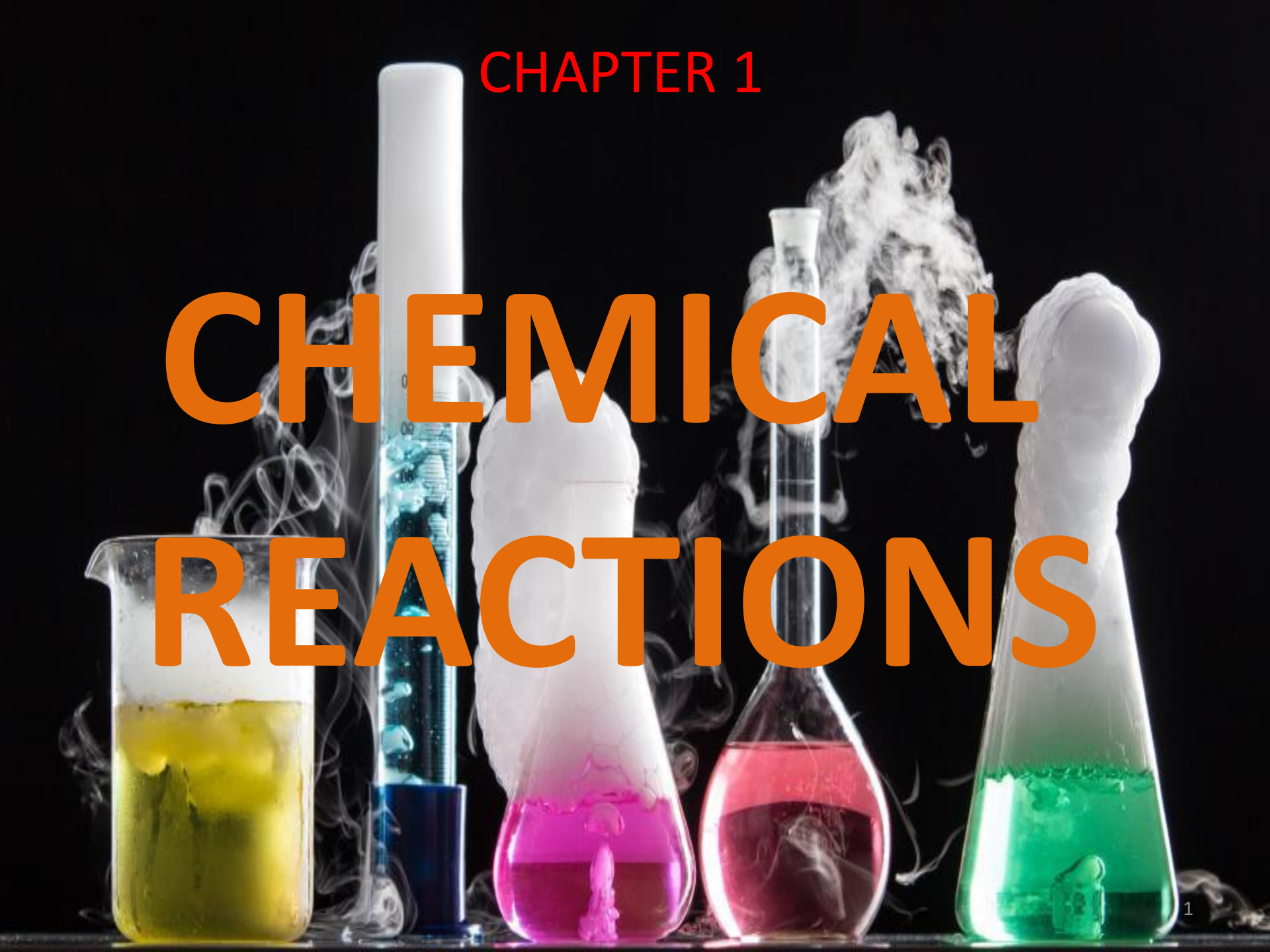
CHAPTER 1

CHEMICAL REACTIONS



Contents

What happens when?

Milk is left at room temperature during summers.

Curdling of milk takes place.

What happens when?

An iron tawa/pan/nail is lift exposed to humid atmosphere.

Rusting of iron takes place.

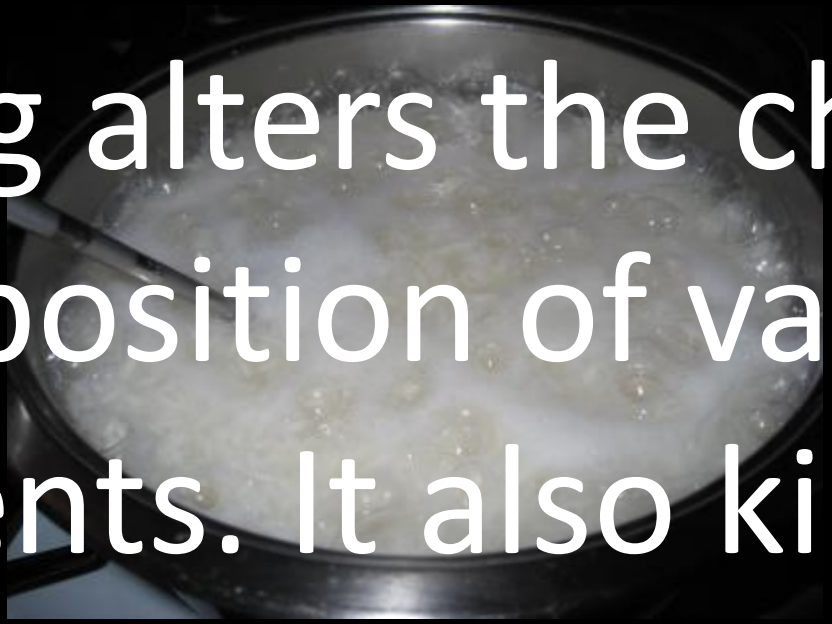
What happens when?

Grapes are fermented.

Alcohol is produced.

What happens when?

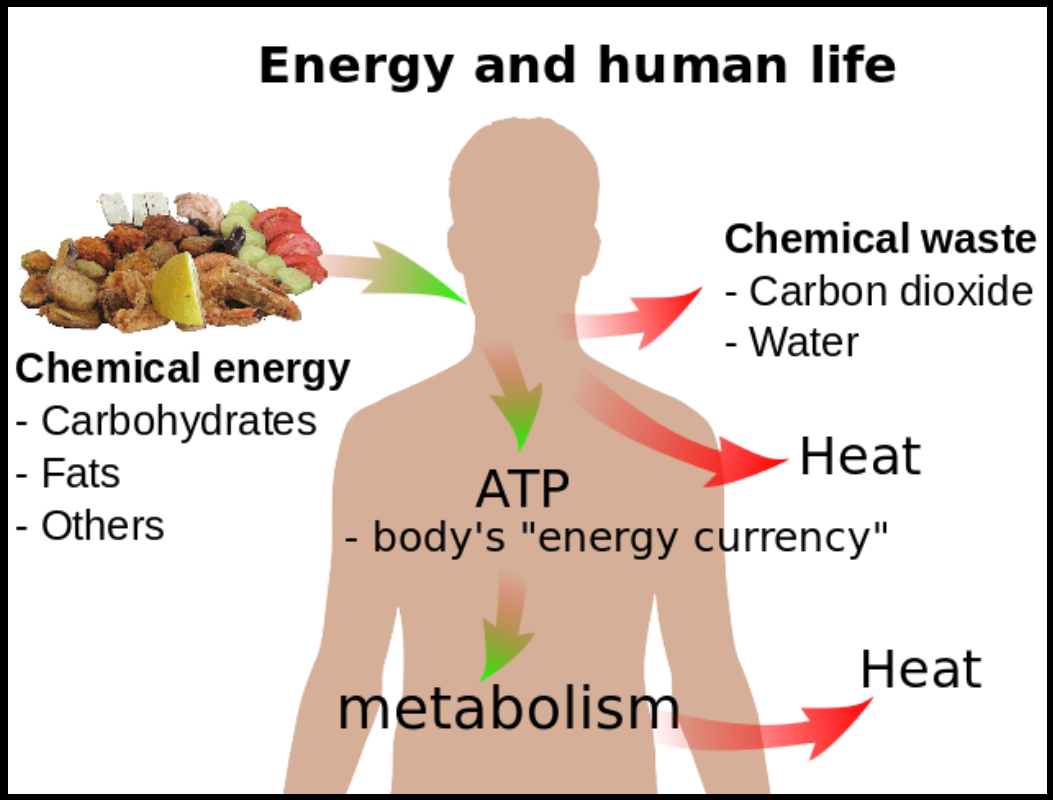
Food is cooked.



Cooking alters the chemical composition of various nutrients. It also kills the several microorganisms.

What happens when?

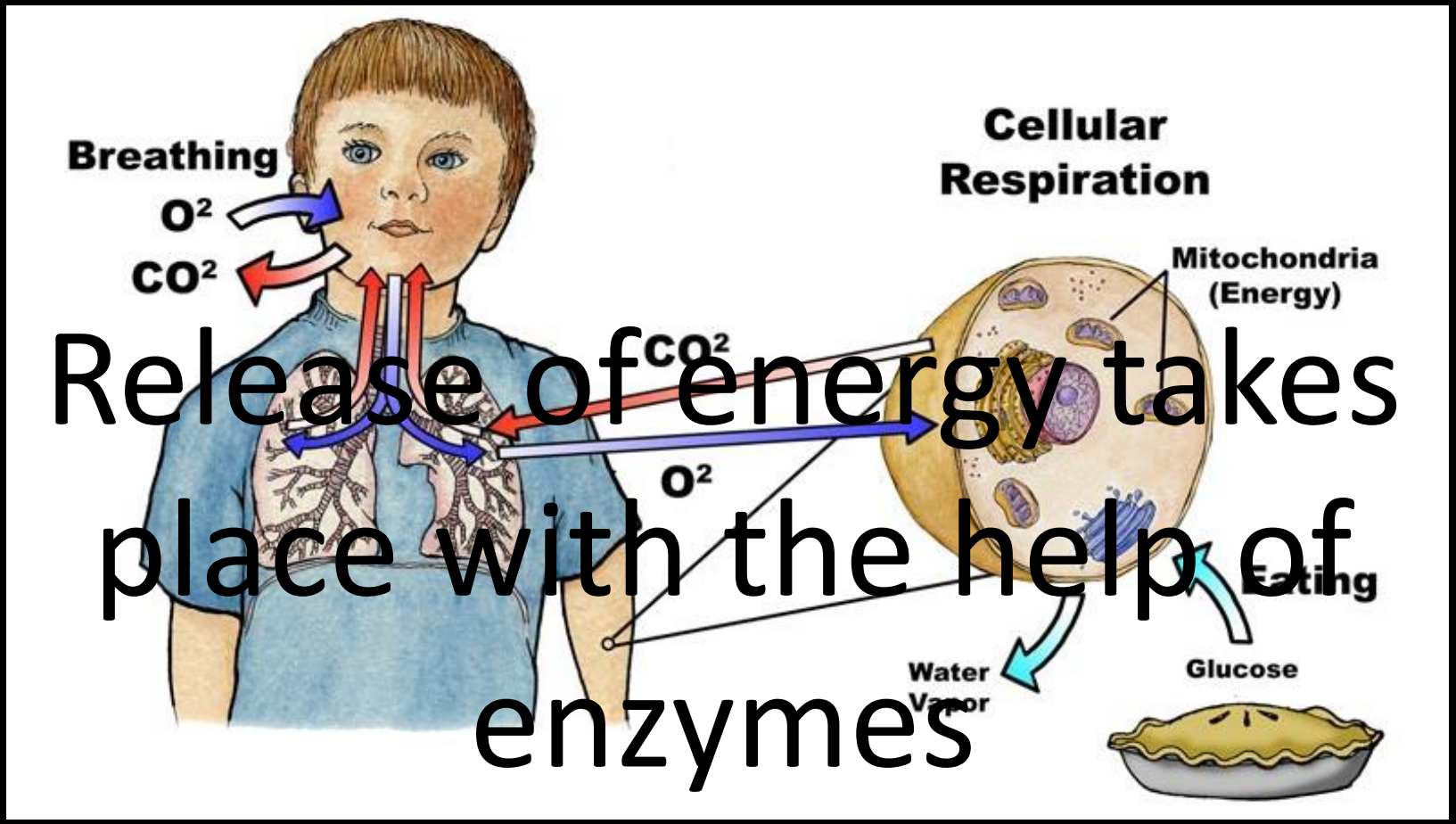
Food gets digested in our body.



Energy is released

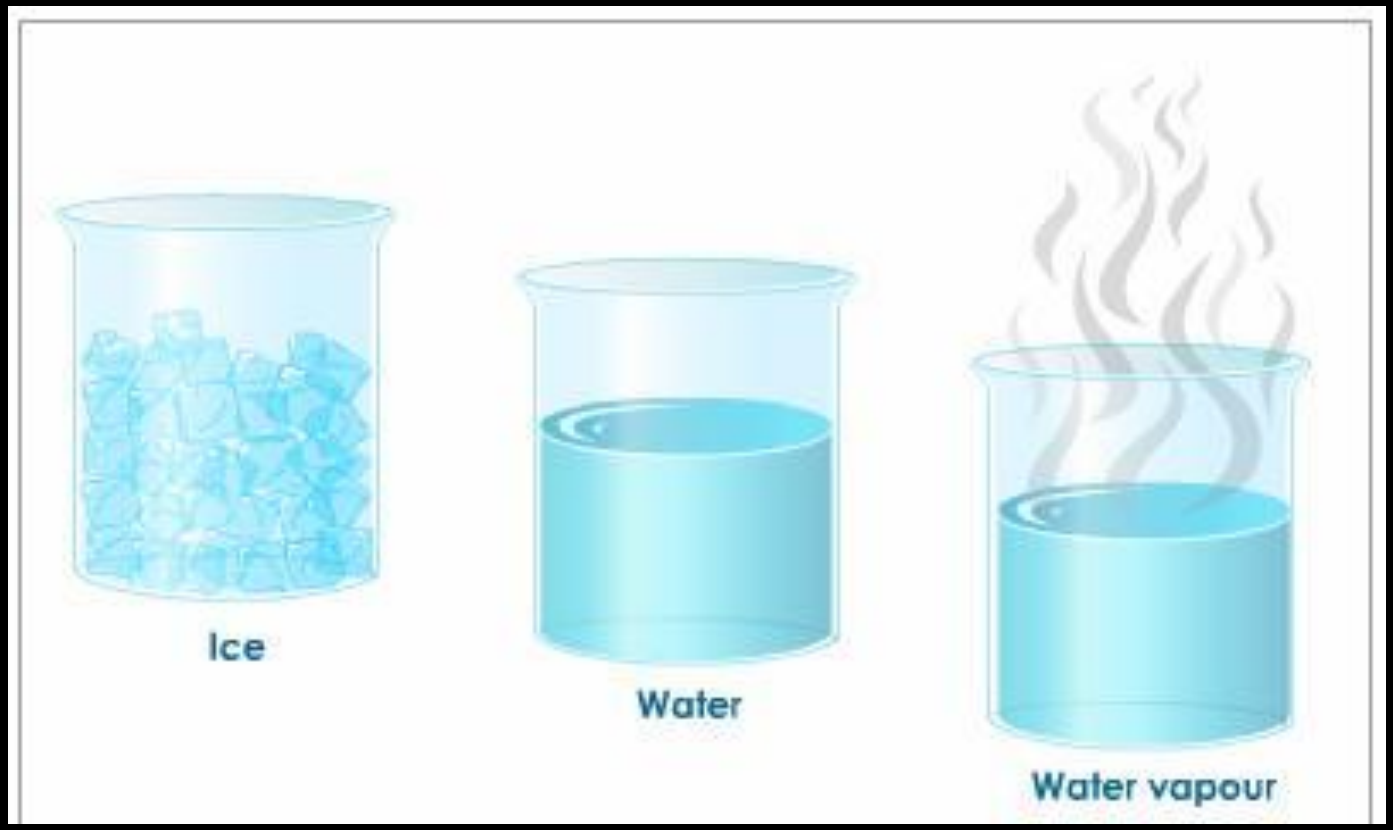
What happens when?

We respire



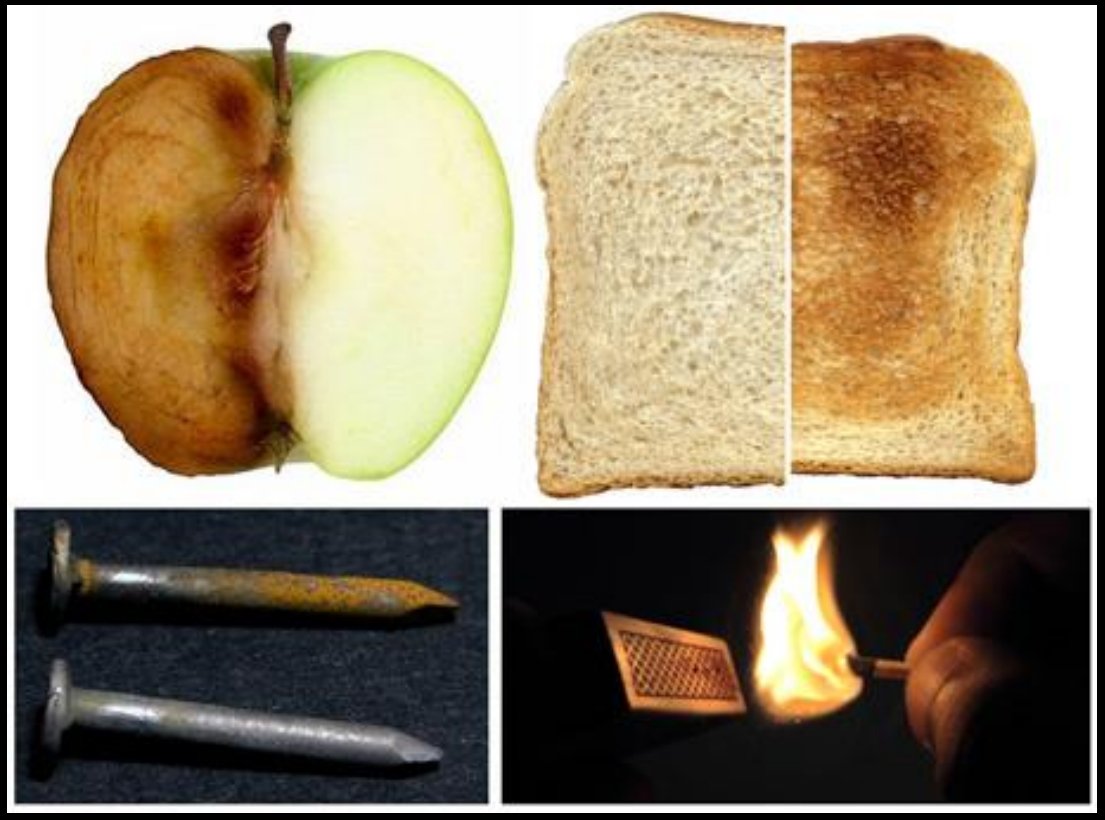
Release of energy takes place with the help of enzymes

Physical change



In physical change, no new substance is formed.

Chemical change



Burning
Cooking
Rusting

In a chemical change a new substance is formed.

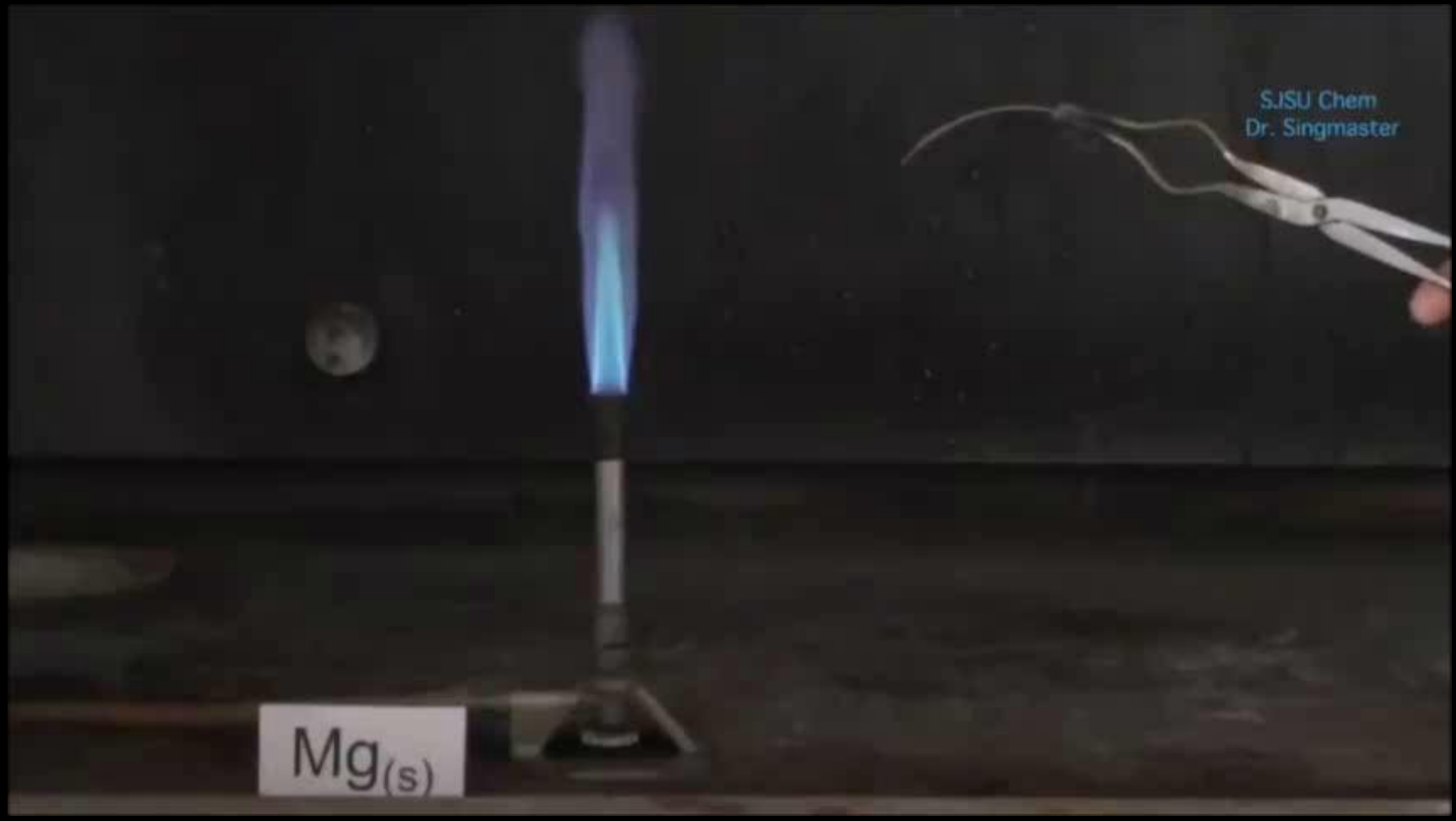
What is a chemical reaction?

Chemical reactions are the processes in which new substances with new properties are formed.

What happens when a magnesium ribbon is burnt in air?

Magnesium ribbon burns with a dazzling white flame and changes into a white powder. This powder is magnesium oxide. It is formed due to the reaction between magnesium and oxygen present in the air.

What happens when a magnesium ribbon is burnt in air?



Why should magnesium ribbon be cleaned before burning in air?

Magnesium is an extremely reactive metal. When stored, it reacts with oxygen to form a layer of magnesium oxide on its surface. This layer of magnesium oxide is quite stable and prevents further reaction of magnesium with oxygen. The magnesium ribbon is cleaned by sand paper for removing this layer so that the underlying metal can be exposed to air.

What happens when a potassium iodide is added to a test tube containing lead nitrate solution?

When potassium iodide reacts with lead nitrate, it forms potassium nitrate and lead iodide.

$$2KI + Pb(NO_3)_2 \longrightarrow 2KNO_3 + PbI_2$$

Potassium iodide reacts with lead nitrate solution

What happens when dilute hydrochloric acid is added to a conical flask containing few zinc granules?

Zinc reacts with dilute HCl to from zinc chloride.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

Dilute hydrochloric acid reacts with zinc granules

What happens when dilute sulphuric acid is added to a conical flask containing few zinc granules?

Zinc reacts with dilute sulphuric acid to from zinc sulphate.

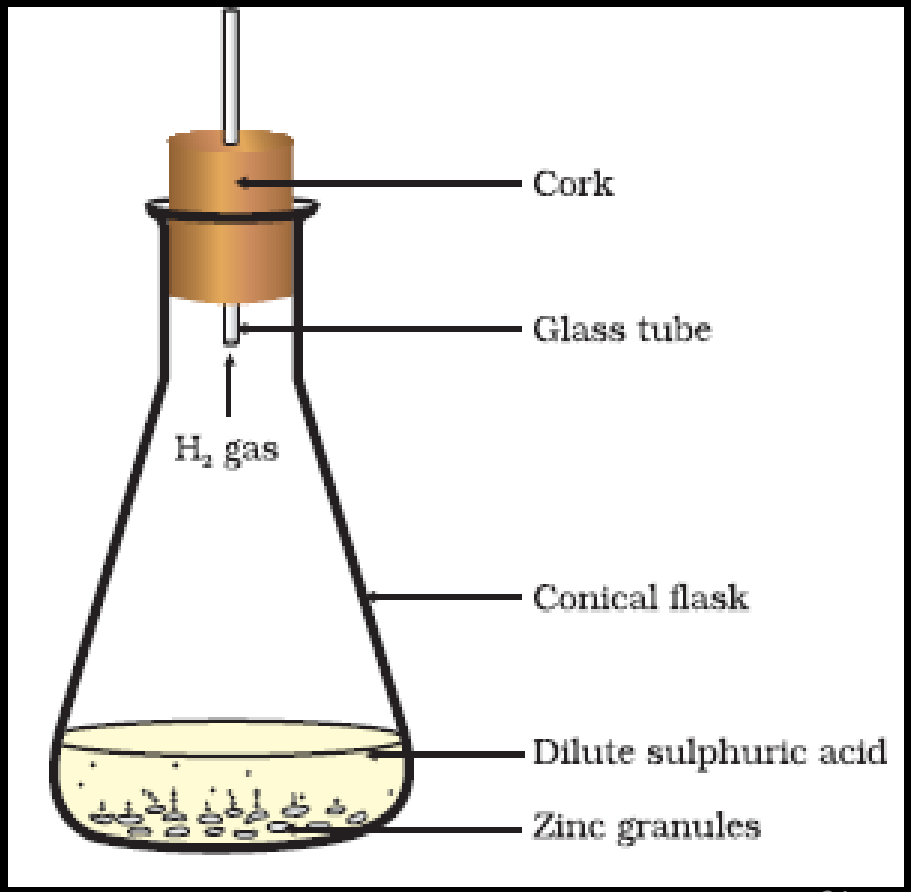
$$Zn + 2H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

Dilute sulphuric acid reacts with zinc granules

In the diagram,

a) What do you observe happening around the zinc granules?

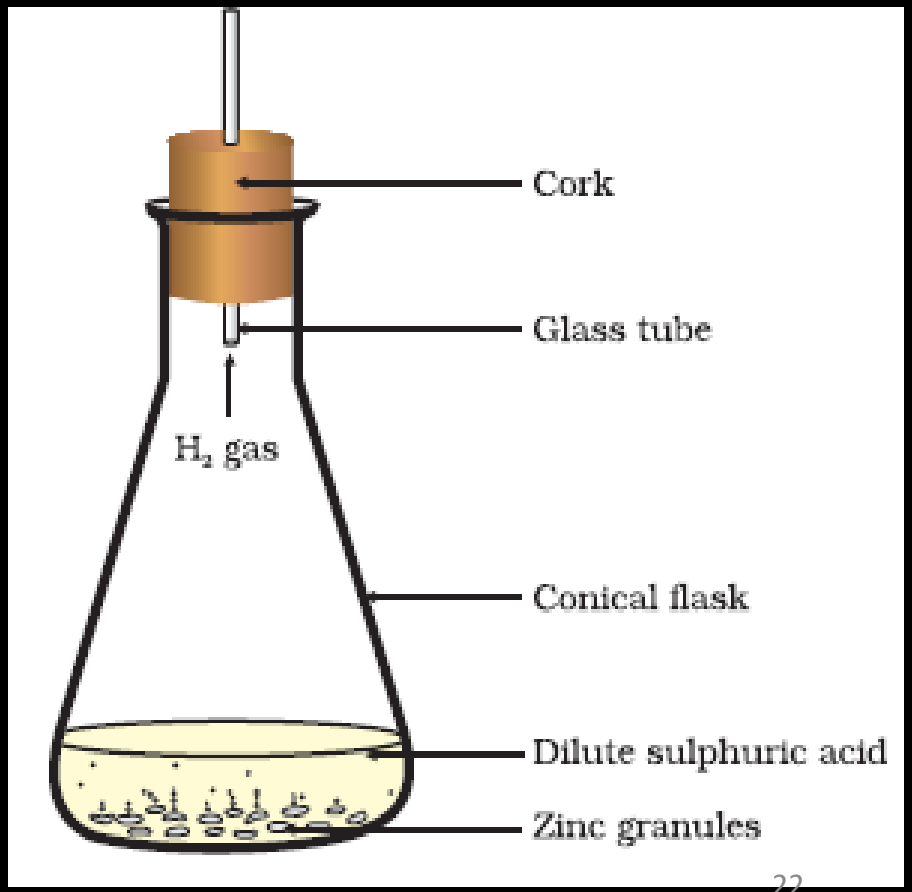
Bubbles of hydrogen gas are being formed around zinc granules



In the diagram,

b) Is there any change in the temperature of the conical flask?

We observe a rise in temperature when we touch the conical flask



Characteristics of chemical reaction

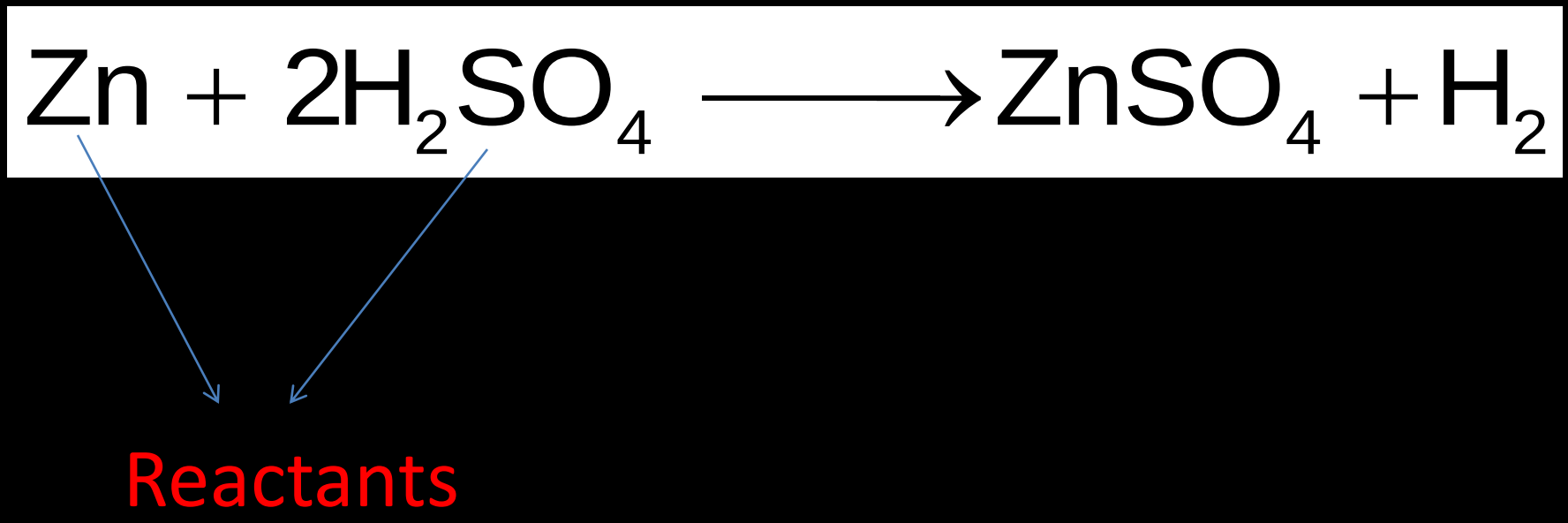
a) Change in state.
b) Change in colour.
c) Evolution of a gas.
d) Change in temperature.
e) Formation of precipitate.

Chemical equation

The method of representing a chemical reaction with the help of symbols and formulas of the substances involved in it is known as chemical equation.

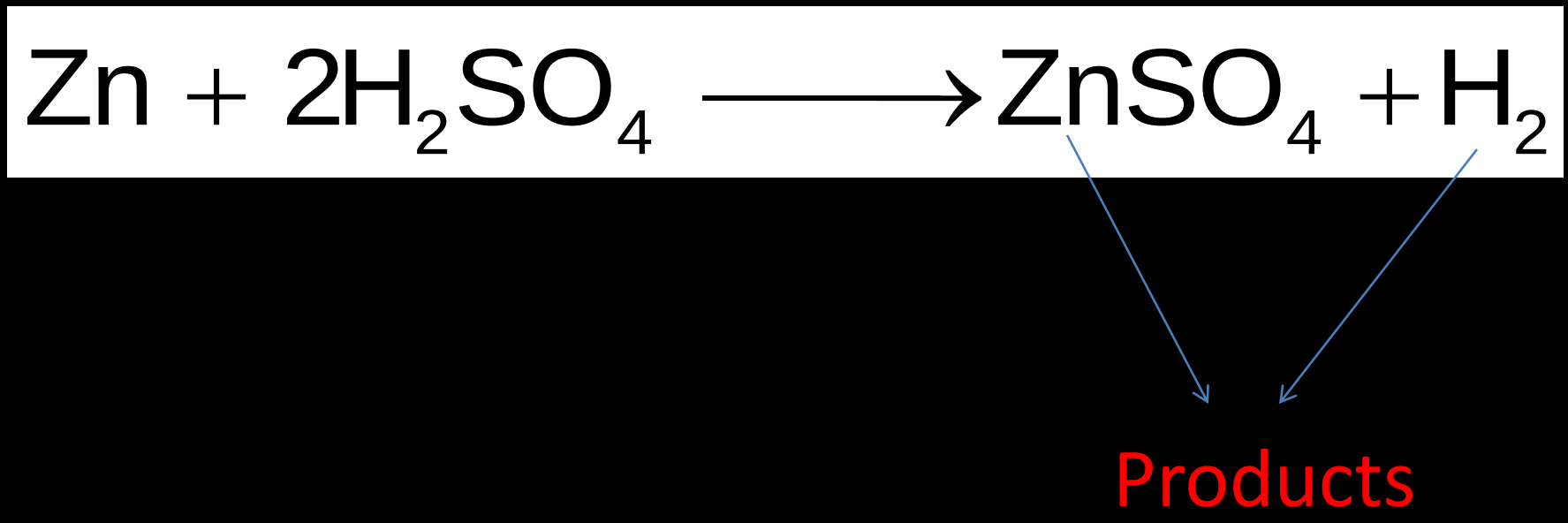
Reactants

The substances which undergo chemical change in the reaction are called reactants.



Products

The new substances formed during a chemical reaction are called products.



Skeletal equation

If the number of atoms of any element in a chemical equation is not equal on both sides, then it is a skeletal equation.

$$Mg + HCl \rightarrow MgCl_2 + H_2$$

Mg=1	Mg=1
H=1	H=2
Cl=1	Cl=2

Balanced equation

A balanced chemical equation means total number of atoms of each element is equal on both sides of a chemical reaction.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

Mg=1	Mg=1
H=2	H=2
Cl=2	Cl=2

Why should an equation be balanced?

A chemical reaction should be balanced because matter can neither be created nor be destroyed. The total mass of reactants should be equal to the total mass of the products. It is on the basis of law of conservation of mass.

Skeletal Vs Balanced equation

Skeletal chemical equation	Balanced chemical equation
If the number of atoms of any element in a chemical equation is not equal on both sides, then it is a skeletal equation. $Mg + HCl \rightarrow MgCl_2 + H_2$	If the number of atoms of different elements on both sides of a chemical equation is equal, then it is balanced chemical equation. $Mg + 2HCl \rightarrow MgCl_2 + H_2$

What happens when water is added to a small amount of calcium oxide or quick lime in a beaker?

Calcium oxide reacts vigorously with water to produce slaked lime (calcium hydroxide) releasing a large amount of heat.

$$CaO + H_2O \rightarrow Ca(OH)_2$$

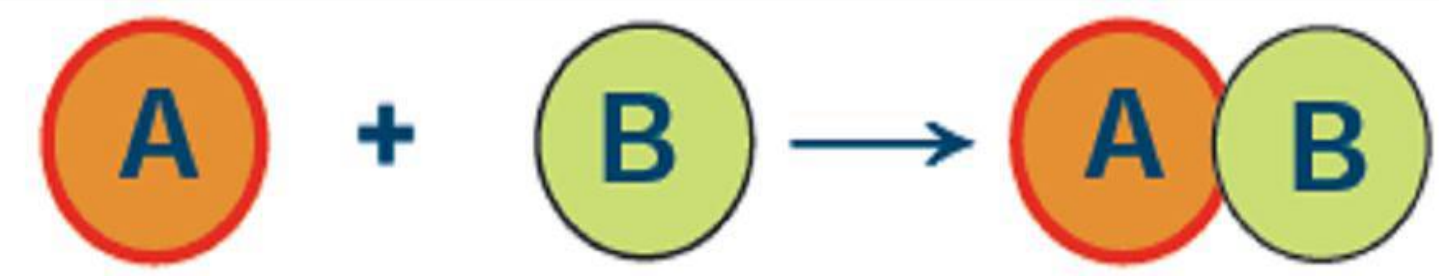
Water is added to calcium oxide or quick lime

Types of chemical reaction

1) Combination reaction
2) Decomposition reaction
3) Displacment reaction
4) Double displacement reaction

Combination reaction

A reaction in which two or more reactant combine to form a single product is called combination reaction.



Combination reaction

Magnesium + Oxygen → Magnesium oxide

$Mg + O_2 \rightarrow 2MgO$

Carbon + Oxygen → Carbon dioxide

$C + O_2 \rightarrow CO_2$

Hydrogen + Chlorine → Hydrogen chloride

$H_2 + Cl_2 \rightarrow 2HCl$

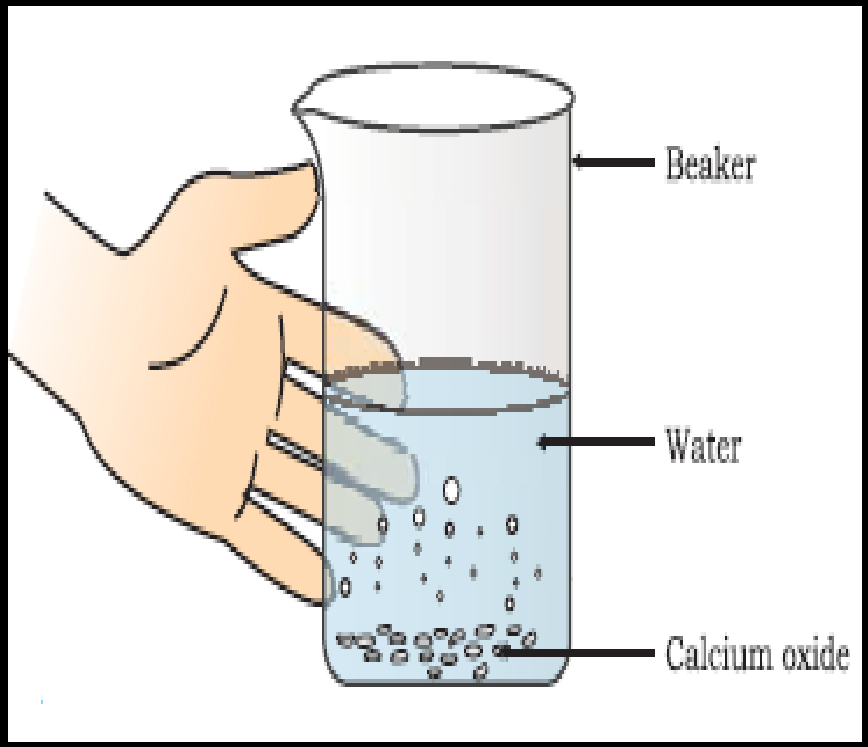
Why do walls after white washing appears shiny after a few days?

Slaked lime (calcium hydroxide) used for white washing reacts slowly with carbon dioxide in air to from a thin layer of calcium carbonate. Calcium carbonate gives a shiny finish to the walls.

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

In the diagram, a small amount of calcium oxide or quick lime in a beaker and water is added. Do you feel any change in temperature?

There is an increase in temperature because calcium oxide reacts with water to produce slaked lime releasing a large amount of heat.



Exothermic reaction

A Reaction in which heat is released along with formation of products is called exothermic reaction.

Burning of natural gas

$CH_4 + O_2 \rightarrow CO_2 + 2H_2O + Heat$

Respiration is also an exothermic reaction.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + energy$

Is respiration an exothermic reaction?

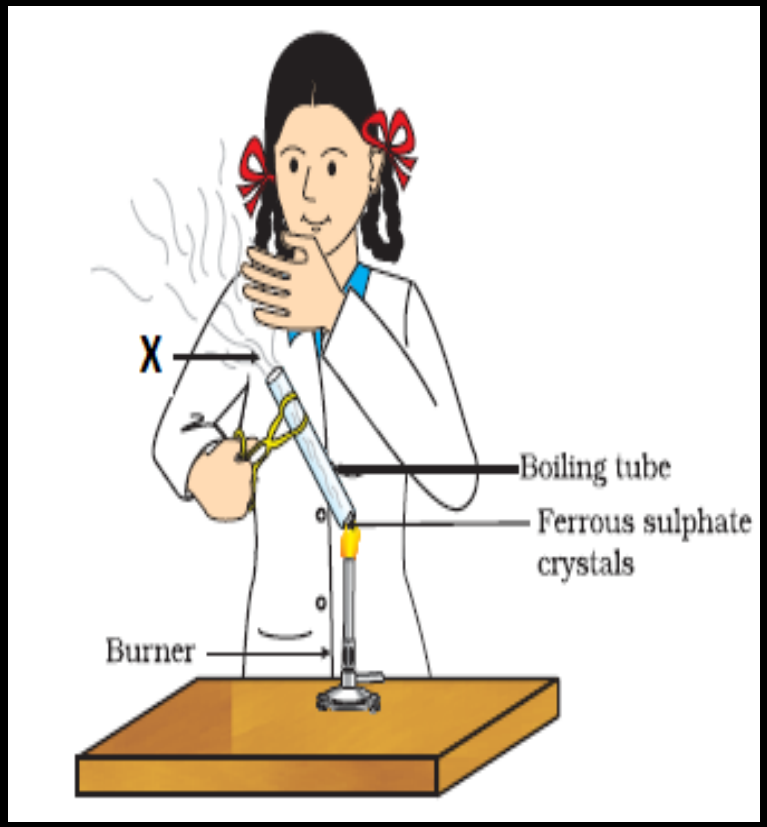
During digestion, large molecules of food are broken down into simpler substances such as glucose. Glucose combines with oxygen in the cells and provides energy. Since energy is released in the whole process, it is an exothermic process.

$$C_6H_{12}O_6 + 6\ O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy}$$

2g of ferrous sulphate crystals are heated in a dry test tube.

2g of ferrous sulphate crystals are heated in a dry test tube.

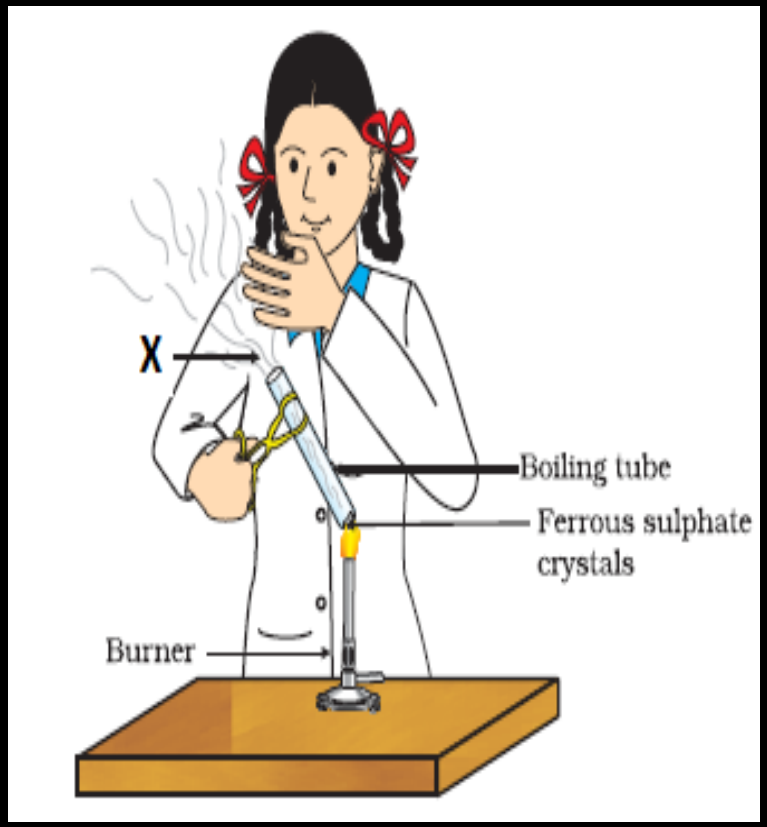
a) What is the colour of ferrous sulphate crystals before and after heating?



Before heating the crystals are green in colour. After heating they turn white.

2g of ferrous sulphate crystals are heated in a dry test tube.

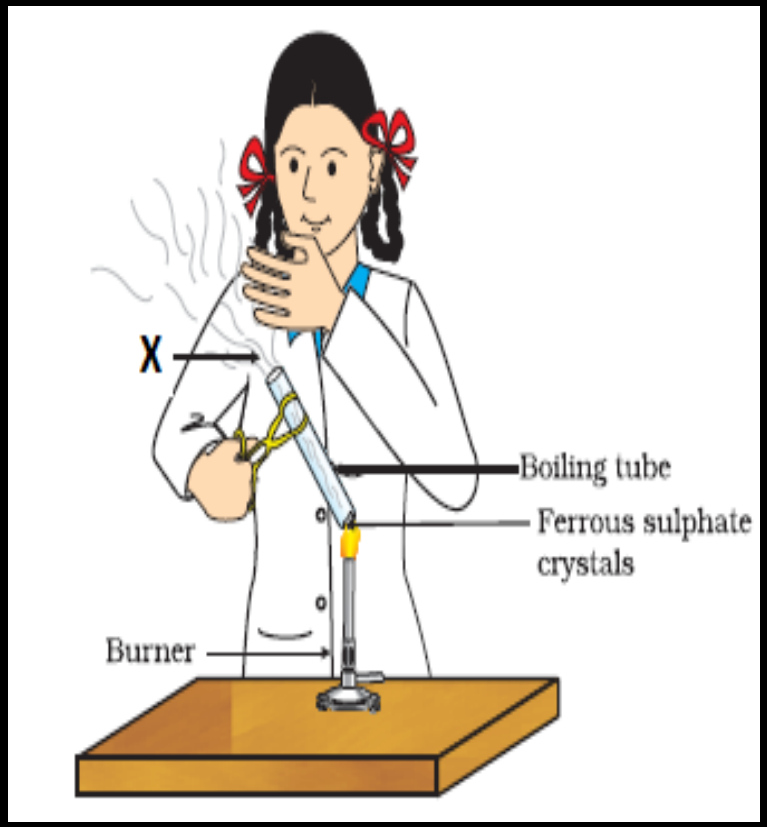
b) How do you identify the gas evolved on heating?



The gas evolved is identified by the characteristic odour of burning sulphur.

2g of ferrous sulphate crystals are heated in a dry test tube.

c) Write balanced chemical equation. What kind of reaction does it represent?



It is a decomposition reaction.

$$2FeSO_4 \xrightarrow{\text{Heat}} Fe_2O_3 + SO_2 + SO_3$$

(green colour) (red – brown)

Why does the colour of ferrous sulphate change when it is heated in a dry test tube?

Ferrous sulphate crystals lose water when heated and the colour of the crystals changes.

Thermal decomposition reaction

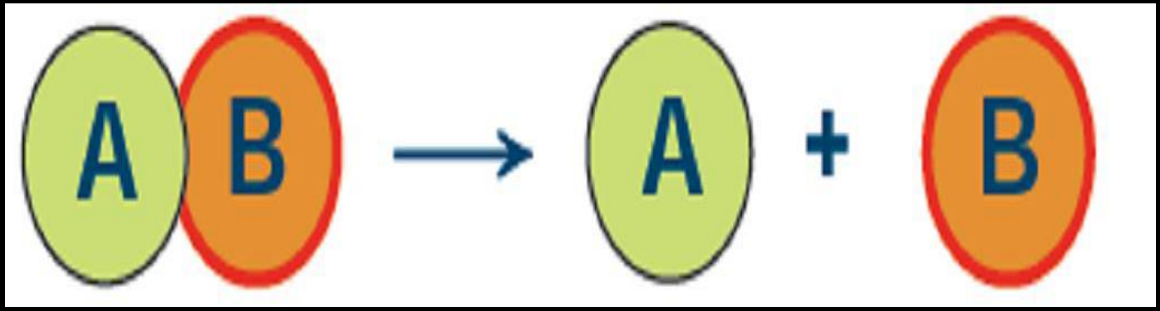
When a decomposition reaction is carried out by heating, it is called thermal decomposition.

Ex: Calcium carbonate on heating decomposes to calcium oxide and carbon dioxide.

$$CaCO_3 \rightarrow CaO + CO_2$$

Decomposition reaction

The reaction in which a compound splits into two or more simple substances is called decomposition reaction.



Decomposition reaction

When calcium carbonate is heated, it decomposes into calcium oxide and carbon dioxide

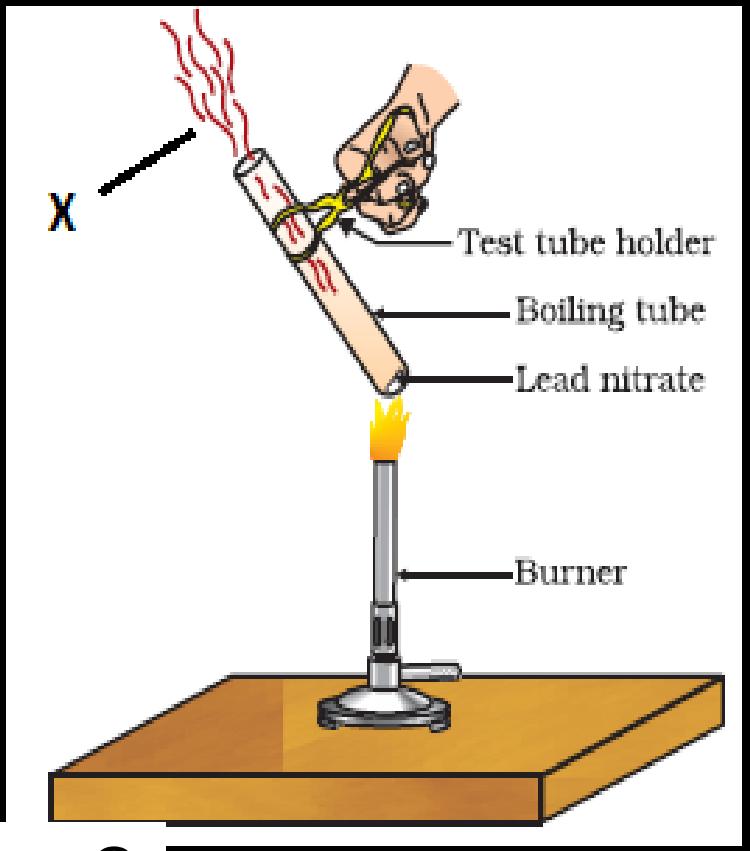
$$CaCO_3 \rightarrow CaO + CO_2$$

Decomposition reactions are opposite of combination reactions.

2g of lead nitrate powder is heated in a test tube

What change do you observe when 2g of lead nitrate powder is heated in a test tube?

Heating of lead nitrate powder produces brown fumes of nitrogen dioxide (NO_2).

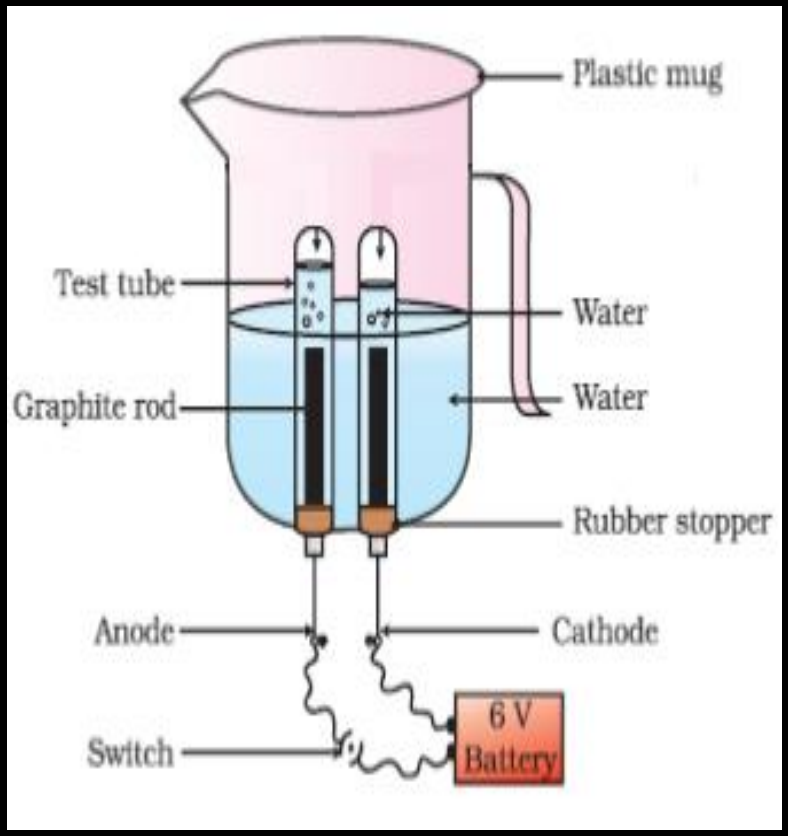


$$2Pb(NO_3)_2 \xrightarrow{\text{Heat}} 2PbO + 4NO_2 + O_2$$

(Lead nitrate) (lead oxide) (Nitrogen dioxide)

Electrolysis of water

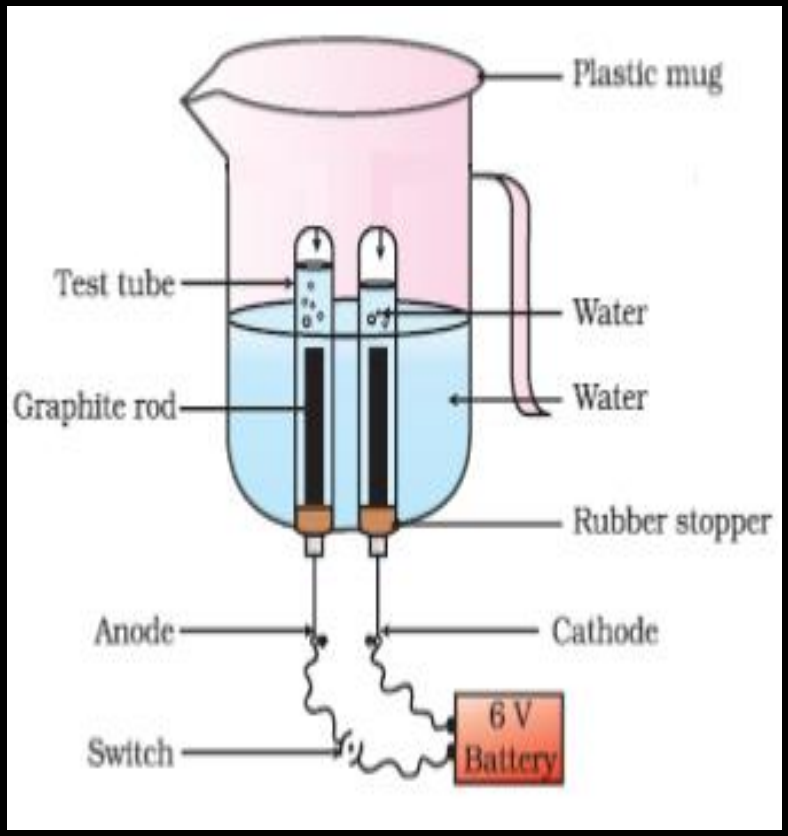
In the diagram given below,
a) Is the volume of gas collected the same in both test tubes?



No, the volume of gas collected at the negative electrode is double the volume of gas collected at the positive electrode.

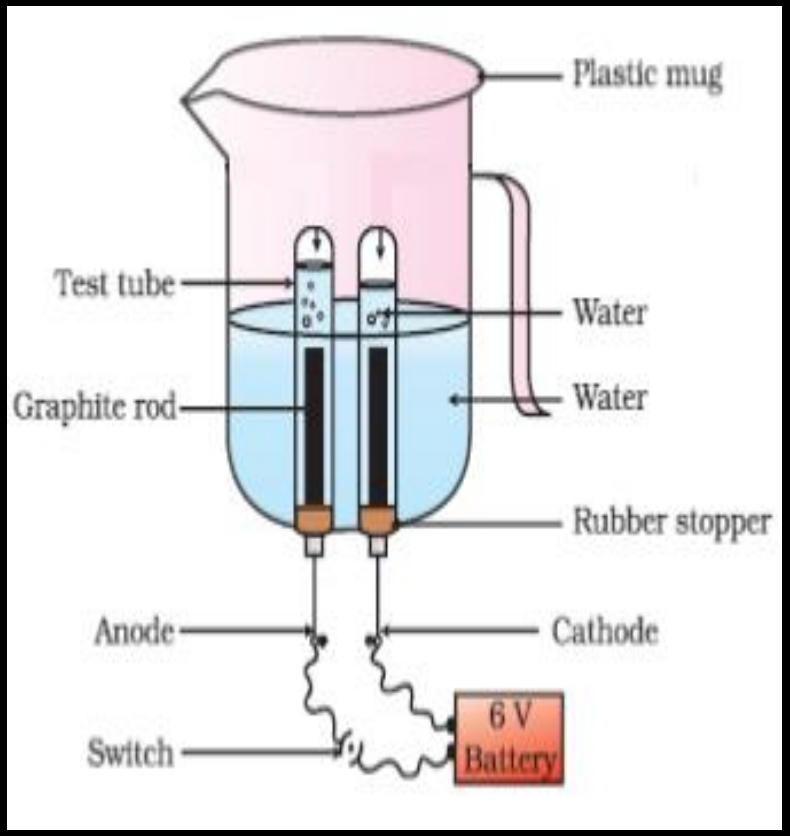
In the diagram given below,
b) Which gas is present in each test tube?

The gas collected at the anode is oxygen.
The gas collected at the cathode is hydrogen.

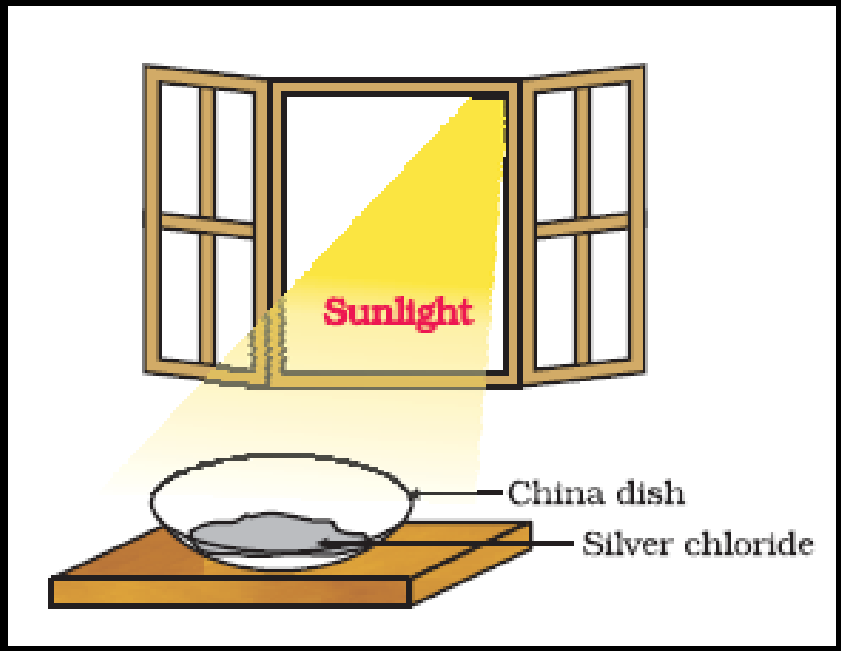


In the diagram given below, What happens at each electrode?

Water on electrolysis decomposes to hydrogen and oxygen gas. Hydrogen gas burns explosively (hydrogen is highly combustible) whereas oxygen gas helps in burning (oxygen is a supporter of combustion)



What happens when 2g of silver chloride taken in a china dish is kept exposed to sunlight?



Silver chloride decomposes into silver and chlorine. The white silver chloride turns grey when exposed to sunlight.

$2AgCl \rightarrow 2Ag + Cl_2$

Why is silver bromide stored in dark bottle?

Silver bromide decomposes when exposed to light. Hence it is stored in dark bottle.

Endothermic reaction

Reactions in which energy is absorbed in the form of heat, light or electricity to break reactants are known as endothermic reactions.

Ammonium chloride with barium hydroxide

1g of ammonium chloride is mixed with 2g of barium hydroxide in a test tube with a glass rod. Touch the bottom of the test tube. Is it an exothermic or endothermic reaction?

Forms aqueous ammonia and barium chloride. The reaction is endothermic.

$Ba(OH)_2 + NH_4Cl \rightarrow BaCl_2 + NH_3 + H_2O$

Iron nail kept in copper sulphate solution.

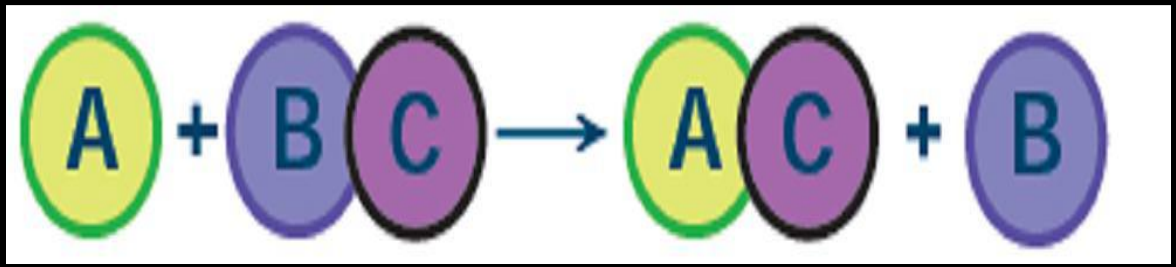
An iron nail is kept in blue coloured copper sulphate solution. After some time the colour of the solution turns green

The iron nail becomes brownish in colour by deposition of copper and blue colour of copper sulphate changes green colour due to formation of $FeSO_4$. Iron displaces copper from copper sulphate solution.

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

Displacement reaction

The chemical reaction in which more reactive element displaces less reactive element from its salt solution is called displacement reaction.



Displacement reaction

When zinc reacts with copper sulphate, it forms zinc sulphate and copper metal.

$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

When lead reacts with copper chloride, it gives lead chloride and copper metal.

$Pb + CuCl_2 \rightarrow PbCl_2 + H_2$

Silver metal is dipped in copper nitrate, no reaction takes place.

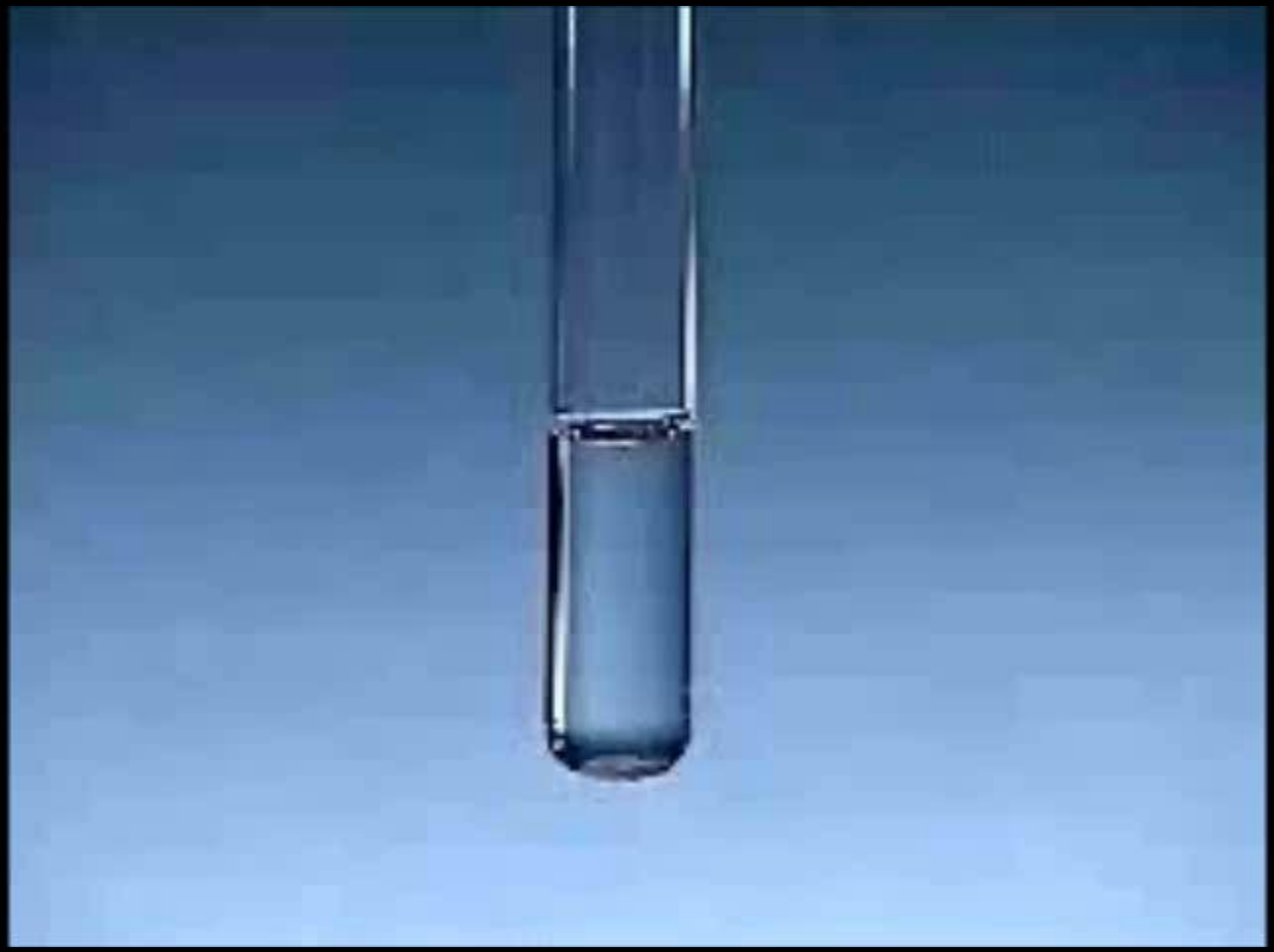
Silver metal is less reactive than copper.

$Ag + Cu(NO_3)_2 \rightarrow$ No reaction takes place

A silver spoon is kept immersed in an aqueous solution of copper sulphate. What change would be observed in the spoon and the solution?

No change will be observed in the silver spoon and aqueous solution of copper sulphate because silver is less reactive than copper. So it will not replace copper from copper sulphate solution.

Sodium sulphate solution is mixed with barium chloride solution.



What happens when 3ml of sodium sulphate solution is mixed with 3ml solution of barium chloride solution in a test tube?

When solution of barium chloride reacts with the solution of sodium sulphate, white precipitate of barium sulphate is formed along with sodium chloride.

$BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

Precipitation reaction

A reaction that produces a precipitate is called a precipitate reaction.

Ex: When solution of barium chloride reacts with the solution of sodium sulphate, white precipitate of barium sulphate is formed along with sodium chloride.

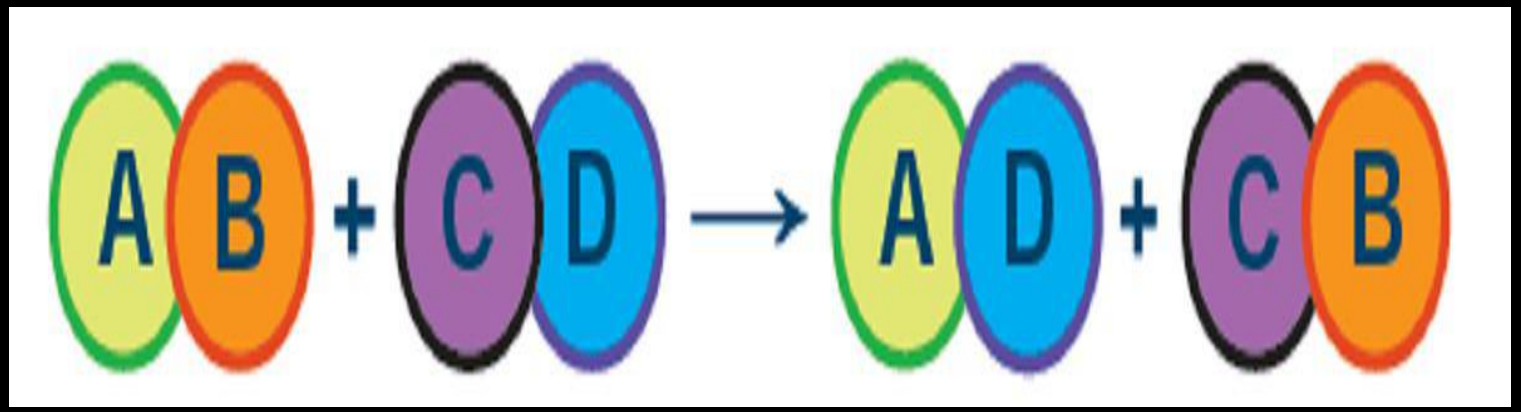
$BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

Why does the colour of copper sulphate solution change when an iron nail is dipped in it?

When an iron nail is placed in a copper sulphate solution, iron displaces copper from copper sulphate solution forming iron sulphate, which is green in colour. Therefore, the blue colour of copper sulphate solution fades and green colour appears.

Double displacement reaction

Reactions in which ions are exchanged between two reactants forming new compounds are called double displacement reactions.

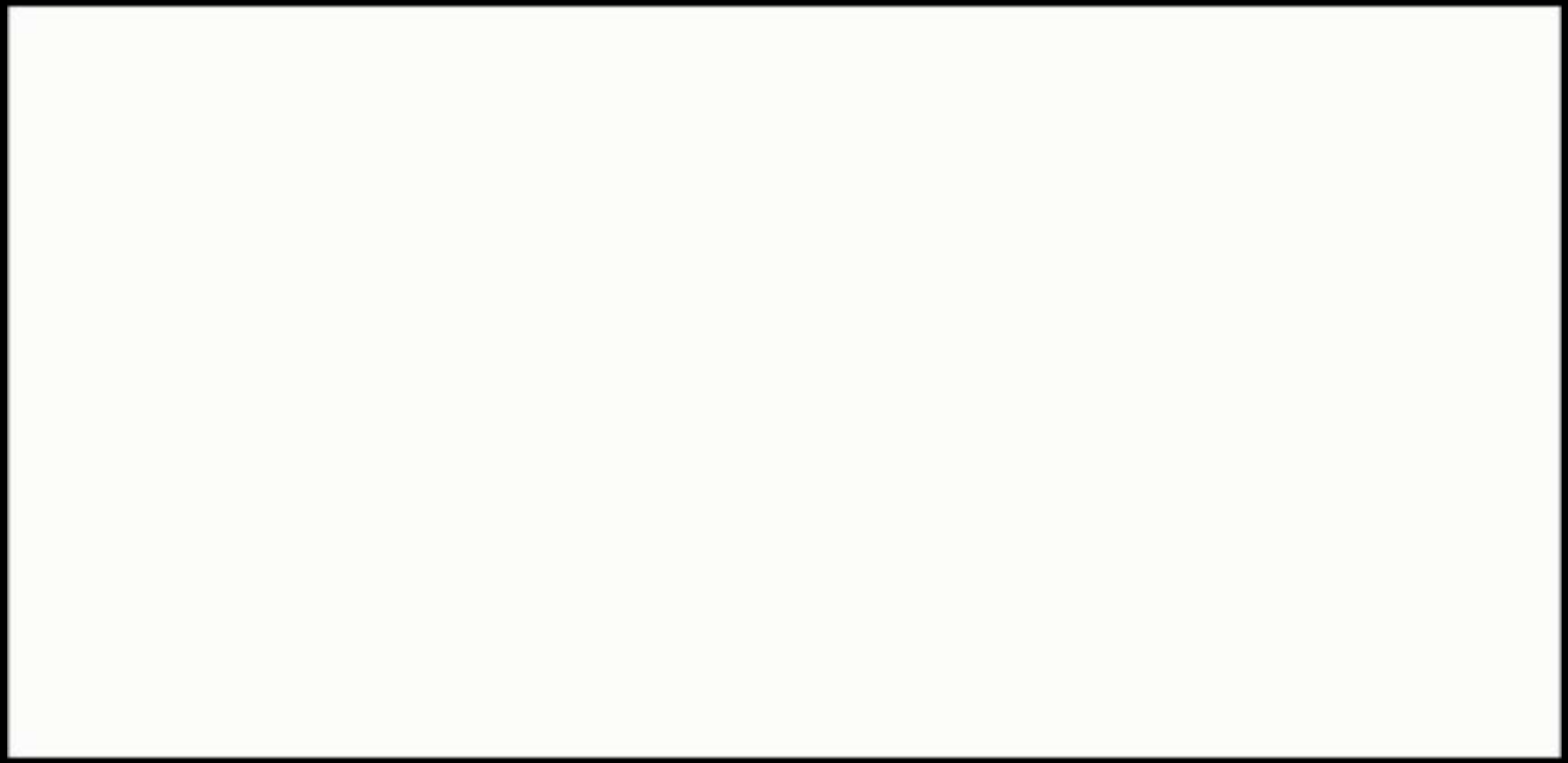


Double displacement reaction

When solution of barium chloride reacts with the solution of sodium sulphate, white precipitate of barium sulphate is formed along with sodium chloride.

$BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

copper powder is heated



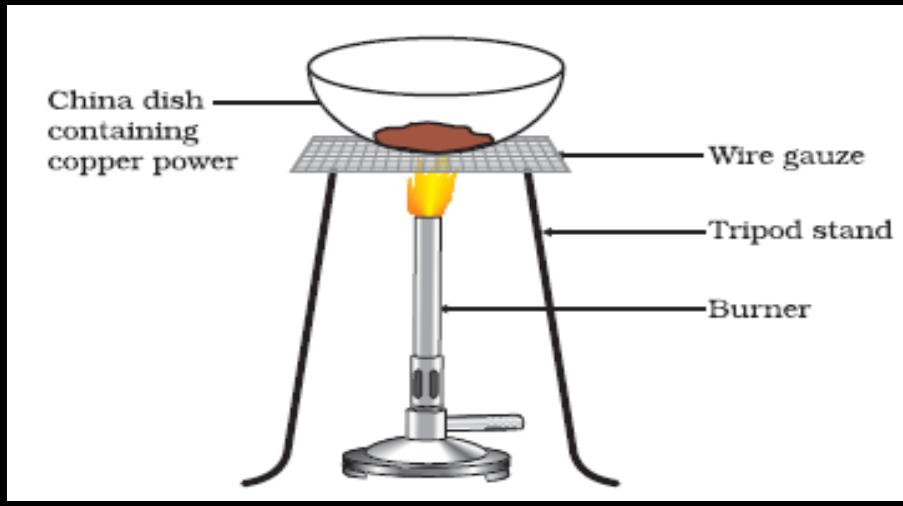
What happens when a china dish containing 1g of copper powder is heated?

The surface of copper powder becomes coated with black copper (II) oxide. Oxygen is added to copper and copper oxide is formed.

$2Cu + O_2 \rightarrow 2CuO$

A china dish containing 1g of copper powder is heated

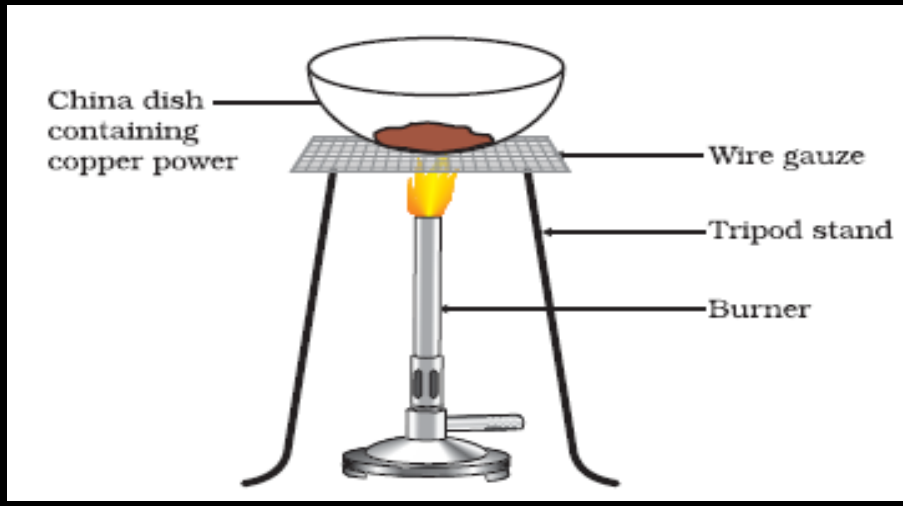
a) State the colour of the reactant and the product of the chemical reaction.



Copper powder (reactant) is brown colour;Copper oxide (product) is black colour.

A china dish containing 1g of copper powder is heated

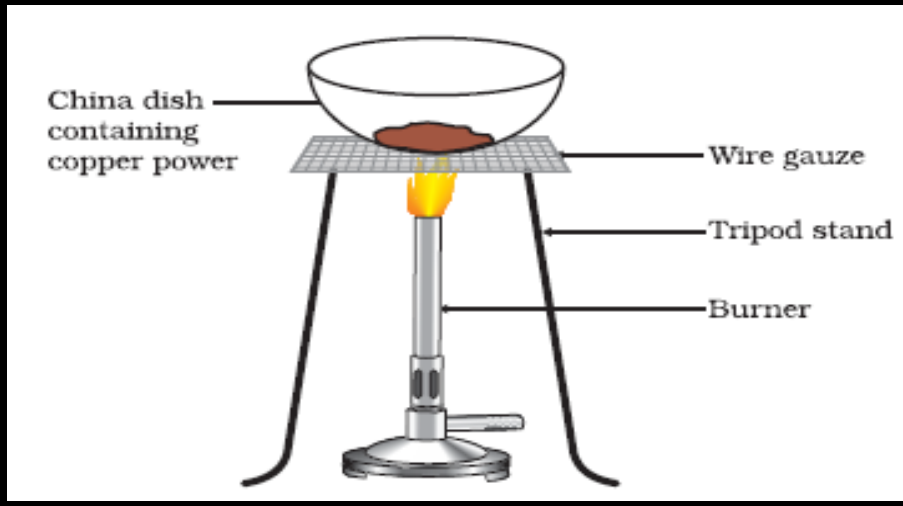
b) Write the chemical equation involved.



$2Cu + O_2 \rightarrow 2CuO$

A china dish containing 1g of copper powder is heated

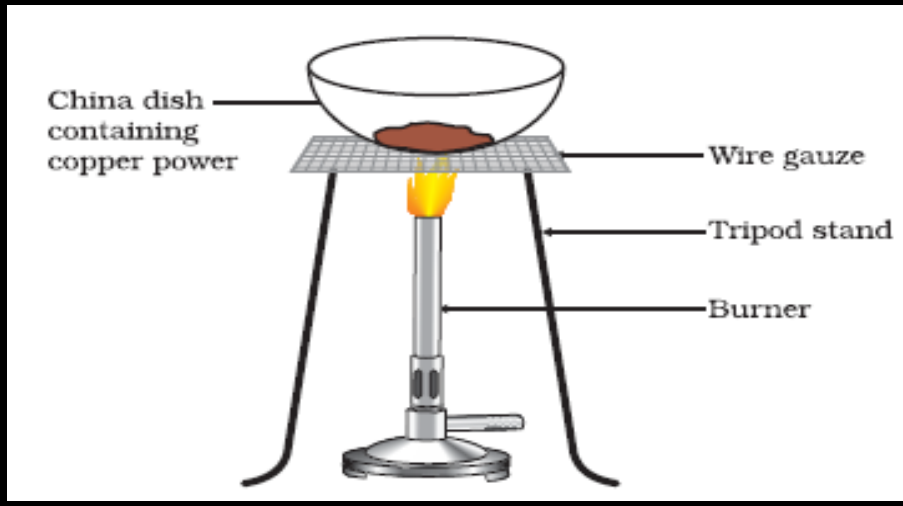
c) Can we reverse the reaction? Write the equation involved.



It can be reversed.

$CuO + H_2 \rightarrow Cu + H_2O$

Hydrogen gas passed over copper oxide



If hydrogen gas is passed over copper oxide, the black coating on the surface turns brown and copper is obtained. $CuO + H_2 \rightarrow Cu + H_2O$

Oxidation

Addition of oxygen (non-metallic element) or removal of hydrogen (metallic element) from a compound is known as oxidation.

$2Cu + O_2 \rightarrow 2CuO$ (addition of oxygen to copper)

$H_2S + I_2 \rightarrow 2HI + S$ (removal of hydrogen from H_2S)

Some Oxidation reaction in daily life

a) Shiny iron articles on exposure to moist air get rusted.
b) Copper articles on exposure to air get coated with a greenish layer.
c) Silver articles on exposure to air become black.
d) Fats and oils in food left for a long time get oxidised.

Oxidising agent

Compounds which can add oxygen (non-metallic compound) or remove hydrogen (metallic element) are known as oxidizing agents. Ex: Chlorine

Reduction

Addition of hydrogen (metallic element) or removal of oxygen (non-metallic element) from a compound is called reduction.

$Cl_2 + H_2 \rightarrow 2HCl$ (addition of hydrogen to chlorine)

$CuO + H_2 \rightarrow Cu + H_2O$ (Removal of oxygen from CuO)

Reducing agent

Compounds or elements which can cause reduction are called reducing agents.

Ex: Hydrogen sulphide.

Is burning of magnesium oxidation or reduction?

Magnesium ribbon burns in oxygen of air to form magnesium oxide.

So magnesium is oxidized to magnesium oxide.

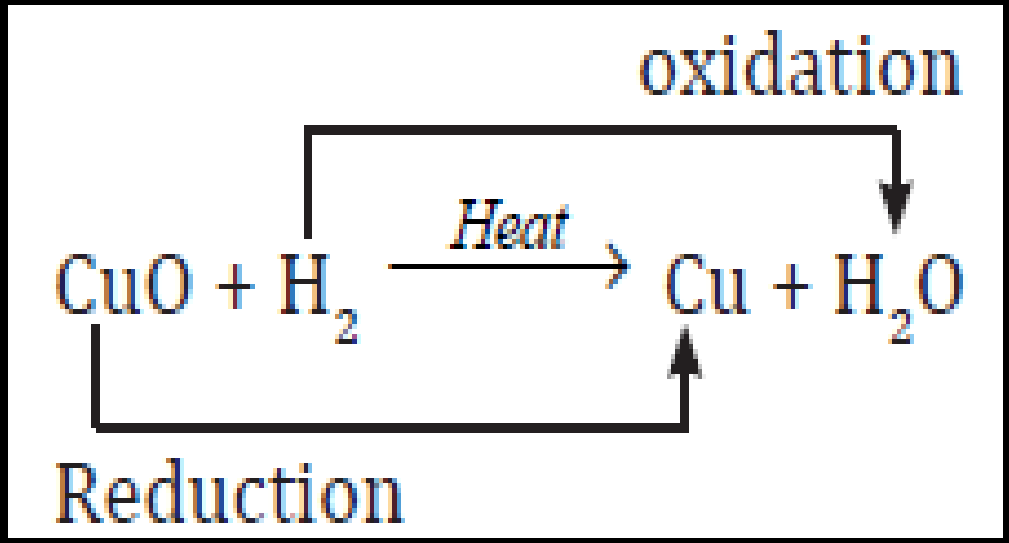
$$2Mg + O_2 \rightarrow 2MgO$$

Redox reaction

In a chemical reaction if oxidation and reduction both take place simultaneously then it is called redox reaction.

Redox reaction

When copper oxide reacts with hydrogen, CuO is losing oxygen, hydrogen is gaining oxygen is being oxidised.



A brown substance ‘X’ on heating in air forms a substance ‘Y’. When hydrogen gas is passed over heated ‘Y’, it changes back into ‘X’.

a) Name the substance X and Y.

X is copper and Y is copper oxide.

A brown substance ‘X’ on heating in air forms a substance ‘Y’. When hydrogen gas is passed over heated ‘Y’, it changes back into ‘X’.

b) Name the type of chemical reaction occurring during both the changes.

Oxidation reduction reaction.

A brown substance 'X' on heating in air forms a substance 'Y'. When hydrogen gas is passed over heated 'Y', it changes back into 'X'.

c) Write the chemical equation.

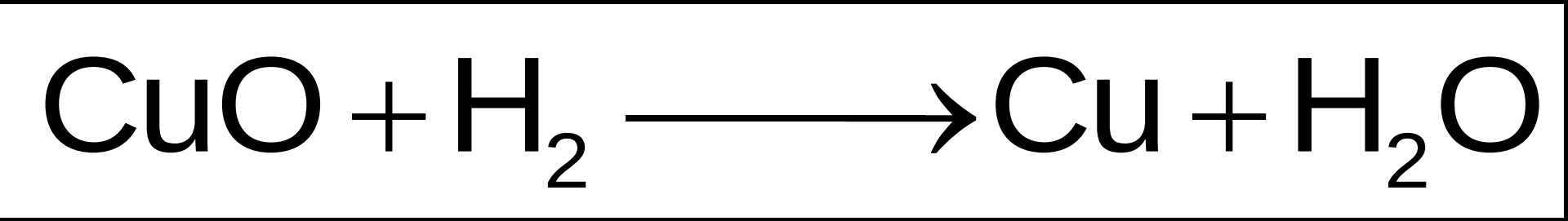
$2Cu + O_2 \rightarrow 2Cuo$

$CuO + H_2 \rightarrow Cu + H_2O$

Identify the substances that are oxidised and the substances that are reduced in the following reactions.

Sodium (Na) is oxidised as it gains oxygen and oxygen gets reduced.

Identify the substances that are oxidised and the substances that are reduced in the following reactions.



Copper oxide (CuO) is reduced to copper (Cu) while hydrogen (H_2) gets oxidised to water (H_2O).

Rusting of iron

The process in which iron articles get coated with a reddish brown powder when exposed to moist air is called rusting of iron.

Rust

Rust is chemically hydrated iron oxide. Its formula is $Fe_2O_3.2H_2O$

Corrosion

When a metal is exposed to substances around it such as moisture, acid etc. for some time, a layer of hydrated oxide is formed. This process is called corrosion.

Problems of Corrosion

a) Corrosion damages the car body.

Problems of Corrosion

b) It damages metal bridges, iron railings

Problems of Corrosion

c) It damages ships made of metal.

Why do we apply paint on iron articles?

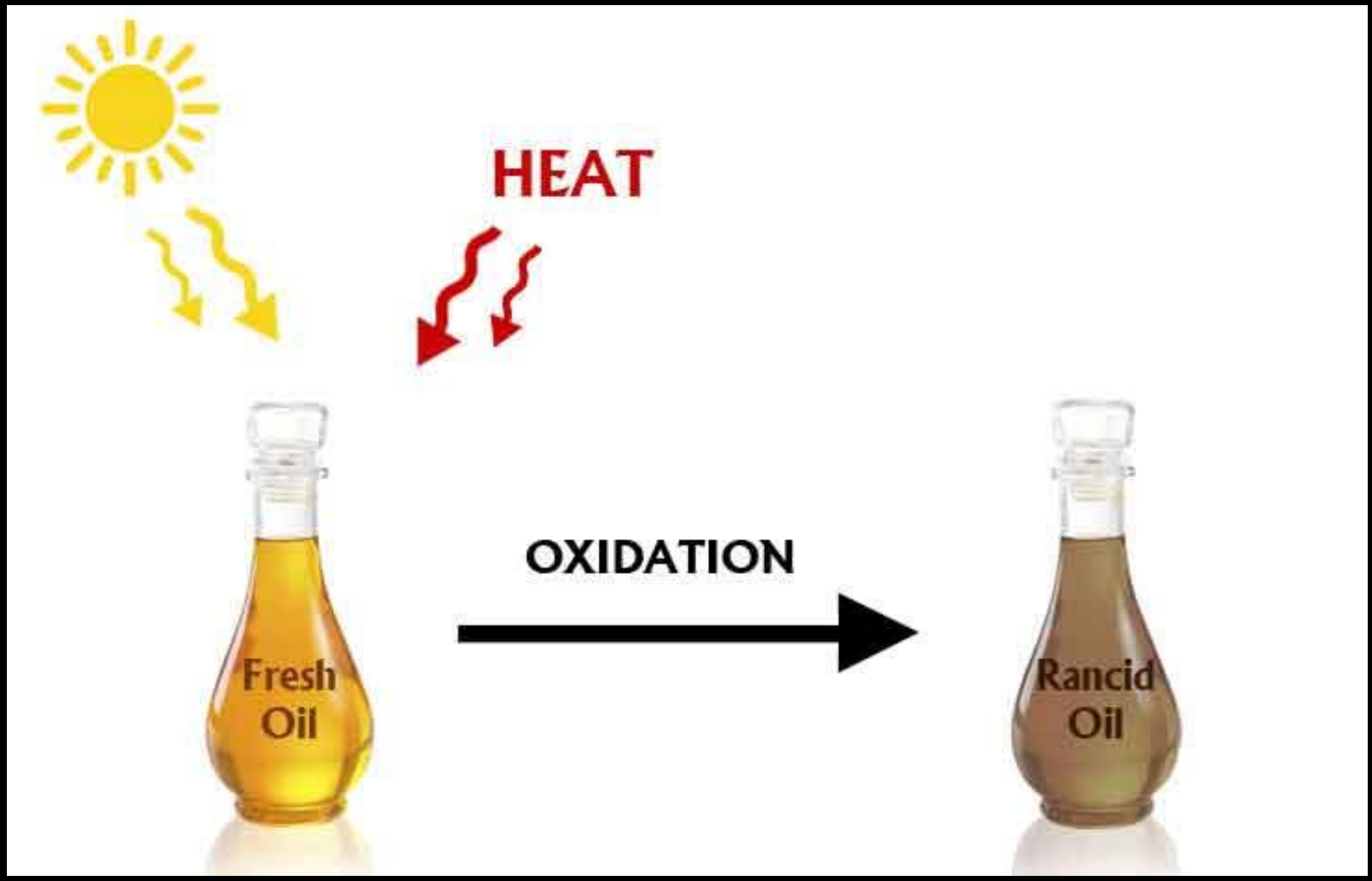
Iron articles are painted because it prevents them from rusting. When painted, the contact of iron articles from moisture and air is cut off. Hence, rusting is prevented. So presence of air and moisture is essential for rusting to take place.

Why do we apply paint on iron articles?

Rancidity

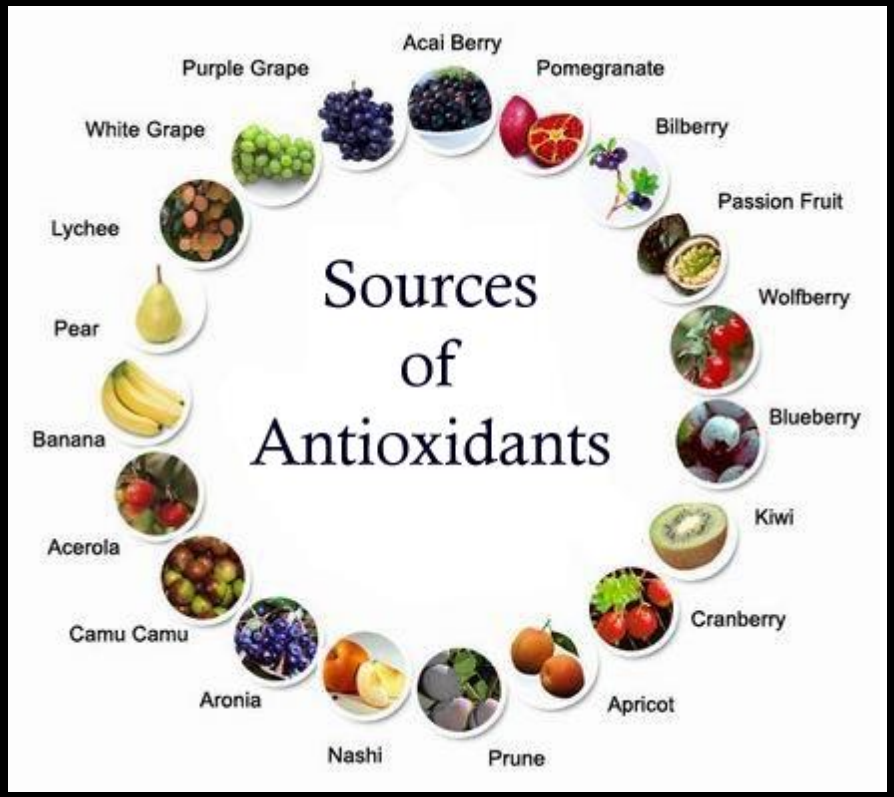
The oxidation of fats and oils when exposed to air is known as **rancidity**.

Rancidity



Antioxidants

Substances which prevent oxidation are called antioxidants.



What happens when food becomes rancid?

When food items become rancid, their smell and taste change.

Methods of prevention of rancidity

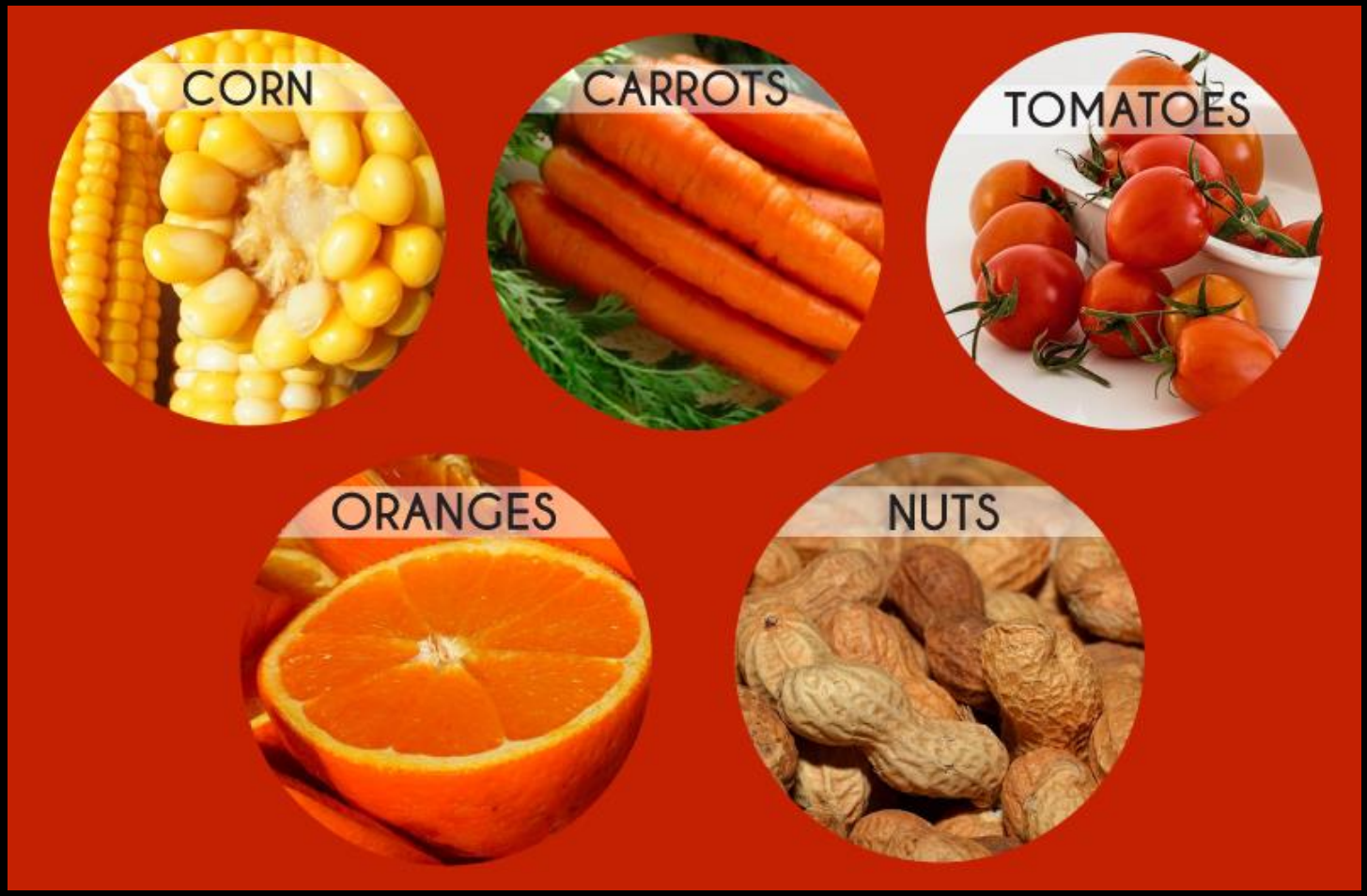
a) Keeping food in air tight containers.

Methods of prevention of rancidity

b) Filling an inert gas like nitrogen in packets containing food items.

Methods of prevention of rancidity

c) By adding antioxidants.



Potato chips manufacturers fill the packet of chips with nitrogen gas.

To prevent potato chips from oxidation, manufacturers remove oxygen and fill it with an inert gas like nitrogen.

Exercise (MCQ)

1. Which of the statements about the reaction below are incorrect?

$2PbO(s) + C(s) \rightarrow 2Pb(s) + CO2(g)$

(a) Lead is getting reduced.

(b) Carbon dioxide is getting oxidised.

(c) Carbon is getting oxidised.

(d) Lead oxide is getting reduced.

(i) (a) and (b)

(ii) (a) and (c)

(iii) (a), (b) and (c)

(iv) all

2. $Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe$
The above reaction is an example of a

(a) combination reaction.
(b) double displacement reaction.
(c) decomposition reaction.
(d) displacement reaction.

3. What happens when dilute hydrochloric acid is added to iron fillings?

(a) Hydrogen gas and iron chloride are produced.

(b) Chlorine gas and iron hydroxide are produced.

(c) No reaction takes place.

(d) Iron salt and water are produced.

4. Which of the following is not a physical change?

(a) Boiling of water to give water vapour
(b) Melting of ice to give water
(c) Dissolution of salt in water
(d) Combustion of Liquefied Petroleum Gas (LPG)

5. $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$
The reaction is an example of a

(i) displacement reaction
(ii) combination reaction
(iii) redox reaction
(iv) neutralisation reaction

(a) (i) and (iv)
(b) (ii) and (iii)
(c) (i) and (iii)
(d) (iii) and (iv)

6. Which of the following statements about the given reaction are correct?

$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$

(i) Iron metal is getting oxidised

(ii) Water is getting reduced

(iii) Water is acting as reducing agent

(iv) Water is acting as oxidising agent

(a) (i), (ii) and (iii) (b) (iii) and (iv)

(c) (i), (ii) and (iv) (d) (ii) and (iv)

7. Which of the following are exothermic processes?

(i) Reaction of water with quick lime
(ii) Dilution of an acid
(iii) Evaporation of water
(iv) Sublimation of camphor (crystals)

(a) (i) and (ii)
(b) (ii) and (iii)
(c) (i) and (iv)
(d) (iii) and (iv)

8. Three beakers labelled as A, B and C each containing 25 mL of water were taken. A small amount of NaOH, anhydrous $CuSO_4$ and NaCl were added to the beakers A, B and C respectively. It was observed that there was an increase in the temperature of the solutions contained in beakers A and B, whereas in case of beaker C, the temperature of the solution falls. Which one of the following statement(s) is(are) correct?

(i) In beakers A and B, exothermic process has occurred.
(ii) In beakers A and B, endothermic process has occurred.
(iii) In beaker C exothermic process has occurred.
(iv) In beaker C endothermic process has occurred.

(a) (i) only
(b) (ii) only
(c) (i) and (iv)
(d) (ii) and (iii)

9. A dilute ferrous sulphate solution was gradually added to the beaker containing acidified permanganate solution. The light purple colour of the solution fades and finally disappears.
Which of the following is the correct explanation for the observation?

(a) $KMnO_4$ is an oxidising agent, it oxidises $FeSO_4$
(b) $FeSO_4$ acts as an oxidising agent and oxidises $KMnO_4$
(c) The colour disappears due to dilution; no reaction is involved
(d) $KMnO_4$ is an unstable compound and decomposes in presence of $FeSO_4$ to a colourless compound.

10. Which among the following is(are) double displacement reaction(s)?

(i) $Pb + CuCl_2 \rightarrow PbCl_2 + Cu$
(ii) $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$
(iii) $C + O_2 \rightarrow CO_2$
(iv) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

(a) (i) and (iv)
(b) (ii) only
(c) (i) and (ii)
(d) (iii) and (iv)

11. Which among the following statement(s) is(are) true? Exposure of silver chloride to sunlight for a long duration turns grey due to

(i) the formation of silver by decomposition of silver chloride
(ii) sublimation of silver chloride
(iii) decomposition of chlorine gas from silver chloride
(iv) oxidation of silver chloride

(a) (i) only
(b) (i) and (iii)
(c) (ii) and (iii)
(d) (iv) only

12. Solid calcium oxide reacts vigorously with water to form calcium hydroxide accompanied by liberation of heat. This process is called slaking of lime. Calcium hydroxide dissolves in water to form its solution called lime water. Which among the following is (are) true about slaking of lime and the solution formed?

(i) It is an endothermic reaction
(ii) It is an exothermic reaction
(iii) The pH of the resulting solution will be more than seven
(iv) The pH of the resulting solution will be less than seven

(a) (i) and (ii) (b) (ii) and (iii)
(c) (i) and (iv) (d) (iii) and (iv)

13. Barium chloride on reacting with ammonium sulphate forms barium sulphate and ammonium chloride. Which of the following correctly represents the type of the reaction involved?

(i) Displacement reaction
(ii) Precipitation reaction
(iii) Combination reaction
(iv) Double displacement reaction

(a) (i) only
(b) (ii) only
(c) (iv) only
(d) (ii) and (iv)

14. Electrolysis of water is a decomposition reaction. The mole ratio of hydrogen and oxygen gases liberated during electrolysis of water is:

(a) 1:1
(b) 2:1
(c) 4:1
(d) 1:2

15. Which of the following is(are) an endothermic process(es)?

(i) Dilution of sulphuric acid
(ii) Sublimation of dry ice
(iii) Condensation of water vapours
(iv) Evaporation of water

(a) (i) and (iii)
(b) (ii) only
(c) (iii) only
(d) (ii) and (iv)

16. In the double displacement reaction between aqueous potassium iodide and aqueous lead nitrate, a yellow precipitate of lead iodide is formed. While performing the activity if lead nitrate is not available, which of the following can be used in place of lead nitrate?

(a) Lead sulphate (insoluble)
(b) Lead acetate
(c) Ammonium nitrate
(d) Potassium sulphate

17. Which of the following gases can be used for storage of fresh sample of an oil for a long time?

(a) Carbon dioxide or oxygen
(b) Nitrogen or oxygen
(c) Carbon dioxide or helium
(d) Helium or nitrogen

18. The following reaction is used for the preparation of oxygen gas in the laboratory $2KClO_3\ (s) \longrightarrow 2KCl\ (s) + 3O_2\ (g)$ Which of the following statement(s) is(are) correct about the reaction?

(a) It is a decomposition reaction and endothermic in nature

(b) It is a combination reaction

(c) It is a decomposition reaction and accompanied by release of heat

(d) It is a photochemical decomposition reaction and exothermic in nature

19. Which one of the following processes involve chemical reactions?

(a) Storing of oxygen gas under pressure in a gas cylinder
(b) Liquefaction of air
(c) Keeping petrol in a china dish in the open
(d) Heating copper wire in presence of air at high temperature

20. In which of the following chemical equations, the abbreviations represent the correct states of the reactants and products involved at reaction temperature?

(a) $2H_2(l) + O_2(l) \rightarrow 2H_2O(g)$
(b) $2H_2(g) + O_2(l) \rightarrow 2H_2O(l)$
(c) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
(d) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

21. Which of the following are combination reactions?

(i) $2KClO_3 \xrightarrow{Heat} 2KCl + 3O_2$
(ii) $MgO + H_2O \rightarrow Mg(OH)_2$
(iii) $4Al + 3O_2 \rightarrow 2Al_2O_3$
(iv) $Zn + FeSO_4 \rightarrow ZnSO_4 + Fe$

(a) (i) and (iii)
(b) (iii) and (iv)
(c) (ii) and (iv)
(d) (ii) and (iii)

END