CHAPTER 3

Metals & Non-metals

Acknowledgment

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Contents

(Activity 3.1) Take samples of iron, copper, aluminium and magnesium. Note the appearance of each sample. Clean the surface of each sample by rubbing them with sand paper and note their appearance again. What do you observe?

Metal	Appearance before cleaning	Appearance after cleaning
Iron	They have shining surface.	They become shinier.
Copper		
Aluminium		
Magnesium		

(Activity 3.2) Take small pieces of iron, copper, aluminium, and magnesium. Try to cut these metals with a sharp knife and write your observations. Hold a piece of sodium metal with a pair of tongs. Put it on a watch-glass and try to cut it with a knife.

Metal	Observation
Iron	They are very hard to cut
Copper	
Aluminium	
Magnesium	
Sodium	It can be cut easily with a knife.

(Activity 3.3) Take pieces of iron, zinc, lead and copper. Place each metal on a block of iron and strike it four or five times with a hammer. What do you observe?

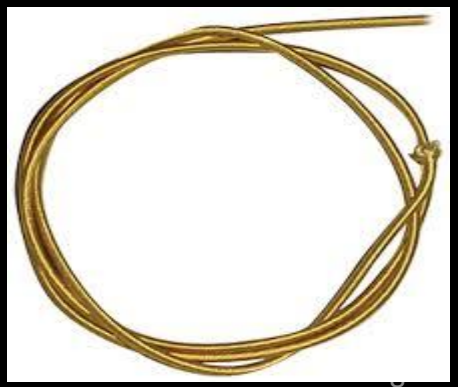
Metal	Observation
Iron	They take the form of sheets on beating.
Zinc	
Lead	
Copper	

Malleability

The ability of metals to be beaten into thin sheets is called malleability.

(Activity 3.4) Consider some metals such as iron, copper, aluminium, lead, etc. Which of the above metals are also available in the form of wires?

Iron, copper, aluminium, gold, silver, platinum and tin metals are available in the form of wires whereas lead is not available in the form of wire.



Ductility

The ability of metals to be drawn into thin wires is called ductility.

Why are some metals used for making vessels?

Some metals are used for making vessels because:

- Their thermal conduction property is very good.
- They transmit heat easily ensuring that the food gets cooked faster.

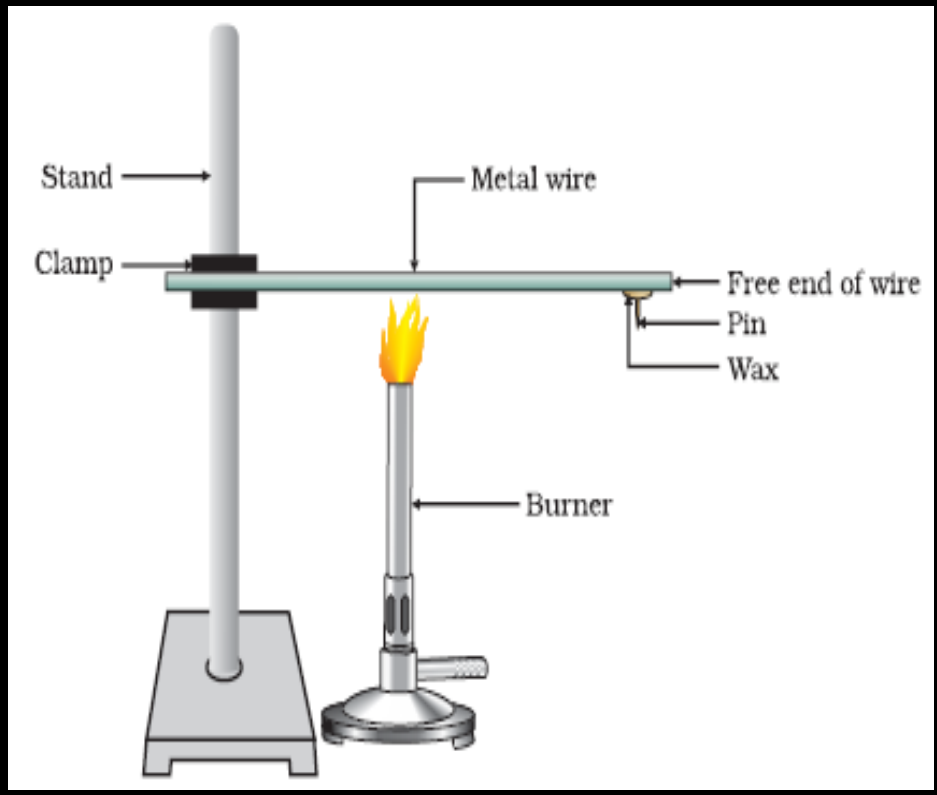
(Activity 3.5) Take an aluminium or copper wire. Clamp this wire on a stand as shown in figure. Fix a pin to the free end of the wire using wax. Heat the wire with a spirit lamp, candle or a burner near the place where it is clamped.

a) What do you observe after some time?

b) Does the metal wire melt?

a) After some time the wax melts and the pin falls down.

b) No, the metal wire does not melt.



(Activity 3.6) Set up an electric circuit as shown in figure. Place a metal in the circuit between terminals A and B as shown.

a) Does the bulb glow?

b) What does this indicate?

Metals are sonorous

The metals that produce a sound on striking a hard surface are said to be sonorous.

Why school bells are made of metals?

Metals are sonorous (produce sound on being hit), so - school bells are made up of metals.

Physical properties of metals

1) Metals, in their pure state, have a shining surface.
2) Metals are generally hard.
3) Some metals can be beaten into thin sheets (Malleable).
4) Some metals can be drawn into thin wires (Ductile).
5) They are good conductors of heat.
6) They have high density and high melting point.
7) They are good conductors of electricity.
8) Most metals produce sound on hitting (sonorous)

Physical properties of metals

a) Electric wires are coated with PVC or rubber like material.

Metals are good conductors are electricity.

b) Metals are used for making bells and strings of musical instruments.

Metals are sonorous.

c) Silver foil is spread over sweets.

Metals are malleable

d) Copper is used as cables

Metals are good conductors of electricity / Metal are ductile.

e) Aluminium is used in making utensils

Metals are good conductors of heat

f) Gold is used in making ornaments

Metals are lustrous.

You are given a hammer, a battery, a bulb, wires and a switch.

(a) How could you use them to distinguish between samples of metals and non-metals?

With the hammer, we can beat the sample and if it can be beaten into thin sheets (that is, it is malleable), then it is a metal otherwise a non-metal. Similarly, we can use the battery, bulb, wires, and a switch to set up a circuit with the sample. If the sample conducts electricity, then it is a metal otherwise a non-metal.

(b) Assess the usefulness of these tests in distinguishing between metals and non-metals.

The above tests are useful in distinguishing between metals and non-metals as these are based on the physical properties. No chemical reactions are involved in these tests.

Give reason: Platinum, gold and silver are used to make jewellery.

Platinum, gold, and silver are used to make jewellery because they are very lustrous. Also, they are very less reactive and do not corrode easily.

(Activity 3.7) Collect samples of carbon (coal or graphite), sulphur and iodine. Record your observations.

Element	Symbol	Type of surface	Hardness	Malleability	Ductility	Conduction		Sonority
						Heat	Electricity	
Carbon	C	Rough	Moderate	Not Malleable	Not ductile	No	No	No
Sulphur	S	Rough	Not hard	Not Malleable	Not ductile	No	No	No
Iodine	I	Shiny	Not hard	Not Malleable	Not ductile	No	No	No

We cannot group elements as metals and non-metals according to their physical properties alone.

As there are many exceptions in metals and non-metals. Example

a) All metals except mercury are solids.

b) Metals generally have high melting points except gallium and caesium.

c) Metals are hard except lithium, sodium and potassium.

d) Non-metals are dull except iodine.

e) Non-metals are bad conductors of electricity except carbon in the form of graphite.

(Activity 3.8.1) Take a magnesium ribbon. Burn the magnesium ribbon. Collect the ashes formed and dissolve them in water. Test the resultant solution with both red and blue litmus paper. Is the product formed on burning magnesium acidic or basic?

The product formed is basic.

$2Mg + O_2 \rightarrow 2MgO$

$MgO + H_2O \rightarrow Mg(OH)_2$

(Activity 3.8.1) Take a magnesium ribbon. Burn the magnesium ribbon. Collect the ashes formed and dissolve them in water. Test the resultant solution with both red and blue litmus paper. Is the product formed on burning magnesium acidic or basic?

(Activity 3.8.2) Take some sulphur powder and burn it. Place a test tube over the burning sulphur to collect the fumes produced. Add some water to the above test tube and shake. Test this solution with blue and red litmus paper. Is acidic or basic? Write equations for these reactions.

The product formed is acidic

$S + O_2 \rightarrow SO_2$

$SO_2 + H_2O \rightarrow H_2SO_4$

(Activity 3.8.2) Take some sulphur powder and burn it. Place a test tube over the burning sulphur to collect the fumes produced. Add some water to the above test tube and shake. Test this solution with blue and red litmus paper. Is acidic or basic? Write equations for these reactions.

Physical properties of non-metals

1) Non-metals occur as solid, liquid and gas.
2) They do not have shining surface except Iodine.
3) They are generally soft except diamond.
4) They are not malleable.
5) They are not ductile.
6) They are poor conductors of heat.
7) They are poor conductors of electricity except graphite.
8) They have low density and low melting point.
9) They are not sonorous.

Metals Vs non-metals

Metals	Non-metals
1. Metals are solids at solids at room temperature (except mercury & gallium)	1. Occurs as solids, liquids & gases
2. They are generally hard.	2. They are generally soft.
3. Sonorous	3. Not sonorous.
4. Generally malleable & ductile	4. Non-malleable & non-ductile, brittle
5. Generally good conductors of electricity	5. Non-conductor of electricity (except graphite)
6. Generally good conductors of heat	6. Non-conductor of heat (except graphite & diamond)
7. They are lustrous	7. They are non-lustrous.
8. They have high density and high melting point.	8. They have low density and low melting point.
9. Metallic oxides are basic in nature.	9. Non-metallic oxides are acidic in nature.

(Activity 3.9) Hold each of the following - aluminium, copper, iron, lead, magnesium, zinc and sodium with a pair of tongs and try burning over a flame. Collect the product if formed. Let the products and the metal surface cool down.

a) Which metals burn easily?

Magnesium

b) What flame colour did you observe when the metal burnt?

Blue

c) How does the metal surface appear after burning?

Silver white

d) Arrange the metals in the decreasing order of their reactivity towards oxygen.

Sodium > Magnesium > Aluminium > Zinc > Iron > lead > copper

e) Are the products soluble in water?

Oxides of aluminium, copper, iron, lead, magnesium, zinc are not soluble. Sodium oxide is soluble in water.

Reaction of magnesium with air

Magnesium burns brightly in air forming magnesium oxide.

$$2Mg + O_2 \rightarrow 2MgO$$

Reaction of Metals with air

Most metals combine with oxygen to form metal oxides.

Metal + Oxygen → Metal oxide

Ex: When copper is heated in air, copper (II) oxide is formed.

$2Cu + O_2 \rightarrow 2CuO$

Aluminium reacts with oxygen to form aluminium oxide

$4Al + 3O_2 \rightarrow 2Al_2O_3$

Amphoteric oxides

Metal oxides which react with both acids as well as bases to produce salts and water are known as amphoteric oxides.

Ex: aluminium oxide, zinc oxide, etc.

Reaction of aluminium oxide with acid and base

Aluminium oxide reacts with hydrochloric acid to form aluminium chloride and water.

$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$

Aluminium oxide reacts with sodium hydroxide to form sodium aluminate and water.

$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

Reaction of metal oxide with water

Some metal oxides dissolve in water to from alkalis.

$Na_2O + H_2O \rightarrow 2NaOH$

$K_2O + H_2O \rightarrow 2KOH$

Why metals like potassium and sodium are kept immersed in kerosene oil?

Metals such as potassium and sodium react so vigorously that they catch fire if kept in the open. Hence, to protect them and to prevent accidental fires, they are kept immersed in kerosene oil.

What happens iron filings is sprinkled into the flame of the burner?

Iron filings burn vigorously when sprinkled in the flame of the burner.

What is anodising?

Anodising is a process of forming a thick oxide layer of aluminium.

Anodising process

A clean aluminium article is made the anode and is electrolysed with dilute sulphuric acid. The oxygen gas evolved at the anode reacts with aluminium to make a thicker protective oxide layer. This oxide layer is dyed to give aluminium articles an attractive finish.

(Activity 3.10) Put small pieces of the aluminium, copper, iron, lead, magnesium, zinc and sodium separately in beakers half-filled with cold water.

(Activity 3.10) Put small pieces of the aluminium, copper, iron, lead, magnesium, zinc and sodium separately in beakers half-filled with cold water.

a) Which metals reacted with cold water?

Sodium, Potassium and Calcium are the metals react with cold water.

b) Arrange them in the increasing order of their reactivity with cold water.

Calcium < Potassium < Sodium

c) Did any metal produce fire on water?

Yes, Sodium and Potassium

d) Does any metal start floating after some time?

Calcium

Reaction of metal oxide with dilute acids

Metals react with dilute acids to give salt and hydrogen gas.

Metal + dilute acid → Salt + Hydrogen

(Activity 3.11) Take aluminium, copper, iron, lead, magnesium, zinc. If the samples are tarnished, rub them clean with sand paper. Put the samples separately in test tubes containing dilute hydrochloric acid. Suspend thermometers in the test tubes, so that their bulbs are dipped in the acid.

Observe the rate of formation of bubbles carefully.

The rate of formation of bubbles is fastest in case of magnesium.

Which metals reacted vigorously with dilute hydrochloric acid?

Metals like magnesium, aluminium, zinc and iron react vigorously with dilute hydrochloric acid.

With which metal did you record the highest temperature?

Magnesium

Arrange the metals in the decreasing order of reactivity with dilute acids.

Magnesium > Aluminium > zinc > iron

Reaction of metal oxide with dilute nitric acid

Metals reactwith nitric acid to form respective nitrates and hydrogen.

a) Magnesium

$Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$

b) Manganese

$Mn + 2HNO_3 \rightarrow Mn(NO_3)_2 + H_2$

Why hydrogen gas is not evolved when some metals react with nitric acid?

Nitric acid is a strong oxidising agent. It oxidizes the hydrogen gas produced to water.

Aqua regia

Aqua regia is a freshly prepared mixture of concentrated hydrochloric acid and concentrated nitric acid in the ratio of 3:1.

Activity 3.12

a) In which test tube did you find that a reaction has occurred?

The reaction occurs in the test tube in which iron nail is placed in solution of copper sulphate.

b) On what basis can you say that a reaction has actually taken place?

The iron nail gets coated with a layer of red copper metal, it is observed that in the first test tube no reaction has occurred.

c) Can you correlate your observations for the Activities 3.9, 3.10 and 3.11?

In this reaction, a more active metal, iron displaces a less reactive metal, copper from it compound copper (II) sulphate.

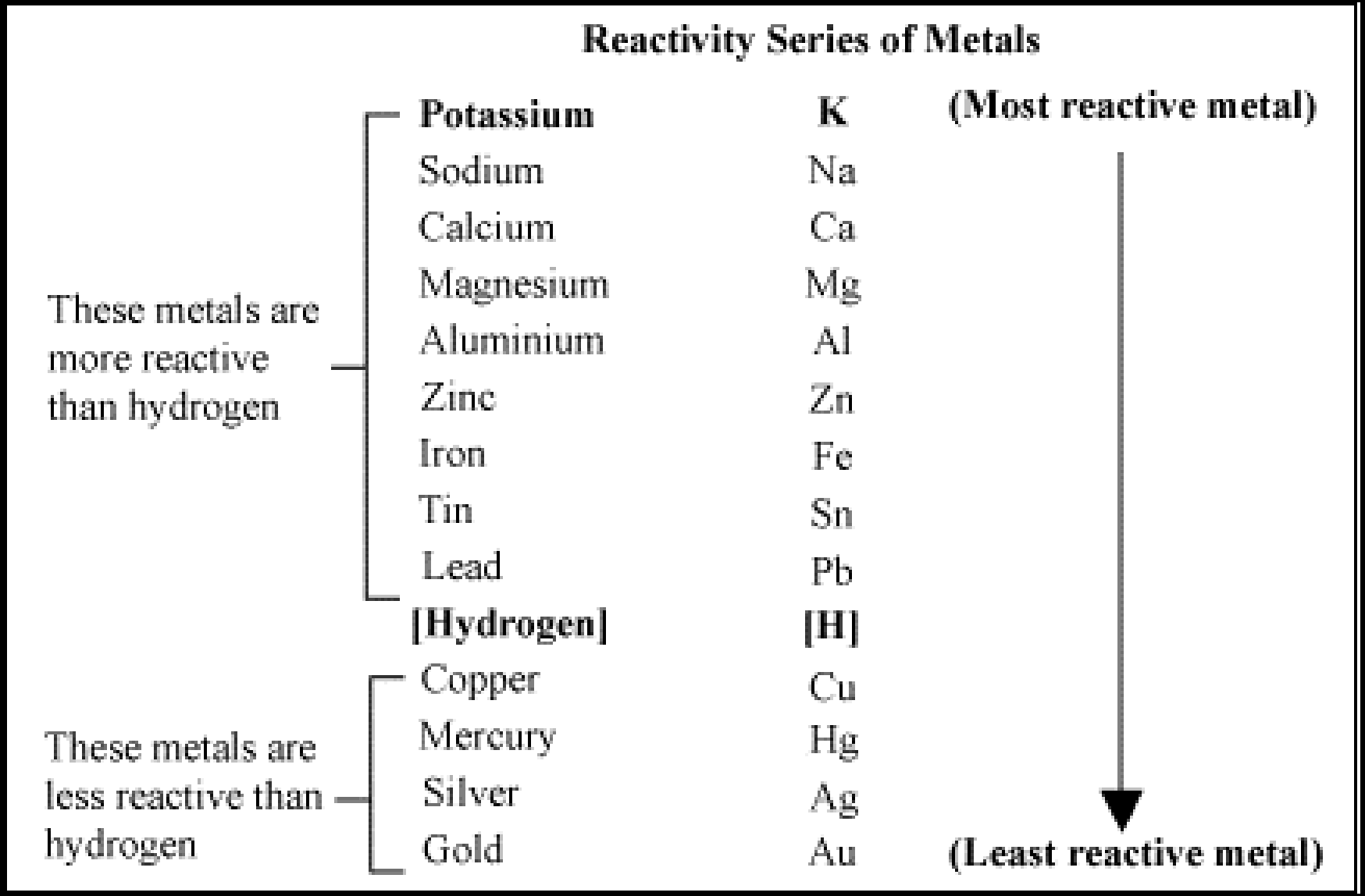
d) Write a balanced chemical equation for the reaction that has taken place.

$CuSO_4 + Fe \rightarrow FeSO_4 + Cu$

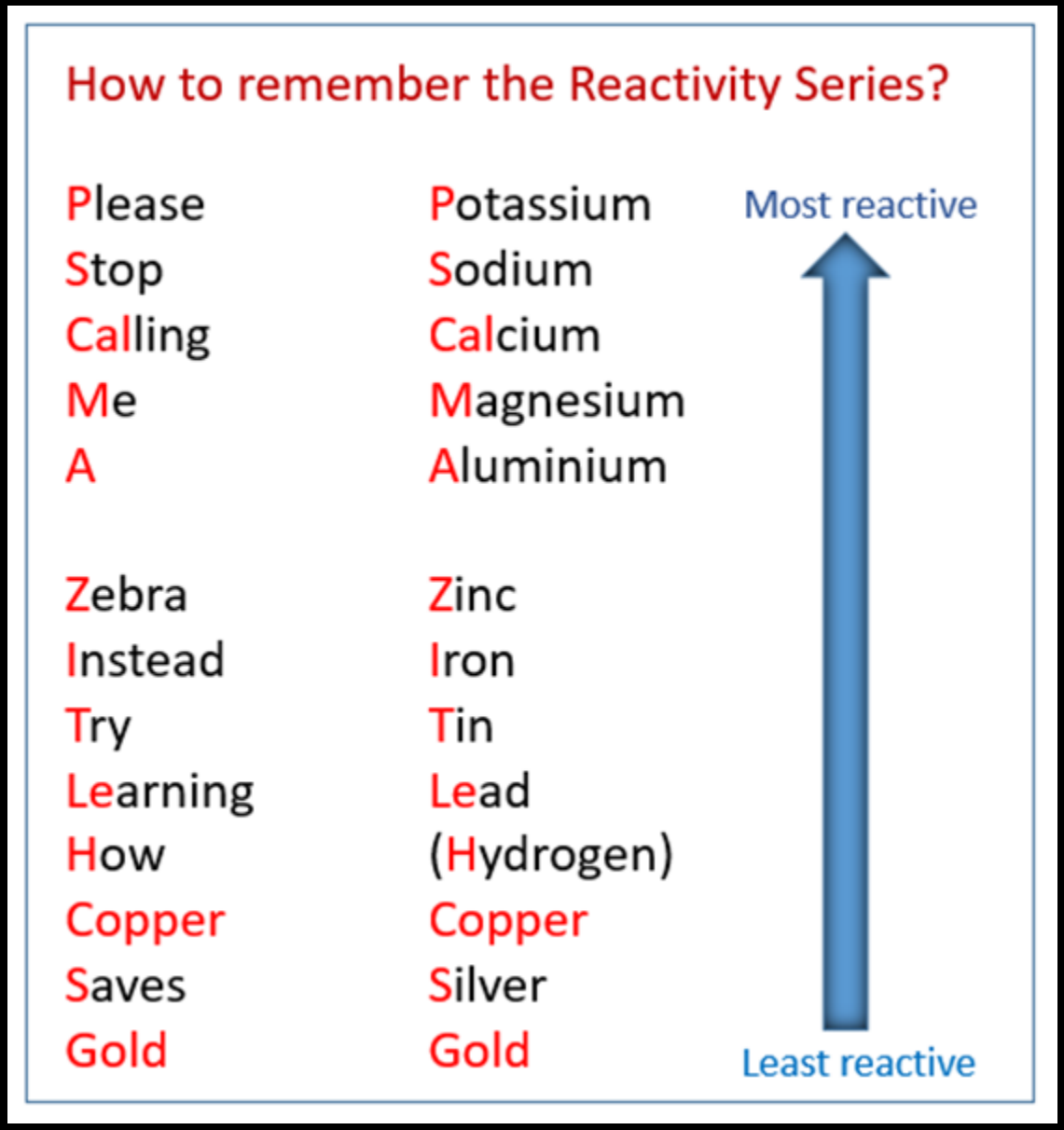
e) Name the type of reaction.

Displacement reaction.

Reactivity series



Reactivity series



An aluminium can is used to store ferrous sulphate solution. It is observed that in a few days holes appeared in the can. Explain the cause for this observation and write chemical equation to support your answer.

Aluminium is more reactive than iron. Therefore aluminium slowly reacts with solution of ferrous sulphate and holes are developed in the aluminium can.

Samples of four metals A, B, C and D were taken and added to the following solution one by one. The results obtained have been tabulated as follows.

Metal	Iron(II) sulphate	Copper(II) sulphate	Zinc sulphate	Silver nitrate
A	No reaction	Displacement		
B	Displacement		No reaction	
C	No reaction	No reaction	No reaction	Displacement
D	No reaction	No reaction	No reaction	No reaction

Use the Table above to answer the following questions about metals A, B, C and D.

(i) Which is the most reactive metal?

B is the most reactive metal.

Samples of four metals A, B, C and D were taken and added to the following solution one by one. The results obtained have been tabulated as follows.

Metal	Iron(II) sulphate	Copper(II) sulphate	Zinc sulphate	Silver nitrate
A	No reaction	Displacement		
B	Displacement		No reaction	
C	No reaction	No reaction	No reaction	Displacement
D	No reaction	No reaction	No reaction	No reaction

(ii) What would you observe if B is added to a solution of Copper (II) sulphate?

If B is added to a solution of copper (II) sulphate, then it would displace copper.

B + CuSO4 Displacement

(iii) Arrange the metals A, B, C and D in the order of decreasing reactivity.

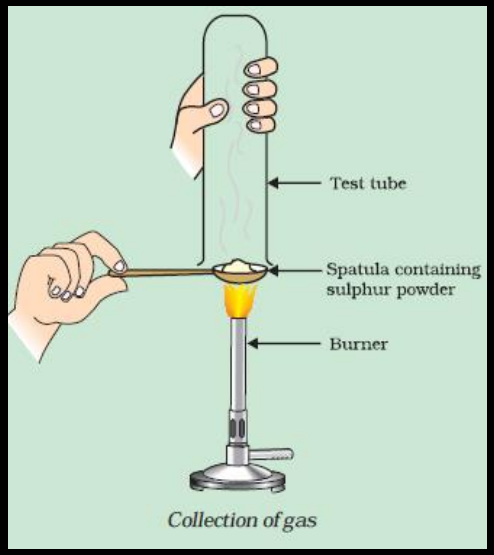
The arrangement of the metals in the order of decreasing reactivity is

B > A > C > D

Metallic oxides of zinc, magnesium and copper were heated with the following metals. In which cases will you find displacement reactions taking place?

Metal	Zinc	Magnesium	Copper
Zinc oxide	No	Yes	No
Magnesium oxide	No	No	No
Copper oxide	Yes	Yes	No

Pratyush took sulphur powder on a spatula and heated it. He collected the gas evolved by inverting a test tube over it, as shown in figure.



(a) What will be the action of gas on

(i) dry litmus paper?

There will be no action on dry litmus paper.

(ii) moist litmus paper?

Since the gas is sulphur dioxide (SO_2), it turns moist blue litmus paper to red because sulphur dioxide reacts with moisture to form sulphurous acid.

(b) Write a balanced chemical equation for the reaction taking place.

$S(s) + O_2(g) \rightarrow SO_2(g)$; $SO_2(g) + H_2O(l) \rightarrow H_2SO_3(aq)$

Aluminium is a highly reactive metal, yet it is used to make utensils for cooking.

Though aluminium is a highly reactive metal, it is resistant to corrosion. This is because aluminium reacts with oxygen present in air to form a thin layer of aluminium oxide. This oxide layer is very stable and prevents further reaction of aluminium with oxygen. Also, it is light in weight and a good conductor of heat. Hence, it is used to make cooking utensils.

You must have seen tarnished copper vessels being cleaned with lemon or tamarind juice. Explain why these sour substances are effective in cleaning the vessels.

Copper reacts with moist carbon dioxide in air to form copper carbonate and as a result, copper vessel loses its shiny brown surface forming a green layer of copper carbonate. The citric acid present in the lemon or tamarind neutralises the basic copper carbonate and dissolves the layer. That is why, tarnished copper vessels are cleaned with lemon or tamarind juice to give the surface of the copper vessel its characteristic lustre.

A man went door to door posing as a goldsmith. He promised to bring back the glitter of old and dull gold ornaments. An unsuspecting lady gave a set of gold bangles to him which he dipped in a particular solution. The bangles sparkled like new but their weight was reduced drastically. The lady was upset but after a futile argument the man beat a hasty retreat. Can you play the detective to find out the nature of the solution he had used?

He must have dipped the gold bangles in the solution of aqua regia – a 3:1 mixture of conc. HCl and conc. HNO_3. Aqua regia is a fuming, highly corrosive liquid. It dissolves gold in it. After dipping the gold ornaments in aqua regia, the outer layer of gold gets dissolved and the inner shiny layer appears. That is why the weight of gold ornament reduced.

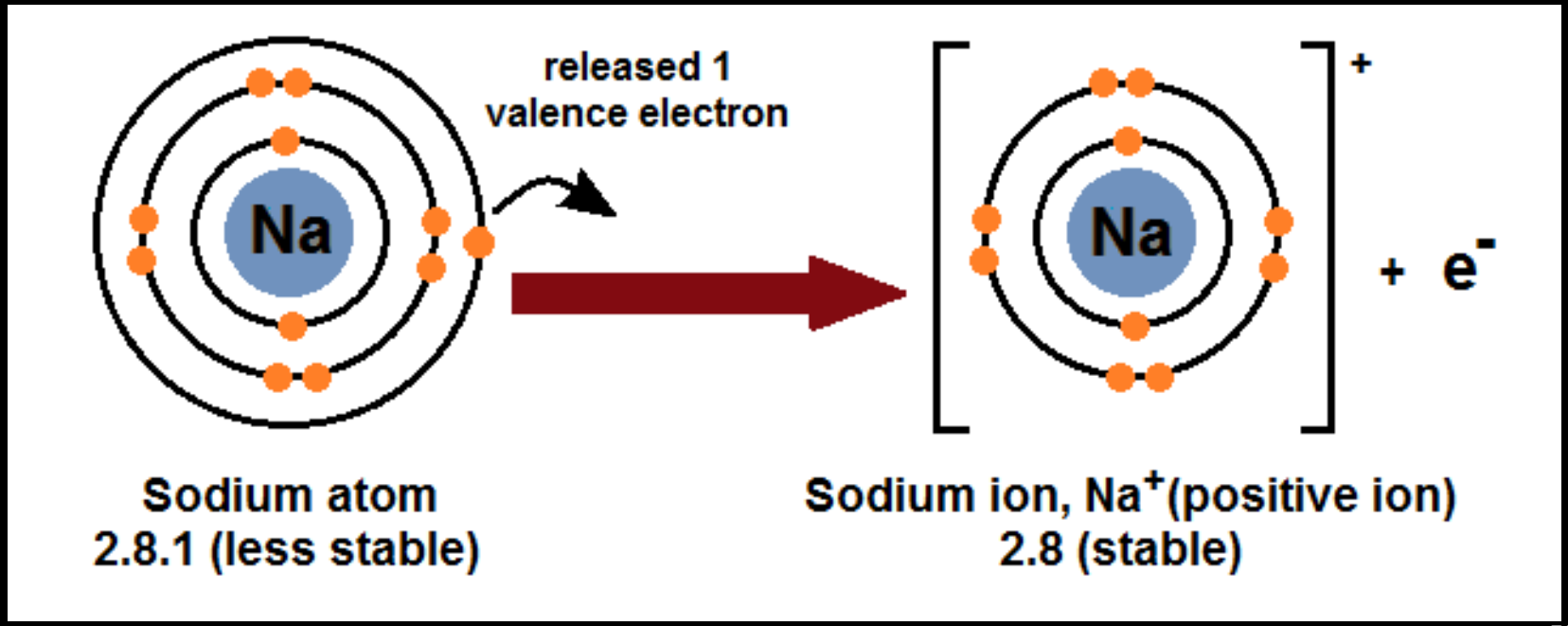
Give reasons why copper is used to make hot water tanks and not steel (an alloy of iron).

Copper does not react with cold water, hot water, or steam. However, iron reacts with steam. If the hot water tanks are made of steel (an alloy of iron), then iron would react vigorously with the steam formed from hot water. That is why copper is used to make hot water tanks, and not steel.

$3Fe + 4H_2O \rightarrow Fe2O_3 + 4H_2$

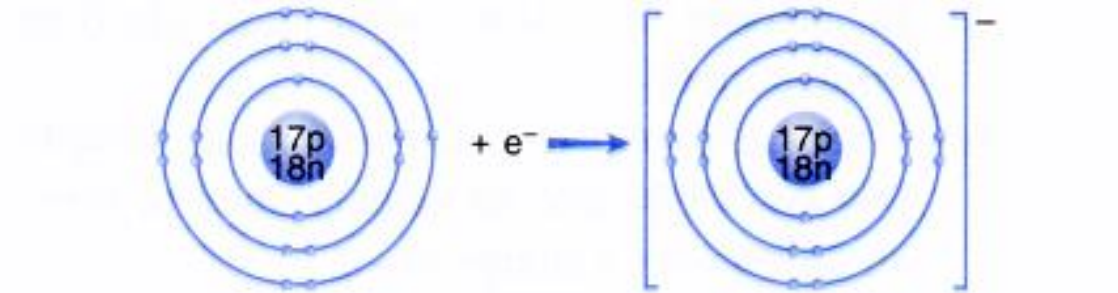
Formation of sodium ion

Sodium atom has one electron in its outermost shell. If it loses the electron from its M shell then its L shell now becomes the outermost shell and that has a stable octet. The nucleus of this atom still has 11 protons but the number of electrons has become 10, so there is a net positive charge giving us a sodium cation Na+.



Formation of chloride ion

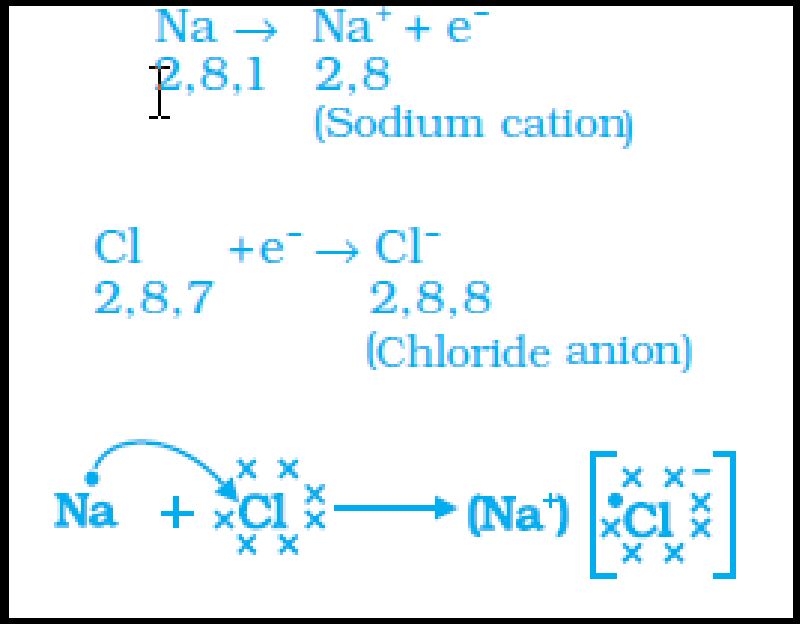
Chlorine has seven electrons in its outermost shell and it requires one more electron to complete its octet. If sodium and chlorine were to react, the electron lost by sodium could be taken up by chlorine. After gaining an electron, the chlorine atom gets a unit negative charge, because its nucleus has 17 protons and there are 18 electrons in its K, L and M shells. This gives us a chloride anion Cl–.



Chlorine atom, Cl (2.8.7)		Chloride ion, Cl^- (2.8.8)	
Charge of 17 protons	= +17	Charge of 17 protons	= +17
Charge of 17 electrons	= −17	Charge of 18 electrons	= −18
Total charge	= 0	Total charge	= −1

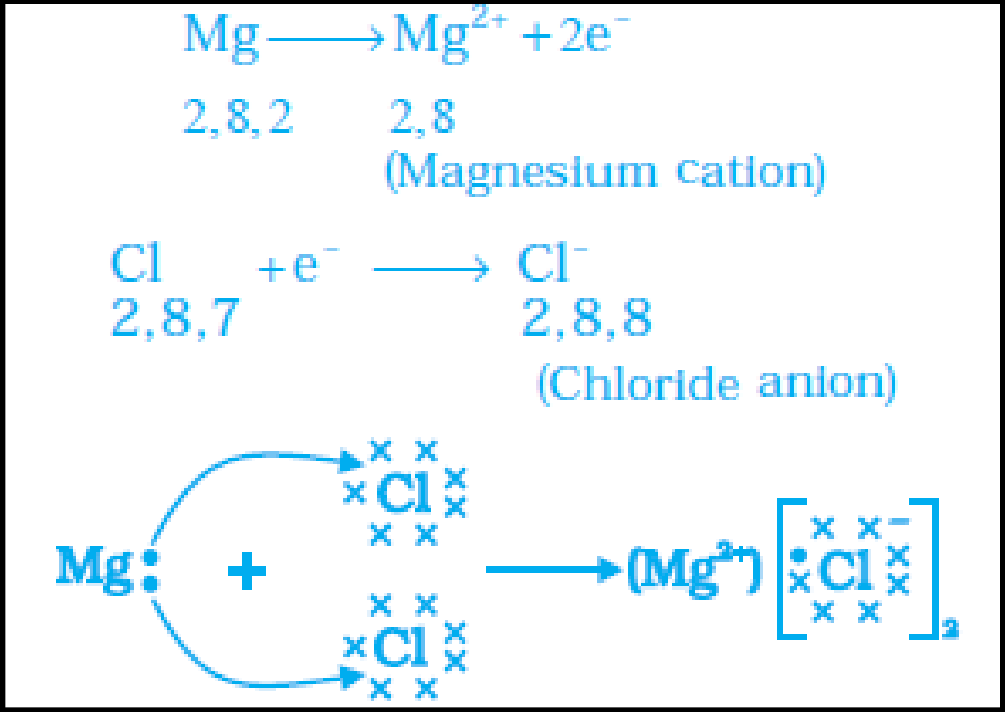
Formation of sodium chloride

Sodium atom has one electron in its outermost shell. It loses one electron and becomes sodium ion. Chlorine has seven electrons in its outermost shell and it requires one more electron to complete its octet. If sodium and chlorine react, the electron lost by sodium is taken up by chlorine. Sodium and chloride ions, being oppositely charged, attract each other and are held by strong electrostatic forces of attraction to exist as sodium chloride (NaCl).



Formation of magnesium chloride

Magnesium atom has two electrons in its outermost shell. It loses two electrons and becomes magnesium ion. Chlorine has seven electrons in its outermost shell and requires one electron to complete its octet. If magnesium and chlorine react, two electrons lost by magnesium are taken by chlorine and magnesium chloride is formed.



Ionic compounds

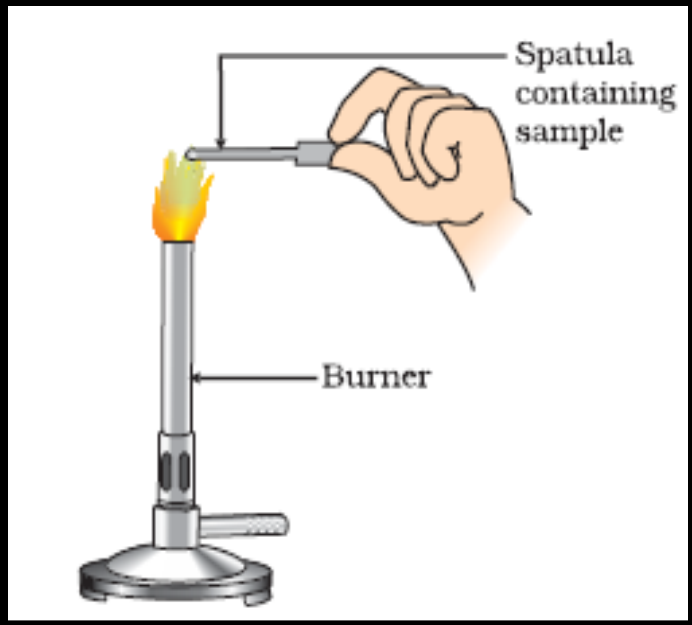
The compounds formed by the transfer of electrons from a metal to a non-metal are known as ionic compounds or electrovalent compounds.

(Activity 3.13) Take samples of sodium chloride, potassium iodide, barium chloride or any other salt from the science laboratory.

a) What is the physical state of these salts?

All the salts are solids.

Take a small amount of a sample on a metal spatula and heat directly on the flame as shown in the figure.



b) What did you observe? Did the samples impart any colour to the flame? Do these compounds melt?

Sodium chloride burns with yellow flame, potassium iodide with pale violet and barium chloride with a pink colour. These compounds melt at high temperatures.

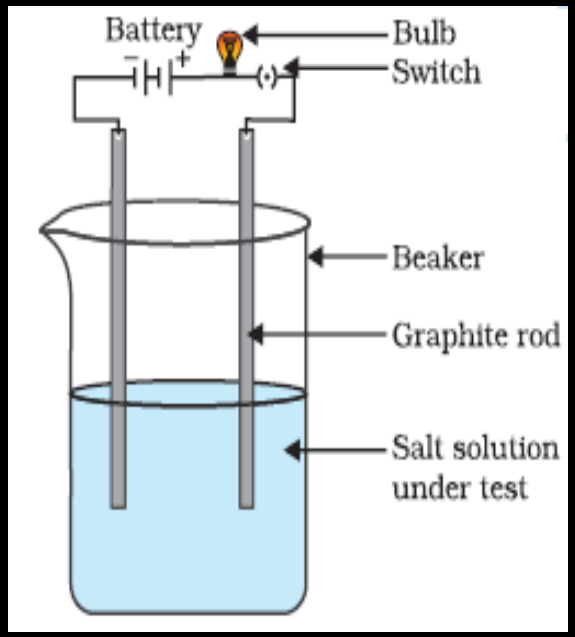
Try to dissolve the samples in water, petrol and kerosene.

c) Are they soluble?

Metal compounds dissolve in water but are insoluble in petrol and kerosene.

Make a circuit as shown in figure and insert the electrodes into a solution of one salt.

What did you observe? Test the other salt samples too in this manner.



Metal compounds conduct electricity in water only, not in petrol or kerosene.

d) What is your inference about the nature of these compounds?

These compounds give charged ions in water.

Properties of ionic compounds

a) Ionic compounds are solids. They are brittle and break into pieces when pressure is applied.
b) Ionic compounds have high melting and boiling points.
c) Ionic compounds are soluble in water and insoluble in organic solvents such as kerosene, petrol etc.
d) Ionic compounds conduct electricity in molten state.

Give reason

a) Ionic compounds are solids and hard.

Due to the strong force of attraction between the positive and negative ions.

b) Ionic compounds have high melting & boiling points.

As considerable amount of energy is required to break the strong inter-ionic attraction.

c) Ionic compounds in solid state do not conduct electricity.

Ionic compounds in the solid state do not conduct electricity because movement of ions in the solid is not possible due to their rigid structure.

d) Ionic compounds conduct electricity in molten state.

Ionic compounds conduct electricity in the molten state since the electrostatic forces of attraction between the oppositely charged ions are overcome due to the heat.

Extraction of metals

Mineral & Ore

The elements or compounds, which occur naturally in the earth's crust, are known as minerals.

Minerals that contain a very high percentage of a particular metal which can be profitably extracted from it are called ores.

Free & Combined state

The metals that are found at the bottom of the activity series which are least reactive. Example: gold, silver, platinum and copper.

Copper, silver, metals found at the top of the activity series like potassium, sodium, calcium, magnesium, aluminium, zinc, iron, lead, etc.

Why potassium & sodium do not occur in free state?

The metals at the top of the activity series like potassium, sodium, calcium, magnesium, aluminium are so reactive that they are never found in nature as free elements.

Why like zinc, iron, lead, etc., found mostly as oxides, sulphides or carbonates?

Zinc, iron lead, etc., are found in the earth's crust mainly as oxides, sulphides or carbonates because oxygen is a very reactive element and is very abundant on the earth.

Steps involved in extraction of carbonate ores of metals of medium reactivity.

1) Concentration of ore.
2) Calcination of carbonate ore to obtain oxide of metal.
3) Reduction to metal.
4) Purification of metal.

Steps involved in extraction of sulphide ores of metals of medium reactivity.

1) Concentration of ore.
2) Roasting of sulphide ore to obtain oxide of metal.
3) Reduction to metal.
4) Purification of metal.

Steps involved in extraction of metals of low reactivity.

1) Concentration of ore.
2) Roasting of sulphide ore.
3) Refining of metal.

Gangue

Large amounts of impurities such as soil, sand, etc., present along with the ore are called gangue.

Extraction of mercury

Cinnabar (HgS) is an ore of mercury.
It is heated in air to convert into mercuric oxide (HgO).

$2HgS(s) + 3O_2(g) \rightarrow 2HgO(s) + 2SO_2(g)$

Mercuric oxide is then reduced to mercury on further heating.

$2HgO(s) \rightarrow 2Hg(l) + O_2(g)$

Extraction of copper

Copper which is found as Chalcocite (Cu_2S) in nature can be obtained by just heating in air.

$2Cu_2S + 3O_2\ (g) \rightarrow 2Cu_2O(s) + 2SO_2\ (g)$

$2Cu_2O + Cu_2S \rightarrow 6Cu(s) + SO_2\ (g)$

Roasting

The process in which sulphide ores are converted into oxides by heating them strongly in excess of air is known as roasting.

Calcination

The process in which the carbonate ores are changed into oxides by heating strongly in limited air is called calcination.

Roasting vs Calcination

Roasting	Calcination
1. The ore is heated in presence of air	1. The ore is heated in absence of air
2. It is used for sulphide ores.	2. It is used for carbonate ores.

Extraction of zinc from zinc blende

Zinc blende (ZnS) is converted into zinc oxide by heating strongly in the presence of air.

$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$

Zinc oxide is heated with carbon to reduce it to metallic zinc.

$ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$

Extraction of zinc from calamine

Calamine or $ZnCO_3$ is changed into zinc oxide by heating strongly in limited air.

$ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$

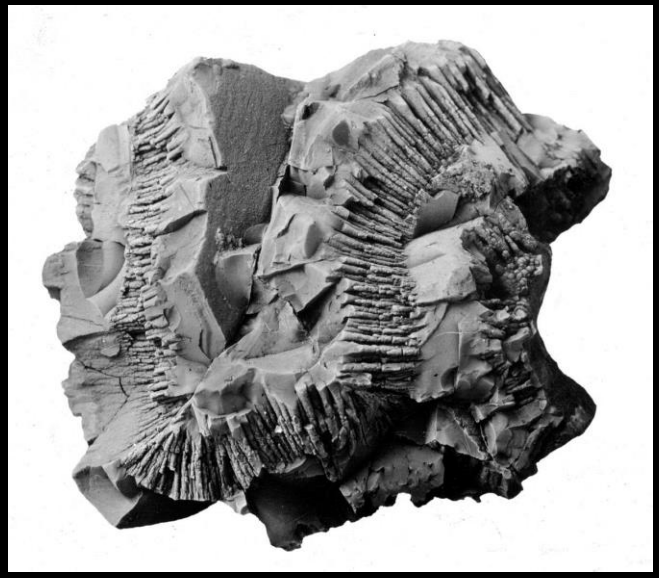
Zinc oxide is heated with carbon to reduce it to metallic zinc.

$ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$

Extraction of manganese from pyrolusite

Manganese dioxide (pyrolusite) is heated with aluminium powder to get manganese.

$3MnO_2(s) + 4Al(s) \rightarrow 3Mn(l) + 2Al_2O_3(s) + Heat$



Reduction of iron oxide to iron

Iron (III) oxide (Fe_2O_3) is heated with aluminium powder, it gets reduced to iron.

$Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(l) + Al_2O_3(s) + Heat$

Thermite reaction

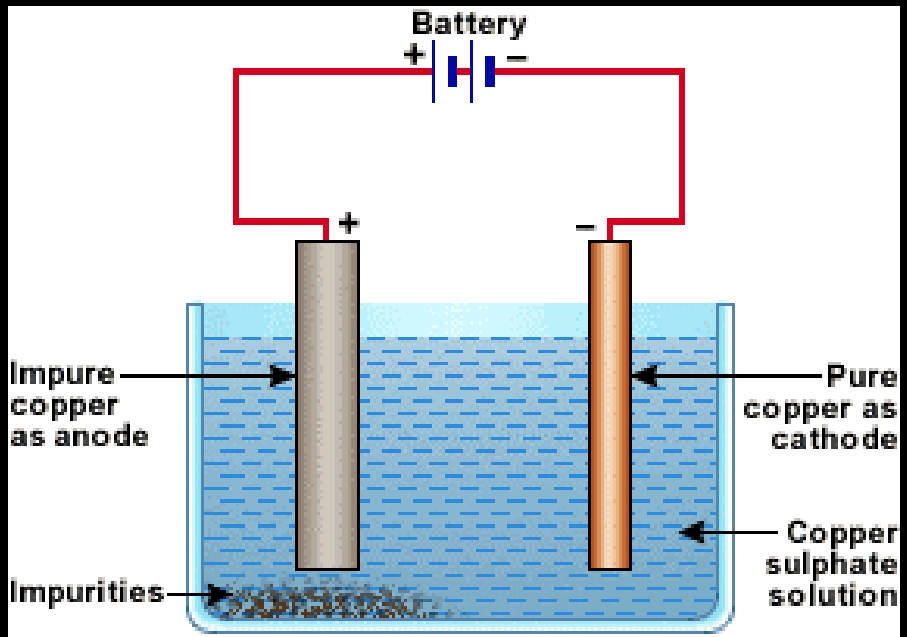
Thermite reaction is an exothermic redox reaction between a metal and metal oxide as reactants.

Thermite reaction

Thermite reactions are highly exothermic. The amount of heat evolved is so large that the metals are produced in the molten state. Hence used to join railway tracks or cracked machine parts.

Electrolytic reduction

Electrolytic reduction is the method of reducing metals with the help of electrolysis.



Experimental set up for the electrolytic refining of copper.

In the electrolytic refining of a metal M, what would you take as the anode, the cathode and the electrolyte?

In the electrolytic refining of a metal M:

Anode → Impure metal M

Cathode → Thin strip of pure metal M

Electrolyte → Solution of salt of the metal M

Electrolytic reduction of sodium

If sodium chloride is melted, two electrodes are inserted and an electric current is passed through the molten salt, then chemical reactions take place at the electrodes. Sodium is deposited at the cathode (negatively charged electrode) and chlorine is liberated at the anode (positively charge electrode)

Electrolytic refining of copper

In the electrolytic refining of copper, impure copper is taken as anode and pure copper strips are taken as cathode. The electrolyte is acidified solution of copper sulphate.

On passing electric current, pure copper is deposited on the cathode.

The reactions are:

Anode: $Cu \rightarrow Cu^{2+} + 2e^-$

Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$

Reaction that takes place at cathode and anode during the electrolytic reduction of sodium.

At cathode: $Na^+ + e^- \rightarrow Na$

At anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

Give reason

a) Silver articles become black after exposure to air.

Silver reacts with sulphur in the air to form a coating of silver sulphide.

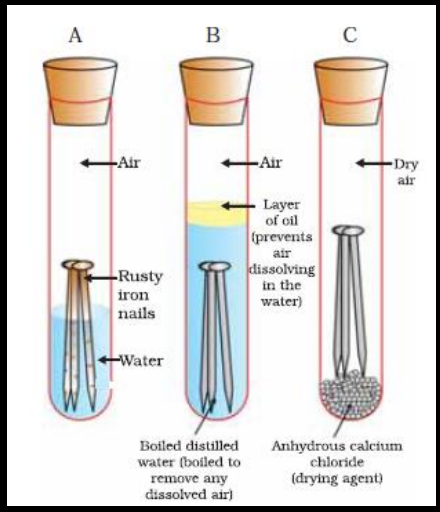
b) Copper articles becomes green after exposure to air.

Copper reacts with moist carbon dioxide in the air and slowly loses its shiny brown surface and forms a green copper carbonate.

c) Iron articles acquires a coating of a brown flaky substance.

Iron on exposure to moist air for a long time forms iron oxide.

(Activity 3.14) Take three test tubes and place clean iron nails in each of them. Label these test tubes A, B and C. Pour some water in test tube A and cork it. Pour boiled distilled water in test tube B, add about 1 mL of oil and cork it. The oil will float on water and prevent the air from dissolving in the water. Put some anhydrous calcium chloride in test tube C and cork it. Leave these test tubes for a few days and then observe.



Methods of preventing corrosion of iron

Rusting of iron can be prevented:

a) By painting.

b) By oiling.

c) By greasing.

d) By galvanizing.

e) By anodising or making alloys.

Painting

Oiling

Greasing

Galvanising

Galvanisation

Galvanisation is a method of protecting steel and iron from rusting by coating them with a thin layer of zinc.

Alloy

An alloy is a homogeneous mixture of two or more metals, or a metal and a non-metal.

Alloy preparation

Alloy is prepared by first melting the primary metal, and then, dissolving the other elements in it in definite proportions. It is then cooled to room temperature.

Pure gold (24 carat) is not suitable for making jewellery.

Pure gold is very soft hence it is not suitable for making jewellery.

Why is silver or copper added to make gold jewellery?

Pure gold (24 carat) is very soft, so to make it hard silver or copper is added.

22 carat gold

22 carat gold means 22 parts of pure gold is mixed with 2 parts of either copper or silver.

Gold standards

Amalgam

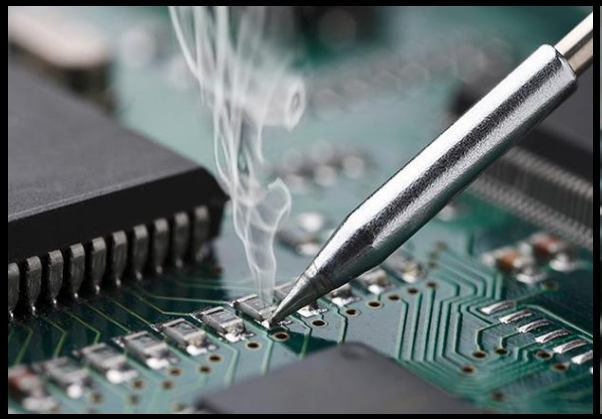
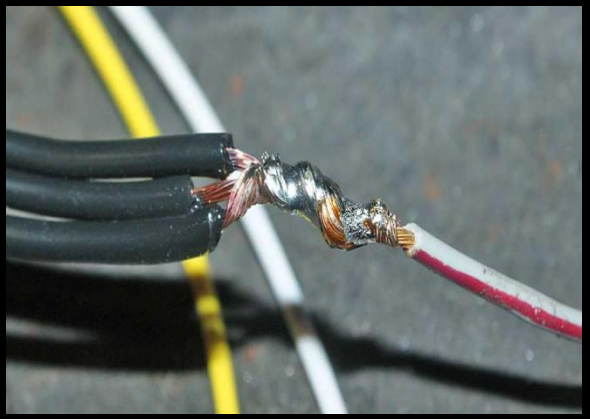
An alloy of mercury with another metal is called an amalgam.

Alloys and composition

Alloy	Composition	Use	
Brass	Copper and zinc	Electrical appliances	
Bronze	Copper and tin	statues	
Solder	Lead and tin	Welding electrical wires	

Solder is used for welding electrical wires together.

Solder an alloy of lead and tin has a low melting point hence used for welding electrical wires together.

Exercise (MCQ)

1) Which of the following pairs will give displacement reactions?

(a) NaCl solution and copper metal
(b) $MgCl_2$ solution and aluminium metal
(c) $FeSO_4$ solution and silver metal
(d) $AgNO_3$ solution and copper metal.

2) Which of the following methods is suitable for preventing an iron frying pan from rusting?

(a) Applying grease
(b) Applying paint
(c) Applying a coating of zinc
(d) all of the above.

3) An element reacts with oxygen to give a compound with a high melting point. This compound is also soluble in water. The element is likely to be

(a) calcium
(b) carbon
(c) silicon
(d) iron

4) Food cans are coated with tin and not with zinc because

(a) zinc is costlier than tin.

(b) zinc has a higher melting point than tin.

(c) zinc is more reactive than tin.

(d) zinc is less reactive than tin

END