meteors are called Meteorites. Scientists claim that about 200 meteoroids are facing down to Earth at very high speed every day but almost all of them will be evaporated before reaching the surface without any harm. Sometimes, many meteors fall at a particular region at a particular time and may cause devastation everywhere. This is called a Meteor shower.

Questions to think:

(a) How are the smaller and bigger circular craters formed on the surface of the moon?

(b) Do meteors fall during day time too?

Project work: 11.4

Make a video of asteroids, comets and meteors from the internet with some still photographs and make a power-point slide to present in your class.

Fig11.21

Galaxy

Observation of a clear sky at night may exhibit a cluster of many brighter or dimmer stars in different regions of the celestial sphere. Some of them, which look like a single star to the naked eye may be a collection of millions of stars. Such a massive collection of millions of stars are called Galaxies. Because of the very great distance between them and the earth, they appear just as a dot of light.

In such galaxies, there may be very big clouds of dust and gases called Nebula. Such organization of millions of stars, nebulas, remnants of nebulas, planetary systems of many stars, dark matter and energy is called Galaxy. Our solar system also lies in a galaxy named The Milky Way which constitutes about 150 million stars and our sun is also one of them. Galaxies may have various shapes elliptical, spiral, lens-like, ring-like, peculiarly shaped or irregular. The Milky Way, Andromeda, Whirlpool, Sombrero, and Messier are some examples of the galaxy.

Fig11.21

According to the report obtained from NASA which was delivered by a spacecraft called New Horizons in 2021, there are about 2×10^{11} galaxies in the observable universe. Galaxies are formed due to the Big Bang of the primaeval atom. There is often a Black-hole at the centre of each galaxy around which the member stars of the galaxy revolve from the same direction.

Fig11.22

Activity 11.4

Visit the Observatory Centre or Planetarium near your school and observe the sky with a powerful telescope or the projector of the Planetarium to prepare a report about heavenly bodies and submit it to your subject teacher.

Fig11.23

Project work: 11.5

Have a virtual tour of the sky through any software or app or device and observe planets, stars, comets, galaxies, asteroids, and constellations. Prepare a report illustrating their special features and submit it to your subject teacher.

Constellation

The region in the sky with some stars making a particular pattern is called Constellation. The patterns of the constellation may resemble various animals, geometric shapes, or any tools or objects. Many such constellations can be seen through the naked eye and their total number is counted as 88. Among the 88 constellations, the twelve which lie in the ecliptic (the circular region of the sky through which the sun seems to move around the earth) are called Zodiacs. Aeries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpios, Sagittarius, Capricorns, Aquarius, and Pisces are the name of the twelve zodiacs.

Fig11.24

Ursa Major, The Orion, Carina, Vela, Draco, Cepheus, Cassiopeia, Canis, and Ursa Minor are some other examples of the constellation. Constellations have a different number of stars, for example, there are 7 stars in Ursa Major and 5 stars in Cassiopeia. Crux is the smallest and Hydra is the biggest constellation.

An experienced one can easily predict the current time and the running season by the observation of these constellations. Similarly, they also help to declare geographic direction from the position of

any constellation in the sky. Before the invention of watches and compasses, sailors used the position of constellations in finding the geographic direction for their successful journey.

Fig11.25

Activity 11.5

With the assistance of your parents, observe the clear sky at night and try to identify comets, meteors, The Milky Way, Ursa Major some other celestial bodies. If available, use a telescope. Prepare a list of the known bodies and present it in class for discussion.

Exercise

1. Choose the correct alternative from the given options:

(a) Who put forward the concept of expanding the universe?

(i) Einstein (ii) Lemaitre

(iii) Halley (iv) Pythagoras

(b) Which comet was destroyed in Jupiter?

(i) Shoemaker-Levy (ii) Bennett

(iii) Temple-Tuttle (iv) Halley

(c) Which of the following statement represents the character of Trojans?

(i) They are in the Kuiper Belt.

(ii) They revolve around the sun along the orbit of Mars or Jupiter.

(iii) They will be destroyed by burning in the atmosphere.

(iv) They have a long bright tail.

(d) What is 'A' shown in the figure made of?

(i) Rock, metal and dust particles

(ii) Ice, gas, and dust particles

(iii) Star, ice, and dark matter

(iv) Stars, nebular dust and cloud

2. Differentiate

(a) Meteors and Meteorites (ii) Galaxy and Constellation

(c) Asteroids and Comets

3. Give a reason

(a) Near-earth asteroids are dangerous for our planet.

(b) Comets gradually lose their material when revolving around the sun many times.

(c) Most of the meteors are completely destroyed after revolving some rounds around the sun.

(d) Galaxies are more important than other celestial bodies to study the universe.

4. Answer the following questions :

(a) What is the universe?

(b) Describe the Big Bang theory in brief.

(c) Mention the characteristics of asteroids.

(d) What is a comet? Explain its different parts with a suitable diagram

(e) What are meteoroids? How are they turned into meteors?

(f) Explain 'meteor shower' and 'observable universe'.

(g) Study the given figure and answer the following questions:

(i) Describe the special features of the celestial bodies shown in the figure.

(ii) Why are they important to study the celestial bodies?