Chapter

4

METALS AND NON -METALS

In previous classes you have studied about some materials that are used in our daily life. You studied about natural fibres and their properties. You also studied about soil and its properties. You learnt about acids, bases and salts. You also studied changes around as like rusting etc. In this chapter you learn about the properties of another type of materials called metals.

You are familiar with a number of materials like aluminium, copper, gold, iron, etc.

- Can you name some objects made of metals?

Observe the fig-1. Try to name the metals of which the objects are made. Add names of more metals that you know to the list.

Fig-1

Your first answer is gold. Some of you may have also added aluminium, silver, lead, iron, copper, tin, mercury etc.

- Did any of your friends add steel to the list of metals?
- Do you think that steel is a metal?

Let us learn the properties of metals so that you are able to answer this question at the end of the chapter. You also learn about another type of materials, called non-metals, which may be new to you.

Now observe carefully all the materials that you have listed above as metals.

- Do all these look alike?
- Do all of them shine?
- Are they hard or soft?
- Do they break off easily?
- Can you group materials into two categories by looking at their properties?

We try to find two groups, then discuss and compare them in detail in this chapter.

Physical Properties

Before we start this section, you will need to collect pieces of iron (iron nails), copper, zinc, sulphur powder, aluminium, carbon, magnesium and iodine for carrying out the activities.

Appearance

In previous classes, you learnt that the materials which have a bright surface and reflect light are called lustrous materials and materials that do not shine are non-lustrous.

Activity-1

Observing appearance and colour of some materials

Observe the appearance of your samples. Look at their colour. Decide whether they appear shining or dull and record your observations in table - 1. If the surface seems dirty, clean it with sand paper.

Table–1

Sample	Appearance Shining/not shining	Colour
Iron		
Zinc		
Copper		
Sulphur		
Aluminium		
Carbon		
magnesium		
Iodine		

Your observations in the table shows that some materials are shining and some are dull.

- Which of the samples did not shine even after you cleaned them with sand paper?

Generally metals are lustrous. Do all lustrous materials are metals?

We all know that mirror is lustrous.

- Can a mirror be called metal?

No, so you need to look at several properties to decide if a given material is metal or not.

Sonority

Aryan was carrying a box of iron nails. All the nails scattered on the floor when he slipped and fell. He noticed that they made a ringing sound when they hit the hard floor. It was similar to the sound that of ringing bell (Figure 2, metal gong).

- Have you observed material used to make school bell or bells in temple?
- Why are wooden bells not used in temples?
- Do all materials produce sound when they dropped on hard surface?

Let us find

Activity-2

Listening the sound produced by some material

Fig-2

Drop a piece of coal on the floor and listen the sound.

- Do you think coal is sonorous?

Take the samples of zinc, copper, sulphur, aluminium, carbon, magnesium and iodine. Drop them one by one, on a hard surface. Listen carefully to the sound produced and record your observation in table 2.

Table-2

Material Sample that Produce sound	Material Sample that do not Produce sound

- What similarity do you noties among materials which produce sound?

You may notice that some of the material produce sound and some of them do not. Materials which produce ringing sound are called sonorous materials. Generally most of the metals are sonorous. Generally materials other than metals are not sonorous.

Lustre and **sonority** are the properties associated with the metals. But there is no need to all metals should posses this property. For example though mercury is a metal it doesn't emit sound i.e., it is not sonorous.

- Which property of metals first attracted the attention of human beings? The story of early tools will give you a hint.

Malleability

Have you ever noticed the thin silver foil used to decorate sweets or the thin aluminium foil used for packing food?

Try to observe a blacksmith at work. He beats a hot iron piece repeatedly till its shape changes.

- Do you bring a similar change in the shape of a clay material by beating it?

Not all materials can be converted into thin sheets to make the desirable objects.

Activity-3

Identifying malleability of material

Take a hammer and beat the material samples which are used in Activity-2 and observe the changes in material samples. Record your observations in the table-3.

Table-3

Observing the change	Name of sample
Flattens	Iron, …..
Breaks/ converts into powder	
No change	

Story of Early Tools

Do you think tools were always made of metals? Early human beings made their tools from what was easily available - stone and wood. Later, they used the bones of animals.

Then they discovered metals like copper and iron. Tools made of copper and iron are much stronger than tools made of stone and wood. Metals had the advantage of not just being harder but they could be heated in a fire and moulded or cast into different shapes. So it became possible to make a wider range of tools with such metals.

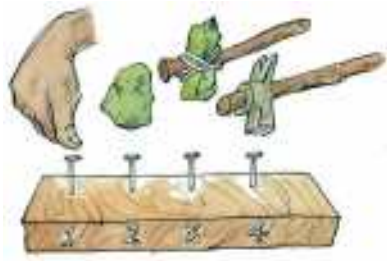

Fig-3 : hammers made of different materials being used to hammer nail

Some of the samples, when beaten hard, were flattened whereas some materials broke into pieces or became a powder. The materials which can be flattened into thin sheets are called malleable materials. Malleability is one of the properties associated with metals.

Fig-4

What did you observe in the case of iron? You may not be able to flatten it but the blacksmith can do it. He heats it before beating. So we can say that materials differ in the range of their malleability. Metals like aluminium, silver and gold are highly malleable.

Ductility

We use wires in different situations in our daily life. Look at the samples given in the table-4.

Table-4

Sample	Can we convert it into Wires (Yes/No)
Iron Zinc Copper Sulphur Aluminium Carbon magnesium Iodine	

- Have you ever seen the wires made up of materials mentioned in table-4.

  Write yes if you have seen wires made of them else where.

Take help from your teacher, friends and elders to decide which of the material can be used to make wires.

From the above table you may infer that some materials can be drawn into wires and some materials cannot be drawn into wires.

Fig-5

The property of drawing a material to make fine wires is called **ductility**. Most metals are ductile.

- Is ductility the only property of metal to use them as connecting wires in electric circuits?

  Let us explore another property of metals.

Electrical Conductivity

You might have seen an electrician using the screwdriver.

- What materials does it contain?
- Why does not a screwdriver used by electricians has metal handle?

Activity-4

Identifying electric conductivity of a material

Arrange an electric circuit with a battery and bulb (remember the simple electric circuits chapter from previous classes). Close the circuit using an iron nail, as shown in figure 6.

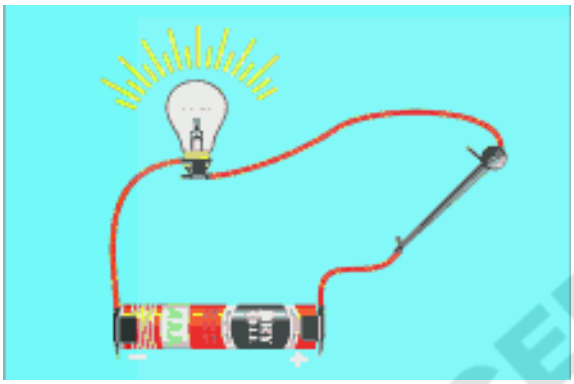

Fig-6

Observe whether the bulb glows or not.

Record your observation in table-5.

Repeat the same experiment using the other samples and record your observations in the same table.

Table-5

Sample	Does the bulb glow? (Yes/No)
Iron	
Zinc	
Copper	
Sulphur	
Aluminium	
Carbon	
magnesium	
Iodine	

- Did all the samples allow the bulb to glow?

Materials that allow electricity to pass through them and make the bulb to glow are called electric conductors. Most metals like iron, copper and aluminium are good conductors of electricity.

Talk to an electrician. Look at the handles of his tools.

- Are the handles made of the same materials? If not why?

Note the precautions to be taken while working with such tools.

The handles of both electrical appliances and cooking utensils are not made of metals. Electrical appliances conduct electricity.

- What do cooking appliances conduct?

Think and discuss

How will you close the circuit using sulphur, Carbon or iodine? They may be in powder form. Try to tightly pack the powder in a straw and use it. Think of other ways!

Activity-5

Observing heat conduction by metals

Take an iron rod. Stick pins on it with the help of wax (see fig-7). Now fix the rod to a stand as shown in the fig-7. Heat one end of the rod with a spirit lamp and see how the pins fall off?

- Why did the pins fall off from iron rod?
- Pin of which end fell off first?
- What could be the reason for this?

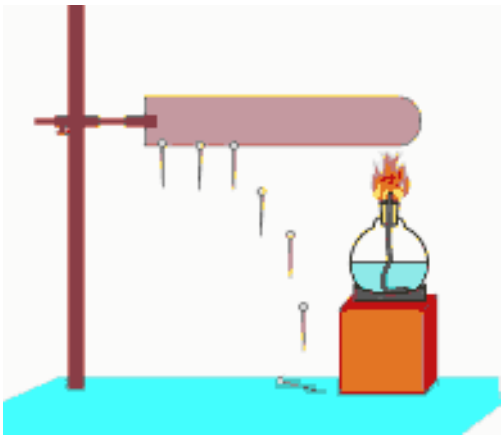

Fig-7

You know that the pin fell off because of the heat supplied to the iron rod makes the wax to melt at one end. The wax closer to the flame melted first. This activity clearly shows that heat moves from one end of the Iron rod to the other. This property of a material is known as **conductivity of heat**. All metals conduct heat.

All materials do not have equal conductivity. Iron, copper and aluminium cooking vessels are preferred due to their high heat conductivity.

Do it!

Go back to the list of samples. On the basis of all the activities carried out, fill the table 6.

We find that it is the metals which possess all the properties of lustre, malleability, ductility, sonority, conduction of heat and electricity. Non-metals generally don't show these properties.

Chemical properties

The properties you have studied so far are all physical properties. Though these properties are quite reliable, chemical properties are better indicators of determining as to whether a given material is metallic or not. Let us try to see what happens when metals and non-metals react with other substances.

Reaction with Oxygen

Lab Activity

Aim: To know the reaction of oxygen with metals and non-metals

Material required: One metal sample (magnesium) and one non-metal sample (sulphur), spirit lamp or Bunsen burner and litmus papers, etc.

Table-6

Material sample	Lustrous	Sonorous	Conducts heat	Conducts electricity	Malleable	ductile
Iron						
Zinc						
Copper						
Sulphur						
Aluminium						
Carbon						
magnesium						
Iodine						

Procedure:

✓ Take a small strip of magnesium and note its appearance. Burn it. Note the appearance after burning.

✓ Collect the ashes of magnesium in a test tube and add some distilled water to it. Test the solution with red and blue litmus papers. Note the colour change in table-7.

Table-7

Sample	Appearance before Reaction	Appearance After Reaction	Effect on Litmus Paper
Magnesium			
Sulphur			

Fig-8

✓ Take a small amount of powdered sulphur in a deflagrating spoon and heat it. (You can make your own spoon using a metal bottle cap and wrapping a wire around it).

(Be cautious, do not inhale fumes, they are harmful).

✓ As soon as sulphur starts burning, introduce the spoon into a gas jar/tumbler. Cover the tumbler with a lid to ensure that the gas produced does not escape. Remove the spoon after some time but try to keep the jar covered. Add a small quantity of water into the tumbler and quickly replace the lid. Shake the tumbler well. Check the solution with red and blue litmus papers. Record the changes in table7.

- What is happening?

When the samples are burnt, they react with oxygen in air to give different products. See how.

Magnesium + Oxygen → Magnesium oxide

Mg (s) + O_2 (g) → Mg O (s)

Sulphur + Oxygen → Sulphur dioxide

S	O_2	SO_2
(s)	(g)	(g)

All the products in the above reactions are oxides but are they same in nature? The oxide of magnesium turns red litmus blue. The oxide of sulphur turns blue litmus red. From this knowledge, you can say that magnesium oxide is basic and sulphur oxide is acidic.

You can also infer that non-metals react with oxygen to give oxides which are acidic, while metals react with oxygen to give oxides that are basic in nature.

Is our body a metal or non-metal?

Most of the human body is made up of water (H_2O). It isn't surprising that majority of a human body's mass is oxygen. Carbon, the basic unit of organic molecules is the second. 99% of the mass of the human body is made up of just six elements. Oxygen (65%), carbon(18%), hydrogen (10%), Nitrogen (3%), calcium (1.5%), phosphorus (1.0%).

Rusting of Metals

In class VII we studied rusting of iron in detail. Recall that iron rusts when it is in contact with air that contains oxygen and moisture. When it is covered with paint, it cannot come in contact with air, hence it does not get rust. If paint covered on iron scratched then the rust forms on it.

Something similar happens with other metals also. Magnesium ribbon is dull when exposed to air and shiny if we cut it. Silver objects and jewellery becomes black. Copper statues and vessels become dull green. All these metals react with components in air. But gold jewellery does not become dull.

- What could be the reason?

Thus different metals react with the components of air in different manner and at different rates and conditions. There are some metals which do not react with the components of air. Gold and platinum are such metals which do not get rust.

Reaction with water

Note:- This is a demonstration to be carried out by the teacher. Sodium is extremely reactive and dangerous and students should see the demonstration from a distance.

Take a 500 ml beaker or a big trough and fill half of it with water. Take the sodium which is stored in kerosene and keep it on a sheet of filter paper to blot the kerosene and cut a very small piece of sodium from it.

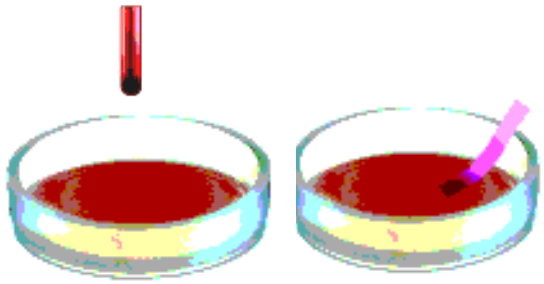

Fig:9

Put the remaining sodium back again in kerosene. Standing away from the beaker put the sodium piece in water using forceps.

The piece of sodium floats on the surface of the water with a 'hissing' sound. This shows that sodium is reacting extremely fast with water. After the reaction is complete, test the solution with litmus paper.

Repeat the same experiment using aluminium or iron. You will not see any change even after five minutes. This is because these metals react extremely slow with water.

- What about non-metals?

  Generally they do not react with water.

Reaction with Acids

Table-8

Sample	Reaction with dilute hydrochloric acid	Reaction with dilute sulphuric acid
Iron		
Zinc		
Copper		
Sulphur		
Aluminium		
Carbon		
magnesium		
Iodine		

Take the samples given in the table 8 in separate test tubes. Add 5ml of dilute hydrochloric acid to each of the test tubes with the help of a dropper.

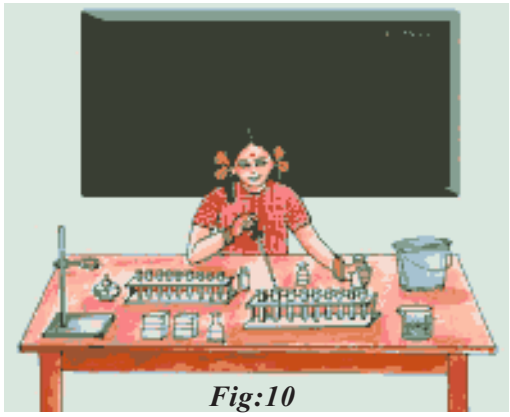

Fig:10

Observe the reactions. If you find no reaction, heat the test tube gently. If you still see no reaction, add 5 drops of conc. Hydrochloric acid. Now bring a burning Match stick near the mouth of the test tube and observe what happens. Record your observations in the table-8.

- Do you find any difference in these reactions?
- When do you notice a pop sound with a burning match stick?

This sound indicates the presence of hydrogen.

You found that some metals react with dilute hydrochloric acid liberating hydrogen but non-metals usually do not react with acids.

Repeat same experiments with sulphuric acid and record your observations in table-8.

Reactivity of metals

You have already seen that some metals react with air and others don't. The reaction is fast in some cases like Megnesium and slow in case of silver and copper. Similarly, different metals react with water and acids under different conditions. Let us explore this reactivity further.

Take five beakers and label them a, b, c, d and e. Take 50ml of water in each beaker and dissolve a spatulaful of copper sulphate in beakers 'a' and 'b'. Dissolve a spatulaful of zinc sulphate, iron sulphate and zinc sulphate in beakers c, d and e . Now put:

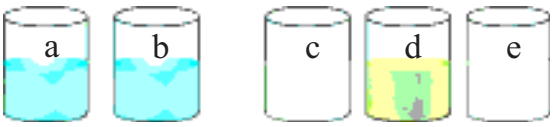

Fig:11 a

* Zinc granules in beaker 'a'
* Iron nail in beaker 'b'
* Copper turnings in beaker 'c'
* Copper turnings in beaker 'd'
* Iron nails in beaker 'e'

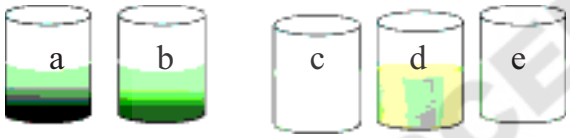

Fig:11 b

Leave the beakers undisturbed. Record the changes in the colour of the solutions in the table.

Table-9

Solutions	Observations
Beaker 'a'	
Beaker 'b'	
Beaker 'c'	
Beaker 'd'	
Beaker 'e'	

The blue colour of copper sulphate disappears and a powdery red mass of copper is deposited at the bottom of the beaker 'a'.

Also notice that in beaker 'b' red copper is found in the bottom of the beaker and on the nail leaving light green iron sulphate solution.

- What are the reactions behind these changes?

In beaker 'a' zinc displaces copper from copper sulphate giving rise to colourless zinc sulphate. Iron displaces copper from copper sulphate in beaker 'b' leaving light green colour of Iron sulphate.

Copper sulphate+Zinc → Zinc sulphate + copper

Copper sulphate + iron→iron sulphate + copper

Similar to the reactions in beakers 'a' and 'b', there is displacement of zinc from Zinc sulphate by copper in beaker 'c' and iron from Iron suphate by copper in beaker 'd'and zinc from zinc sulphate by iron in'e'.

- Do you find any changes in beakers c,d and e?

Since we do not see any change in the other three beakers (c,d and e) we can infer that.

i) Copper is unable to displace zinc from zinc sulphate.
ii) Copper is unable to displace iron from iron sulphate.
iii) Iron is unable to displace zinc from zinc sulphate.

We can understand with the above reactions that a more reactive metal can replace a less reactive metal, but a less reactive one cannot replace a more reactive metal. That is why there are no displacement reactions in beaker c, d and e.

Some uses of non-metals

You are all aware of the uses of metals, non-metals are also useful. The three non-metals studied by us are sulphur, carbon and iodine. Let us know about their uses.

Sulphur is used in making fireworks, crackers, gun powder, matchsticks and antisceptic ointments. It is found in onions, garlic, eggs, hair and nails.

Activated carbon is used as a decolourising agent and also in water purification systems.

Tincture iodine is used in medical purposes.

Uses of metals

Have you ever noticed a thin silver foil decorated on sweats and thin aluminium foil used in inner packing of food materials and toffees. Aluminium and copper mixture is used in currency coins, medals and statues. Zinc and iron mixture used in making of iron sheet. Most of the agricultural iinstruments are made by iron. Electrical appliances, automobiles, satellites, aeroplanes ,cooking utencils, machinery, decorative materials made by metals due to their malleability, ductility and low weight.

Try this

- Recall the names of the some of the laboratory acids and bases that you know. Write down their names in (table -10) and identify metal/non-metal present in them, which form oxides when react with oxygen. Take the help of your teacher (table -10).
- Have you seen a periodic table?
- Try to find the metals and non-metals that you come across in the chapter on the periodic table.

Table-10

S.No.	Name of the Base	Metal present in it	Name of the Acid	Non- Metal present in it
1.	Calcium hydroxide	Calcium	Sulphuric acid	Sulphur

Key words

Metals, non-metals, lustrous, malleability, ductility, good conductors of heat and electricity, sonorous, oxides of metals and non-metals, displacement reaction.

What we have learnt

★ The materials which show brightness on surface and reflect the light are called lustrous and which do not shine are non-lustrous material.

★ The property of materials by which they can be beaten into thin sheets is called malleability.

★ The property of drawing material to make fine wires is called ductility.

★ The ability of materials to produce a particular sound when it is dropped on the hard surface is termed as sonorous.

★ Metals often possess all of the following properties. They are lustrous, hard, malleable, ductile, good conductors of heat and electricity and sonorous Ex: copper, magnesium, aluminium, iron, zinc etc.

★ Most of the metals exist in solid state.

★ Some metals react with the component of air in different manner with different rate and in different conditions.

★ Gold and platinum are the metals which do not react with air.

★ Metals react with acids and liberate hydrogen gas.

★ Metals can displace each other according to their reactivity.

★ Oxides of non-metals are usually acidic in nature.

★ Oxides of metals are usually basic in nature.

Improve your learning

1. Explain the physical properties of metals with suitable examples? (AS_1)
2. You are given two samples. How do you distinguish which one is metal and which is non-metal? (AS_1)
3. How is malleability of metals used in our daily life? (AS_7)
4. Which metals are used in making jewellery? Why? (AS_1)
5. Which substance liberates hydrogen when reacts with metals? (AS_1)
6. In a chemical reaction iron is unable to displace zinc from zinc sulphate. Why? (AS_1)
7. Why cooking pans don't have metal handles? (AS_1)
8. Discuss the acidic and basic nature of the metals and non-metals with suitable experiments. (AS_3)
9. sulphur dioxide is---------- (AS_1)
   (a) basic oxide (b) acidic oxide (c) neutral oxide (d) amphoteric oxide

10. Match the following: (AS_1)

1) Making into thin sheets	( )	(a) ductility
2) Shinning materials	( )	(b) conductivity
3) Making into wires	( )	(c) sonority
4) Transmission of heat	( )	(d) lustrous
5) Making ringing sound	( )	(e) malleability

11. Which gas makes a 'pop' sound if exposed to lighted matchstick? (AS_1)

12. Why are bells made up of metals instead of wood? (AS_1)

13. How do you appreciate wide range utility of aluminium right from utensils to space craft? (AS_6)

14. Dumping of waste material made up of metals and non-metals leads to environment pollution. Do you support the statement? Give your justification with suitable examples. (AS_7 ,AS_1)

15. Imagine the human life without metals, write briefly about the consequences. (AS_2)

16. After completion of metals and non metals chapter. Raheem understood that metals are hard and non metals are soft. During the discussion with his brother he came to know that Diamond is a hardest material and it is a non metal. Similarly mercury is a soft material and it is a metal. These findings from the discussion raised some questions in Raheem's mind. Can you guess those questions? Write them. (AS_2)

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