5 METALS AND NON-METALS

5.1

You know that till now 118 elements have been discovered. Write names of any five elements which you use. Our list may have the elements as iron, copper, aluminium, gold, silver, oxygen, carbon, hydrogen etc. Do all these elements have the same properties. Let us find properties of some elements by doing some activities.

5.1.1

Activity 1

Materials required : Pencil lead (graphite) copper wire, iron piece, coal, sulphur, emery/sand paper, hammer.

Rub graphite, copper wire, iron piece, coal, sulphur on an emery paper. Now hit them with a hammer. What changes happen on beating or hammering?

On rubbing with an emery paper iron and copper piece shines and on hammering or hitting with a hammer, they flatten out to a sheet. This property is known as malleability. Graphite, coal and sulphur break up into pieces on hammering with a hammer because they are fragile or brittle. Hence this property is called fragility or brittleness.

Activity 2

Materials required : Copper wire, pencil lead (graphite), candles and matches.

Heat one end of both copper wire and pencil lead on the flames of different candles separately. After some time touch the other end of both. Is it hot? The other end of copper wire being hot shows that heat has transferred from one end to other end. Hence copper is a good conductor of heat, but graphite is an ordinary conductor of heat.

Activity 3

Materials required : Iron rod, sulphur, electric wire, bulb, drycells, graphite, glass slide, candles and match box .

Arrange the electric wire, bulb and dry cell according to fig.5.1. Open the two ends (A,B) of the wire in the circuit. Now connect the ends A,B to a iron rod as shown in the figure and see if the bulb lights up or not. Do the same experiment with the graphite rod in place of the iron rod. Does the bulb light up? Now take the sulphur powder on a glass slide and melt it over the flame of the candle and then cool it. You will get a layer of sulphur. Use this sulphur layer in place of graphite rod and repeat the experiment. Does the bulb light up ?

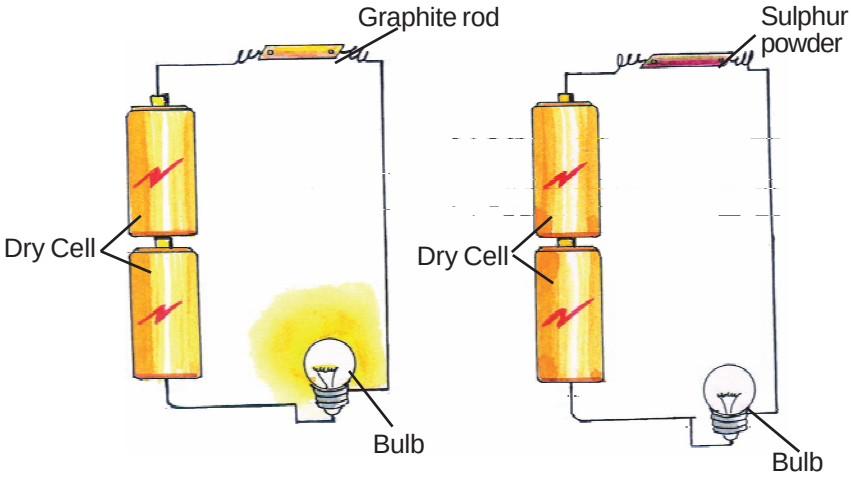


Fig 5.1 Conductivity of metals & nonmetals

Connecting the iron rod and graphite rod on the circuit makes the bulb light up. This shows that they are good conductors of electricity and sulphur is a bad conductor of electricity. That's why the bulb does not light up.

As per the above activity 1, 2, and 3 note the observations in table 5.1 in your notebook (copy) in the given space.

TABLE 5.1

S.No.	Element	Brightness or Lustre	Malleability	Fragility/ Brittleness	Heat conductivity	Electric conductivity
1.	Iron	----------	----------	----------	----------	----------
2.	Copper	----------	----------	----------	----------	----------
3.	Coal	----------	----------	----------	----------	----------
4.	Graphite	----------	----------	----------	----------	----------
5.	Sulphur	----------	----------	----------	----------	----------

We see that iron and copper have brightness are malleable and good conductors of heat and electricity. Whereas coal and sulphur are fragile or brittle and bad conductors of heat and electricity. So we can differentiate them according to their properties. Iron and copper like elements are called **metals**. Most of the elements in nature, are metals. Other examples of metals are gold, silver, aluminium, tin, lead, zinc etc.

In contrast to these the element carbon and sulphur like elements are called **non-metals**. In nature their number is less than metals. Other examples of non metals are chlorine, bromine, oxygen, helium, iodine, nitrogen, phosphorous etc. Graphite is also a non metal but it has the property of conduction of electric current.

NOW ANSWER THESE:

Fill in the blanks -

1. The number of metals is .....than non metal.
2. .....is a good conductor of heat and electricity.
3. .....is fragile or brittle.
4. .... and ..... are examples of metals.

5.1.2 Are all metals and non metals solids ?

Do you know any metal which has a different state other than solid at normal temperature? Mercury is a metal which exists in liquid form, and no metal exists in a gaseous state.

Usually all non metals are found in gaseous state. Five non metals are found in solid state (carbon, phosphorous, sulphur, selenium, iodine) and one in liquid state (bromine).

Gold and silver are the brightest metals. Silver is a very reflective metal. It reflects about 90 % of the light falling on it. It is used in the thin layer of metal coating for manufacturing of mirrors.

5.1.3 Are all metals and non metals hard.

Usually metals are hard. It is very difficult to cut them. Because of this hardness, they are very useful to us. Iron is a very hard metal, so it is used in the making of houses, bridge, rails, vehicles and machines. On the other hand sodium and potassium are also metals but soft. They can easily be cut by a knife.

Usually nonmetals are not hard. But diamond (a form of carbon) is the hardest substance (non-metal) in the nature.

5.1.4 Are metals and non-metals ductile

Usually which wire have you seen? Have you seen sulphur wires?

The property of metals to be drawn into wire, is known as **ductility**. In our

houses, in the bulbs thin wire of tungsten metal is used.

The property of ductility is not present in non metals. We cannot have wires of non metals. But now a days by new modern methods wires of carbon are being built.

- *The property of ductility is maximum in gold. Two kilometre wire can be drawn from 10 g of gold.*
- *Gold and silver are very malleable. Due to this property they can be beaten to very thin sheets. Sweets are decorated by silver foils.*
- *In the same way thin sheets of aluminium is used for keeping medicines and chocolates fresh and is also used as a cover for milk bottles.*

Let us see some other properties of metals and non metals.

Sonorous - Usually all metals are sonorous. You must have heard the school bell which is metallic. If metals are struck hard they produce sound. It is because of this, that copper, iron etc. are used to make bells. The strings of metals are also used in same musical instruments like Sitar, Guitar, Banjo etc.

Non metals do not produce sound on beating.

Melting Point- Usually the melting point of all metals are high. The melting point of iron is 1535° C and that of copper is 1083° C.

The melting point of nonmetals are very low. The melting point of sulphur is 119°C and that of iodine is 113° C.

NOW ANSWER THESE

Choose the correct alternative :

1. Metal are (harder/softer) than nonmetals.
2. Most of the metals are (bad/good) conductors of heat.
3. (Metals/Non metals) have Lustre.
4. The property of metals to be beaten into thin sheets is called (ductility/malleability).

Like physical properties, do metals and nonmetals differ in their chemical properties too ? Let us find out.

5.2 Chemical Properties of Metal and Non metals

1. Reaction with Oxygen

Activity 4

Materials required : Two test tubes, one glass slide and forceps, match box, blue/red litmus paper, magnesium wire, sulphur and water.

1. Burn the magnesium wire on the flame of the candle, holding it with the help of a forcep. When it catches fire and starts burning properly place a test tube upside down over it, so that the liberated gas is collected in it. When it is completely burnt, put the ash into the test tube. Immediately add little water in the test tube so that the ash and gas is dissolved in it. Test this solution with blue and red litmus paper.
2. Do the same experiment with sulphur also. Place sulphur on a glass slide and then heat it. Collect the liberated gas in a test tube and dissolve it in water. Test this solution also with blue and red litmus paper. Now draw table 5.2 in your copy and write the observations there.

TABLE 5.2

S.No.	Solution	Effect on red litmus	Effect on blue litmus	Acidic/Alkaline
1.	Solution of gas obtained on burning magnesium	----------	----------	----------
2.	Solution of gas obtained on burning sulphur	----------	----------	----------

Most of the metals react with the oxygen in air to form oxides, which reacts with water to form hydroxides having alkaline nature.

$$Mg + O_2 \longrightarrow 2MgO$$

Magnesium + Oxygen $\longrightarrow$ Magnesium Oxide

Magnesium Oxide + Water $\longrightarrow$ Magnesium Hydroxide (Alkali)

In contrast to this most of the non metals react with the oxygen in air to form oxides which reacts with water to form acids.

$$S + O_2 \longrightarrow SO_2$$

Sulphur + Oxygen Sulphur dioxide

$$SO_2 + H_2O \longrightarrow H_2SO_3$$

Sulphur dioxide + Water ⟶ Sulphurous Acid

2. Reaction with water

Activity 5 (Demonstration by teacher)

Materials required : Glass trough, water, sodium, filter paper, forceps.

Fill the glass trough with water. Take sodium which is kept dipped in kerosene and cut a small piece of it. Dry it on the filter paper. Now put it into the water in the trough. Immediately on putting, sodium starts moving around trough with a hissing sound and then it catches fire.

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

Sodium + Water ⟶ Sodium hydroxide + Hydrogen

Reaction between sodium and water produces hydrogen gas. This reaction produces a lot of heat

Take readily available metals around us like copper, magnesium, iron, zinc etc and put them into the water. Do they also react in a same way as sodium does?

Magnesium reacts mildly with cold water, but reacts vigorously with hot water or steam and forms Magnesium hydroxide and Hydrogen gas.

$$Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2$$

Magnesium + Water ⟶ Magnesium hydroxide + Hydrogen

Zinc and iron mildly react with steam. Copper, gold silver do not react with water or steam.

In this way we can say that reaction of metals with water differ. Non metals do not react with water. Phosphorous is kept under water to keep it safe from reacting with air. If it is kept open then it reacts with the oxygen in air and burns.

3. Reaction with Acids

Activity 6

Materials required : Magnesium, Zinc, Copper piece, Dilute Hydrochloric acid, test tubes, match box and heating apparatus.

Take the three metals in three different test tubes and add dilute hydrochloric acid to each. If there is no reaction, heat the test tubes slowly. Test the gas liberated in each test tube by bringing a burning match stick to the mouth of the test tube.

The gas from test tubes containing Magnesium and zinc burns with a "pop" sound which indicates that the gas liberated is hydrogen.

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

Magnesium + Hydrochloric acid ⟶ Magnesium chloride + Hydrogen

$$Zn + 2HCl \longrightarrow Zn Cl_2 + H_2$$

Zinc + Hydrochloric acid ⟶ Zinc chloride + Hydrogen

Copper pieces do not react with Hydrochloric acid. It reacts with Sulphuric acid and Nitric acid.

We use utensils made of metals in our day to day life. When food products (like pickles, curd, sour fruits) which have acid in them are kept in this utensils then the acid in these food items react with the metal and produce some poisonous substances. So it is recommended that such food items with acidic nature must not be kept in metallic utensils.

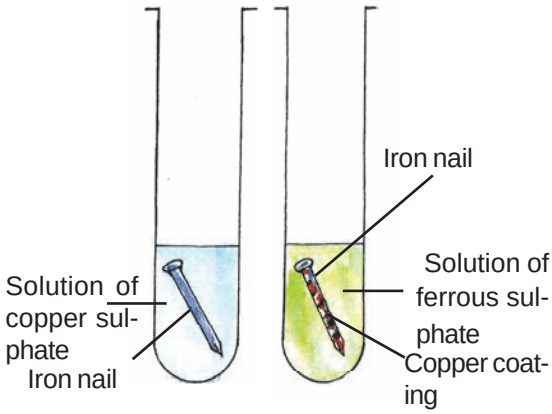
4. Displacement of metals with other metals

You know that metals react with acids and displace hydrogen gas. Let us see, can metals displace other metals from their solutions?

Activity 7

Materials required : Beaker, 5 test tubes, test tube stand, water, copper sulphate, iron pieces, zinc pieces, magnesium wire, aluminium (seal of the injection bottle) copper wire.

Take about 50 mL water in a 100 mL beaker. Add 5 g of copper sulphate in it and dissolve it . Pour a clear solution of it in equal amount into the five test tubes and keep them in the test tube stand. Now add, iron piece, zinc piece, magnesium wire, aluminium piece and copper wire into the different test tubes. Let the test tube stand with out any disturbance for some time. Draw the obsevation table 5.2 in your copy and note the observations.



Pic 5.2 Displacement of metals from a salt solution

TABLE 5.2

S.No.	Metals put into copper sulphate solution	Change in colour of copper sulphate solution	Layer of copper on metal deposited or not	Any other changes
1.	Iron	Colour fades	Layer of copper on iron deposited	----------
2.	Zinc	----------	----------	----------
3.	Magnesium	----------	----------	----------
4.	Aluminium	----------	----------	----------
5.	Copper	No change	No	----------

In this experiment you find that there is no change in the fifth test tube but in the other four test tubes the metal displaces the copper from the solution and takes the place of copper. On this basis we can say that iron, zinc, magnesium and aluminium are more reactive than copper. Do this experiment in groups in the class. Each group must prepare a different solutions as sodium chloride, ferrous sulphate, silver nitrate and observe the reaction with these elements.

To know if the reaction has taken place observe if there is any differences (gas bubbles) any change in colour of the solution, change in the colour of the metal or if heat is evolved or absorbed.

On the basis of all the experiments done by groups in the class, fill the table No. 5.4, and observe whether the metal has replaced the metal in the salt solution or not.

TABLE 5.4

S.No.	Solution	Iron	Zinc	Magnesium	Aluminium	Copper
1.	Sodium chloride	------	------	----------	----------	---------
2.	Copper sulphate	------	------	----------	----------	---------
3.	Ferrous sulphate	------	------	----------	----------	---------
4.	Silver nitrate	------	------	----------	----------	---------

From the above table we can know that which metal is more reactive and which is less. If zinc displaces iron from ferrous sulphate then we can say that zinc is more reactive than iron. If iron displaces copper from copper sulphate then iron is more

reactive than copper. As Zinc is more reactive than iron, it is also more reactive than copper.

Now you can make the reactivity series according to table 5.4. Does this series match with the one given here.

Li . K . Na . Ca . Mg . Al . Zn . Fe . Pb . H . Cu . Hg . Ag . Au

The more reactive the metal the more it will react with water and air. Sodium is so reactive that it has to be kept in kerosene to keep it safe from air and water. On the other hand gold which is almost inactive as it does not react with water and air, and not even react with acids.

NOW ANSWER THESE

1. What is the nature of the solution of magnesium oxide dissolved in water?
2. What happens when zinc pieces are put into copper sulphate solution?
3. Does copper displace iron from ferrous sulphate solution?
4. Why are pickles not kept in aluminium or iron vessels?
5. Which gas is produced normally when metals react with acids?

5.3 Nobel Metals

Do you know the ornaments are made from which metals? As per the reactivity series you can say which metals can be used for ornaments? One of the reason, for using gold in gold ornaments is due to its less reactivity. Silver, gold, platimum are the least reactive metals. These do not react with air, water, acids or alkaline compounds. Such metals are called noble metals. One property of nobel metals is that, due to its least reactivity its metallic lustre/brightness stays for a longer time.

Adding a bit of silver or copper with gold makes the gold more harder with which ornaments are made. Gold percentage is expressed in terms of carats. Pure gold (100 percent) is 24 carats. As the percentage of the mixed metal increases the carat of gold decreases. 22 carat gold means 22 parts gold and 2 parts of silver or copper.

5.4 Corrosion

You must have seen the iron nails, pipes etc. when left in open air for some time get rusted. In this way the formation of a compound on the metal surface is called **corrosion**.

Activity 8

Materials required: Three test tubes, iron nails or scraps, anhydrous calcium chloride and water.

Place three unrusted iron nails in each of the three test tubes. Put some water in the first test tube, in the second test tube add boiled water (oxygen free) and in the third test tube add anhydrous calcium chloride ($CaCl_2$) which absorbs the moisture in the test tube. Close all three test tube with rubber corks. After two or three days, observe and find out which test tube has rusted nails? After this observation can you say what are the factors necessary for rusting?

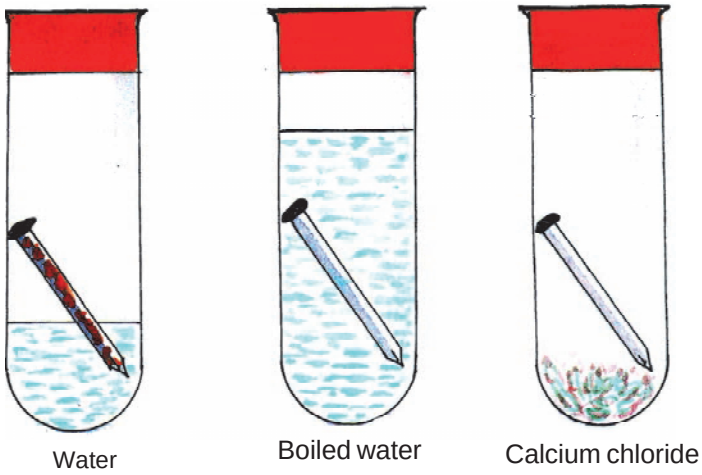


Fig. 5.3 Factors necessary for corrosion

This experiment shows that both oxygen and water are necessary for rusting. This indicates that to protect iron from rusting we must keep it away from moist air.

Prevention from Rusting :-

1. **By painting :** Most common method to stop corrosion is covering the metal with a layer of paint. We paint the objects made of iron in our houses to protect them from rusting.
2. **By applying grease :** By applying grease or oil, the contact of the metal with air and water is broken. To protect it from rusting, grease is applied to the bicycle chains.
3. **By metallic coating :** In this method objects made of iron is cleaned and then dipped in molten zinc. The objects get coated with a layer of zinc. To protect from corrosion, the iron sheets used to make the roof of our houses, buckets and tanks are coated with a layer of less reactive metal. This can also be done by electroplating. By electroplating, iron is protected with a layer of tin or chromium metal. Steel furnitures are made more durable and attractive by electroplating with chromium.
4. **Manufacture of Alloys :** You know that pure gold is not used to make ornaments. Iron rusts easily. So cooking utensils and materials used in

operations are not made of pure iron. In this way we have seen that pure metals are not useful always. To make these metals useful some other metal or nonmetal is added. This mixed metal is called an alloy. Alloys are more tough and resistent to corrosion. We can change the percentage of the metals and get the alloy with the desired properties.

In table 5.5 some important alloys, their constituents and their uses are given:

TABLE 5.5

S.No.	Alloy	Constituents	Uses
1.	Steel	Iron, Carbon	Ships, bridges, rails
2.	Stainless Steel	Iron, Carbon, Chromium Nickel	Utensils, Medical/surgical Instruments
3.	Bronze	Copper, Tin	Statues, Coins, medals
4.	Brass	Copper, Zinc	Utensils, Machines
5.	Duralumin or Dural	Aluminium, Copper, Manganese, Manganesium	Presure cooker, parts of aeroplane
6.	German silver	Copper, Zinc, Nickel	Utensils

5.5 Uses of metals and non metals.

You have come to know of some important metals and non metals. Try to fill this table as per your knowledge.

TABLE 5.6

S.No.	Metals/ Non Metals	Uses
1.	Iron	----------
2	Gold and Silver	----------
3	Copper and Aluminium	----------
4	Oxygen	----------
5	Zinc	----------
6	Carbon (Coal)	----------

Lead is used is making bearing balls of bicycle and motorcycles, soldering wires and water pipes. Titanium metal is used in making of different parts of machines, space - crafts and rockets.

A foil strip of aluminium or gold is used to make electroscope

Phosphorous is used in matches and chlorine is used as a disinfectant in purification of water. Iodine is used as tinture iodine, an antiseptic medicine. Sulphur is used in making many medicines, gun powder and crackers.

NOW ANSWER THESE

1. What are noble metals ?
2. What do you understand by corrosion? How can you protect metals from corrosion by electro plating?
3. Give the constituents of bronze and steel?
4. For what is chlorine and tincture iodine used?

Poisonous effect of lead and mercury

Lead and mercury are metals which are used in different industries. But these metal have poisonous effect in our bodies.

Lead is used in the manufacture of paint and batteries. Burning of products like petrol produce smoke having lead and its compounds.These compounds enter our body and can damage our red blood cells, brain and liver.

Compounds of mercury are used in making of paints, insecticides, fungicides. This compounds may enter our body through polluted water and food as fish and vegetables. They effect our kidneys and central nervous systems.

Metal Sculpture of Chhattisgarh

Man, from ancient times have known to obtain iron from iron ore. Adhariya tribes of Rajnandgaon district in Chhattisgarh have known the method to extract iron from iron ore. Now a days also the metal workers or sculptors make articles in traditional methods. The people of Lohar caste of Chhattisgarh make stoves, chisel, axes, pickaxe, spade angles spears and axles of vehicles of iron which is used in the daily village life.Nagarnar area of Bastar is famous for metal sculpture. People of this area make beautiful

Fig 5.4 Metal sculpture of Chhattisgarh

statues of birds and animals and very artistic lanterns lamps etc. Ghadwa tribes of Chhattisgarh is world famous for metal sculpture. The statues made by them are appreciated and are bought in our country and also in foreign countries.

In the same way the Jhara tribals of Raigarh area make statues which are famous as Jhara metal sculpture. Jhara sculptors usually make statues, utensils, lamps etc. of metals.

The statues made by Malar tribe of Surguja are known as Malar metal sculptures. These are usually utensils, chimneys, grain measuring cups.

They also make statues of birds animals, wild animals, Gods and Goddesses.

WE HAVE LEARNT

- Elements can be classified as metals and non metals.
- Metals have the properties of lustre, ductility, hardness, malleability, conductivity.
- Non metals are fragile brittle and bad conductors.
- Burning of metals produce basic oxides and that of non metals produce acidic axides.
- Aluminium, zinc metal reacts with acids.
- Usually non-metals does not react with acids.
- More reactive metal displaces the less reactive metal from the solution of its salt.
- Gold, silver and platinum are noble metals.
- Alloys are homogenous mixture, of metals with other metals and nonmetals.
- Metals like iron corrode. There are many methods to stop corrosion.
- There are many uses of the metals and non metals in our daily life.

QUESTIONS FOR PRACTICE

1. Choose the correct alternative :-

1. This is not a property of metals

   a) Fragility b) Conduction of electricity

   c) High density d) Malleability and ductility

2. Out of the three pins of gold, silver and iron which pin can get a coat of copper when dipped in copper sulphate solution :-

   a) Iron b) Gold c) Silver d) None of these

3. Which halogen is used as an antiseptic?

   a) Fulorine b) Chlorine c) Bromine d) Iodine

4. Iron rusts :-

   a) Only in air b) Only in presence of carbon dioxide

   c) Only in water d) In presence of both air and water

5. An example of Noble metal is :-

   a) Iron b) Copper c) Gold d) Aluminium

6. Which of these is classified as metal or non-metal :-

   a) Element b) Compound c) Mixture d) All of these

2. Fill in the blanks

1. Noble metals are usually..... .
2. Breaking up of the non metals into pieces is known as..... .
3. On burning metals form..... oxides.
4. The main constituent of German silver is ..... .
5. .....alloy is used in manufacture of rails.

3. Match the following :-

1.	Duralumin	Disinfectant
2.	Stainless Steel	Ornaments
3.	Phosphorous	Medical Instrument used in surgery
4.	Chlorine	Parts of aeroplane
5.	Gold	Match box

4. Mark the statements true or false :-

1. All metals are solid at room temperature.
2. Sodium is more reactive than magnesium.
3. Stainless steel is an alloy of iron, nickel, carbon and chromium.
4. Non metals react with oxygen to form alkaline oxides (basic oxide).
5. Rusting is an example of corrosion of metals.

5. Answer the following questions :-

1. Differenciate metals and non metals on the basis of physical and chemical properties. Write three differences of each.
2. Why is gold and silver used for making ornaments?
3. What do you understand by reactivity series?
4. How much carat is pure gold? Why is pure gold not used for making ornaments?
5. What are alloys? Give names of any four alloys and write their constituents and uses.
6. What is metal corrosion? What are the ways to protect corrosion?
7. Why is graphite used as a electrode?
8. Iron is not used in making of railway tracks ? Why ?
9. Explain through an activity that Magnesium is more reactive than Iron ?
10. Rub any Copper vessel with sand paper and observe. Now explain with giving reasons.

TRY TO DO THIS ALSO :

1. Interview some blacksmith, goldsmiths and sculptors of your city/village and try to find out more about metals and its characteristics.
2. Take small scrap pieces of Aluminium foil, iron nail, 4-5 cm long copper wire. Let them be exposed to moisture and leave them in the open. Observe after every 2 days for 10-15 days and write your observation.

   What do you conclude from the experiment ? Discuss with your teacher.
3. Make your own Electroscope.

   Take an empty bottle having a wide mouth. Take a piece of cardboard slightly bigger in size than the mouth of the bottle. Pierce a hole in it, so that a metal clip can be inserted. Open out the paper clip. Cut two strips of aluminium foil about 4cm x 1cm each. Hang them on the paper clip. Insert the paper clip in the cardboard lid so that it is perpendicular to it. Charge a refill and touch it to the end of the paper clip. Now observe what happens.

1) Is there any effect on the foil strips?
2) Do they repel each other or attract each other and why?
3) Can this apparatus be used to detect whether a body is charged or not?