NCERT CBSE Solutions for Class 10 Science Chapter 3

METALS AND NON-METALS

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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.

Solution: (D)

Metal higher in the electrochemical series displaces the metal lower in the series.

$NaCl + Cu \rightarrow$ no reaction

$MgCl_2 + Al \rightarrow$ no reaction

$FeSO_4 + Ag \rightarrow$ no reaction

$Cu + 2AgNO_3 \rightarrow 2Ag + Cu(NO_3)_2$.

This reaction happens because copper is higher on the activity series than silver. If the free metal is below the metal bonded to the anion, the reaction would not proceed. When copper is added to silver nitrate (solution), the copper dissolves to form copper nitrate.

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.

Solution: (C)

By the galvanisation (applying a coating of zinc) we can protect iron frying pan from rusting and it remains uncorroded for a long time.

Grease and paint also prevent iron from rusting. However, we cannot use them on an iron frying pan because when the pan is heated and washed repeatedly, the coating of grease and paint would get destroyed.

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

Solution: (A)

$Ca + O_2 \rightarrow CaO$ high melting point $+ H_2O \rightarrow Ca(OH)_2$ Soluble

Thus, the element will be Calcium.

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.

Solution: (C)

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

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

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

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

Solution:

(i) With the hammer, we can beat the sample if it can be beaten into thin sheets (that is, it is malleable), then it is a metal, if not, it is a non-metal.

(ii) 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, if not, it is a non-metal. Since metals have free electron, they are good conductors of electricity while non-metals do not have free electrons to move. They are hence bad conductors of electricity.

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.

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

Solution:

Amphoteric oxides: Those oxides that behave as both acidic and basic or that can react with acid as well as base are called amphoteric oxides. Example: aluminium oxide Al_2O_3, zinc oxide ZnO.

(i) Amphoteric Nature of Zinc Oxide

Acidic nature: ZnO reacts with hydrochloric acid forming zinc chloride and water.

$$ZnO + 2HCl \rightarrow ZnCl_2 + H_2O.$$

Basic nature: With sodium hydroxide(base), it forms sodium zincate and water.

$$ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O.$$

(ii) Amphoteric nature of Aluminium Oxide.

Acidic nature (Reaction with alkalis)

$$2Al(s) + 2NaOH(aq) + 6H_2O(l) \rightarrow 2Na + [AlOH_4] - \text{Sodium tetrahydroxoaluminate III } (aq) + 3H_2(g)$$

Basic nature (Reaction with acids)

$$2Al\ (s) + 6HCl\ (aq) \rightarrow 2Al_3 + (aq) + 6Cl^-(aq) + 3H_2(g)$$

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

Solution:

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. Example: Copper and Silver.

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

Solution:

Electrolytic refining: it is a method to gain pure metal from impure metal that has been obtained through a reduction process.

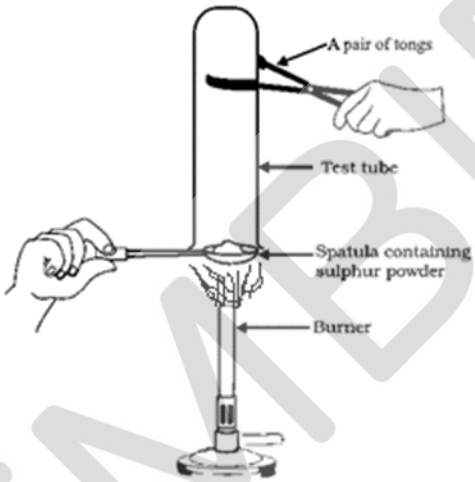
In the electrolytic refining of a metal M such as Zn, Ni, Ag, Sn, Au, etc.,

Anode: Impure metal M

Cathode: Thin strip of pure metal M

Electrolyte: Solution of salt of the metal M.

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 the figure below.



(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.

Solution:

When Sulphur powder on the spatula is heated, SO_2 will form.

(a) $S\ (s) + O_2\ (g) \rightarrow SO_2\ (g)$ (Sulphur dioxide)

(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) $SO_2\ (g) + H_2O\ (l) \rightarrow H_2SO_3\ (aq)$ (Sulphurous acid)

It turns red litmus to blue.

10. State two ways to prevent the rusting of iron.

Solution:

Two ways to prevent the rusting of iron are:

(i) Oiling, greasing or painting: By applying oil, grease or paint, the surface becomes waterproof 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 thin layer of zinc metal, both iron and zinc are in contact, zinc corrodes preferentially and releases electrons faster than iron. So, chances of iron corrosion is reduced as zinc releases electron quickly and that electron is accepted by iron. Whenever a metal accepts electron it will not undergo corrosion rapidly. This prevents the iron from meeting oxygen and moisture. Hence, rusting is prevented.

11. What type of oxides are formed when non-metals combine with oxygen?

Solution:

Non-metals combine with oxygen to form neutral or acidic oxides.

$C(s) + O_2 \rightarrow CO_2$ (acidic oxide)

$N_2 + \frac{1}{2}O_2 \rightarrow N_2O$ (neutral oxide)

$N_2 + O_2 \rightarrow NO$ (neutral oxide)

$N_2 + 2O_2 \rightarrow 2NO_2$ (acidic oxide)

$N_2 + \frac{1}{2}O_2 \rightarrow N_2O_3$ (acidic oxide)

$N_2 + \frac{3}{2}O_2 \rightarrow N_2O_5$ (acidic oxide)

$S(s) + O_2(g) \rightarrow SO_2(g)$ (acidic oxide)

12. Give reasons

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

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

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

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

Solution:

(i) Platinum, gold and silver are used to make jewellery because they are highly malleable and ductile as well as lustrous. Also, they are less reactive and do not corrode easily.

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

When sodium is heated in an excess of oxygen or air, sodium peroxide Na_2O_2 is the product.

$2Na + O2 \rightarrow Na2O2$

When the reaction is carried out with a limited supply of oxygen or air, the major product will be sodium oxide.

$4Na + O_2 \rightarrow 2Na_2O$

Since the reaction is very exothermic, part of the hydrogen reacts with the oxygen of the air to give water. Lithium, sodium and potassium metals reacts with water to form a colourless solution.

Sodium reacts with water to form Sodium hydroxide $(NaOH)$ with the evolving of hydrogen gas H2.

The reaction is $Na + H_2O \rightarrow NaOH + H_2$

(iii) 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.

$4Al(s) + 3O_2(l) \rightarrow 2Al_2O_3(s)$

Also, Al is light in weight and a good conductor of heat. Hence, it is used for making cooking utensils.

(iv) 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.

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.

Solution:

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

14. Differentiate between metal and non-metal based on their chemical properties.

Solution:

Metals	Non-metals
Metals are electropositive	Non-metals are electronegative
They react with oxygen to form basic oxides. $4Na + O_2 \rightarrow 2Na_2O$ $Na + O_2 \rightarrow Na_2O_2$ These have ionic bonds.	They react with oxygen to form acidic or neutral oxides. $C + O_2 \rightarrow CO_2$ (acidic oxide) $C + \frac{1}{2}O_2 \rightarrow CO$ (neutral oxide) $N_2 + \frac{1}{2}O_2 \rightarrow N_2O$ (neutral oxide) $N_2 + O_2 \rightarrow NO$ (neutral oxide) $N_2 + 2O_2 \rightarrow 2NO_2$ (acidic oxide) $N_2 + \frac{1}{2}O_2 \rightarrow N_2O_3$ (acidic oxide) $N_2 + \frac{3}{2}O_2 \rightarrow N_2O_5$ (acidic oxide) These have covalent bonds
They react with water to form oxides and hydroxides. Some metals react with cold water, some with hot water and some with steam. $2Na + 2H_2O \rightarrow 2NaOH + H_2$	They do not react with water.
They react with dilute acid to form a salt and evolves hydrogen gas. However, Cu, Ag, Au, Pt, Hg do not react. $2Na + 2HCl \rightarrow 2NaCl + H_2$	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.	These react with the salt solution of non-metals.

$CuSO_4 + Zn \rightarrow ZnSO_4 + Cu$	
They act as reducing agents (as they can easily lose electrons). $Na \rightarrow Na^+ + e^-$	Generally, these act as oxidising agents (as they can gain electrons) $Cl_2 + 2e^- \rightarrow 2C^-$

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 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?

Solution:

He must have dipped the gold and silver metals in the solution of aqua regia (3:1 mixture of conc. HCl and conc. HNO_3). Aqua regia is a fuming, highly corrosive liquid which can even dissolve noble metals in it like gold and platinum.

After dipping the gold ornaments in aqua regia, the outer layer of gold gets dissolved and the inner shiny layer appears. Therefore, the weight of gold ornament is reduced.

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

Solution:

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.

$3Fe$ Iron $+ 4H_2O$ Steam $\rightarrow$ Fe_3O_4 Iron oxide $+ 4H_2$ Hydrogen

Fe_3O_4 is a mixture of ferrous oxide and ferric oxide

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

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In-Text Questions

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.

Solution:

(i) Mercury Hg is a metal which is liquid at room temperature.
(ii) Sodium and potassium are metals that can be easily cut with a knife.
(iii) Silver metal is the best conductor of heat.
(iv) Lead metal is a poor conductor of heat.

2. Explain the meanings of malleable and ductile.

Solution:

Malleable: A metal is said to be malleable if it can be beaten into thin sheets. For example, Silver and Gold are highly malleable metals.

Ductile: A metal is said to be ductile when it can be drawn into thin wires. For example, Platinum and gold are highly ductile metals.

3. Why is sodium kept immersed in kerosene oil?

Solution:

Sodium is a highly reactive metal. It reacts with oxygen present in the air at room temperature and this reaction is highly exothermic. To prevent this, sodium is kept immersed in kerosene oil since sodium does not react with kerosene.

4. Write equations for the reactions of

(i) Iron with steam

(ii) calcium and potassium with water

Solution:

(i) Iron reaction with steam is given as:

$$3Fe(s) + 4H_2O\,(g)\text{steam} \rightarrow Fe_2O_4(s) + 4H_2(g)$$

(ii) Calcium reaction with water is:

$$Ca(s) + 2H_2O(l)\text{Cold water} \rightarrow CaOH_2(aq) + H_2(g)$$

Potassium reaction with water is:

$$2K(s) + 2H_2O(l)\ \text{Cold water} \rightarrow 2KOH\ (aq) + H_2(g)$$

5. 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?
(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.

Solution:

From the given table we can write the following observations:

1) A is less reactive than Fe but more reactive than Cu.

2) B is more reactive than Fe but less reactive than Zn.

3) C is more reactive than Ag but less reactive than Fe, Cu, and Zn.

4) D is less reactive than Fe, Cu, Zn, Ag.

Hence:

(i) B is the most reactive.
(ii) The blue colour of copper sulphate solution disappears, and a reddish-brown copper metal is deposited on the metal B.
(iii) $B > A > C > D$ is the order of reactivity.

6. 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.

Solution:

When a reactive metal reacts with hydrochloric acid, hydrogen gas is produced. A reactive metal displaces the hydrogen from acid and releases hydrogen gas.

The chemical reaction when iron reacts with dilute H_2SO_4 is

$$Fe(s) + \text{dil. } H_2SO_4\,(aq) \rightarrow FeSO_4\,(aq) + H_2(g)$$

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

Solution:

Zinc is more reactive than iron, hence when added to iron (II) sulphate, it displaces iron metal to form zinc sulphate. The colour of solution fades from green to colourless due to the formation of zinc sulphate and greyish black iron metal is deposited. The chemical reaction is given as:

$$Zn(s) + FeSO_4\ (aq)\text{Pale green} \rightarrow ZnSO_4(aq)\text{Colourless} + Fe(s)$$

6. (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.

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

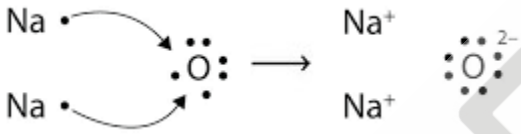
Solution:

(i) Sodium Na (2,8,1)

Oxygen O (2,8,6)

Magnesium Mg (2,8,2)

(ii) Na_2O



MgO

(iii) Ions in Na_2O are N^+ and O^{2-}

Ions in MgO are Mg^{2+} and O^{2-}

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

Solution:

Gold and platinum are two metals that are found in nature in the free state.

8. What is the chemical process that is used for obtaining a metal from its oxide?

Solution:

To obtain metals from its oxides, for metals of medium reactivity, one can use carbon as reducing agent and the chemical process is called reduction. In the displacement reaction, the highly reactive metal acts as the reducing agent.

For the metals of high reactivity, the method of electrolytic reduction in used. For example,

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

9. Metallic oxides of zinc, magnesium and copper were heated with the following metals.

Metal	Zinc	Magnesium	Copper
Zinc oxide			
Magnesium oxide			
Copper oxide			

In which cases will you find displacement reactions taking place?

Solution:

Based on reactivity series of metals, the displacement reaction will take place as follows:

Metal	Zinc	Magnesium	Copper
Zinc oxide	No reaction	Displacement	No reaction
Magnesium oxide	No reaction	No reaction	No reaction
Copper oxide	Displacement	Displacement	No reaction

10. Which metals do not corrode easily?

Solution:

Metals which are less reactive and lie at the bottom of reactivity series i.e., silver, gold, platinum do not react with atmospheric gases and hence do not corrode easily.

11. What are alloys?

Solution:

Alloys are homogeneous mixture of two or more metals or metal and non-metal.

Some examples of alloys are:

Brass -	Cu + Zn	metal + metal
Steel-	Fe + Ni + Cr + C	metals + non-metals
Bronze-	Cu + Zn	metal + metal

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