METALS AND NON-METALS

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Question 1:

Give an example of a metal which

(i) is a liquid at room temperature.

(ii) can be easily cut with a knife.

(iii) is the best conductor of heat.

(iv) is a poor conductor of heat.

(i) Metal that exists in liquid state at room temperature → Mercury

(ii) Metal that can be easily cut with a knife → Sodium

(iii) Metal that is the best conductor of heat → Silver

(iv) Metals that are poor conductors of heat → Mercury and lead

Question 2:

Explain the meanings of malleable and ductile.

Malleable: Substances that can be beaten into thin sheets are called malleable. For example, most of the metals are malleable.

Ductile: Substances that can be drawn into thin wires are called ductile. For example, most of the metals are ductile.

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Question 1:

Why is sodium kept immersed in kerosene oil?

Sodium and potassium are very reactive metals and and combine explosively with air as well as water. Hence, they catch fire if kept in open. Therefore, to prevent accidental fires and accidents, sodium is stored immersed in kerosene oil.

Question 2:

Write equations for the reactions of

(i) iron with steam

(ii) calcium and potassium with water

(i) $3Fe_{(s)} + 4H_2O_{(g)} \longrightarrow Fe_3O_{4(aq)} + 4H_{2(g)}$

Iron Steam Iron (II,III) oxide Hydrogen

(ii) $Ca_{(s)} + 2H_2O_{(l)} \longrightarrow Ca(OH)_{2(aq)} + H_{2(g)} + \text{Heat}$

$2K_{(s)} + 2H_2O_{(l)} \longrightarrow 2KOH_{(aq)} + H_{2(g)} + \text{Heat}$

Calcium/ Potassium Water Calcium Hydroxide/ Potassium hydroxide Hydrogen

Question 3:

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	Cooper (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?

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

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

Explanation

$A + FeSO_4 \rightarrow$ No reaction, i.e., A is less reactive than iron

$A + CuSO_4 \rightarrow$ Displacement, i.e., A is more reactive than copper

$B + FeSO_4 \rightarrow$ Displacement, i.e., B is more reactive than iron

$B + ZnSO_4 \rightarrow$ No reaction, i.e., B is less reactive than zinc

$C + FeSO_4 \rightarrow$ No reaction, i.e., C is less reactive than iron

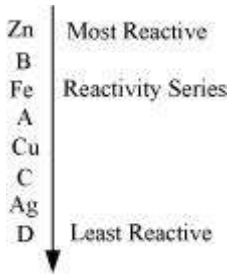
$C + CuSO_4 \rightarrow$ No reaction, i.e., C is less reactive than copper

$C + ZnSO_4 \rightarrow$ No reaction, i.e., C is less reactive than zinc

$C + AgNO_3 \rightarrow$ Displacement, i.e., C is more reactive than silver

$D + FeSO_4/CuSO_4/ZnSO_4/AgNO_3 \rightarrow$ No reaction, i.e., D is less reactive than iron, copper, zinc, and silver

From the above equations, we obtain:



(i) B is the most reactive metal.

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

$B + CuSO_4 \rightarrow$ Displacement

(iii) The arrangement of the metals in the order of decreasing reactivity is:
B > A > C > D

Question 4:

Which gas is produced when dilute hydrochloric acid is added to a reactive metal? Write the chemical reaction when iron reacts with dilute H_2SO_4.

Hydrogen gas is evolved when dilute hydrochloric acid is added to a reactive metal.

When iron reacts with dilute H_2SO_4, iron (II) sulphate with the evolution of hydrogen gas is formed.

$$Fe_{(s)} + H_2SO_{4(aq)} \longrightarrow FeSO_{4(aq)} + H_{2(g)}$$

Question 5:

What would you observe when zinc is added to a solution of iron (II) sulphate? Write the chemical reaction that takes place.

Zinc is more reactive than iron. Therefore, if zinc is added to a solution of iron (II) sulphate, then it would displace iron from the solution.

$$Zn_{(s)} + FeSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + Fe_{(s)}$$

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Question 1:

(i) Write the electron-dot structures for sodium, oxygen and magnesium.

(ii) Show the formation of Na_2O and MgO by the transfer of electrons.

(iii) What are the ions present in these compounds?

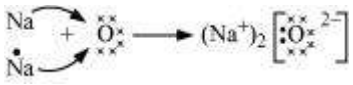
(i) The representation of elements with valence electrons as dots around the elements is referred to as electron-dot structure for elements.

(a) Sodium (2, 8, 1) = $\dot{Na}$

(b) Oxygen (2, 6) = $:\ddot{O}:$

(c) Magnesium (2, 8, 2) = $\dot{M}g$

(ii)



(iii) The ions present in Na_2O are Na^+ and O^{2-} ions and in MgO are Mg^{2+} and O^{2-} ions.

Question 2:

Why do ionic compounds have high melting points?

Ionic compounds have strong electrostatic forces of attraction between the ions. Therefore, it requires a lot of energy to overcome these forces. That is why ionic compounds have high melting points.

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Question 1:

Define the following terms.

(i) Mineral (ii) Ore (iii) Gangue

(i) Mineral: Most of the elements occur in nature as in combined state as minerals. The chemical composition of minerals is fixed.

(ii) Ore: Minerals from which metals can be extracted profitably are known as ores.

(iii) Gangue: The impurities (sand, silt, soil, gravel, etc.) present in the ore are called gangue.

Question 2:

Name two metals which are found in nature in the free state.

The metals at the bottom of the reactivity series are mostly found in free state. For example: gold, silver, and platinum.

Question 3:

What chemical process is used for obtaining a metal from its oxide?

The chemical process used for obtaining a metal from its oxide is reduction. In this process, metal oxides are reduced by using suitable reducing agents such as carbon or by highly reactive metals to displace the metals from their oxides.

For example, zinc oxide is reduced to metallic zinc by heating with carbon.

$$ZnO_{(s)} + C_{(s)} \xrightarrow{\Delta} Zn_{(s)} + CO_{(g)}$$

Manganese dioxide is reduced to manganese by treating it with aluminium powder. In this case, aluminium displaces manganese from its oxide.

$$3MnO_{2(s)} + 4Al_{(s)} \longrightarrow 3Mn_{(l)} + 2Al_2O_{3(s)} + Heat$$

Oxides of more reactive metals are reduced by electrolysis.

EXERCISES

Question 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.

(d) $AgNO_3$ solution and copper metal

Question 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.

(c) Applying a coating of zinc

(We can also apply grease and paint to prevent iron from rusting. However, in case of iron frying pan, grease and paint cannot be applied because when the pan will be heated and washed again and again, the coating of grease and paint would get destroyed.)

Question 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

(a) The element is likely to be calcium.

Question 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.

(c) Food cans are coated with tin and not with zinc because zinc is more reactive than tin.

Question 5:

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?

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

(a) 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) 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.

Question 6:

What are amphoteric oxides? Give two examples of amphoteric oxides.

Those oxides that behave as both acidic and basic oxides are called amphoteric oxides.

Examples: aluminium oxide (Al_2O_3), zinc oxide (ZnO)

Question 7:

Name two metals which will displace hydrogen from dilute acids, and two metals which will not.

Metals that are more reactive than hydrogen displace it from dilute acids. For example: sodium and potassium. Metals that are less reactive than hydrogen do not displace it. For example: copper and silver.

Question 8:

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:

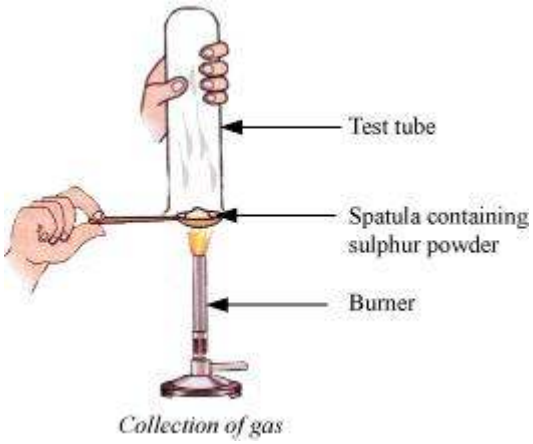
Anode → Impure metal M

Cathode → Thin strip of pure metal M

Electrolyte → Solution of salt of the metal M

Question 9:

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 below.



Collection of gas

(a) What will be the action of gas on

(i) dry litmus paper?

(ii) moist litmus paper?

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

(a) (i) There will be no action on dry litmus paper.

(ii) 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)

$$S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)}$$

Sulphur dioxide

$$SO_{2(g)} + H_2O_{(l)} \longrightarrow H_2SO_{3(aq)}$$

Sulphurous acid

Question 10:

State two ways to prevent the rusting of iron.

Two ways to prevent the rusting of iron are:

(i) Oiling, greasing, or painting: By applying oil, grease, or paint, the surface becomes water proof and the moisture and oxygen present in the air cannot come into direct contact with iron. Hence, rusting is prevented.

(ii) Galvanisation: An iron article is coated with a layer of zinc metal, which prevents the iron to come in contact with oxygen and moisture. Hence, rusting is prevented.

Question 11:

What type of oxides is formed when non-metals combine with oxygen?

Non-metals combine with oxygen to form acidic oxides.

For example:

$$S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$$

(Acidic in nature)

Question 12:

Give reasons

(a) Platinum, gold and silver are used to make jewellery.

(b) Sodium, potassium and lithium are stored under oil.

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

(d) Carbonate and sulphide ores are usually converted into oxides during the process of extraction.

(a) 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.

(b) Sodium, potassium, and lithium are very reactive metals and react very vigorously with air as well as water. Therefore, they are kept immersed in kerosene oil in order to prevent their contact with air and moisture.

(c) 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.

(d) Carbonate and sulphide ores are usually converted into oxides during the process of extraction because metals can be easily extracted from their oxides rather than from their carbonates and sulphides.

Question 13:

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 basis 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.

Question 14:

Differentiate between metal and non-metal on the basis of their chemical properties.

Metal	Non-metal
Metals are electropositive.	Non-metals are electronegative.
They react with oxygen to form basic oxides. $4Na + O_2 \longrightarrow 2Na_2O$ These have ionic bonds.	They react with oxygen to form acidic or neutral oxides. $C + O_2 \longrightarrow CO_2$ These have covalent bonds.
They react with water to form oxides and hydroxides.	They do not react with water.

Some metals react with cold water, some with hot water, and some with steam. $2Na + 2H_2O \longrightarrow 2NaOH + H_2 \uparrow$	
They react with dilute acids to form a salt and evolve hydrogen gas. However, Cu, Ag, Au, Pt, Hg do not react. $2Na + 2HCl \longrightarrow 2NaCl + H_2 \uparrow$	They do not react with dilute acids. These are not capable of replacing hydrogen.
They react with the salt solution of metals. Depending on their reactivity, displacement reaction can occur. $CuSO_4 + Zn \longrightarrow ZnSO_4 + Cu$	These react with the salt solution of non-metals.
They act as reducing agents (as they can easily lose electrons). $Na \longrightarrow Na^+ + e^-$	These act as oxidising agents (as they can gain electrons). $Cl_2 + 2e^- \longrightarrow 2Cl^-$

Question 15:

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 metal 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.

Question 16:

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.

$$\underset{\text{Iron}}{3Fe} + \underset{\text{Steam}}{4H_2O} \longrightarrow \underset{\text{Iron(II, III) oxide}}{Fe_3O_4} + \underset{\text{Hydrogen}}{4H_2}$$

That is why copper is used to make hot water tanks, and not steel.