Chapter 4

POLLUTANTS AND THEIR EFFECTS ON ENVIRONMENT

STUDENTS' LEARNING OUTCOMES

After studying this chapter, students will be able to:

- ☑ Explain the sources, properties and harmful effects of air pollutants.
- ☑ List problems in human organ systems caused by air pollutants.
- ☑ Plan and conduct a campaign that can help to reduce air pollution in their local environment.
- ☑ Explain the greenhouse effect.
- ☑ Describe the causes and effects of ozone depletion.
- ☑ Carry out a research to explain global warming and its likely effects on life on the Earth.
- ☑ Design a model to explain the greenhouse effect.
- ☑ Explain the formation of acid rain and identify its consequences on living and non-living things.
- ☑ Define deforestation.
- ☑ State the effects of deforestation on the environment.
- ☑ Identify human activities that have long-term adverse consequences on the environment.
- ☑ Explain the importance of local and global conservation of natural resources.
- ☑ Suggest ways in which individuals, organizations and government can help to make the Earth a better place to live.

The environment we live in is not as clean as it should be. Various natural and human activities contaminate it with harmful substances. Dust storms, rotting of vegetation, volcanic eruption, etc., are the natural phenomena which release dust particles and poisonous gases in the environment. On the other hand, burning of fuels in the vehicles and industry and many other human activities are releasing poisonous

compounds in the environment. The poisonous and harmful substances which contaminate or pollute the air are called **air pollutants**. In this chapter, we will discuss the effects of air pollutants on human life and the environment. Awareness about environmental pollution and measures to reduce it will also be discussed.

4.1 Air Pollutants and Their Sources

Carbon monoxide (CO), sulphur dioxide (SO_2), oxides of nitrogen (NO and NO_2), chlorofluorocarbons (CFCs), etc., are the main air pollutants. Poisonous gases produced during the decay of dead organic matter and particulate matter like soot, dust particles, pollens, metallic compounds (e.g., compounds of lead), etc., also pollute the air.

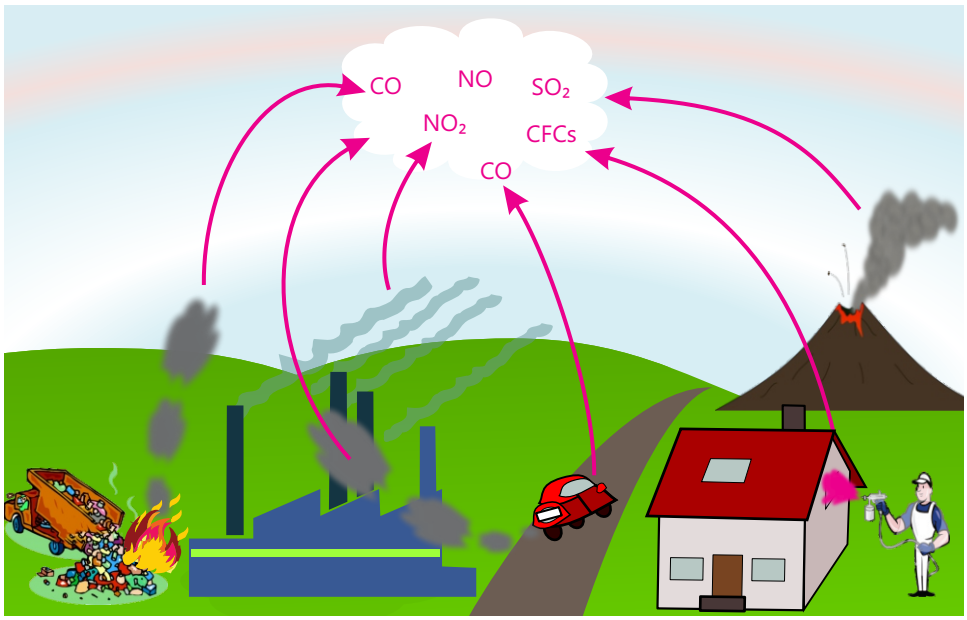


Figure 4.1: Air pollutants

Carbon monoxide is produced by the incomplete combustion of coal and other fossil fuels (natural gas, petrol, oil, etc.). Smoke released from motor vehicles and industries is the main source of carbon monoxide (Figure 4.1).

Sulphur dioxide is produced by burning of coal or oil in factories. Smoke released from thermal power stations usually contains sulphur dioxide. Oxides of nitrogen are produced by burning of coal and oil at high temperature in industries and vehicle engines. Chlorofluorocarbons (CFCs) are the compounds which contain chlorine, fluorine and carbon atoms. CFCs are used in aerosol sprays, refrigerators and air conditioning system.

On leakages from these appliances, CFCs enter the air. Fossil fuels (coal, natural gas, oil, petrol, etc.) and aerosols are the main **sources of air pollutants** (Figure 4.2).

Vehicles' smoke

Industrial smoke

Smoke emitted from thermal power station

CFCs in aerosol spray

Figure 4.2: Sources of air pollutants

Rotting vegetation and volcanic eruption are natural sources of air pollution (Figure 4.3).

Rotting vegetation

Volcanic eruption

Figure 4.3: Natural sources of air pollutants

4.1.1 Properties of Air Pollutants Their and Effects on Human Organ Systems

Carbon monoxide

Carbon monoxide is a colourless, odourless and poisonous gas. It affects the human organ systems badly and causes headache, brain damage and respiratory problems. When carbon monoxide reaches our blood, it binds with haemoglobin and reduces its oxygen-carrying capacity.

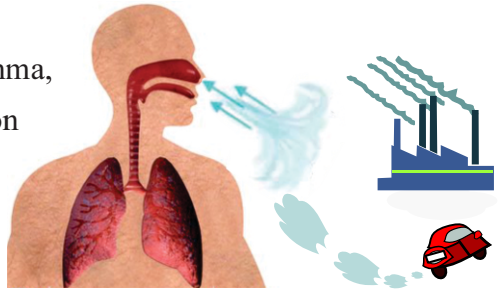
Sulphur dioxide

It is a colourless gas with irritating smell. It dissolves in rain water and causes acid rain. Exposure to sulphur dioxide causes breathing difficulties, pneumonia, lung cancer etc.

Interesting information

Sulphur dioxide causes:

- Severe respiratory problems such as asthma, chronic bronchitis, degraded lung function
- Respiratory failure
- Cardiovascular diseases
- Cancer



Oxides of Nitrogen

Oxides of nitrogen are all toxic gases. They dissolve in rain water to cause acid rain. They have severe effects on lungs and damage them (Figure 4.4).

(a) Oxides of nitrogen released by burning of fuel at high temperature

(b) Effect of oxides of nitrogen on lungs

Figure 4.4

For your information

- Sulphur dioxide destroys chloroplast in plants. As a result, the photosynthesis and plant growth are affected.

4.2 Effects of Human Activities on Environment

Human activities such as burning of fuels, extensive use of vehicles, aerosols, fertilizers, insecticides, pesticides, etc., and deforestation are affecting the environment badly. We will discuss here a few examples of adverse effects of human activities on the environment.

4.2.1 Greenhouse Effect

When sunlight falls on the Earth, a small part of it is absorbed by the Earth and is converted to heat energy. A part of this heat energy is reflected by the Earth back to the atmosphere. Some gases present in the atmosphere, e.g., carbon dioxide, methane, oxides of nitrogen, water vapours, etc., trap a part of the heat reflected by the Earth causing increase in the atmospheric temperature (Figure 4.5). These gases are called **greenhouse gases** and the phenomenon is called **greenhouse effect**.

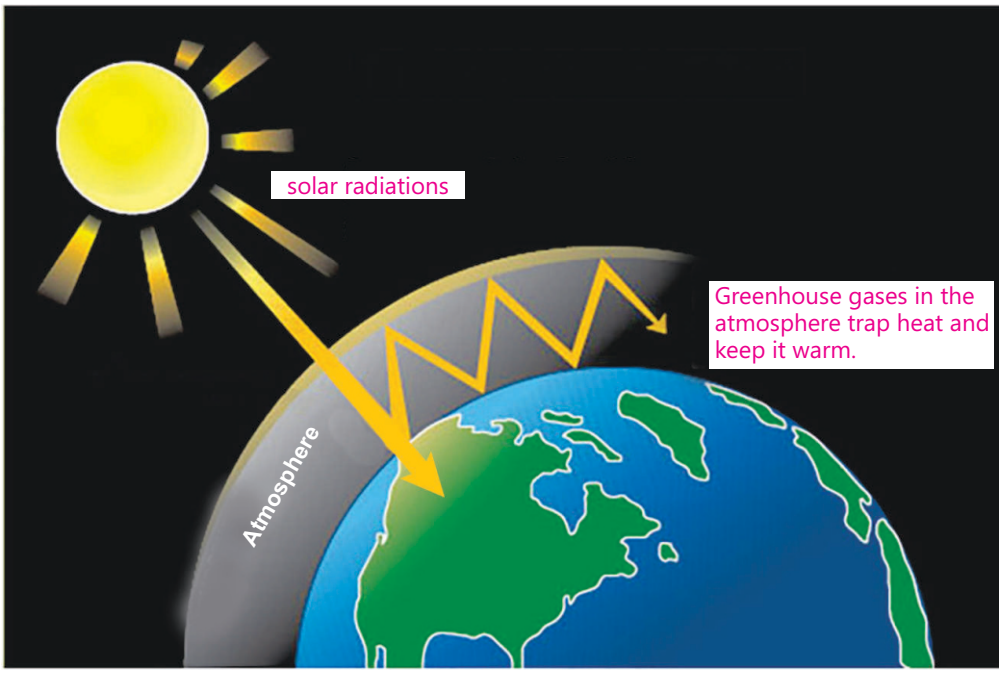


Figure 4.5: Greenhouse effect

Interesting information

Greenhouse is a big room made of glass panels or transparent plastic sheets. It provides warm environment to the plants and vegetation grown inside it so that they can grow well during winter. Glass or transparent plastic sheets used in greenhouses allow the Sun's heat to enter the greenhouse and trap the heat which is reflected back by the Earth. The heat trapped by the walls and roof of the greenhouse keeps the inside environment warm.

Activity 4.1

Material required:

Collect some easily available plastic sheets, wooden strips, nails, etc. and potted plants.

Procedure:

- Follow the Figure given in the boxed information above and design simple greenhouse.

4.2.2 Ozone Depletion

A layer of ozone (O_3) in the upper atmosphere of the Earth stops the ultraviolet rays coming from the Sun to the Earth. In this way, the living things on the Earth remain safe from harmful effects of the ultraviolet radiation coming from the Sun.

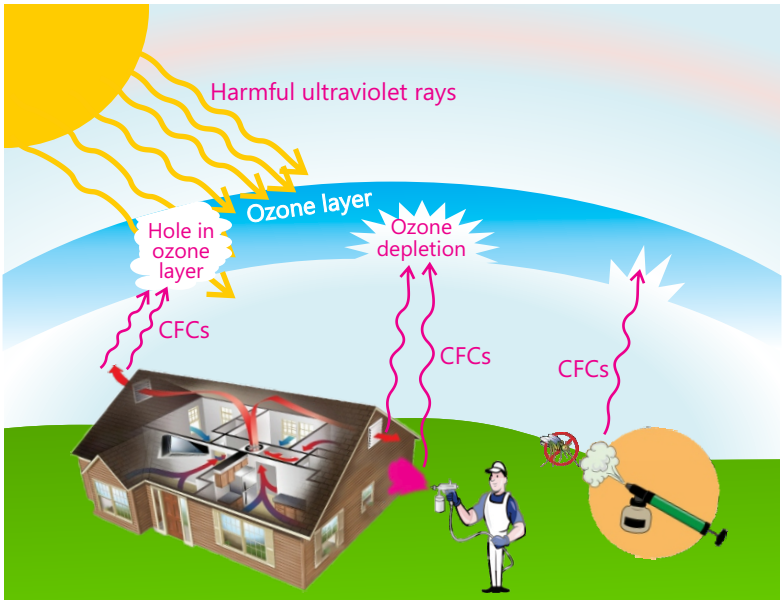


Figure 4.6: Ozone depletion

Chlorofluorocarbons (CFCs) which are used in air conditioners, refrigerators, spray cans, etc., enter the air on leakage from these appliances. On reaching the ozone layer, they react with ozone and cause thinning of this layer. Hence, the ozone layer is depleted (Figure 4.6). The phenomenon is called **ozone depletion**.

Through the thin ozone layer, ultraviolet rays of the Sun pass and reach the Earth where they affect the life by causing serious diseases like skin cancer and eye problems, etc. These ultraviolet rays also increase the temperature of the Earth.

4.2.3 Global Warming

Due to human activities like burning of fuel, etc., the amount of greenhouse gases is increased in the atmosphere. This speeds up the greenhouse effect. The increasing rate of greenhouse effect and ozone depletion is increasing the average temperature of the Earth. As a result, the Earth globe is getting warmer. This is called **global warming**.

Due to global warming, the ice in the Polar Regions and at the mountains melts at a greater rate. This leads to rise in the level of sea water which creates floods in low lying coastal areas.

Figure 4.7: Effects of global warming

The climate of many regions of the world is also changing due to global warming. The global warming is thus a threat to the life on the Earth (Figure 4.7).

Interesting information

Burning of fuels releases millions of tonnes of carbon dioxide into the environment each year.

Mini Exercise

- Explain the effects of global warming on the life on Earth.

4.2.4 Acid Rain

Sulphur dioxide and oxides of nitrogen are present in the atmosphere as air pollutants. They get dissolved in water vapours in clouds and turn into acids like sulphuric acid and nitric acid. These acids make the rain water acidic (Figure 4.8).

The effects of acid rain on animals, plants and buildings are shown in the Figure 4.9.

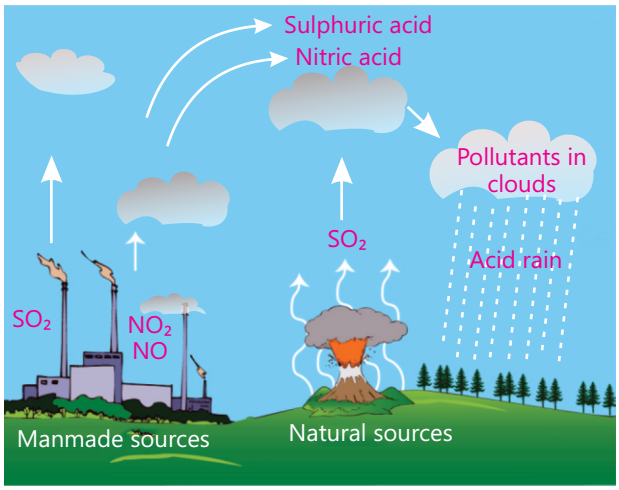


Figure 4.8: Acid rain

Fish killed by acid rain water

Effect of acid rain on trees

Stonework erosion caused by acid rain

Corrosion of metals caused by acid rain

Figure 4.9: Effects of acid rain

Acid rain kills the aquatic life in rivers, lakes and ponds etc. It destroys the leaves and barks of the trees. It corrodes the metals and the stones used in buildings. The acid rain water flowing into fields makes the soil acidic. The crops do not grow well in acidic soil. Microorganisms present in soil are also affected by acid rain.

4.2.5 Deforestation

Forests are our great wealth. They bring favourable changes in climate of an area. They stop storms and bring rains. They are source of many useful materials such as timber, firewood, resins, gums and medicines, etc. They prevent soil erosion. They provide habitat to a wide variety of wild life. Unfortunately, forests are cut to meet the demand for timber and to obtain land for housing and agriculture. As a result, the ecosystem is destroyed. Destruction of forests as a result of human activities is called **deforestation** (Figure 4.10).

Figure 4.10: Deforestation

Effects of Deforestation on the Environment

Deforestation has many adverse effects on the environment. It changes weather and climate. Roots of trees hold the soil. Cutting of trees leads to soil erosion and fertile part of the soil is lost through this process. When forests are cut, rate of evaporation is reduced which results in less rain. Deforestation decreases the carbon dioxide consumption by plants increasing its amount in the environment. This leads to the increased greenhouse

effect and global warming.

Effects of Deforestation on Wildlife

All non-cultivated plants and non-domesticated animals of an area are collectively called wildlife. Deforestation destroys the habitats of wildlife (Figure 4.11). The extinction risk of wildlife is increased while the natural balance maintained by the wildlife is disturbed.

Figure 4.11: Effects of deforestation on wildlife

Information

- According to the experts, at least 25% of the total area of a country must be covered by forests but in Pakistan only 5% of its total area is covered by forests.

Do you know?

- Human activities have increased the proportion of carbon dioxide in the air from 0.03% to 0.04% in about 100 years. Scientists think that if this trend is continued, the amount of carbon dioxide in the air will be doubled by the middle of the next century.

4.2.6 Lack of Natural Resources

Resources are the materials in the environment that are ready for human use or may be used in future. Fossil fuels (coal, natural gas, oil, etc.), minerals, trees, animals, water, etc. are all natural resources. The resources on the Earth are limited. Many of them, e.g., minerals and fossil fuels are non-renewable. A resource that does not regenerate quickly is called **non-renewable resource**.

The limited and non-renewable resources (fossil fuels, etc.) are used to produce energy for running industry, transport and household appliances. They will get depleted and hence alternate sources of energy need to be developed. A lot of energy which could do useful work is wasted by man. For instance, household appliances are left running even when no one is using them. Similarly, instead of using public transport personal cars are used which consume a lot of fuel. The unwise use of non-renewable resources of energy may result into non-recoverable loss. To avoid such loss, the resources must be conserved for future use. We must also search for alternate sources of energy like solar energy, wind energy, hydropower and atomic energy, etc.

Do you know?

- Formation of fossil fuels is a very slow process. It takes millions of years.

4.3 Conservation of Resources

Fossil fuels are present on the Earth in limited quantities. Their unwise use must be stopped and they need to be conserved.

Three (3) R strategies, i.e., **Reduce-Reuse-Recycle** can be adopted for conservation of resources (Figure 4.12).

- The first strategy in this connection is **"Reduce"**, i.e., the use of non-biodegradable objects should be reduced and the resources which are used in their manufacture should be conserved.
- The second step in three (3) R strategies is **"Reuse"**, i.e., the non-biodegradable objects should be used again and again instead of throwing them after first use.

Figure 4.12:
Three R Strategies

- The third strategy is **"Recycling"**, i.e., the waste objects made of non-biodegradable materials should be collected, cleaned, melted and remolded into new objects.

By adopting the above said (3R strategies) habits, we can conserve our resources.

4.4 Saving the Earth

The Earth is the only planet in our Solar System where life can survive. Pollutants are harmful to the life on Earth. We should keep the Earth's environment clean and healthy. Following measures can be taken for saving the Earth from the toxic effects of pollutants.

4.4.1 Solid Waste Management

Solid wastes include plastic and glass items, styrofoam, sewage sludge, agricultural wastes, and domestic trash, etc. These wastes pollute the Earth's environment when dumped on open places or burnt (Figure 4.13). Hence, we should not dump them on open places nor burn them. They should be managed properly. Landfill, incineration and recycling are the common methods of solid waste management.

Figure 4.13: Solid wastes

Landfill

In this method, solid wastes are buried in properly designed landfills which are well managed for maintaining hygienic conditions. It is relatively inexpensive method of disposing of waste materials.

Incineration

In this method, wastes are burned at extremely high temperatures.

Recycling

In this method, plastic items (like plastic bottles and polythene bags), glass pieces, aluminium and steel cans, copper wires, etc. are collected separately, cleaned, melted

and moulded into new products. In this way, they are used again and again to reduce pollution.

4.4.2 Environmental campaigns

Environmental campaigns should be conducted frequently for creating awareness among common people about pollution and reducing its harmful effects. Such campaigns may include seminars, school talks / debates, celebrating the World Environment Day (5th of June every year), etc.

Activity 4.3

- Prepare banners and posters showing harmful effects of air pollution.
- Prepare some banners reflecting methods to reduce pollution.
- Conduct a walk in your locality to create awareness about air pollution and its harmful effects.

Activity 4.4

- Conduct a seminar on the importance of local and global conservation of natural resources.

4.3.3 Responsibility for All

All of us are responsible for keeping the environment clean. The individuals, the organizations and the Government must share their responsibility to check the activities which cause pollution. Following measures can be taken to reduce air pollution.

- Domestic trash and other solid wastes should not be dumped on open places.
- Instead of personal car, public transport should be used for travel.
- Sulphur and lead free fuel should be used in vehicles.
- Factories and industries should be shifted away from the urban areas.
- Acidic industrial exhaust gases must be neutralized before releasing into the air.
- Engines of the vehicles should be tuned properly.
- CFC-free products should be used.
- 3R strategies of Reduce-Reuse-Recycle for the conservation of resources should be adopted.
- Trees should be grown along the road sides.
- Deforestation should be avoided.

KEY POINTS

- The poisonous and harmful substances which contaminate or pollute the air are called air pollutants.
- The main air pollutants are carbon monoxide, sulphur dioxide, oxides of nitrogen and chlorofluorocarbons (CFCs).
- Fossil fuels (coal, natural gas, oil, petrol, etc.) and aerosols are the main sources of air pollutants.
- Air pollutants enter the human body through breathing and affect the human organ systems causing serious diseases.
- Chlorofluorocarbons cause the thinning of protective ozone layer in our atmosphere.
- Rotting of vegetation and volcanic eruption, etc., are the natural sources of air pollutants.
- Carbon dioxide, methane, oxides of nitrogen, water vapours, etc., are called greenhouse gases.
- Greenhouse gases trap the heat reflected by the Earth and produce a warming effect on the Earth. This is called greenhouse effect.
- Earth's globe is getting warmer as a result of the greenhouse effect and the ozone depletion. The phenomenon is called global warming.
- The air pollutants, e.g., sulphur dioxide and oxides of nitrogen get dissolved in rain water and produce acid rain.
- Deforestation produces changes in the weather and climate and disturbs the ecosystem.
- A resource that does not regenerate quickly is called non-renewable resource.
- Three (3) R strategies, i.e., "Reduce-Reuse-Recycle" is the best way to be adopted for conservation of natural resources.
- Landfill, incineration and recycling are the common methods of solid waste management.
- The individuals, the organizations and the Government must share their responsibility to check the activities which cause air pollution.

QUESTIONS

4.1. Encircle the correct option.

(i) Indicate an air pollutant among the following:

a. oxygen b. nitrogen
c. water d. carbon monoxide

(ii) The gas which is responsible to stop ultraviolet radiation coming from the Sun:

a. carbon dioxide b. sulphur dioxide
c. ozone d. nitrogen

(iii) Which of the following is not a greenhouse gas?

a. Methane b. Carbon dioxide
c. Sulphur dioxide d. Water

(iv) The pollutants which are mainly responsible for ozone depletion are:

a. oxides of carbon b. oxides of sulphur
c. oxides of nitrogen d. chlorofluorocarbons

(v) Identify the chemicals which cause the rain to become acidic:

a. oxides of carbon and dust particles
b. oxides of sulphur and nitrogen
c. solid particles of carbon and lead
d. chlorofluorocarbons.

(vi) Reason for increase in the amount of carbon dioxide in air:

a. plantation b. deforestation
c. using CFC-free products d. recycling of materials

(vii) Which air pollutant when attaches itself with haemoglobin, reduces its oxygen carrying capacity?

a. Carbon dioxide b. Sulphur dioxide
c. Oxides of nitrogen d. Carbon monoxide

(viii) The phenomenon which does not lead to global warming:

a. greenhouse effect b. ozone depletion
c. deforestation d. photosynthesis

(ix) Glass and styrofoam are the examples of:

a. biodegradable materials b. non-biodegradable materials
c. harmful products d. air pollutants

(x) The amount of which greenhouse gas can you reasonably control?

a. Oxides of nitrogen b. Water vapours

c. Methane d. Carbon dioxide

4.2 Write short answers.

(i) What are the main air pollutants?

(ii) Name greenhouse gases.

(iii) Name the acids which are present in the acid rain?

(iv) Ozone layer is important. Why?

(v) 3R strategies stand for what?

(vi) Write down the names of three such products which can be recycled.

(vii) Name common methods which are used for solid waste management.

(viii) How does ozone depletion contribute towards global warming?

(ix) Sulphur dioxide is an important pollutant. From where does it enter the atmosphere?

4.3 Describe the adverse effects of carbon monoxide on human organ systems.

4.4 Explain the following phenomena and their effects on the environment.

(a) Greenhouse effect (b) Global warming

(c) Acid rain (d) Ozone depletion

4.5 Point out the sources of air pollutants you find in your locality and suggest ways to reduce the pollution produced from these sources.

4.6 Suggest what can following communities do to reduce air pollution.

(a) Students (b) Farmers (c) Factory owners (d) Scientists

4.7 What is deforestation? Explain its effects on wildlife.

4.8 What types of climatic changes can appear by deforestation?

4.9 Suggest ways for proper management of solid wastes.

4.10 Recycling is good practice to conserve natural resources. Explain.

4.11 What should we do to adopt 3R strategies for conservation of resources?

4.12 Controlling pollution is a responsibility for all. What would you suggest for the individuals, the organizations and the governments to share this responsibility?

Critical Thinking

1. What line of action will you adopt to reduce the amount of CO_2 in air?
2. Predict what will happen if the amounts of greenhouse gasses are drastically reduced in the atmosphere?