

11

SOME NON-METALS IN NATURE



What are the ways in which trees support human life?

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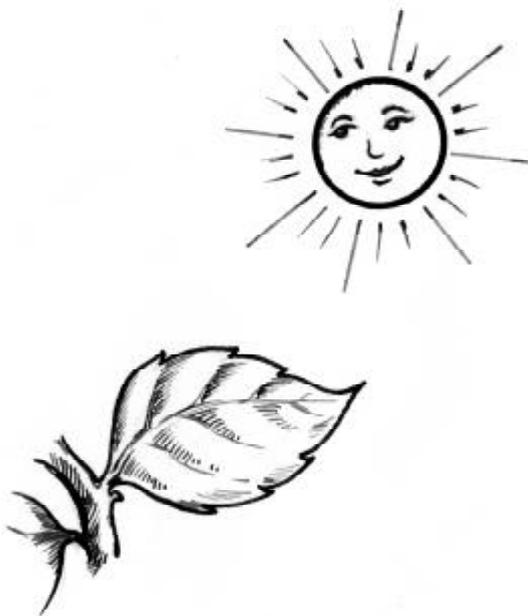


Fig. 11.1

What is the role of plants in providing oxygen and food? Do you know the chemical process behind this?

 You have learnt that the elements in carbohydrates are carbon, hydrogen and oxygen. What are those in the other components of food?

Components of food	Elements
Carbohydrates	C, H, O
Protein	C, H, O, N
Fat	C, H, O
Mineral salts	Mg, Ca, Fe, Na, K, Cl, P, O, S etc.
Water	H, O

Table. 11.1

There are metallic and non-metallic elements among these. Identify them.

As you know water and air have a major role in sustaining life. What are their constituents?

Hydrogen and oxygen are the constituent elements of water. Now take a look at the components of the atmosphere.

Components	Percentage
Nitrogen	78
Oxygen	21
Argon	0.934
Carbon dioxide	0.033
Other gases, water vapour etc	0.000256

Table. 11.2

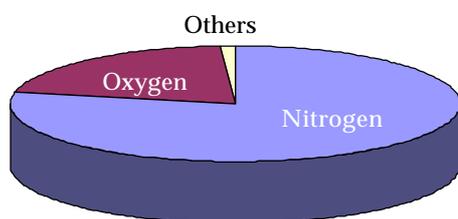


Fig. 11.2

Which among them are compounds? Note down their constituent elements.

The constituent elements of air and water are non-metals. The main components of food articles are also made of non-metals.

★ Which component of air is essential for respiration?

★ How many compounds of oxygen are known to you?

Oxygen

Oxygen exists in nature in the free state as well as in the combined state.

★ How is free oxygen represented? Write down its chemical formula.

★ To which of the following categories does oxygen molecule belong?

(Monoatomic, Diatomic, Polyatomic)

Oxygen is also found in air in a triatomic form, called ozone.

★ How is ozone represented?

Write down the characteristic features of ozone you know. Learn about the occurrence of oxygen in nature from table 11.3

Earth's crust (In the form of compounds)	50%
Water	89%
Minerals	45 - 50%
Atmosphere	21%
Flora and fauna :	
Vegetation	60 - 70%
Animals	60 - 70%

Table 11.3

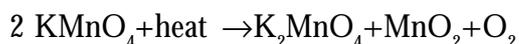
We use the oxygen in the atmosphere for respiration. Like this, animals and plants too need oxygen for respiration.

★ Millions of living beings, animals and plants use oxygen every minute for respiration. Will this not lead to the exhaustion of oxygen in the atmosphere?

- ★ Prepare a note explaining the role of green vegetation in maintaining the quantity of oxygen in the atmosphere.

Is it possible to prepare oxygen in your laboratory?

Notice the balanced equation for the reaction taking place, when powdered potassium permanganate is heated in a test tube.



What happens if a glowing agarbathi is introduced into this test tube?

Try it yourself.

- ★ What did you observe?
- ★ What is the reason?

Keep a lighted candle on the table and cover it with an inverted glass tumbler.

- ★ Why did the candle flame get extinguished?
- ★ What is your inference regarding the role of oxygen in the combustion of objects?

Combustion is a process in which a substance reacts with oxygen.

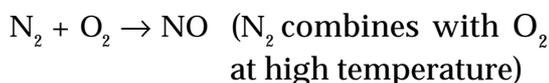
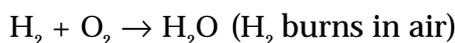
You are already familiar with the burning of magnesium in air. What was the end product? Complete the equation and balance it.



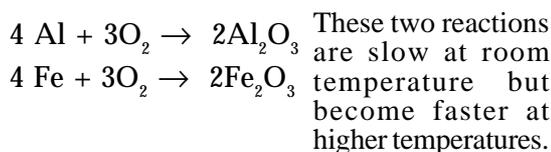
- ★ Write the equation for the formation of carbon dioxide by the burning of carbon.

Given below are the equations for the reactions of certain non-metals with

oxygen. Balance those which are not balanced. The conditions of the reactions are indicated in brackets.



Like non-metals, metals also react with oxygen and become their oxides.



In all such reactions, the metals lose their lustre due to the oxide layer formed on the surface.

- ★ Are there metals which do not lose their lustre in contact with air? What could be the reason? Find out.

- ★ What are the purposes for which oxygen is essential?

- For combustion of fuels
- In rocket fuels as oxidiser
- For medical purposes
- For natural degradation of materials.
-

Oxygen is produced industrially by the fractional distillation of liquefied air.

Nitrogen

Which is the major element in air?

- ★ Which properties of nitrogen are you aware of?

- ★ Fill up the following table after finding out the position of nitrogen in the periodic table.

Symbol	<input type="text"/>
Atomic number	<input type="text"/>
Atomic mass	<input type="text"/>
Electronic configuration	<input type="text"/>
Valency	<input type="text"/>
Physical state	<input type="text"/>
Colour	<input type="text"/>

You have already learnt that nitrogen is inevitable for the growth and sustenance of living organisms as it is the essential constituent of proteins.

Animals get nitrogen through food. What about plants?

Nitrates through lightning

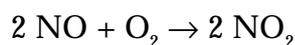
Nitrogen is more or less inert among the gases in the atmosphere. Still, it combines with oxygen at high temperature. During lightning, nitrogen in the atmosphere is converted to nitric oxide (NO).

- ★ What could be the reason for that?

-
- ★ Complete the equation and balance it.



Now take note of the equation for this nitric oxide combining with more oxygen:



NO_2 is a gas highly soluble in water. It dissolves in rain water, to form nitric acid and reaches the soil. There it changes to nitrate salts by interacting

with the minerals in the soil. The roots of plants take up these nitrate salts. This is the reason for the common saying that lightning is a blessing in disguise.

Nitrogen fixation through bacteria

The bacteria called rhizobium, living in the roots of some plants like beans can directly absorb nitrogen from the atmosphere and convert it into salts. The nitrogen thus converted to salts is stored as minerals in the root nodules and used by plants for their growth.

Plants get only a very small amount of nitrogen through lightning and micro-organisms, whereas the decomposition and decay of dead plants and animals provide large quantities of nitrogen to plants.

- ★ What are the organic wastes generally supplied to plants for their growth?

-
-
-

- ★ What is the importance of organic fertilizers in agriculture?

- ★ What are the limitations of organic fertilizers?

-
-
-

- ★ How can this be overcome?

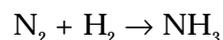
Nitrogen, phosphorous, potassium and sulphur are the main elements that plants should get through fertilizers. Among these, nitrogen is the most important one. The main material for the manufacture of fertilizers is ammonia gas. You can prepare ammonia in the classroom by a simple experiment.

Take some ammonium chloride in a test tube, add lime $[Ca(OH)_2]$ and heat it. Record the observations in table 11.4.

Chemical formula :	NH_3
of ammonia	
Density :	less than air
Smell :	
Colour :	

Table. 11.4

NH_3 is produced on a large scale by the reaction of nitrogen with hydrogen under special conditions. The chemical equation for this is given below. Balance it.



The nitrate minerals in nature are the other sources of nitrogen for plants. The most important ones are the following :

Name	Chemical formula
Saltpetre	KNO_3
Chile saltpetre	$NaNO_3$

Table. 11.5

Nitrogen cycle

Examine the illustration of the nitrogen cycle given below. How wonderfully nature manages the balance of atmospheric nitrogen and nitrates in the life cycle!

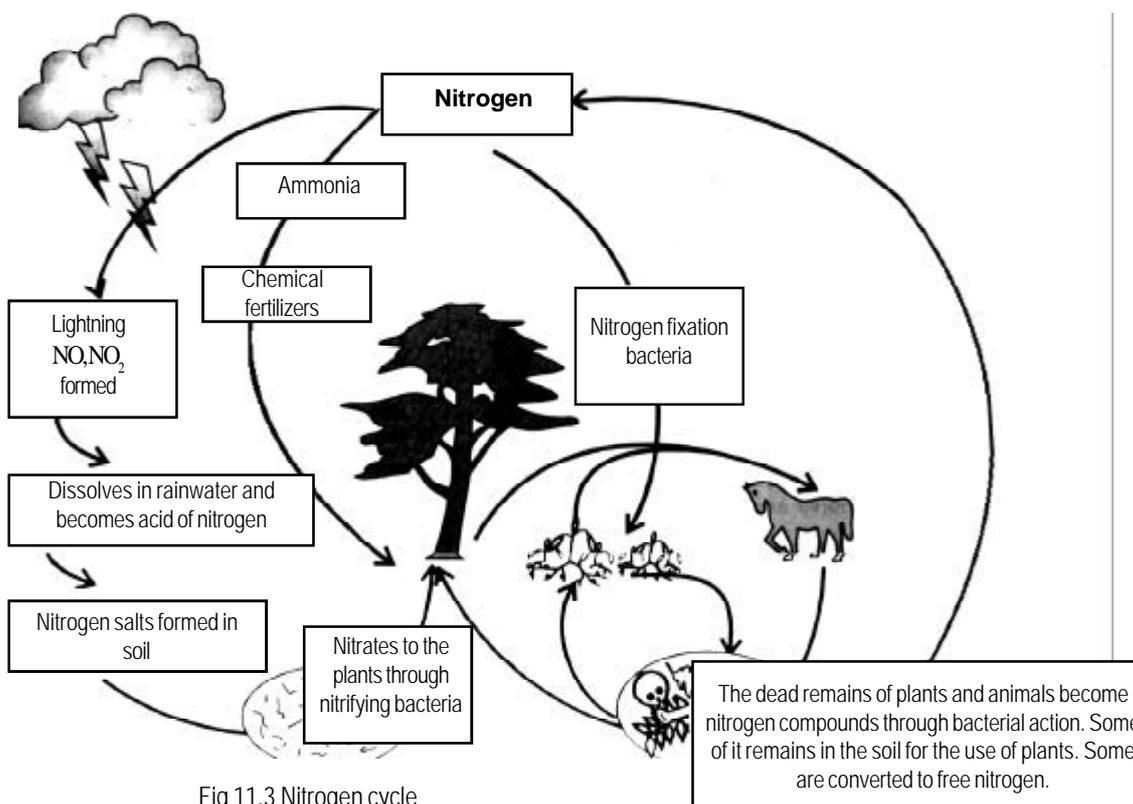


Fig 11.3 Nitrogen cycle

- ★ What do plants use nitrogen for?
- ★ How is nitrogen formed again in the atmosphere?
- ★ How is atmospheric nitrogen made available to plants?

Hydrogen

Take dilute hydrochloric acid in a wash bottle and put some zinc granules in it. Close the bottle and dip the free end of the tube in soap solution in a beaker. Bring a lighted matchstick close to the bubbles that are formed. What an interesting sight you see!

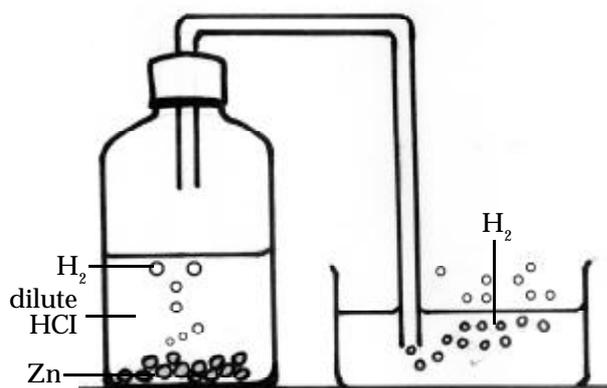
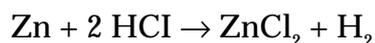


Fig. 11.4

- ★ How are bubbles formed here?
- ★ Which is the gas that burns with a 'pop' sound?

Look at the equation of the activity just done here:



What about collecting the gas that was formed in this experiment in a balloon?

What are the preliminary arrangements to be done for this? See fig. 11.5.

What are the materials required for this experiment?

Tie the inflated balloon with a thread, detach it from the jar and leave it free.

- ★ What happens? The balloon goes up. What conclusion can be reached with regard to the density of hydrogen?

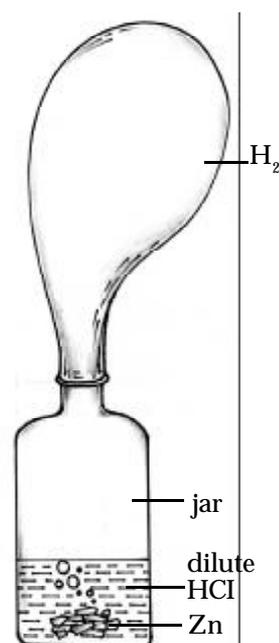


Fig. 11.5

The presence of hydrogen

99 % of the universe is hydrogen. The main component of the sun and the stars as well as the source of stellar energy is hydrogen.

Hydrogen occurs as free hydrogen and also in the form of compounds. List the compounds of hydrogen you know.

- NH_3
- HCl
-
-

Locate hydrogen in the periodic table.

★ What is the atomic number of hydrogen?

★ Mass number?

★ What are the features of hydrogen that differentiate it from other atoms?

● Size : -----

● Weight : -----

● Atomic structure : -----

★ Write the chemical formula of hydrogen

★ There are hydrogen isotopes with and without neutrons. Write the names and symbols of these.

The main compound of hydrogen is water (H_2O). Just as water is formed by hydrogen combining with oxygen, heavy water is formed by deuterium (heavy hydrogen) reacting with oxygen. Heavy water (D_2O) is mainly used in nuclear reactors.

You know that hydrogen is a combustible gas. Can it be used as a fuel?

Fig. 11.6 is a graph of the heat energy produced by the combustion of one gram each of different fuels.

★ Will the burning of hydrogen cause atmospheric pollution?

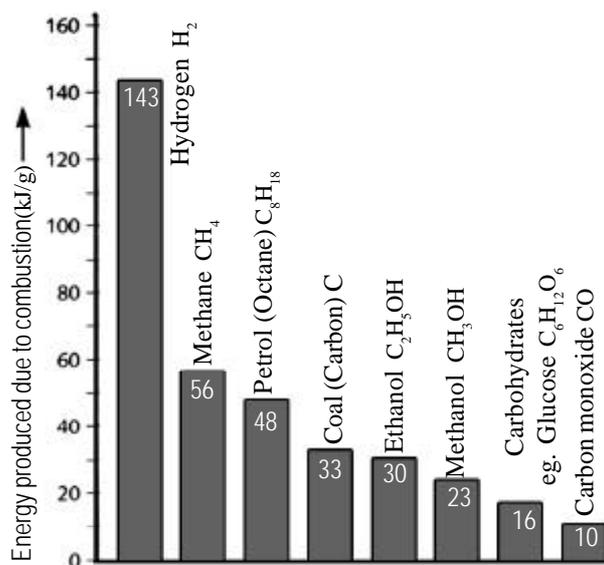


Fig. 11.6

★ Find out the equation for hydrogen burning in air

..... +..... →

★ Discuss and record the advantages of using hydrogen as a fuel on the basis of the following.

- Availability of hydrogen
- Available energy
- Least possibility of pollution

★ Despite all these advantages, why is hydrogen not used as a common fuel?

★ What are the technical difficulties in handling this fuel? Think it over in relation to hydrogen's combustibility and find out the answer.

And if this limitation is overcome?

Fuel Cell

Hydrogen-Oxygen fuel cells are used for the production of electricity by the reaction between oxygen and hydrogen under specific conditions. Water is the byproduct of this activity. So it is

considered a pollution free cell. Such cells are used for running motor cars with hydrogen as fuel. Hydrogen-Oxygen fuel cells are also used in space ships.

- ★ The availability of fossil fuels such as petrol, diesel and kerosene is fast diminishing. In these circumstances, can hydrogen be considered as the fuel of the future? Collect more details and prepare a note on the possibilities of using hydrogen as a fuel.

Chlorine

What are the main sources of drinking water?

- Well
-
-

Haven't you noticed the peculiar smell of tap water? This is due to the dissolved chlorine added to water as part of its purification process. It is the oxidizing action of chlorine that makes water free of germs.

Chlorine does not occur in nature in the free state. It is found as chlorides. Add more examples you know to the list of chlorine compounds:

- KCl
- AlCl₃
- MgCl₂
- CaCl₂
-

- ★ What guess can you make, about the chemical reactivity of chlorine based on the fact that chlorine is found in nature only as its compounds?

Use the periodic table to collect more details about chlorine and fill up the table below (table 11.6).

Atomic number	
Atomic mass	
Electronic configuration	
Valency	

Table. 11.6

What is the reason for the high chemical reactivity of chlorine? Arrive at a conclusion by considering its electronic configuration and valency.

Preparing chlorine

The fig 11.7 shows the arrangement for preparing chlorine in the laboratory. Analyse the figure.

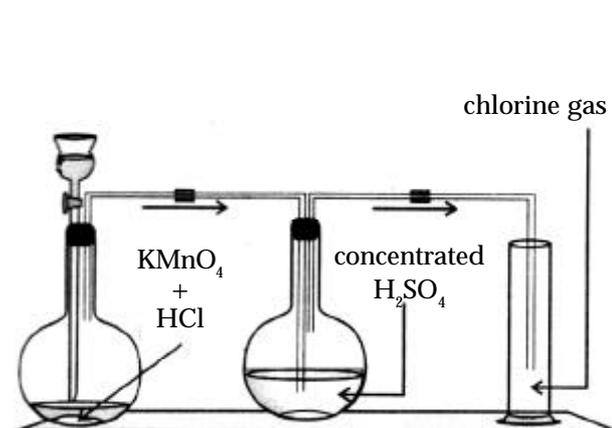


Fig. 11.7



Sulphuric acid (H_2SO_4)

Sulphuric acid which is used extensively in laboratories and industries is known as the king of chemicals. Sulphuric acid can be used to obtain the more volatile acids like hydrochloric acid and nitric acid from their salts. Concentrated sulphuric acid is highly corrosive. It acts as a drying agent by removing water from materials and also as dehydrating agent by eliminating hydrogen and oxygen from other compounds in the form of water.

- What are the reactants used?
- What are the products?
- Chlorine is collected by the upward displacement of air in the jar. From this what can you deduce regarding the density of chlorine?
- Why is chlorine gas passed through concentrated sulphuric acid? Find out by examining the products.
- Examine whether the equation is balanced.

Arrange the apparatus as in the figure with the help of your teacher and do the experiment. Note down the observations in the science diary.

- The colour of the gas that was produced
- Smell (Don't inhale)

Bleaching activity of chlorine

Let us do an experiment using chlorine. Take petals of colourful flowers, green leaves and coloured pieces of clothes and wet them in

water. Put them in a gas jar. Prepare chlorine and pass it through the jar.

What is the observation?

Chlorine has the ability to bleach coloured substances and make them colourless. Chlorine is used in garment industry for bleaching cloth.

Look at some more important uses of chlorine.

- For bleaching in various fields
- In the manufacture of pesticides.
- For preparing chloro-fluoro carbons used in refrigerators and air conditioners.
- For making stain removers
- For disinfecting drinking water
- ★ Which is the substance used for purifying drinking water in ponds and wells?

-
- ★ Take a pinch of bleaching powder and smell it. Are you able to recognize the main component of bleaching powder from its smell? What is it?
-

Bleaching powder is made by passing chlorine through dry slaked lime. It is used as a source of chlorine for common purposes.

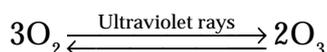
Conduct an experiment to find out if chlorine is present in the water to which bleaching powder has been added.

Ozone layer and chlorine

Chlorine and its compounds are

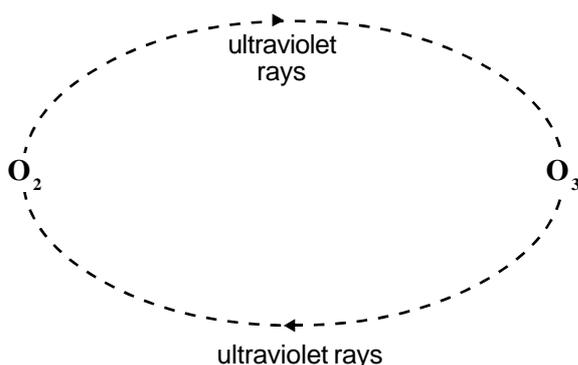
causing various environmental problems. Depletion of the ozone layer of the atmosphere is one among them.

It is in the stratosphere that ozone (O₃) is mainly found. Look at the equation for the formation of ozone.



The energy for splitting up of O₂ is received by the absorption of ultraviolet rays. The atoms thus formed combine with the unbroken O₂ molecules to form O₃ molecules.

This ozone again splits up into oxygen by absorbing ultraviolet rays.



Chloro- Fluoro carbons

Chloro- Fluoro carbons or CFC are compounds formed by the combination of chlorine and fluorine with carbon. These can be liquefied easily under pressure and then they evaporate with a cooling effect. Hence CFC are extensively used in refrigerators, air conditioners and air coolers. These are also used in spray perfumes.

The chloro-fluoro carbons which reach the atmosphere react with the ozone. This process depletes the quantity of ozone and causes imbalance in the oxygen-ozone cycle.

★ If so, will the absorption of ultraviolet rays in the stratosphere increase or decrease?

★ What will be its after effect?

Excess ultraviolet rays reaching the earth will prove harmful to living organisms.

★ What is the role of the modern way of life in the depletion of the ozone layer?

★ From which appliances and substances used in our day-to-day life will CFC ultimately reach the atmosphere?

★ Of these, which are the ones that are indispensable for living? What steps can be taken for reducing the depletion of the ozone layer and thus ensuring the preservation of the earth and the biosphere? Discuss with friends and make suggestions.