7. Metals and Nonmetals

Can you recall?

1. What are the three types in which the elements are generally classified?
2. What are the metals and nonmetals that we use in everyday life?

All the objects or materials in the world are made from elements, compounds or their mixtures. Scientists classified all the elements into three general types which are metals, nonmetals and metalloids.

Metals : Gold, silver, iron, copper, aluminium, magnesium, calcium, sodium, platinum are a few metals. Metals have lustre. The metals are hard. Wire or sheet can be from them made metal. Metals are good conductors of heat and electricity. Metals lose their valence electrons to produce positively charged ions, that is, cations.

Physical Properties of Metals

1. Physical State : Under ordinary temperature metals stay in solid state. However metals like mercury and gallium are exception, which are in liquid state even at room temperature.

Can you recall?

You might have seen a doctor's pressure gauge to measure blood pressure, during your visit to a dispensary, accompanying your relative. In that, you might have seen a grey coloured liquid in a glass tube. What is that metal?

2. Lustre : Take copper vessels at your home. Scrub them with lemon and rinse with water. Observe the lustre before and after cleaning. Light gets reflected from the cleaned or freshly cut surface of metal and the metal looks lustrous.

3. Hardness : Generally metals are hard, not soft. Exception : Sodium and potassium are soft and can be easily cut by a knife.

4. Ductility : Have you ever gone to a goldsmith's shop ? Have you seen the goldsmith making a wire of gold or silver? When a metal is pulled through a hole its wire is formed. This property of metal is called ductility.

5. Malleability : Take an iron nail. Place it on a platform and keep on hammering it. After sometime you will see a thin sheet forming. This property is called malleability of metals.

6. Conduction of Heat : Take a copper plate. Fix some wax at one of its ends. Heat the other end and observe what happens. Discuss with teacher.
Metals are good conductors of heat. Silver, copper and aluminium are the best conductors of heat.

7. Conduction of Electricity : Which metals are used to make electrical wires? Metals are good conductors of electricity. Lead is an exception, which is neither a good conductor of heat nor a good conductor of elctricity.

8. Density : Metals have high density Sodium, potassium and lithium are exception, having lower density then water. The density of lithium is only 0.53 g/cc.

9. Melting point & Boiling Point : Generally metals have high melting points and boiling points. Exceptions : Hg, Ga, Na, K.

10. Sonority : What is the metal that your school bell is made of ? How does a bell is function? Metals are sonorous. They produce sound on striking.

Nonmetals : Carbon, Sulphur, Phosphorus are a few nonmetals. Generally nonmetals are brittle and nonlustrous.

Physical Properties of nonmetals :

1. Physical State : At ordinary temperature nonmetals occur as solids, liquids and gases. For example : Solids : C, S, P; Liquids : Br_2; Gases : H_2, N_2, O_2

2. Lustre : Nonmetals do not have lustre, except diamond and iodine crystals. Some nonmetals are colourless while others have different colours. What is the colour of carbon in the form of coal ? Sulphur is yellow and bromine is brown.

3. Brittleness : Take coal and hammer it. See what happens to it. Solid nonmetals are brittle. Some nonmetals are soft. Diamond (an allotrope of carbon) is an exception, which is the hardest natural substance.

4. Ductility & Malleability : Non metals are neither ductile nor malleable.

5. Conduction of Heat & Electricity : Non metals are bad conductors of heat and electricity, except graphite (an allotrope of carbon) which is a very good conductor of electricity.

6. Density : Nonmetals have low densities.

7. Melting & Boiling Point : Nonmetals have low melting and boiling points. Exceptions : the solid nonmetals carbon and boron melt at high temperature.

Always remember

1. Gold, Silver, Aluminium are highly malleable metals.
2. A sheet with thickness 1/10,000 mm and a wire with diameter 1/5000 mm can be made from gold.

Metalloids : Some elements such as arsenic (As), Silicon (Si), Germanium (Ge), Antimony (Sb) have properties which are intermediate between metals and nonmetals. Such elements are called metalloids.

Chemical properties of Metals

a. Electronic configuration : Electronic configuration is the basis of chemical behaviour of elements. Majority of metals have upto three electrons in their outermost shell.

Metal	Atomic number	Electronic configuration
$_{11}Na$	11	2, 8, 1
$_{12}Mg$	12	2, 8, 2
$_{13}Al$	13	2, 8, 3

b. Formation of ions : Metals have a tendency to lose their valence electrons to form positively charged ions, that is, cations.

$Na \longrightarrow Na^+ + 1e^-$

(2,8,1) (2,8)

Sodium Sodium ion

$Mg \longrightarrow Mg^{++} + 2e^-$

(2,8,2) (2,8)

Magnesium Magnesium ion

$Al \longrightarrow Al^{+++} + 3e^-$

(2,8,3) (2,8)

Aluminium Aluminium ion

c. Reaction with oxygen : Metals combine with oxygen to form their oxides.

Metal + Oxygen $\longrightarrow$ Metal oxide

The metal oxides are basic in nature. Metal oxides react with an acid to form salt and water.

Metal oxide + Acid $\longrightarrow$ Salt + Water

d. Reaction with acid : Take dilute hydrochloric acid in a test tube. Then add zinc dust to it. Take a glowing splinter near the mouth of the tube. Observe the glowing splinter. You will notice some sound coming out from it.

Most of the metals react with dilute acids to form metal salts while hydrogen gas is released.

Metal + dilute Acid ⟶ Salt + Hydrogen gas.

e. Reaction with water : Most metals do not show any observable and fast reaction with cold water. But some metals like sodium and potassium react with cold water to produce their hydroxides and hydrogen gas. magnesium metal requires steam to give similar reactions.

Chemical properties of nonmetals

a. Electronic configuration : Most of the nonmetals have 4 to 7 electrons in their valence shells.

Nonmetal	Atomic number	Electronic configuration
$_{7}N$	7	2, 5
$_{8}O$	8	2, 6
$_{17}Cl$	17	2, 8, 7

b. Formation of ions : Non metals have a tendency to accept electrons in their valence shell to form negatively charged ions called anions.

$Cl + e^- \longrightarrow Cl^-$

(2, 8, 7) (2, 8, 8)

Chlorine Chloride ion

$O + 2e^- \longrightarrow O^{--}$

(2, 6) (2, 8)

Oxygen Oxide ion

$N + 3e^- \longrightarrow N^{---}$

(2, 5) (2, 8)

Nitrogen Nitride ion

c. Reaction with oxygen : Nonmetals combine with oxygen to form their oxides.

Nonmetal + oxygen ⟶ Nonmetal oxide

The oxides of nonmetals are acidic in nature. They react with bases to form soluble salt and water.

$C + O_2 \longrightarrow CO_2$

$CO_2 + 2NaOH \longrightarrow Na_2CO_3 + H_2O$

The oxides of nonmetals react with water to form an acid.

$CO_2 + H_2O \longrightarrow H_2CO_3$ Carbonic acid

$SO_2 + H_2O \longrightarrow H_2SO_3$ Sulphurous acid

$SO_3 + H_2O \longrightarrow H_2SO_4$ Sulphuric acid

d. Nonmetals do not react with dilute acids.

Uses of metals and nonmetals

Make a list and discuss

Prepare a list of the uses of metals and nonmetals in our everyday life.

Name of metal	Use	Name of nonmetal	Use

Can you recall?

While studying chemical properties of metals it is found that gold or silver do not react readily.

Noble Metal : Some metals like gold, silver, platinum, paladium and rhodium are noble metals. They occur in nature in the elemental state. Gold which is100 percent pure is called 24 carat gold. Pure gold is soft. As a result the ornaments made from pure gold bend or break due to pressure. Therefore goldsmiths mix it with certain proportion of copper or silver. Ornaments are made from 22 carat gold or gold with still smaller carat value.

Uses of Noble metals :

1. Gold, silver and platinum are used to prepare ornaments.
2. Silver used in medicines. (It has antibacterial property).
3. Gold and silver also use to make medals.
4. Gold and silver also used to make few electronic devices.
5. Platinum, palladium metals are used as catalyst.

Purity of Gold :

When we ask rate of gold in gold shop, it always differ ? Why is it ? Gold is a noble metal, in nature it occurs in element form. 100% pure gold is 24 carat. Pure gold is soft. Therefore gold ornaments prepared by pure gold may break or bend due to pressure. Hence gold-smith add specific amount of copper or silver in pure gold. To prepare ornaments 22 carat gold is used.

Carat	Percentage
24	100
22	91.66
18	75.00
14	58.33
12	50.00
10	41.66

Corrosion : Gases in the air react with metals in presence of moisture to form metal compounds. The metals get affected by this process and undergo what is called corrosion.

Do you know?

There is a statue of Liberty in the sea near New york city in America. The original surface of their statues was made of copper. But now it, looks green. This is because green coloured copper carbonate has been formed by a reaction of copper with the carbon dioxide and moisture in the air. This is an example of corrosion.

Make a list and discuss

Prepare a list of the examples of corrosion in your everyday life.

A reddish coloured deposit is formed on iron by reaction with oxygen gas. A greenish coloured deposit is formed on copper by reaction with carbondioxide gas. A blackish coloured deposit is formed on silver by reaction with hydrogen sulphide gas. To prevent corrosion of metals, layers of oil, grease, varnish and paint are applied on them. Also plating with another noncorroding metal is done. Iron is arrested by zinc plating. Due to these processes the contact of metal surface with air is lost and corrosion cannot occur as the chemical reaction cannot occur.

Alloy : A homogeneous mixture of two or more metals or a homogeneous mixture metal with nonmetals is called alloy. Alloys are made by mixing the constituent elements in as per the requirement. For example, the stainless steel utensils used at home are made of an alloy of iron with carbon, chromium and nickel. The alloy bronze is formed from copper and tin.

Do you know?

There is an iron pillar in the premices of Kutubminar in Delhi, made about 1500 year ago. The pillar is lustrous even after so many years. This is becasuse our ansestors had made it from an alloy.

It contains small proportion of carbon, silicon and phosphorus mixed in iron.

Do you know?

A cheap variety of stainless steel is made sometimes by using copper instead of costly nickel. You might have seen the vertical cracks in stainless steel vessels. The reason is as above.

Discuss

You might be knowing scrap dealers. What do they do with the scrap ? Why is this needed ?

Exercises

1. Complete the table

Property of metal	Use in everyday life
i. Ductility	
ii. Malleability	
iii. Conduction of heat	
iv. Conduction of electricity	
v. Sonority	

2. Identify the odd term

a. Gold, silver, iron, diamond

b. Ductility, brittelness, sonority, malleability

c. Carbon, bromine, sulphur, phosphorus

d. Brass, bronze, iron, steel

3. Write scientific reasons.

a. The stainless steel vessels in kitchen have copper coating on the bottom.

b. Copper and brass vessels are cleaned with lemon.

c. Sodium metal is kept in kerosene.

4. Answer the following.

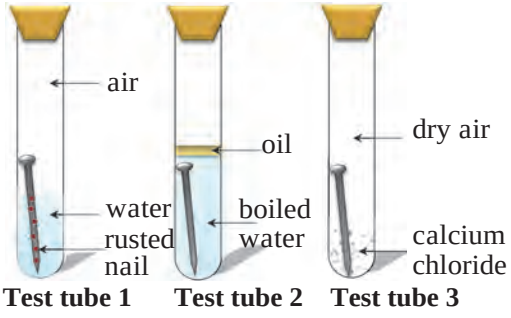
a. What is done to prevent corrosion of metals?

b. What are the metals that make the alloys brass and bronze?

c. What are the adverse effects of corrosion?

d. What are uses of Noble metals?

5. Three experiments to study the process of rusting are given below. Observe the three test tubes and answer the following questions.



a. Why the nail in the test tube 2 is not rusted ?

b. Why is the nail in the test tube 1 is rusted highly?

c. Would the nail in the test tube 3 get rusted ?

Project :

How is the 'Varkha' or sliver foil used in sweets made ? Collect the information about which metals are used to make 'Varkha'.

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