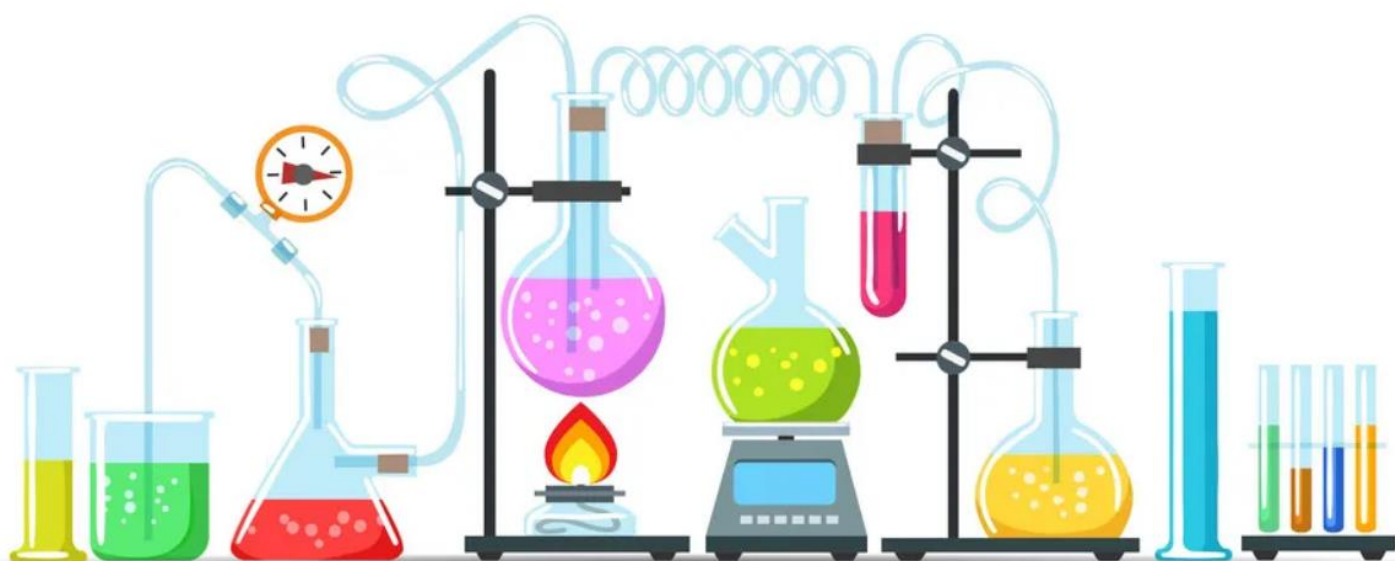


SCIENCE

Chapter 4: Materials: Metals and Non-Metals



Materials: Metals and Non-Metals

Elements can be divided into metals and non-metals on the basis of their physical and chemical properties.

Metals

- The elements which are hard, shiny can be beaten into sheets, drawn into wires and are good conductor of heat and electricity are generally metals. For example: iron, copper, gold etc.
- In nature most metals occur in the combined state as minerals and they are reactive.
- Only a few unreactive metals like gold, silver, platinum are found as free metals in the earth's crust.
- Minerals from which metals can be profitably extracted are called ores. For example: calcium occurs in limestone (calcium carbonate) or iron in the ore haematite.



Non-metals

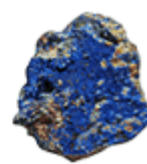
- The elements which are brittle, dull cannot be beaten into sheets or drawn into wires and are poor conductors of heat and electricity are generally non-metals.
- For example: oxygen and nitrogen occur in free state in air and in combined state in earth's crust. Sulphur occurs both in free and the combined state in earth's crust.
- The noble gases, helium, neon, argon, krypton, xenon occurs only in Free State.



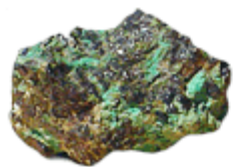
Chalcopyrite



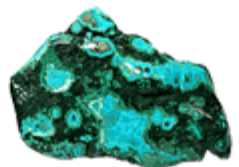
Bornite



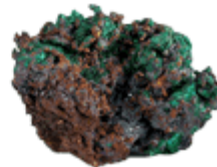
Azurite



Chrysocolla



Malachite



Cuprite

Non Metals

Physical Properties of Metals and Non-metals

| Physical Property | Metals | Non-metals |
|---------------------|--|--|
| Malleability | <ul style="list-style-type: none"> Metals are malleable. The property which allows metals to be hammered into thin sheets is called malleability. Example: Aluminium metal can be hammered into a thin aluminium foil. | <ul style="list-style-type: none"> Non-metals are not malleable. Example: Carbon (i.e. coal) breaks into smaller pieces when hammered. The property due to which non-metals break on hammering them is called brittleness. |
| Ductility | <ul style="list-style-type: none"> Metals are ductile, i.e. they can be drawn into thin wires. The property which allows the metals to be drawn into wires is called ductility. | <ul style="list-style-type: none"> Non-metals are not ductile, i.e. they cannot be drawn into wires. Sulphur and phosphorus break into pieces on stretching and do not form wires. |
| Conductivity | <ul style="list-style-type: none"> Metals are good conductors of heat and electricity. Copper, silver, gold, aluminium and iron are good conductors of heat and electricity. | <ul style="list-style-type: none"> Non-metals are poor conductors of heat and electricity, i.e. they do not allow heat and electricity to pass through them. |
| Sonority | <ul style="list-style-type: none"> Metals are sonorous, i.e. they produce a ringing sound when struck (sonorous means capable of producing a ringing sound). | <ul style="list-style-type: none"> Solid non-metals do not make a ringing sound when we strike them. Thus, we can say that non-metals are not sonorous. |

Lustre

- Metals have a shiny appearance. So, we can say that metals are lustrous or shiny.
- Non-metals are dull and not lustrous.

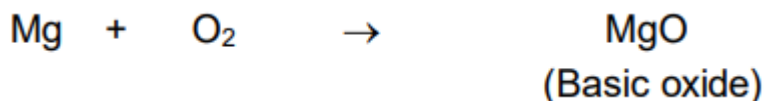
Chemical Properties of Metals and Non-metals

Reaction with Oxygen

- The metal oxides are basic in nature.
- The basic metal oxides turn red litmus

blue. Example:

Magnesium burns in air and combines with the oxygen of the air to form magnesium oxide.



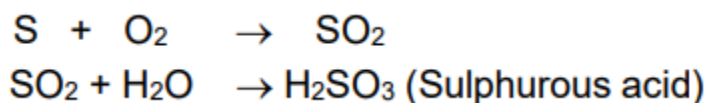
Magnesium oxide dissolves partially in water to form magnesium hydroxide. It is a base and turns red litmus blue.



- Non-metal oxides are acidic in nature.
- Acidic non-metal oxides turn blue

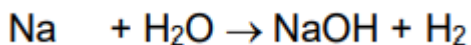
litmus red. Example:

Sulphur burns in air and combines with the oxygen of the air to form sulphur dioxide.



Reaction with Water

- Metals react with water to form metal hydroxide along with the evolution of hydrogen gas. Example: Sodium reacts violently with cold water to form sodium hydroxide solution along with the evolution of hydrogen gas.



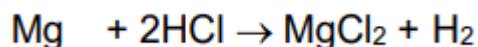
Because sodium reacts vigorously with oxygen and water producing a lot of heat, it is stored in kerosene.

- Non-metals do not react with water though they may be very reactive in the air.

Reaction with Acids

- Most metals react with dilute acids to form salts and hydrogen gas. Example:

Magnesium reacts with dilute hydrochloric acid to form magnesium chloride and hydrogen gas.



- Hydrogen gas burns with a pop sound when a lighted matchstick is brought near the mouth of the test tube.
- Metals such as copper, silver and gold do not react with dilute acids.
- Non-metals do not react with dilute acids to form salts and hydrogen gas.

Reaction with Bases

- **Metals** react with bases to form salts and hydrogen gas.
- Aluminium and zinc are the two common metals which react with bases to produce hydrogen gas.



- Reactions of non-metals with bases are complex.

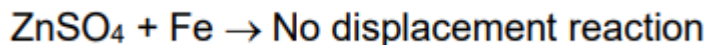
Displacement Reactions

- A more reactive metal displaces a less reactive metal from its salt solution. Example: Reaction of iron metal with copper sulphate solution



In this reaction, a more reactive iron displaces a less reactive copper from its salt solution, i.e. copper sulphate. A less reactive metal cannot displace a more reactive metal from its salt solution.

Example: Reaction of iron metal with zinc sulphate solution



Iron metal is less reactive than zinc metal. So, a less reactive iron metal cannot displace a more reactive zinc metal from zinc sulphate solution.

Uses of Metals

- Copper and aluminium are used to make wires for carrying electric currents.
- Zinc is used for galvanising iron to protect iron from rusting.
- Silver, gold and platinum are used make jewellery.
- Iron, copper and aluminium metals are used to make utensils for cooking and for manufacturing machines parts.
- Mercury is used in thermometer.
- Lead is mainly used for making electrodes for automobile batteries and for making alloys.

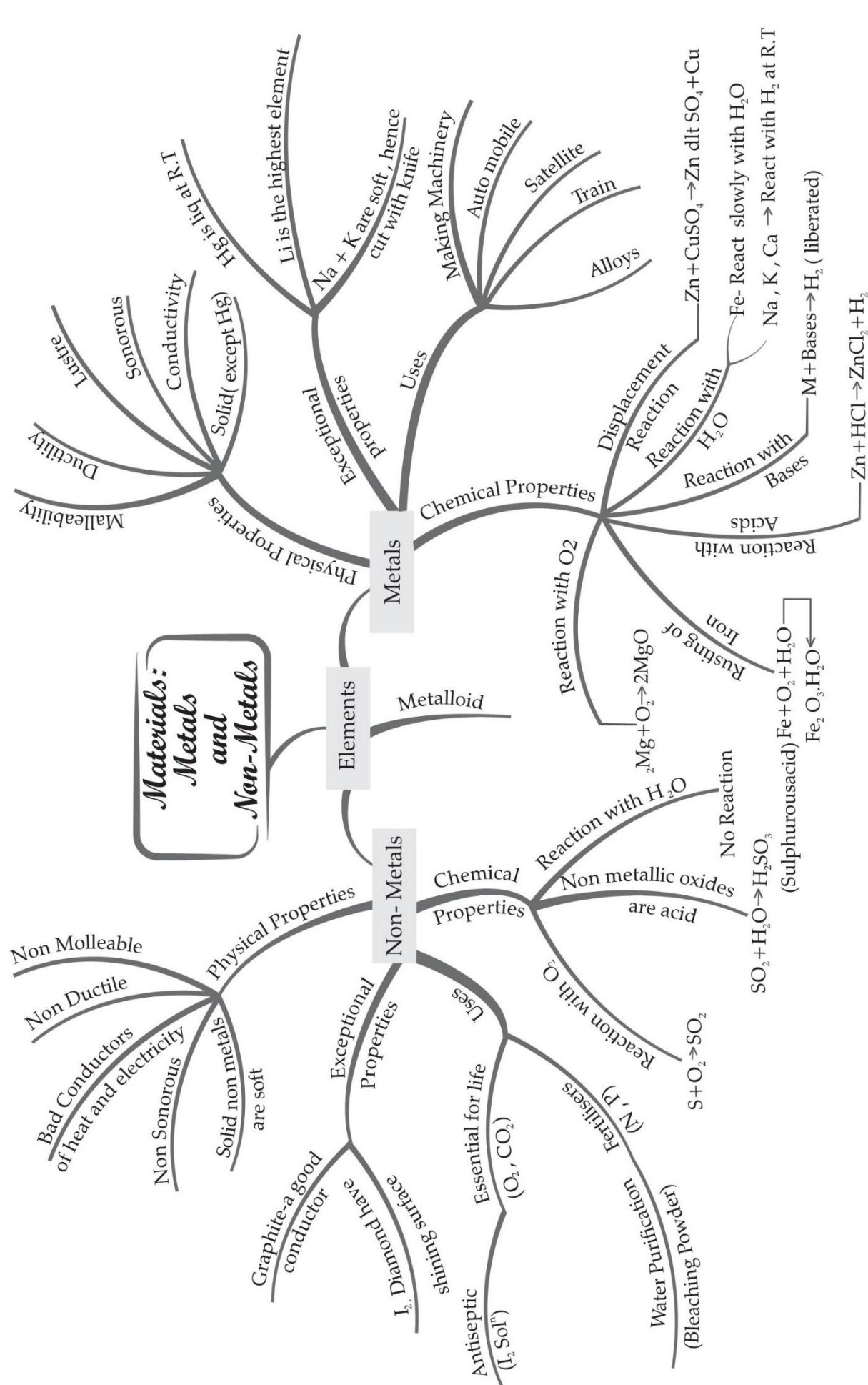
Uses of Non-Metals

- Hydrogen is used in manufacture of ammonia, industrial chemicals.
- Liquid nitrogen is used in refrigerant, in storing human organs at low temperature.
- Sulphur is used in manufacture of sulphuric acid, sulphur dioxide gas, sulphur drugs etc.
- Sulphur is used for vulcanisation of rubber and making gunpowder.

- Phosphorus is used in the manufacture of fertilisers.
- Silicon is used for making semiconductors for which microchips are made.
- Chlorine is used for disinfecting drinking water.
- Oxygen is used in breathing support system for patients.

MIND MAP : LEARNING MADE SIMPLE

CHAPTER-7



Important Questions

Multiple Choice Questions-

Question 1. The metal having fastest rate of formation of bubbles of hydrogen with dil. HCl is

- (a) zinc
- (b) copper
- (c) magnesium
- (d) silver

Question 2. The non-metal which has very high melting point is:

- (a) sulphur
- (b) iodine
- (c) phosphorus
- (d) graphite

Question 3. The non-metal which is good conductor of electricity is:

- (a) sulphur
- (b) iodine
- (c) phosphorus
- (d) graphite

Question 4. The non-metal which is liquid at room temperature is:

- (a) chlorine
- (b) bromine
- (c) iodine
- (d) carbon

Question 5. The colour of chlorine is:

- (a) yellow
- (b) white
- (c) green
- (d) yellowish green

Question 6. The metal which cannot be stored in packets is:

- (a) sodium

(b) calcium

(c) magnesium

(d) zinc

Question 7. The metal which is poorest conductor of heat is:

(a) mercury

(b) zinc

(c) lead

(d) copper

Question 8. Property of producing sound by metals is called:

(a) malleability

(b) sonority

(c) ductility

(d) none of these

Question 9. The metal which develops a protective layer over its surface by reaction with air is:

(a) zinc

(b) aluminium

(c) iron

(d) silver

Question 10. The metal not corroded by air, water and acid is :

(a) copper

(c) gold

(b) zinc

(d) aluminium

Question 11. The metal which is soft is:

(a) sodium

(c) silver

(b) gold

(d) copper

Question 12. The correct statement is:

- (a) all metals are ductile
- (c) generally, metals are ductile
- (b) all non-metals are ductile
- (d) some non-metals are ductile

Question 13. When copper is added to iron sulphate solution:

- (a) iron is displaced
- (b) SO_4 is displaced
- (c) no reaction takes place
- (d) none of these

Question 14. Arrange the following in the order of their decreasing chemical activity: magnesium, potassium, iron and gold.

- (a) magnesium, potassium, iron, gold
- (b) magnesium, iron, potassium, gold
- (c) potassium, magnesium, iron, gold
- (d) none of these

Question 15. Which of the following is true about metals?

- (a) metals generally have low melting point
- (b) metal generally have a shiny appearance
- (c) metals are poor conductors of heat and electricity
- (d) metals are non-malleable and non-ductiles

Very Short :

1. How many types of materials are there?
2. You are given following materials. Classify them into metals and non metals Iron, Coal, Sulphur, Aluminium and Copper.
3. How can you distinguish metals from non metals?
4. Name two physical properties.
5. What do you mean by malleability?
6. Coal and pencil lead do not show the property of malleability. Can we call them metal?
7. What do you mean by conductivity?

8. What is ductility?
9. What do you mean by sonority?
10. Why are metals called sonorous?

Short Questions :

1. Differentiate between metals and non-metals.
2. Why we use aluminium foil to wrap food items?
3. Why can't we store lemon pickles in an aluminium container?
4. Explain malleability in metals and non-metals.
5. Explain ductility in metals and non-metals.
6. Why there is difference in sound on dropping a metal coin and a piece of coal?
7. State some of the chemical properties of metals.
8. State some of the chemical properties of non-metals.
9. Explain the process of rusting of iron.
10. Explain the process of rusting of copper.

Long Questions :

Question 1. Distinguish between metals and non-metals on the basis of their physical properties.

or

Compare the physical properties of metals and non-metals.

Question 2. Distinguish between metals and non-metals on the basis of their chemical properties.

or

Compare between metals and non-metals on the basis of their chemical properties.

Question 3. Explain chemical properties of metals with examples.

Question 4. Explain with suitable examples the chemical properties of non-metals.

Question 5. What are main uses of metals?

or

How are metals useful to us?

Question 6. What are the main uses of non-metals?

or

How are non-metals useful to us?

Question 7. What is reactivity series? Suggest an activity to arrange sodium, magnesium

and copper in the order of their decreasing reactivity.

Answer

MCQ

1. Answer

(c) magnesium

Magnesium is higher in reactivity series therefore the rate of formation of bubbles of hydrogen with dil HCl is fastest.

2. Answer

(d) graphite

Graphite is a non-metal having very high melting point.

3. Answer

(d) graphite

Graphite is the only non-metal which is a good conductor of electricity.

4. Answer

(b) bromine

Bromine is the non-metal which is liquid at room temperature.

5. Answer

(d) yellowish green

The colour of chlorine is yellowish green.

6. Answer

7. sodium

Sodium cannot be stored in packets because it will catch fire.

8. Answer

(c) lead

Lead is the metal which is poorest conductor of heat.

9. Answer

(b) sonority

Sonority is the property of producing sound by metals.

10. Answer

(b) aluminium

Aluminium metal develops a protective layer of aluminium oxide over its surface by reaction with air.

11. Answer

(c) gold

Gold metal is not corroded by air, water and acid because one of the least reactive metals in reactivity series.

12. Answer

(a) sodium

Sodium metal is soft whereas gold, silver and copper are solids.

13. Answer

(c) generally, metals are ductile

Generally, metals are ductile. Sodium, potassium, calcium etc. are not ductile.

14. Answer

(c) no reaction takes place

When copper is added to iron sulphate solution then no reaction takes place because copper is below iron in reactivity series.

15. Answer

(c) potassium, magnesium, iron, gold

Potassium, magnesium, iron, gold.

16. Answer

(b) metals generally have a shiny appearance

Metals generally have a shiny appearance. They have high melting point, are good conductors of heat and electricity. They are malleable and ductile.

Very Short-

1. Answer: There are two types of materials:

(i) Metals (ii) Non-metals

2. Answer: Iron, aluminium and copper are the metals. Coal, sulphur are non-metals.

3. Answer: Metals can be distinguished from non-metals on the basis of their physical and chemical properties.

4. Answer: (i) Lustre (ii) Hardness.

5. Answer: The property of metals by which they can be beaten into thin sheets is called malleability.

6. Answer: No, they are not metals.

7. Answer: The metals allow the electricity to pass through them. This property of metals is called conductivity.

8. Answer: The property of metals by which they can be drawn into wires is called ductility.
9. Answer: The property of metal, to produce ringing sound is called sonority.
10. Answer: Since metals produce ringing sounds, they are called sonorous.

Short Answer-

1. Answer:

| Metals | Non-metals |
|---|--|
| These are solids at room temperature except mercury | These exist in all three states |
| These are very hard except sodium | These are soft except diamond |
| These are malleable and ductile | These are brittle and can break down into pieces |
| These are shiny | These are non-lustrous except iodine |
| Electropositive in nature | Electronegative in nature |
| Have high densities | Have low densities |

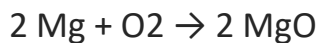
2. **Answer:** The property of metals by which they can be beaten into thin sheets, is called malleability. Aluminium is a metal. Aluminium foils are made by using this property of aluminium. They keep food items warm and prevent them from getting contaminated.
3. **Answer:** As we know metals react with acids and produce metal salts and hydrogen gas, aluminium is a metal and lemon contains citric acid. So if we store lemon pickle in an aluminium utensil after some time utensil metal will get corroded due to reaction and lemon pickle inside will not be fit for human consumption.
4. **Answer:** The property of metals by which they can be beaten into thin sheets is called malleability. This is the characteristic property of metals which is exploited to make silver foil for decorating food items and aluminium foil to store food items.
- Non-metals do not show this property, on beating a coal or wood they get break down into small pieces, thus we can say that metals are malleable and non-metals are not malleable.
5. **Answer:** The property of metals by which it can be drawn into wires is called ductility, thus we can see aluminium or copper wires around us. Non-metal do not show this property so we never see plastic wires around us, they are not ductile.
6. **Answer:** This is because metals produce ringing sound and are called sonorous while non-metals do not show this property.

7. Answer:

Reaction with oxygen:

Metals react with oxygen to form metallic oxides. These are basic oxides because they react with water to form bases.

Eg. Magnesium burns in air to form magnesium oxide.



Reaction with water:

Metals react with water to form metal hydroxides and hydrogen.

Eg. Sodium reacts with water to form sodium hydroxide and hydrogen.



E.g. Magnesium reacts with water to form magnesium hydroxide and hydrogen.



Reaction with acids:

Metals react with acids to form metallic salts and hydrogen.

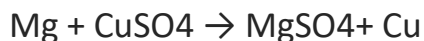
Eg. Zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen.



Metals replace metals:

A more reactive metal replaces a less reactive metal from its salt solution.

Eg. Magnesium replaces copper from copper sulphate solution to form magnesium sulphate and copper.



Zinc replaces copper from copper sulphate solution to form zinc sulphate and copper.

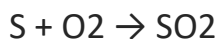


8. Answer:

Reaction with oxygen:

Non-metals react with oxygen to form non-metallic oxides. These oxides are acidic oxides because they react with water to form acids.

Eg. Sulphur burns in air to form sulphur dioxide. Sulphur dioxide reacts with water to form sulphurous acid.



Reaction with water:

Non-metals do not react with water

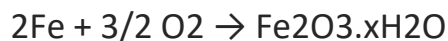
Reaction with acids:

Most non-metals do not react with acids.

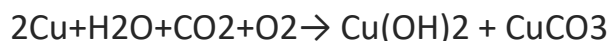
Some non-metals like sulphur react with concentrated nitric acid to form sulphur dioxide, nitrogen dioxide and water.



9. Answer: The surface of some metals gets corroded when exposed to moist air for a long time. This is called corrosion. Rusting of iron is an example of corrosion, here an oxide is formed and the chemical equation for rusting of iron is



10. Answer: When a copper vessel is exposed to moist air for long time, it acquires a dull green coloured coating on its surface; this green material is the mixture of copper hydroxide and copper carbonate. Reaction is as follows:



Long Answer-

1. Answer:

Difference between metals and non-metals on the basis of their physical properties.

| Physical Properties | | Non-metals |
|---------------------------------|--|--|
| 1. Malleability | Metals are malleable, i.e., they can be beaten into thin sheets. Exception: Mercury | Non-metals are non-malleable. They are broken into pieces when hammered. Hence they are also called brittle. |
| 2. Sonority | Metals are sonorous, i.e., they produce ringing sound when struck. | Non-metals are non-sonorous. |
| 3. Ductility | Metals are ductile, i.e., they can be drawn into wires. Exception: Mercury | Non-metals are non-ductile. |
| 4. Lustre | Metals are lustrous, i.e., they are shiny. | Non-metals are non-lustrous, i.e., they are dull in appearance. Exception: Graphite and iodine. |
| 5. Hardness or solidness | Metals are hard except sodium and potassium. | Non-metals are soft except diamond. |

| | | |
|---------------------------------------|--|---|
| 6. Conductivity | Metals are good conductor of heat and electricity. | Non-metals are poor conductor of heat and electricity. Exception: Graphite is a non-conductor of heat and electricity. |
| 7. Density | Metals are of high density except lithium. | Non-metals are of low density. |
| 8. Melting and boiling points. | Metals have high melting and boiling points. | Non-metals have low melting and boiling points except graphite. |

2. Answer:

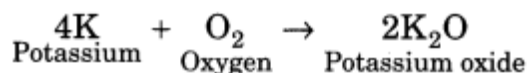
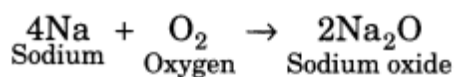
Difference between metals and non-metals on the basis of their chemical properties.

| Chemical Properties | Metals | Non-metals |
|-----------------------------|--|--|
| Reaction with oxygen | Metals react with oxygen to form basic oxides which form bases when dissolve in water. | Non-metals react with oxygen to form acidic oxides which form acids when dissolve in water. |
| Reaction with water | Metals react with water to form their oxides or hydroxides. | Non-metals do not react with water. |
| Reaction with acids | Metals react with acids to produce respective salts along with evolution of hydrogen gas. Some metals like Cu, Ag, Au, etc., do not liberate hydrogen gas. | Non-metals do not react with acids except sulphur which react with hot, concentrated acid. |
| Reaction with bases | Most of the metals do not react with bases. However, some metals like Al, Pb, Zn react with strong bases like NaOH to form complex salts and hydrogen gas. | Generally, non-metals do not react with bases. Sometimes, some complex reactions take place between nonmetals and bases. |

3. Answer:

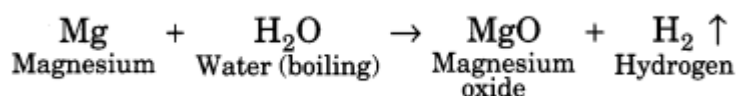
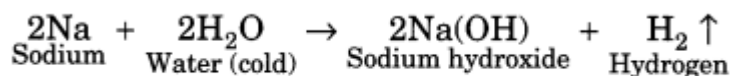
(i) Reaction with oxygen or air: Metals react with oxygen to form basic oxides.

Some metals like potassium and sodium react vigorously with oxygen. For example,

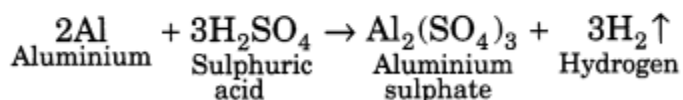
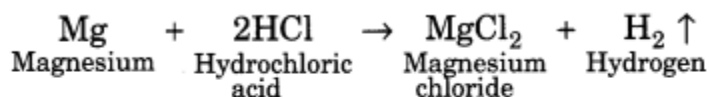


Some noble metals like gold, silver and platinum do not react with oxygen. Iron (Fe) and copper (Cu) get rusted when react in presence of oxygen and water (moist air).

(ii) Reaction with water: Metals react with water to form their oxides or hydroxides. Gold, silver and platinum do not react with water. Some metals like sodium, potassium react vigorously with water. For example,



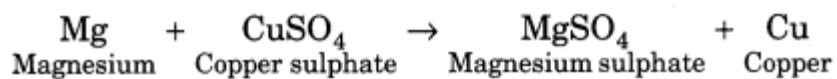
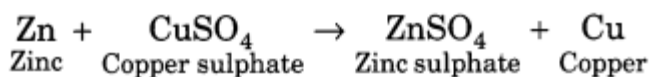
(iii) Reaction with acids: Metals react with acid to form their salts followed by evolution of hydrogen gas. For example,



Some metals like gold, copper, silver, etc., do not liberate hydrogen gas with acids.

(iv) Reaction with bases: Most of the metals do not react with bases. However some metals like aluminium, zinc and lead react with strong bases like sodium hydroxide to make complex salts and produce hydrogen.

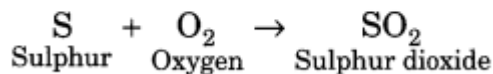
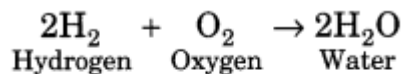
(v) Displacement reactions: More reactive metals displace less reactive metals. For example,



In the above reactions, zinc (Zn) and magnesium (Mg) are more reactive than copper (Cu), hence they replace copper from its solution.

4. Answer:

Reaction with oxygen: Non-metals react with oxygen to form acidic oxides. But most of them do this on ignition. For example,



They form negative ions and are good oxidising agents.

Reaction with water: Non-metals do not react with water.

Reaction with acids and bases: Generally, non-metals do not react with acids and bases. However, sometimes some complex reactions take place between non-metals and bases.

5. Answer:

Metals are very useful to us in many ways. For example,

- (i) Due to their thermal and electrical conductivity, metals are used to make utensils, cooking vessels, wires and appliances. For example, copper and aluminium are mainly used for these purposes.
- (ii) Metals like iron and steel are used in various tools, machinery, pipes, rods, sheets, doors, windows, construction works like bridges, roads, buildings, etc.
- (iii) Aluminium is used as packaging and wrapping materials. It is also used in aircrafts and automobiles, etc.
- (iv) Metals like gold, silver and platinum are used to make jewellery and other decorating items.
- (v) Zinc is used in galvanisation and dry cell and chromium in electroplating.
- (vi) Lead is used in making electrodes and batteries.


6. Answer:

Like metals, non-metals also play an important role in our lives. They help us in many ways. For example,

- (i) We breathe oxygen which is the basis of life of all living things including human beings. Without it, no living beings can exist alive on this earth.
- (ii) CO₂ which is a non-metal oxide is essential for plants to carry out photosynthesis.
- (iii) Non-metals like nitrogen and phosphorus are used in fertilisers for better yield of plant. Phosphorus is used in manufacturing of matchsticks and fireworks.
- (iv) Non-metal like iodine is used in the purple coloured solution applied on wounds. Sulphur is also used in preparing skin medicines and making ointment due to its fungicidal properties.
- (v) Non-metal like chlorine is used in water purification process. Due to its bleaching properties it is used to make bleaching powder.
- (vi) Carbon, a non-metal, is used in most of the fuels.

7. Answer:

Reactivity series is an arrangement of metals in decreasing order of their reactivity from highest to lowest. The metals occupying the higher positions in the activity series are more reactive in displacing the other metals lying below it from the solutions of their salts.

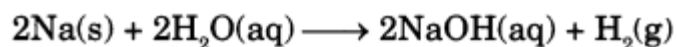
| | | |
|-----------|---|----|
| Potassium | most reactive | K |
| Sodium |  | Na |
| Calcium | | Ca |
| Magnesium | | Mg |
| Aluminium | | Al |
| Carbon | | C |
| Zinc | | Zn |
| Iron | | Fe |
| Tin | | Sn |
| Lead | | Pb |
| Hydrogen | | H |
| Copper | | Cu |
| Silver | | Ag |
| Gold | | Au |
| Platinum | least reactive | Pt |

The activity series is a useful guide for predicting the products of metal displacement reactions. For example, placing a strip of zinc metal in a copper (II) sulphate solution will produce metallic copper and zinc sulphate, since zinc is above copper on the series.

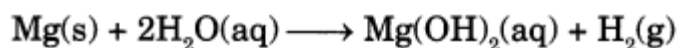
A strip of copper placed into a zinc sulphate solution will not produce an appreciable reaction, because copper is below zinc on the series and can't displace zinc ions from solution.

Activity to arrange sodium, magnesium and copper in the order of their decreasing reactivity:

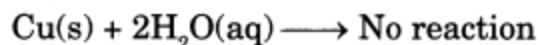
- Take a pinch of sodium with a forceps and place in a beaker containing water. You will notice that sodium reacts vigorously.



- Take a small piece of magnesium ribbon and add warm water to it. Magnesium reacts with warm water to form magnesium oxide and hydrogen gas. Magnesium reacts very slowly with cold water.



- Take small pieces of copper turnings and add warm water to it. It doesn't react with warm water also.



Hence, increasing order of reactivity is $\text{Na} > \text{Mg} > \text{Cu}$.