Chapter 7

Air and Atmosphere

Chapter Objectives

In this chapter, you will learn about:

- The constituents of air, their properties and importance
- Greenhouse effect and global warming
- Air pollution, various types of air pollutants and their prevention

We feel air all around us. What do you think air is made of? How can we say that air is matter?

AIR

We have learned that the Earth is surrounded by a blanket of air called **atmosphere**. Air is transparent and invisible. Thus, we cannot see air but we can feel it. Air is a mixture of gases as it contains nitrogen, oxygen, carbon dioxide and other gases in small amounts. Oxygen is essential for the survival of living things. Carbon dioxide is used by the plants to prepare their food during the process of photosynthesis. Nitrogen is also used by plants and is an important nutrient for their growth.

Occurrence of Air

Air is matter, as it occupies space and has mass. What happens when you blow air in a balloon? It expands. This shows that air occupies the space inside the balloon. Let us perform an activity to show that air has mass.

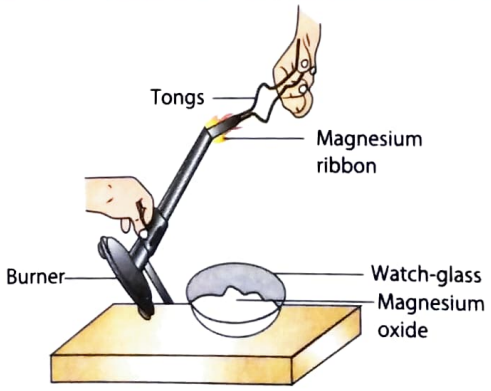
ACTION TIME 1

Aim: To show that air has mass.

Materials required: magnesium ribbon, china dish or watch glass, tongs, weighing balance, Bunsen burner

Procedure:

1. Weigh the magnesium ribbon. Hold that magnesium ribbon with tongs and place it over a Bunsen burner. Tilt the burner and place a china dish or watch glass below the ribbon such that ash gets collected in it (see figure).
2. Once the ribbon is burnt (in the presence of air), take the ashes from the watch glass and weigh them using a weighing scale. Compare the weight of the ribbon and the ashes.



Observation: The weight of the ash is more than the weight of the magnesium ribbon.

Conclusion: Burning of magnesium takes place in the presence of air. The ash formed is called magnesium oxide. It was found that the ash weighs more than the weight of magnesium ribbon. This shows that air has mass.

The reaction between magnesium and oxygen can be represented as:

$$\underset{\text{Magnesium}}{2Mg} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Magnesium oxide}}{2MgO}$$

Reactions of metals with oxygen are also known as ***oxidation reactions.***

CONSTITUENTS OF AIR

As already mentioned, air is a mixture of gases. The main gases present in the air are nitrogen which accounts for 78% and oxygen 21% by volume. The other main gases are argon and carbon dioxide. Water vapour is also present, whose amount varies from place to place and also depends on the season. Apart from all these, there are dust particles and polluting gases in the air.

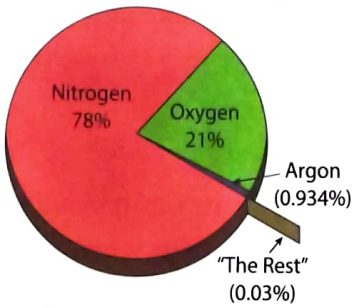


Fig. 7.1 Composition of air

Table 7.1 Chemical composition of air

Name	Symbol	% by volume/ (approx.)
Nitrogen	N_2	78.084%
Oxygen	O_2	20.9476%
Argon	Ar	0.934%
Carbon dioxide	CO_2	0.0314%
Neon	Ne	0.001818%
Methane	CH_4	0.0002%
Helium	He	0.000524%
Krypton	Kr	0.000114%
Hydrogen	H_2	0.00005%
Xenon	Xe	0.0000087%

The composition of air changes from place to place. In cities, where the motor vehicles, industries, etc., are more, the percentage of carbon dioxide is more than that in the villages. Major constituents of air are as follows:

Nitrogen

Nitrogen occurs both in free state as well as in combined state. In the free state, it comprises about 78% by volume of air. In the combined state, it is available in the form of proteins, which are essential for the growth of living things. Nitrogen is present in minerals, such as potassium nitrate (KNO_3) also known as saltpeter and Chile saltpeter ($NaNO_3$). Nitrogen is also present in gases, such as in oxides of nitrogen, ammonia, and in acids like nitric acid.

Physical properties of nitrogen

Nitrogen is a colourless, odourless and tasteless and mostly inert diatomic (N_2) gas at room temperature. Some of its properties are

- It is non-metallic.
- The density of nitrogen is 1.251 gram/litre at 0°C.
- It is slightly lighter than air.
- The boiling point of liquid nitrogen is –195.8°C.
- The freezing point of nitrogen is –209.8 °C.

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Nitrogen was first identified by a Scottish scientist Daniel Rutherford in 1772. The properties of nitrogen gas were studied by Lavoisier and he named it as '*azote*' which means 'without life'. In 1790, a French chemist, Antoine Chaptal, named it nitrogen from the Greek word '*nitron*'.

Preparation of nitrogen

In the laboratory, nitrogen is prepared by the action of heat on a mixture of ammonium chloride (NH_4Cl) and sodium nitrite ($NaNO_2$). In a round bottom flask, a saturated solution containing equal amounts of ammonium chloride (NH_4Cl) and sodium nitrite ($NaNO_2$) is taken and heated gently. You will see that a slow evolution of nitrogen gas takes place.

$$\underset{\text{Ammonium chloride}}{NH_4Cl} + \underset{\text{Sodium nitrite}}{NaNO_2} \xrightarrow{\text{Heat}} \underset{\text{Sodium chloride}}{NaCl} + \underset{\text{Ammonium nitrite}}{NH_4NO_2}$$

$$\underset{\text{Ammonium nitrite}}{NH_4NO_2} \xrightarrow{\text{Heat}} \underset{\text{Water vapour}}{2H_2O} + \underset{\text{Nitrogen}}{N_2}$$

Uses and importance

- Nitrogen is one of the major components of proteins. Plants and animals need nitrogen for their growth and functioning. Plants get the nitrogen from the nitrogen-fixing bacteria present in the soil or root nodules of the plants for making proteins.
- Nitrogen as a gas is used to fill tyres of aircraft and other vehicles.
- It is used in the manufacture of ammonia using the Haber process or Haber-Bosch process (Fig. 7.2)
- Nitrogen is used in the manufacture of explosives, such as trinitrotoluene (TNT) and nitroglycerine.
- Nitrogen is used in controlling pollution. In many industries, it is used to destroy toxic liquids and vapours in industrial **equipment.**
- In hospitals, liquid nitrogen is used for preserving and storing blood and tissues, because it provides a very low temperature for preservation.
- Due to its inert nature, nitrogen plays a key role in reducing spoilage, discolouration and off-flavouring, giving strength to the food packaging industry.

Renewal of nitrogen

The waste products of animals and plants contain nitrogen compounds.

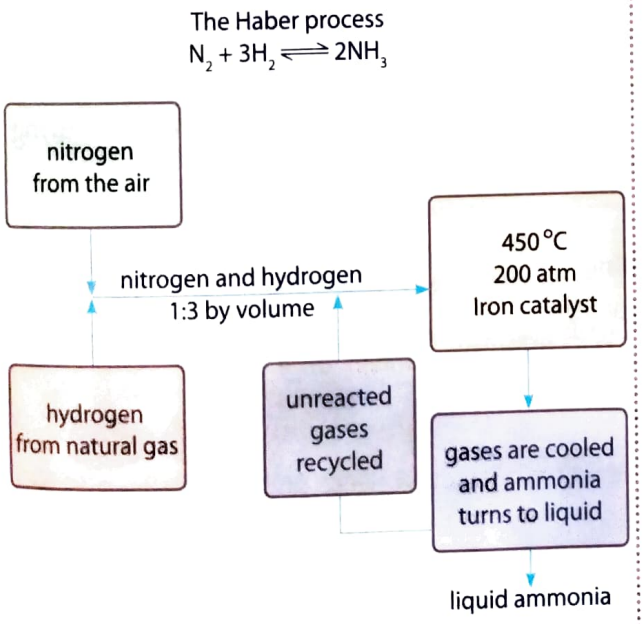


Fig. 7.2 The flowchart showing Haber's process

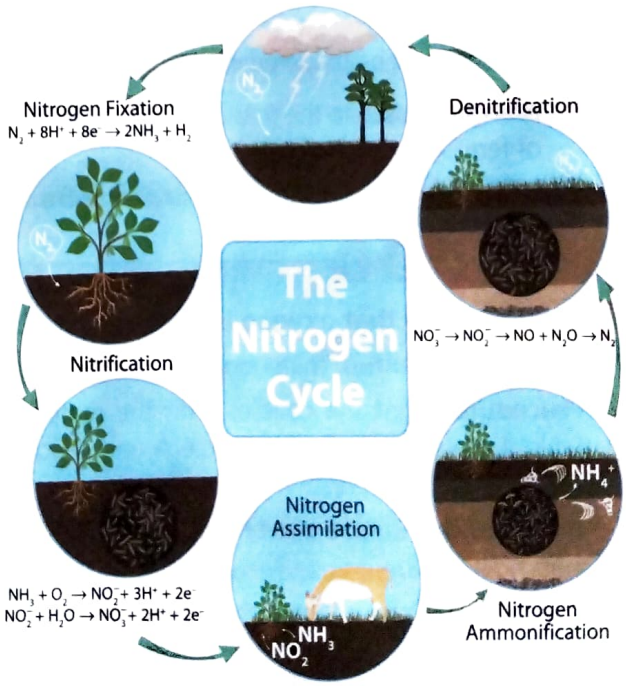


Fig. 7.3 Nitrogen cycle

Teaching Tip: The Haber process can be briefly discussed in class. | **Inert:** Not reactive

These compounds are acted upon by bacteria and other decomposers present in the soil (Fig. 7.3). These bacteria convert the nitrates back into atmospheric nitrogen. Similarly, when plants and animals die, bacteria decay their bodies and release nitrogen compounds into the soil. This process is called **ammonification**. Plants use these nitrogen compounds from the soil for their own growth and this process is called **assimilation.** These events repeat and the cycle continues. The circulation of nitrogen between the atmosphere, soil and living organisms is called the **nitrogen cycle**. This nitrogen cycle helps to maintain the amount of nitrogen in air at a fairly constant level.

Quick Check 1

State whether the following statements are True (T) or False (F).

1. Air is a mixture of two gases. ✗
2. Nitrogen accounts for 78% by volume in air. ✓
3. The boiling point of liquid nitrogen is –195.8°C. ✓
4. Nitrogen can be prepared in laboratory. ✓
5. Nitrogen is used in the manufacture of fertilisers. ✓

Oxygen

Oxygen is essential for the survival of living things as it is required for respiration. Plants, animals and human beings cannot live without oxygen. Oxygen also supports burning (Action Time 2). It is present in air as well as in water (dissolved form). The amount of oxygen dissolved in fresh water is used by fish and other aquatic life for respiration. It is found both in a free and combined state. In the free state, it constitutes about 21% of air by volume.

In the combined state, oxygen is an abundant element on the Earth. In the combined state, it is found in air as a constituent of CO_2 (0.03%). It is also present in rocks, minerals, in the form of oxides, etc. It is also present in carbonates, nitrates, silicates, phosphates, etc. The human body contains about 65% of oxygen by weight.

Preparation of oxygen

Oxygen is prepared by electrolysis of water. An electric current is passed through acidified water. It decomposes into hydrogen and oxygen.

$$\underset{\text{Acidified water}}{2H_2O} \xrightarrow{\text{electric current}} \underset{\text{Hydrogen}}{2H_2} + \underset{\text{Oxygen}}{O_2}$$

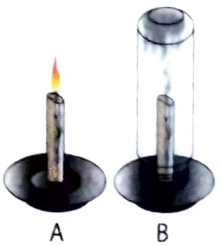
Oxygen can be prepared in the laboratory by the decomposition of hydrogen peroxide using manganese dioxide as a catalyst.

ACTION TIME 2

Aim: To show that oxygen is necessary for burning.

Materials required: matchbox, two candles, glass jar

Procedure: Light the candles with the matchstick. Place both the candles on a table. Label the candles as candle A and candle B. Now, invert a glass jar on the candle B and observe.



Observation: Candle B extinguishes after some time whereas candle A keeps on burning.

Conclusion: Candle B uses the oxygen available in the jar and extinguishes when oxygen is completely used up. Candle A is supplied with oxygen from the surrounding air continuously, and therefore keeps on burning. This shows that oxygen supports burning.

ACTION TIME 3

Aim: To prepare oxygen from hydrogen peroxide using manganese dioxide as a catalyst.

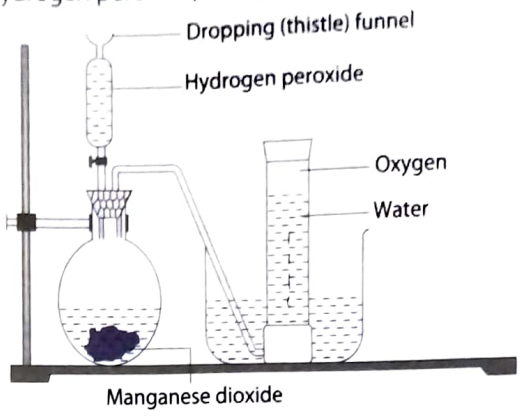
Materials required: a round bottom flask, two-holed stopper, a delivery tube, a beehive shelf, thistle funnel with stopper, a glass jar, a trough containing water, hydrogen peroxide, manganese dioxide (MnO_2)

Method: Take MnO_2 in a round bottom flask. Add hydrogen peroxide drop-by-drop through the thistle funnel.

Observation: As hydrogen peroxide falls on manganese dioxide, a brisk effervescence of oxygen gas evolves.

$$\underset{\text{Hydrogen peroxide}}{2H_2O_2} \xrightarrow{\text{Manganese dioxide}} \underset{\text{Water}}{2H_2O} + \underset{\text{Oxygen}}{O_2}$$

Collection of oxygen gas: Oxygen gas is collected through the downward displacement of water because it is slightly soluble in water.



Preparation of oxygen in the lab

Chemical Properties

Oxygen is one of the most reactive elements on the Earth. Let's learn about its chemical properties.

1. Oxygen is a non-combustible gas but is a good supporter of combustion (burning).
2. Oxygen gas converts carbon into carbon dioxide.

$$\underset{\text{Carbon}}{C} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Carbon dioxide}}{CO_2}$$

3. Oxygen reacts with metals and non-metals and forms their respective oxides. The chemical reaction of an element or a compound with oxygen is known as oxidation **reaction.** When a metal or non-metal reacts with oxygen or burns in oxygen, the product formed is known as oxides. For example, sodium reacts with oxygen to form sodium oxide.

$$4Na + O_2 \longrightarrow 2Na_2O \text{ (Sodium oxide)}$$

Sulphur reacts with oxygen to form sulphur dioxide.

$$S + O_2 \longrightarrow SO_2 \text{ (Sulphur dioxide)}$$

Different substances combine with oxygen at different rates. Depending on this, oxidation can be categorised into the following types:

1. Spontaneous oxidation 2. Rapid oxidation
3. Slow oxidation

Spontaneous oxidation: In this type of oxidation, the substance begins to burn on its own while being ignited by any physical means such as a flame or a spark. For example, metals like sodium and potassium react spontaneously with oxygen to form sodium oxide and potassium oxide, respectively.

$$\underset{\text{Sodium}}{4Na} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Sodium oxide}}{2Na_2O}$$

$$\underset{\text{Potassium}}{4K} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Potassium oxide}}{2K_2O}$$

Non-metals, such as phosphorus, burn in a jar of oxygen gas spontaneously producing dense white fumes of phosphorus pentoxide.

$$\underset{\text{Phosphorus}}{P_4} + \underset{\text{Oxygen}}{5O_2} \longrightarrow \underset{\text{Phosphorus pentoxide}}{P_4O_{10}}$$

Teaching Tip: Downward displacement can be explained to students.

Rapid oxidation: In this type of oxidation, a substance reacts with oxygen rapidly to release large amounts of heat and light energy. For example, combustible substances such as petrol, kerosene, methane and LPG burn rapidly in the presence of oxygen to produce a large amount of heat and light energy.

Slow oxidation: In this type of oxidation, a substance reacts with oxygen very slowly. It takes place over a long period of time. For example, iron reacts with oxygen from the air to form iron oxide.

$$\underset{\text{Iron}}{4Fe} + \underset{\text{Oxygen}}{3O_2} \longrightarrow \underset{\text{Iron (III) oxide or ferric oxide}}{2Fe_2O_3}$$

Table 7.2 Reactions of some non-metals with oxygen

Non-metal	Reaction with oxygen
Carbon (C)	$C + O_2 \xrightarrow{heat} CO_2$ (Carbon dioxide) $2C + O_2 \rightarrow 2CO$ (Carbon monoxide)
Hydrogen (H)	$2H_2 + O_2 \rightarrow 2H_2O$ (Water)
Sulphur (S)	$S + O_2 \rightarrow SO_2$ (Sulphur dioxide)
Phosphorus (P)	$P_4 + 5O_2 \rightarrow P_4O_{10}$ (Phosphorous pentoxide)

Table 7.3 Reactions of some metals with oxygen

Metal	Reaction with oxygen
Sodium (Na)	$4Na + O_2 \rightarrow 2Na_2O$ (Sodium oxide)
Potassium (K)	$4K + O_2 \rightarrow 2K_2O$ (Potassium oxide)
Aluminium (Al)	$4Al + 3O_2 \rightarrow 2Al_2O_3$ (Aluminium oxide)
Magnesium (Mg)	$2Mg + O_2 \rightarrow 2MgO$ (Magnesium oxide)

Uses of oxygen

- Oxygen is necessary for respiration. In the process of respiration, living organisms take in oxygen that helps breakdown food and give out carbon dioxide, water vapour and energy.
- Oxygen is essential for burning of fuels.
- Oxygen cylinder is used in hospitals and ambulances for artificial respiration of seriously ill patients. A mixture of 95% oxygen and 5% carbon dioxide, called **carbogen,** is given to the patients to stimulate natural breathing.
- Deep sea divers carry oxygen cylinders with them for respiration under seawater.

Fig. 7.4 Oxygen cylinder

- Oxygen is used for welding, cutting metals and glass. Burning of a mixture of oxygen and hydrogen produces flame with a very high temperature (2800 °C) and is known as oxy-hydrogen flame. This flame is used for welding, cutting metals and glass.

Fig. 7.5 Oxy-acetylene torch used for welding

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Oxy-acetylene flame is produced by burning acetylene with oxygen which produces a very hot flame (3700 °C). This flame is used for cutting and welding metals.

- Oxygen is used for removing impurities like carbon and silicon in the steel industry.
- Pure oxygen is used in the manufacture of acids like nitric acid and sulphuric acid.
- Liquid oxygen is used in space vehicles for burning of rocket fuel. Oxygen is also used for the respiration of astronauts as there is no oxygen in outer space.
- Fish and other aquatic animals use dissolved oxygen in the water for respiration.

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The process by which inhaled oxygen is used to break down food into simpler substances to produce energy is called **respiration**. However, the process by which a substance is burnt in the presence of oxygen is called **combustion**.

Both respiration and combustion are very different processes. Let us understand the differences between the processes, (Table 7.4).

Table 7.4 Differences between respiration and combustion

	Respiration	Combustion
1.	It is a biological (chemical) process that takes place in living beings.	It is a chemical process that takes place outside and involves inflammable materials.
2.	It is a slow process.	It is a fast process.
3.	The energy is released in some parts as heat.	The energy released during combustion is mostly in the form of heat.
4.	Carbon dioxide is released as a result of respiration.	Carbon dioxide, carbon monoxide, or some other gases are released depending on the type of combustion.

Rusting is another process that takes place in the presence of oxygen. It is also a chemical process but is very different from combustion. Let us understand the differences between these processes given in Table 7.5.

Table 7.5 Differences between combustion and rusting

	Combustion	Rusting
1.	It requires only oxygen to take place.	It requires both water and oxygen to take place.
2.	It takes place at high temperatures.	It takes place at low temperatures.
3.	It takes place rapidly.	It takes days or months to happen.
4.	Large amount of heat is released during this process.	Release or evolution of heat is very slow and it cannot be easily measured.

Quick Check 2

Fill in the blanks.

1. ..... constitutes about 21% of air by volume.
2. Oxygen is a ..... gas but is a good ..... of combustion.
3. Sodium + Oxygen → Sodium oxide, is an example of ..... oxidation.
4. ..... flame is produced by burning acetylene with oxygen.
5. Oxygen can be prepared in the laboratory by the decomposition of hydrogen peroxide using ..... as a catalyst.

Carbon Dioxide

Carbon occurs naturally as anthracite (a type of coal), graphite and diamond. Carbon dioxide occurs in the free state and in the combined state.

In the free state, carbon is present about 0.03–0.04% by volume in the atmosphere. It is present in coal regions.

In the combined state, it is present in the form of carbonates, bicarbonates in the Earth's crust, especially in the form of limestone ($CaCO_3$) and dolomite ($MgCO_3$. $CaCO_3$), sea shells and coral reefs contain $CaCO_3$.

In 1630, Van Helmont discovered carbon dioxide by burning material rich in carbon. He found that this gas did not support combustion. Later in 1783, Lavoisier established the true nature of carbon dioxide as an oxide of carbon. Carbon dioxide is obtained by burning carbon or carbon-containing compounds in air or oxygen.

Uses of carbon dioxide

- Solid carbon dioxide (that is, in the form of dry ice) is used in processes requiring large scale refrigeration. Carbon dioxide in the form of dry ice is mostly used in the wine-making process to cool down bunches of grapes quickly after picking in order to prevent the spontaneous fermentation by yeast.

Fig. 7.6 Dry ice sublimates quickly

- Carbon dioxide is used in fire extinguishers as a desirable alternative to water for most fires.

Fig. 7.7 A fire extinguisher

- It is also used in carbonated drinks.
- In the chemical industry, carbon dioxide is mainly used as an ingredient in the production of urea, washing soda (sodium carbonate), baking soda (sodium bicarbonate), etc.
- Plants use carbon dioxide to perform photosynthesis. Greenhouses can support plant growth with additional CO_2 in them.

- Compressed carbon dioxide is used as the cheapest non-combustible pressurised gas. Pressured CO_2 is used inside tins and in life jackets. Compressed CO_2 gas is used in paintball markers and air guns.

Greenhouse Effect

Solar radiation emitted by the Sun heats the Earth's surface. As the Earth's surface gets heated, it radiates some heat energy into the space. This heat energy is absorbed by the greenhouse gases, and increases the temperature of the atmosphere and the temperature of the planet Earth. This is known as the **Greenhouse effect.** The greenhouse effect keeps the Earth warm. The gases that cause greenhouse effect are called greenhouse gases. Greenhouse gas is any gas that has the ability to absorb or trap heat energy reflected from the Earth's surface. Carbon dioxide, methane and water vapour are major greenhouse gases.

Carbon dioxide is the most important greenhouse gas. Excessive burning of fossil fuels and other carbon-containing fuels, and deforestation leads to an increase in the release of carbon dioxide in the atmosphere.

The increasing level of carbon dioxide in the atmosphere has led to excessive heating of the Earth's surface. This phenomenon of increasing air temperature on the surface of the Earth is called **global warming.**

Water Vapour

Air contains water vapour. The amount of water vapour in the air affects the weather and the climate of a particular place. Water vapour plays a very important role in the water cycle. It is another greenhouse gas which can absorb thermal radiations coming from the Earth's surface more efficiently than carbon dioxide.

The amount of water vapour present in the air depends upon the location and season of that place.

Inert Gases

Lord Rayleigh, an English physicist, and William Ramsay, a Scottish chemist, found chemically unreactive gases in the air such as helium, neon, argon, krypton and xenon. These are present in air in very small quantities. Let us study some uses of inert gases.

- Helium is used to fill balloons used for weather studies. It is a very light gas.
- Neon is widely used in advertisement sign boards. When an electric current is passed through it, it gives a bright orange-red light.
- Argon is filled in electric bulbs.
- Radon is radioactive and is used in the treatment of cancer.
- Krypton and xenon are used in high intensity flash lamps for photography.

Dust Particles

Dust particles in the air come from various sources such as soil, volcanic eruptions, pollution from road, coal, burning of substances, etc. All these dust particles are hazardous to health. They lead to air pollution.

Quick Check 3

State whether the following statements are True (T) or False (F).

1. Oxygen is used as dry ice in refrigerators. ✗
2. In the free state, carbon is present about 0.03–0.04% by volume in the atmosphere. ✓
3. The amount of water vapour in the air affects the weather and the climate of a particular place. ✓
4. Unreactive gases present in air are called inert gases. ✓
5. Helium is a light gas and it is used to fill balloons used for weather studies. ✓

AIR QUALITY

We know that air consists of nitrogen, oxygen, carbon dioxide and water vapour. Air provides good conditions and support for the living things. But this normal composition of air gets disturbed due to many causes, such as human activities, industrial gases, burning of fossil fuels in vehicles, etc. All these activities lead to addition of unwanted particles to the natural air which causes air pollution. Substances that cause pollution are called **pollutants.**

Fig. 7.8 Smoke coming out from factories is one of the contributors of air pollution

Types of Air Pollutants

Pollutants may be solid, liquid or in gaseous form. The common air pollutants are fine particles such as smoke, soot and dust; carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and chlorofluorocarbons (CFCs)

Fine particles

Tiny particles of solid materials suspended in air are called **particulates**. Some very common particulates include smoke, dust and soot particles. Soot and smoke are produced due to burning of fossil fuels and woods. They carry very small particles which cause respiratory problems like asthma and bronchitis. Smoke mixed with fog is called **smog**. Smog reduces the visibility which leads to road accidents. Inhalation of particulates of lead oxide released by automobile exhausts leads to brain damage in children. Asbestos fibres can cause silicosis which is a disease of the lungs.

Fig. 7.9 Smog during daytime

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Fog forms when the temperature of air drops below **dew point**. So, fog can be said to be a cloud that occurs at or very near to the ground. Fog is formed generally when warm and cold air currents meet. It reduces the visibility to less than 1 km. Fog begins to form when water vapour condenses into small/tiny liquid water droplets in the air.

Smog, on the other hand, is a mix of smoke and fog. Smog forms when organic compounds and nitrogen oxides chemically react with sunlight to create ozone. These pollutant compounds often come from automotive exhaust, factories, power plants and even our hair spray.

Carbon monoxide (CO)

Carbon monoxide (CO) is a deadly, colourless, odourless and toxic gas. It is produced by the incomplete burning of various fuels, including coal, wood, charcoal, oil, kerosene, propane, etc. The main source of carbon monoxide are the petrol vehicles which are not fitted with a catalytic convertor. Carbon monoxide levels in urban areas are more due to heavy traffic. Other human-made sources releasing this gas are power stations and waste incinerators. At a domestic level, faulty gas appliances and cigarette smoking are significant sources of carbon monoxide. Natural processes produce relatively small amounts of carbon monoxide.

Fig. 7.10 Vehicles release smoke containing carbon monoxide gas

When we breathe in high concentrations of CO, it combines with the haemoglobin present in the blood to form a stable compound called carboxyhaemoglobin, and lead to reduced oxygen (O_2) carrying capacity of blood. It has hazardous effects on health that include headaches, dizziness and increased risk of chest pain for persons with heart disease.

Sulphur dioxide

Sulphur dioxide is present in the form of a gas. It is invisible, poisonous and has a nasty, sharp smell. It reacts easily with other substances to form harmful compounds, such as sulphuric acid, sulphurous acid and sulphate particles.

About 99% of the sulphur dioxide in air comes from human activities. The main sources of sulphur dioxide in the air are the industries processing materials that contain sulphur. For example, the generation of electricity from coal, oil or gas contains sulphur. Sulphur dioxide is also produced due to motor vehicle emissions, as a result of combustion of fossil fuels.

Inhalation of sulphur dioxide irritates the nose, throat and airways to cause coughing, wheezing, shortness of breath or uneasy feeling around the chest.

Sulphur dioxide combines with oxygen in the air and forms sulphur trioxide (SO_3). This sulphur trioxide reacts with water vapour present in the air to form sulphuric acid (H_2SO_4). This acid combines with the rain and falls on the Earth as acid rain. Acid rain reacts with the marble and corrodes the buildings. Yellowing of the marble of the Taj Mahal is also due to acid rain.

Incinerators: A furnace for incinerating (especially to dispose of refuse)

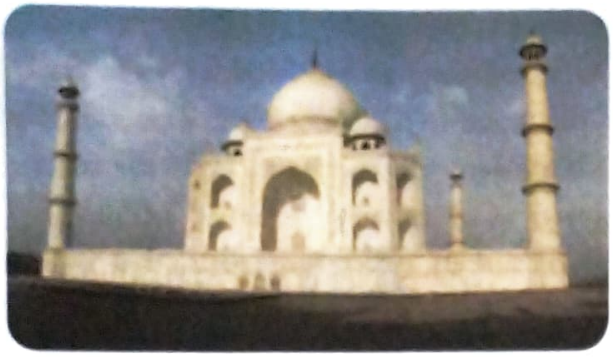


Fig. 7.11 Corrosion of Taj Mahal due to pollution

Looking at the condition of Taj Mahal, government of India decided to shift the nearby industries to relocate away from the monument and residential buildings.

Nitrogen dioxide

Nitrogen dioxide (NO_2) is a nasty-smelling gas. Some nitrogen dioxide is formed naturally in the atmosphere by lightning and some is produced by plants, soil and water.

Nitrogen dioxide is an important air pollutant because it contributes to the formation of photochemical smog, which can have significant impact on human health. Oxides of nitrogen form smog, which affects the human lungs and eyes.

The major source of nitrogen dioxide is the burning of fossil fuels such as coal, oil and gas. About 80% of the nitrogen dioxide in cities comes from motor vehicle exhaust. Other sources of nitrogen dioxide are petrol and metal refining, electricity generation from coal-fired power stations, other manufacturing industries and food processing.

Inhalation of nitrogen dioxide causes problems such as wheezing, coughing, colds, flu and bronchitis.

Chlorofluorocarbons (CFCs)

Chlorofluorocarbons (CFCs) are a group of compounds which contain the elements chlorine, fluorine and carbon. At room temperature, they are usually colourless gases or liquids which evaporate easily. They are generally unreactive and stable, non-toxic and non-flammable.

Chlorofluorocarbons are used in aerosol sprays, refrigerators and air conditioners. They cause the depletion of the ozone layers in the atmosphere. Ozone depletion means the steady and slow decline of the ozone concentration in the Earth's atmosphere. The ozone layer absorbs the harmful ultraviolet radiation emitted by the Sun and prevents them from reaching the Earth's surface. But, due to the depletion of the ozone layer in the atmosphere, the harmful UV rays can reach the Earth's surface.

How to Prevent Air Pollution

We have seen that air pollutants have an adverse effect on environment, human health, plants and animals. Hence, we must take necessary steps to prevent air pollution. Some methods are:

- Vehicles should be properly maintained and we all should adhere to emission control standards. This can be done by installing a special device called **catalytic converter**. It converts unburnt carbon monoxide gas and hydrocarbons into water vapour and carbon dioxide.
- Better designed equipment and smokeless fuels should be used in homes and industries.
- More trees should be planted along roadsides and houses which would help absorb carbon dioxide and release oxygen.

Photochemical: Relating to or caused by the chemical action of light

- As far as possible, use public modes of transport. This will help in reducing the levels of pollution. Also, encourage carpooling.
- Encourage walking and the use of bicycle to neighbourhood places.
- Industries should be located away from the residential areas.
- Alternative energy sources should be opted for, such as solar energy and wind energy, whenever possible. These sources have low carbon emissions and are environment-friendly.
- Do not burn the waste generated at home; instead, put it in the garbage for disposal.
- Use advanced air pollution control equipment, such as fabric filters and wet scrubbers. Fabric filters help to remove the dust particles by a process called 'bag filtration'. Wet scrubbers help to remove acid gases, like sulphur dioxide, present in the atmosphere.

Quick Check 4

State whether the following statements are True or False.

1. Nitrogen dioxide is a pollutant. .....
2. Carbon monoxide is non-toxic to human beings. .....
3. Tiny particles of solid material suspended in air are called particulates. .....
4. Sulphur dioxide is present in liquid form. .....
5. Nitrogen dioxide is a nasty smelling gas. .....
6. Acid rain reacts with marbles and corrode them. .....
7. Using public transport helps to reduce pollution from vehicles. .....
8. Trees absorb carbon dioxide and release oxygen. .....

KEY TERMS

Oxidation: A chemical reaction involving the addition of oxygen

Carbogen: A mixture of 95% oxygen and 5% carbon dioxide

Acid rain: Rain that becomes acidic, when mixed with emissions of nitrogen and sulphur

QUICK NOTES

* Air is a mixture of gases. It contains 78% of nitrogen, about 21% of oxygen, 0.9% argon and the remaining is carbon dioxide, dust particles and water vapour.
* Nitrogen is a colourless, odourless and tasteless gas. It is one of the major components of proteins.
* Nitrogen is prepared by the action of heat on a mixture of ammonium chloride (NH_4Cl) and sodium nitrite ($NaNO_2$).
* Oxygen reacts with metals and non-metals and forms their oxides.
* Oxygen is important for life, as it is required for respiration in most living organisms.

* Oxygen supports the process of burning. It is used in oxy-acetylene torches.
* Carbon dioxide is necessary for the process of photosynthesis.
* Carbon dioxide is used in making fire-extinguishers, fertilisers and aerated drinks.
* Air pollutants cause air pollution; carbon monoxide, sulphur dioxide, fine particles, dust are some of the pollutants of air.
* Acid rain is formed when pollutants such as sulphur dioxide, carbon dioxide and nitrogen oxides mix with rainwater.

RUN-THROUGH

I. Very Short Answer Questions.

A. Tick (✓) the correct answer.

1. Nitrogen constitutes nearly ..... % of the atmosphere.
   a. 24 ☐ b. 47 ☐ c. 68 ☐ d. 78 ☑
2. This is not a constituent of the atmosphere.
   a. Oxygen ☐ b. Nitrogen ☐ c. Carbon dioxide ☐ d. Aluminum ☑
3. On burning charcoal, which of the following gas is produced?
   a. Carbon dioxide ☑ b. Oxygen ☐ c. Nitrous oxide ☐ d. Hydrogen ☐
4. ..... is not an inert gas.
   a. Radon ☐ b. Xenon ☐ c. Krypton ☐ d. Hydrogen ☑
5. ..... is necessary for burning a substance.
   a. Light ☐ b. Gasoline ☐ c. Hydrogen ☐ d Oxygen ☑
6. When we breathe in, we inhale ..... gas.
   a. helium ☐ b. oxygen ☑ c. carbon dioxide ☐ d. hydrogen ☐
7. This gas in the atmosphere saves us from the UV rays of the Sun.
   a. Ozone ☑ b. Nitrogen ☐
   c. Oxygen ☐ d. Carbon monoxide ☐
8. Dry ice is ..... .
   a. very cold ice ☐ b. ice with added salt ☐
   c. any frozen liquid ☐ d. solid carbon dioxide ☑
9. Which of the following is not an atmospheric pollutant?
   a. Carbon monoxide ☐ b. Helium ☑
   c. Oxides of nitrogen ☐ d. Sulphur dioxide ☐
10. The main cause of air pollution is ..... .
    a. bird droppings ☐ b. solid rubbish ☐
    c. oil spills ☐ d. exhaust from vehicles ☑

B. Fill in the blanks.

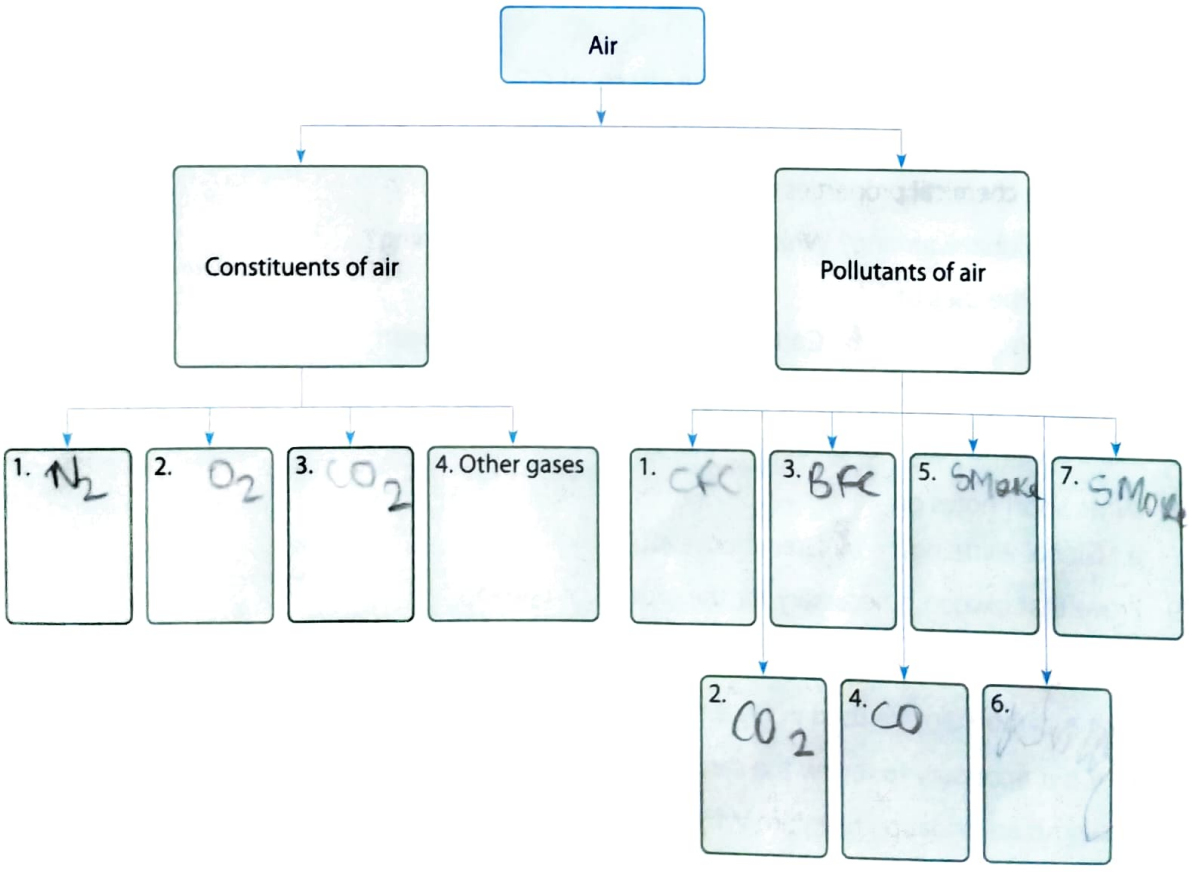
Sulphur, Nitrogen, Oxygen, Carbon Dioxide, Lighter, Oxygen, Air pollution, CFCs

1. O_2 gas is produced by plants during photosynthesis.
2. Hot air balloon rises up because hot air is ..... than cool air.
3. N_2 gas is used as fire extinguisher.
4. O_2 reacts with metals and non-metals, and forms their oxides.
5. CFC cause the depletion of ozone layer in the atmosphere.
6. We should encourage carpooling to prevent Air pollution
7. Oxides of ..... and ..... are the major cause of acid rain.

C. State whether the following statements are True or False.

1. Helium is a greenhouse gas. false
2. In desert areas, water vapour content is low. false
3. Catalytic converters help to prevent air pollution. true
4. The oxygen layer absorbs the harmful ultraviolet radiation emitted by the Sun. false
5. Sea shells and coral reefs contain nitrogen. false

D. Complete the concept map.



II Short Answer Questions.

A. Question and Answer.

1. What is an acid rain?
2. Which are the two main acids present in acid rain?
3. What is the boiling and freezing point of nitrogen?
4. Define dry ice. Write its uses.
5. Write the use of liquid nitrogen in hospitals.
6. What is a greenhouse gas?
7. What is global warming?
8. What are oxidation reactions? Give one example.
9. What is air pollution?
10. How do aquatic animals and plants breathe?

B. Differentiate between:

1. Combustion and Rusting
2. Respiration and Combustion
3. Carbon dioxide and Carbon monoxide
4. Smoke and Fog

C. Define the following terms.

1. Pollutant
2. Atmosphere
3. Inert gases
4. Greenhouse effect
5. Combustion
6. Rusting

III. Long Answer Questions.

1. Define air pollution. Write the harmful effects of CO, SO_2 and NO_2.
2. How can we prevent air pollution?
3. Write the chemical properties of carbon dioxide.
4. What is global warming? What is the impact of global warming?
5. Describe the uses of:
   a. Oxygen b. Carbon dioxide c. Nitrogen
6. Describe different kinds of air pollutants and their harmful effects.
7. Explain with the help of an activity that air has mass.
8. Write short notes on:
   a. Global warming b. Greenhouse effect
9. Prove that oxygen is necessary for the process of burning.

IV. Challenge

1. Why is carbon dioxide used in fire extinguisher, and not oxygen?
2. Why is it necessary to renew the carbon dioxide in the air?
3. Rusting is an oxidation reaction. Why?

4. How is combustion different from rusting?
5. What happens when we inhale carbon monoxide?
6. How do aquatic animals get oxygen to breathe?

V. Enrichment

A. **Smog:** The term smog was first used in London during the early nineteenth century to describe the combination of smoke and fog that often blanketed the city.

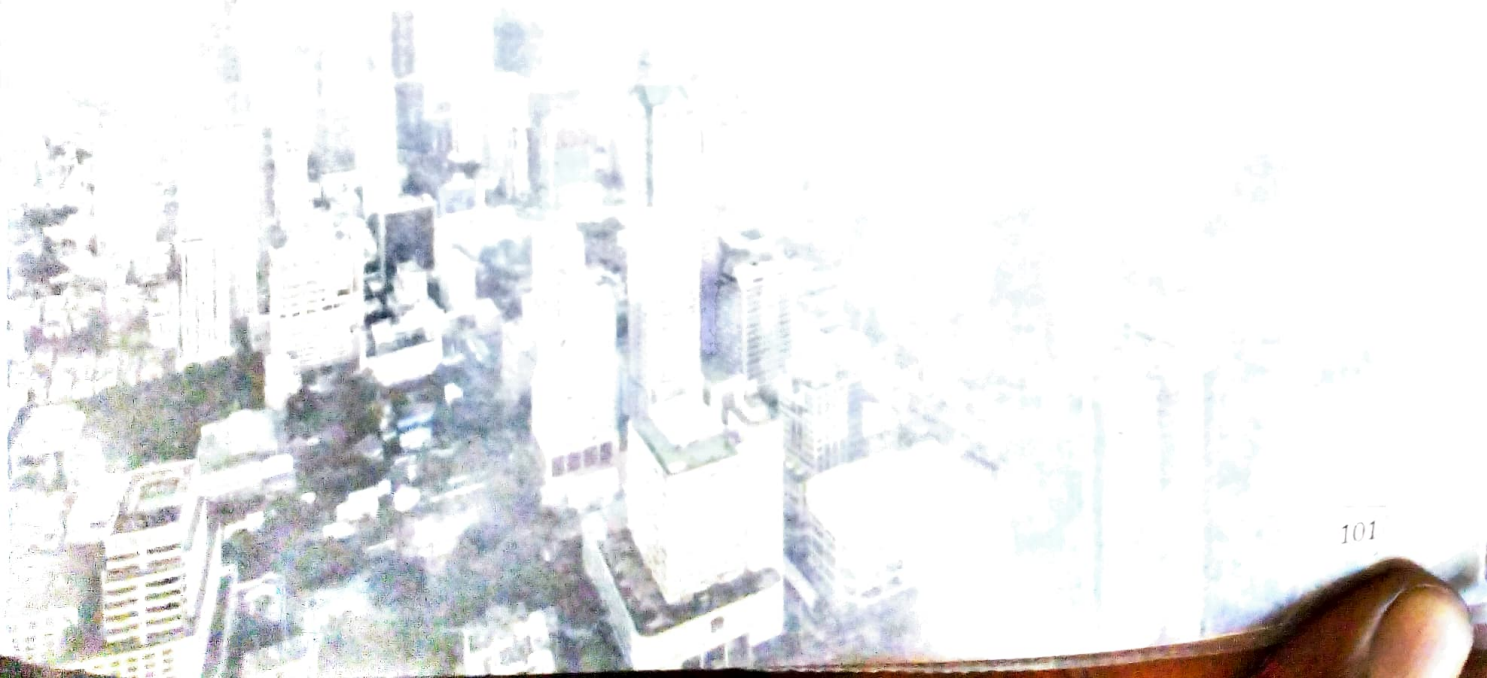
The Great Smog, which blanketed the British capital for five days in December 1952, is estimated by some experts to have killed more than 12,000 people and hospitalised 1,50,000. Thousands of animals died as well. The reason was air pollution. Sulphur particles mixed with fumes from burning coal and made the yellow fog smell like rotten eggs.

Sulphate was a big contributor to the fog, and sulphuric acid particles were formed from sulphur dioxide released by coal burning for residential use and power plants, and other means.

The incident eventually led to the Clean Air Act of 1956, restricting the burning of coal in urban areas in the United Kingdom.

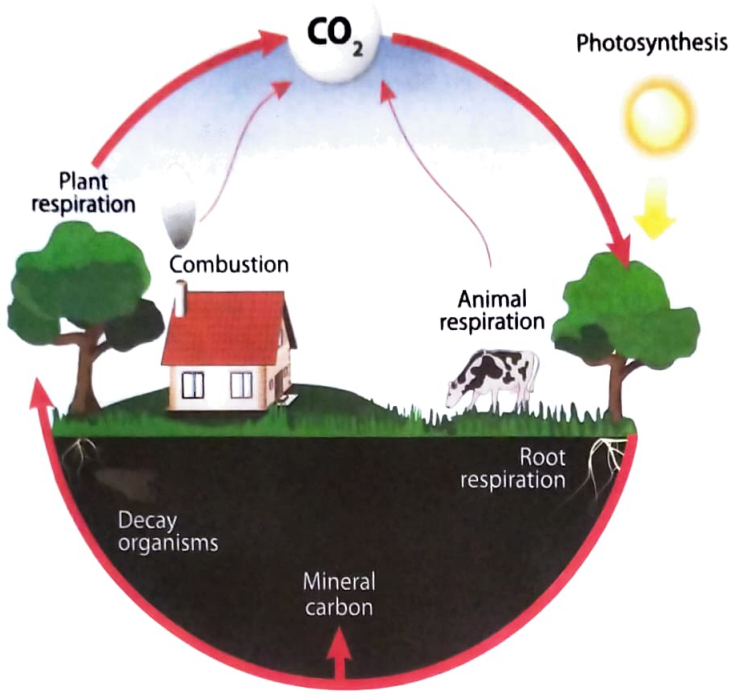
Nowadays, smog is produced by a set of complex photochemical reactions involving volatile organic compounds (VOCs), nitrogen oxides and sunlight, which form ground-level ozone. Smog-forming pollutants come from many sources such as automobile exhaust, power plants, factories and many consumer products, including paints, hair sprays, charcoal starter fluid, chemical solvents, and even plastic popcorn packaging.

Life Connect



B. **Carbon cycles:** The carbon cycle is the circulation of carbon between the atmosphere, soil, water and living organisms.

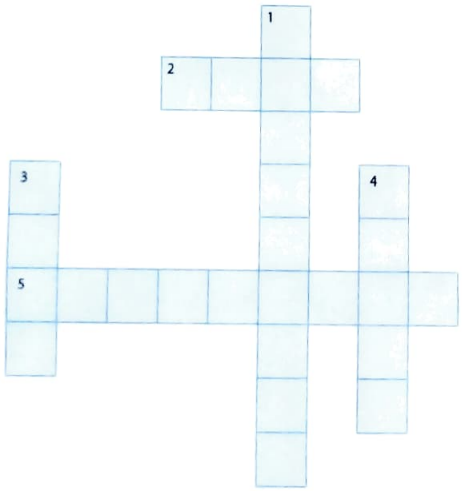
CARBON CYCLE



Discuss more about the carbon cycle and make a one-page report in your notebook.

ENJOY SCIENCE

1. **Solve the crossword**



Across

2. This gas is widely used in advertisement sign boards.

5. It is a chemical reaction, where oxygen is added.

Down

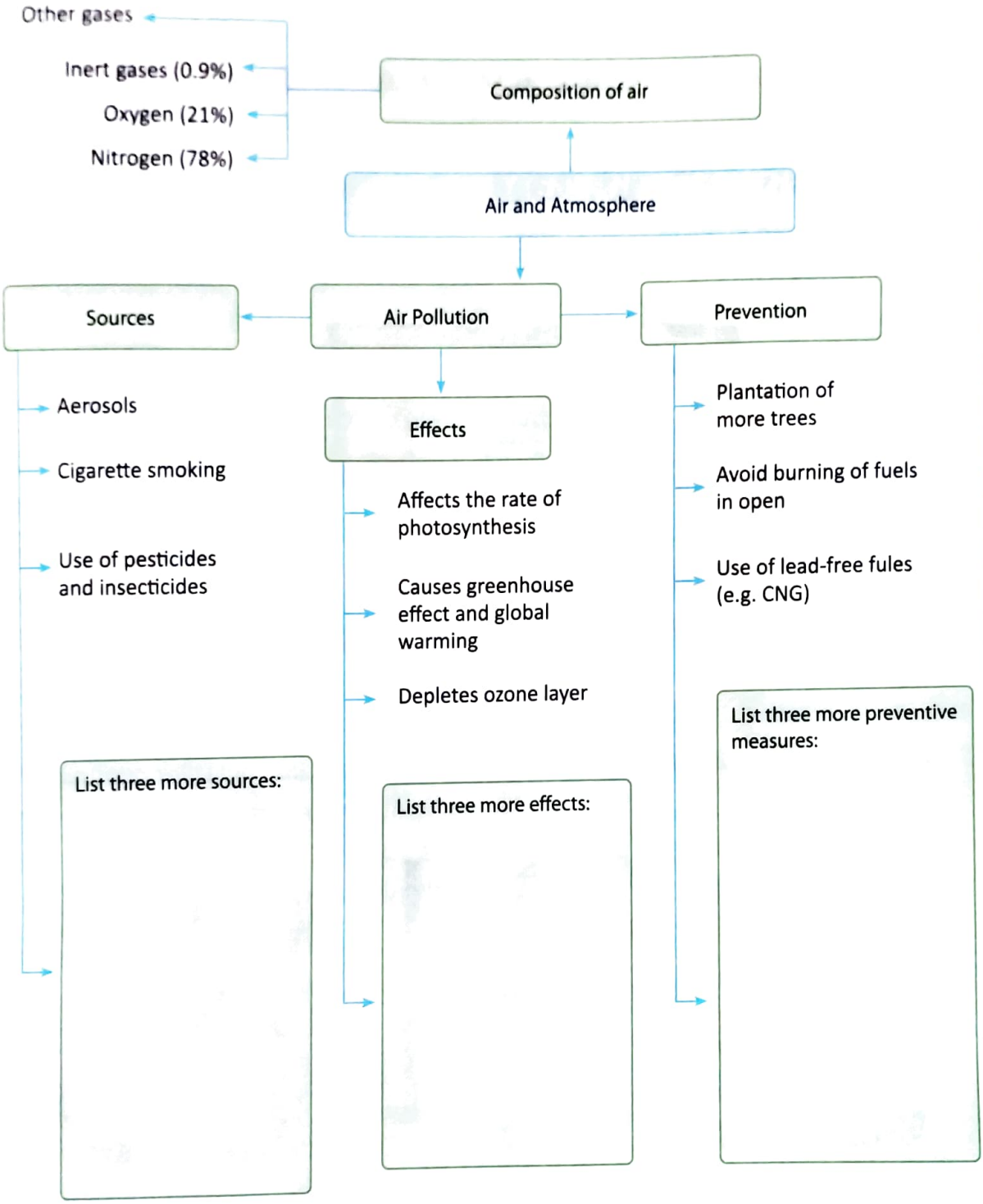
1. Using CNG as fuel, car pooling and public transport helps us to reduce this.

3. It is mixture of fog and smoke.

4. Due to the depletion of this layer in atmosphere, harmful UV rays reach the Earth's surface.

Volatile: Evaporating readily at normal temperatures and pressures

2. **Let's learn more. Learn, discuss and complete the concept map.**



SCIENTIFIC QUEST

Prepare a poster or a collage to create awareness among people towards 'Increasing Pollution and Its Harmful Effects'. Discuss your poster and state what it shows, with your class. Display your work on the class notice board.

PICTURE SURVEY

Name the gas used in the following cases.

a. .....

b. .....

c. .....

d. .....

RAPID FIRE 3

Fill in the blanks.

1. The change of silver to blackish or greyish colour is due to ..... of metal.
2. Substances written on the left-hand side of chemical equations are called ..... .
3. Reactions of metals with oxygen are known as ..... reactions.
4. There could be ..... or more products of a chemical reaction.
5. Negative electrode of dry cells can be made from ..... .
6. In a ..... reaction, a more reactive substance displaces a less reactive substance.
7. Low pressure ..... oxygen is used as breathing gas in space suits.
8. 0.0314% of air is ..... .
9. Tincture of iodine is widely used as a/an ..... .
10. Dilute HCl + Ammonium Chloride gives foul smell due to evolution of ..... gas.
11. Plants get ..... from bacteria in soil.
12. Nitrogen is ..... than air.
13. Most important use of ..... is as a water purifier.
14. In nitrogen fixation, ... temperatures are suitable.
15. Helium, neon, argon were found by ..... .
16. Change in ..... is a characteristic of occurrence of chemical reactions.
17. Elements with properties in between metals and non-metals are called ..... .
18. Smoke mixed with fog causes ..... .
19. In a ..... reaction, acid and base react to form a neutral product.
20. ..... is the hardest known material.
21. ..... is used as lubricant, in making pencil tips, dry cells and electrodes.
22. Hydrogen is used in the preparation of ..... flame.

Help Box:

nitrogen, neutralisation, smog, two, rusting, oxidation, zinc, pure, Rayleigh, magnesium, oxy-hydrogen, disinfectant, ammonia, metalloids, chlorine, graphite, reactants, low, lighter, heavier, one, diamond, displacement, oxidation, carbon dioxide.

Practice Test Paper 2

I. State whether the following statements are True or False.

1. Zinc is not used in brass.
2. Gas is evolved during some chemical reactions.
3. Air contains water vapour and it affects the weather of a particular place.
4. Oxygen can be used for removing impurities.
5. In decomposition reaction, single compound breaks down into smaller molecules.
6. Air has no mass.
7. Corrosion weakens the metals.
8. Nitrogen is present in the waste of animals and plants.
9. Iodine dissolves easily in water.
10. Combustion is a slow chemical process.

II. Name the following:

1. Substances formed as a result of chemical reaction. .....
2. Device used in cars that converts unburnt carbon monoxide and hydrocarbons into water vapour and carbon dioxide. .....
3. The effect that keeps the Earth warm. .....
4. It is obtained by burning of wood in limited supply of oxygen. .....
5. CH_3OH .....

III. Unscramble the words to get the answer.

1. Gas used to fill weather balloons. (DGNRYHEO) .....
2. Drinks which have carbon dioxide. (BTDENAACRO) .....
3. Substances that react together in a chemical reaction. (ACTATNSER) .....
4. A silvery-white metal used to make jewelery. (MILNUPAT). .....
5. Plating of iron or copper objects with zinc, tin or chromium by electrolysis. (TRPOCLEETLATGIN) .....

IV. Answer the following:

1. What is smog and how does it affect us?
2. Give some uses of lead.
3. How is galvanisation useful?
4. What are the different types of reactions?
5. How are greenhouse effect and global warming related?

Logical-Reasoning

Write the correct answer. ***One is done for you.***

A. Both A and B are true. B is the correct explanation of A.
B. Both A and B are true. B is NOT the correct explanation of A.
C. A is true, B is false.
D. A is false, B is true.
E. Both A and B are false.

1. A. Gases have the least intermolecular forces. B. Liquids have strong intermolecular forces.	E
2. A. Melting is a physical process. B. In melting, solid changes to liquid on heating. The process can be reversed by freezing.	
3. A. Tin is a silvery-white metal. B. Zinc is used to make alloys.	
4. A. Oil mixed in water is an emulsion. B. It is a heterogeneous solution.	
5. A. Petrol can be separated into its constituents by a separating funnel. B. The condenser used in distillation is the Leibig's condenser.	
6. A. Gases do not have a fixed shape or size. B. Liquids do not have a fixed volume.	
7. A. Smoke mixed with ice is called smog. B. Nitrogen dioxide is a nasty-smelling gas.	
8. A. In a displacement reaction, a more reactive substance displaces a less reactive substance. B. In a neutralisation reaction, an acid and a base react to form a neutral product.	
9. A. 'Dalton's Atomic Theory' states that all elements are made up of atoms. B. Electrons are negatively charged particles.	
10. A. Ripening of fruit is a desirable change. B. Rusting of iron is an undesirable change.	
11. A. In hospitals, liquid nitrogen can be used to store blood and tissues. B. The formula for dolomite is $MgCO_3.CaCO_3$	
12. A. Silicon and Arsenic are metalloids. B. Neon and Argon are non-metals.	
13. A. Gold is a precious metal. B. The primary use of gold is to make ornamental objects, jewellery and coins.	
14. A. Burning of paper is an endothermic change. B. Melting of ice is also an endothermic change.	
15. A. Matter occupies space. B. Matter has mass.	
16. A. Cation has a negative charge. B. Anion has a positive charge.	

CASE STUDY 1

Carbon Footprint

Carbon footprint is the measure of an individual's or an organisation's activities, measured in units of carbon dioxide. For example, a family uses a car, it adds to that family's carbon footprint. This is because a car runs on petrol/diesel/CNG/LPG. It produces CO_2 (carbon dioxide) as waste. Buses, trains and planes also produce CO_2. The trash one creates also contributes to carbon footprint. This happens because, over time, trash produces CO_2 and methane, another type of greenhouse gas. In this way, overall emission of greenhouse gases increases.

The best way to reduce our carbon footprint is to use less electricity and less fossil fuels.

Be sure to turn off your computer, television and lights when you're not using them.

Walk or use a bicycle whenever you can, instead of using a car or a bus. Reduce the amount of trash you create by recycling and reusing items.

Production of goods also emits a large amount of greenhouse gases. Buying used and recycled products helps to reduce carbon footprint up to a great extent.

Answer the following questions.

1. What can be the ill-effects of carbon footprint?
2. How does an organisation/school contribute to carbon footprint?
3. How can an individual help in reducing carbon footprint?
4. How does reduce-reuse-recycle help in reducing carbon footprint?

Think and Answer.

1. Maira's mother exchanged her desktop for a laptop. She told Maira that it will help her to reduce her carbon footprint. How?
2. Navneet loves to drive his car. However, he keeps on changing the speed of his car. His father tells him that unnecessary speeding not only wastes fuel but also increases the carbon footprint. How?
3. Give a relevant heading to the case study given above.

CASE STUDY 2

Pollution: Is it a serious concern?

Case 1: The day after the festival, the city people woke up to find themselves enveloped in a cloud of smog so thick that you could not see beyond a few feet. The news reported a sharp decline in air quality, with most places registering off-the-charts severe conditions. Reports also suggested that this city's air quality over the festival weekend was one of the worst in the world.

Case 2: 'We haven't seen the stars in a while', said the twelve-year old girl to her mother.

Let us see a comparison of a night sky as shown in the picture about two different places.

Picture A

Picture B

Think and Answer.

- What do you conclude from the above case study?
- Why is the night sky in the mountains more clear than in the cities?
- How can pollution be harmful for our health?
- How can pollution be harmful for our monuments?
- What measures can we take to reduce pollution? List any two.