Chapter 14

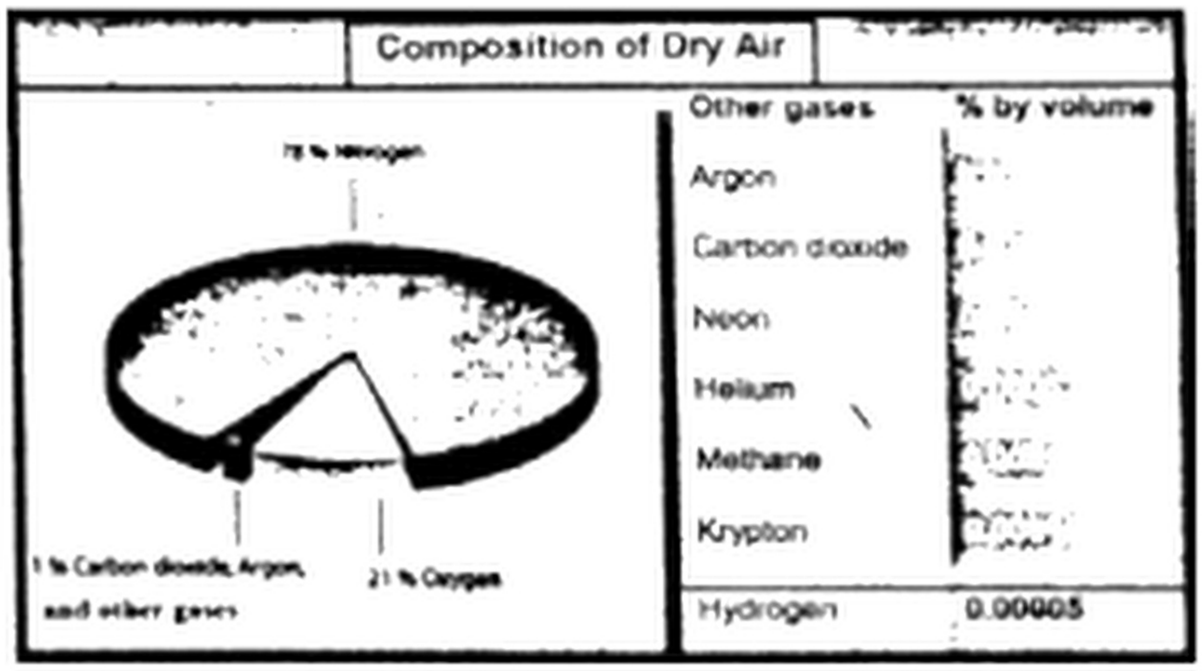
Environmental Chemistry-1:

The Atmosphere

Q1. Explain composition of atmosphere?

Ans: Composition of Atmosphere:

Air is a mixture of gases. The pie chart given below shows the composition of dry air by volume.



Q2. Define atmosphere.

Ans: Atmosphere:

The envelope of gases and water vapour surrounding the planet Earth is called atmosphere.

Self-Assessment Exercise 14.1

1. What two gases make up most of the air?

2. Which gas has highest percentage in the air?

3. **Which gas has lowest percentage in the air?**

4. **Why the percentage of water has not been mentioned in the pie chart?**

Solution:

1. **What two gases make up most of the air?**

Nitrogen=78% and Oxygen = 21%

2. **Which gas has highest percentage in the air?**

Nitrogen=78%

3. **Which gas has lowest percentage in the air?**

Hydrogen = 0.00005%

4. **Why the percentage of water has not been mentioned in the pie chart?**

Beside gases there are varying amount of water vapours in the air. There is little water in the air in the dessert.

Whereas, in tropical rain forest the air may contain upto 4% water vapour. This means the amount of water vapour varies from place to place and time to time.

That is why the percentage of water has not been mentioned in the pie chart.

Q3. List the layers of atmosphere?

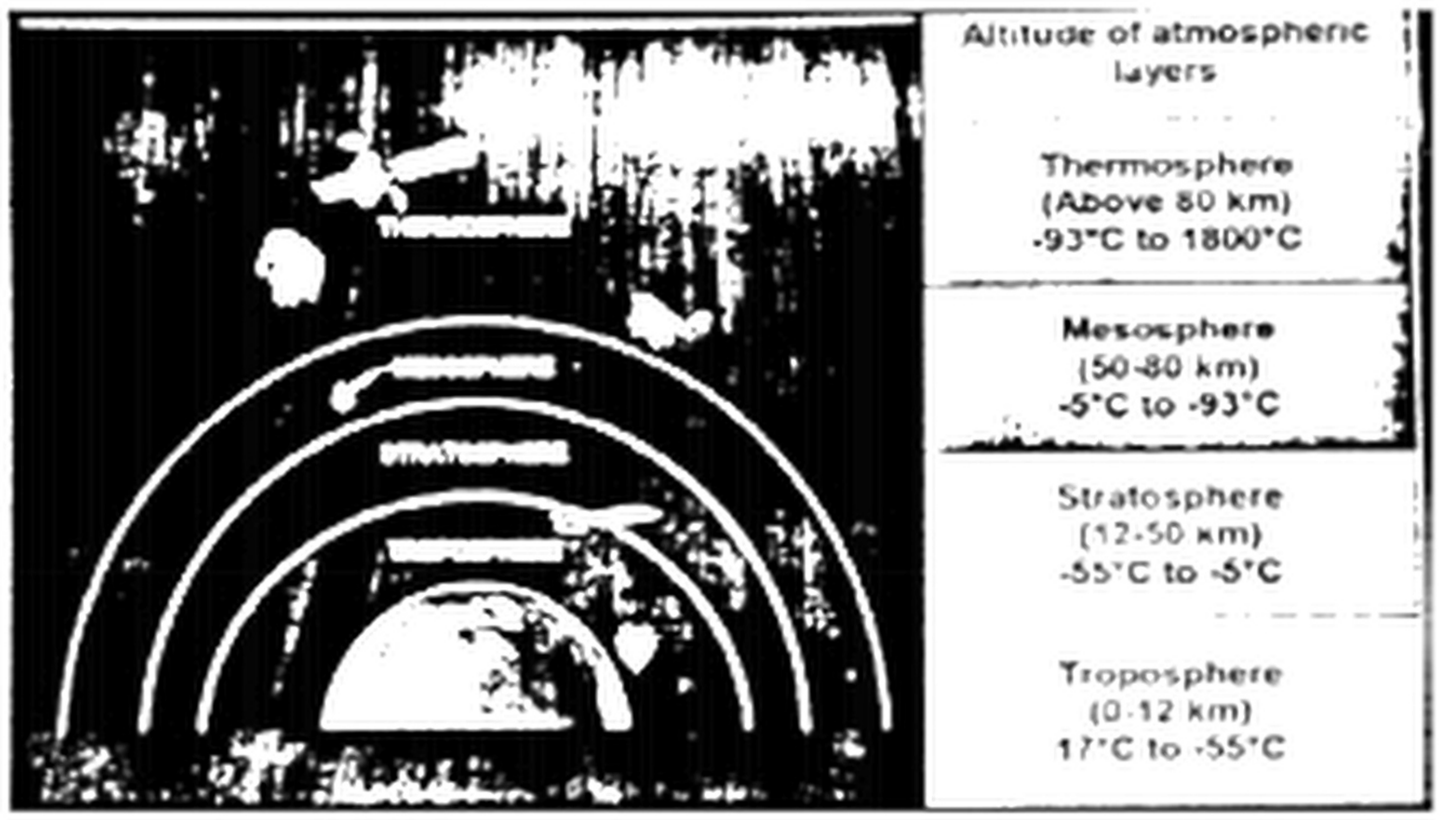
Ans: Layers of atmosphere:

The atmosphere is divided into four layers:

i. The troposphere **ii.** The stratosphere

iii. The mesosphere **iv.** The thermosphere

Note: The thermosphere id further divided into the. Each atmospheric layer has its own temperature and precise chemical composition.



Layer of atmosphere

Q5. What is the height of the troposphere? What is the minimum and maximun temperature of this layer?

Ans: Height of the troposphere is 12km. Minimum temperature of troposphere is -55°C and maximun temperature is 17°C.

Q6. What is the height of the stratosphere? What is the minimum and maximun temperature of this layer?

Ans: Height of the troposphere is 50km. Minimum temperature of troposphere is -55°C and maximun temperature is -5°C.

Q7. Explain temperature variation in mesosphere. List the components of mesosphere?

Ans: The Mesosphere:

The Mesosphere extends from top of stratosphere to about 80km from the Earth surface. Meso- means middle so the mesosphere is the middle layer of the atmosphere. Above the stratosphere a drop in temperature is observed. In the outer mesosphere the temperature approaches -93°C. This layer protects Earth's surface from being hit by most meteoroids.

Q8. Explain temperature variation in thermosphere. List the components of thermosphere.

Ans: Thermosphere:

The outermost layer of the atmosphere is the thermosphere. It extends from 80km above the earth's surface outward into space. Thermo- means heat. This layer is very hot upto 1800°C. This is because sunlight strikes the thermosphere first. Oxygen and nitrogen molecules convert this energy into heat.

Layers of Thermosphere:

The thermosphere is divided into two layers:

i. **Ionosphere:**

The lower layer is called the ionosphere extends from 80km to 400km above the surface of Earth.

ii. **Exosphere:**

The outer layer of the thermosphere is the exosphere. It extends from 400km to thousands of km from Earth's surface.

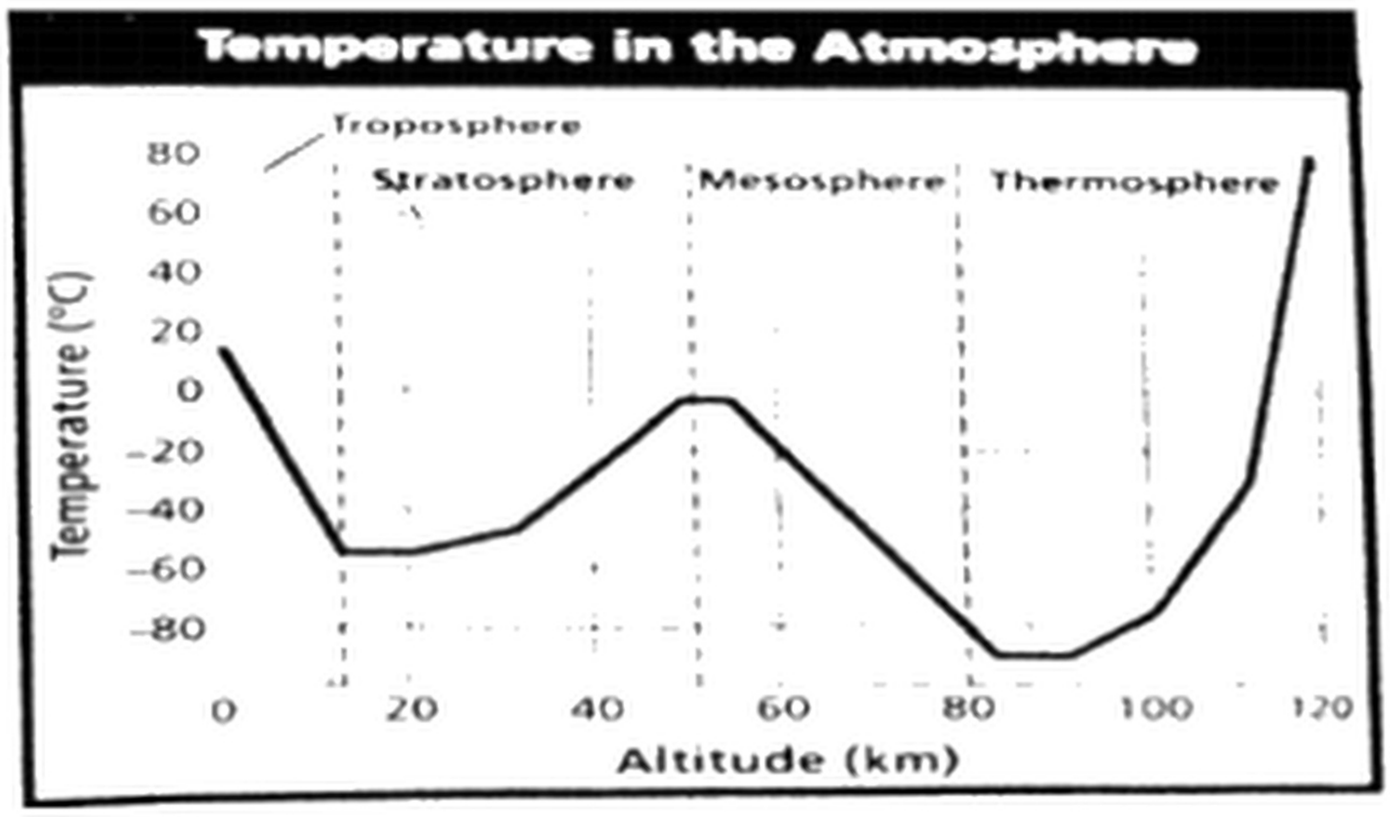
DO YOU KNOW?

Aurora Borealis:

In the northern hemisphere, brilliant light displays, such as shown in the figure occur in the ionosphere.

These light displays are called aurora Borealis. Auroras are caused by particles from the sun that enters the ionosphere near the poles. These particles strike atom in the ionosphere, causing them to glow.

Q9. Activity 14.1: The following graph (figure 14.3) shows how the temperature changes with altitude?



Temperature variations in the troposphere and the stratosphere

Complete the following table:

Layers of atmosphere	Temperature (°C)	
	At the bottom	At the highest point
Troposphere	17 °C	-55 °C

Stratosphere	-55 °C	-5 °C

Self-Assessment Exercise 14.2

Describe how temperature changeswhen one moves from Earth's surface into the atmosphere upto 50km?

Solution: 1km increase in altitude = 6.5°C cooler

50km increase in altitude = 6.5 * 50 = 325 °C cooler

Q10. Explain sources and effects of air pollutant sulphur oxides?

Ans: Sulphur Oxides (So_x):

In the air sulphur oxide is converted into sulphur trioxide, which is responsible for acid rain.

$$2SO_{2\,(g)} + O_{2\,(g)} \longrightarrow 2SO_{3\,(g)}$$

Sulphur dioxide is readily absorbed in the respiratory system. Being powerful irritant, it aggravates the symptoms of people who suffer from asthama, bronchitis, emphysema and other lung diseases.

Q11. You might have noticed that the color of silk clothes fade away, if left in open air for a week or so. What due to it is?

Ans: Photodegradation:

The technical term for color fading is photodegradation. There are light absorbing color bodies called chromophores that are present in dyes. The

color(s) we see based on these chemical bonds and the amount of light that is absorbed in a particular wavelength.

Ultraviolet rays can break down the chemical bonds and thus fade the color(s) in an object. It is a bleaching effect.

Self-Assessment Exercise 14.3

1. **What are pollutants?**

2. **List some effects of sulphur dioxide on human beings?**

3. **List some of the air pollutants?**

Solution:

1. **What are pollutants?**

Anything that is in the air, water or soil which has harmful effect on some part of the environment is called pollutant.

2. **List some effects of sulphur dioxide on human beings?**

Sulphur dioxide is readily absorbed in the respiratory system. Being powerful irritant, it aggravates the symptoms of people who suffer from asthama, bronchitis, emphysema and other lung diseases.

3. **List some of the air pollutants?**

Important air pollutants are a follows

i. Sulphur oxides (SO_x)

ii. Carbon monoxide

iii. Nitrogen oxides (NO_x)
iv. Methane
v. Chlorofluorocarbons (CFC's)
vi. Lead compounds
vii. Ozone

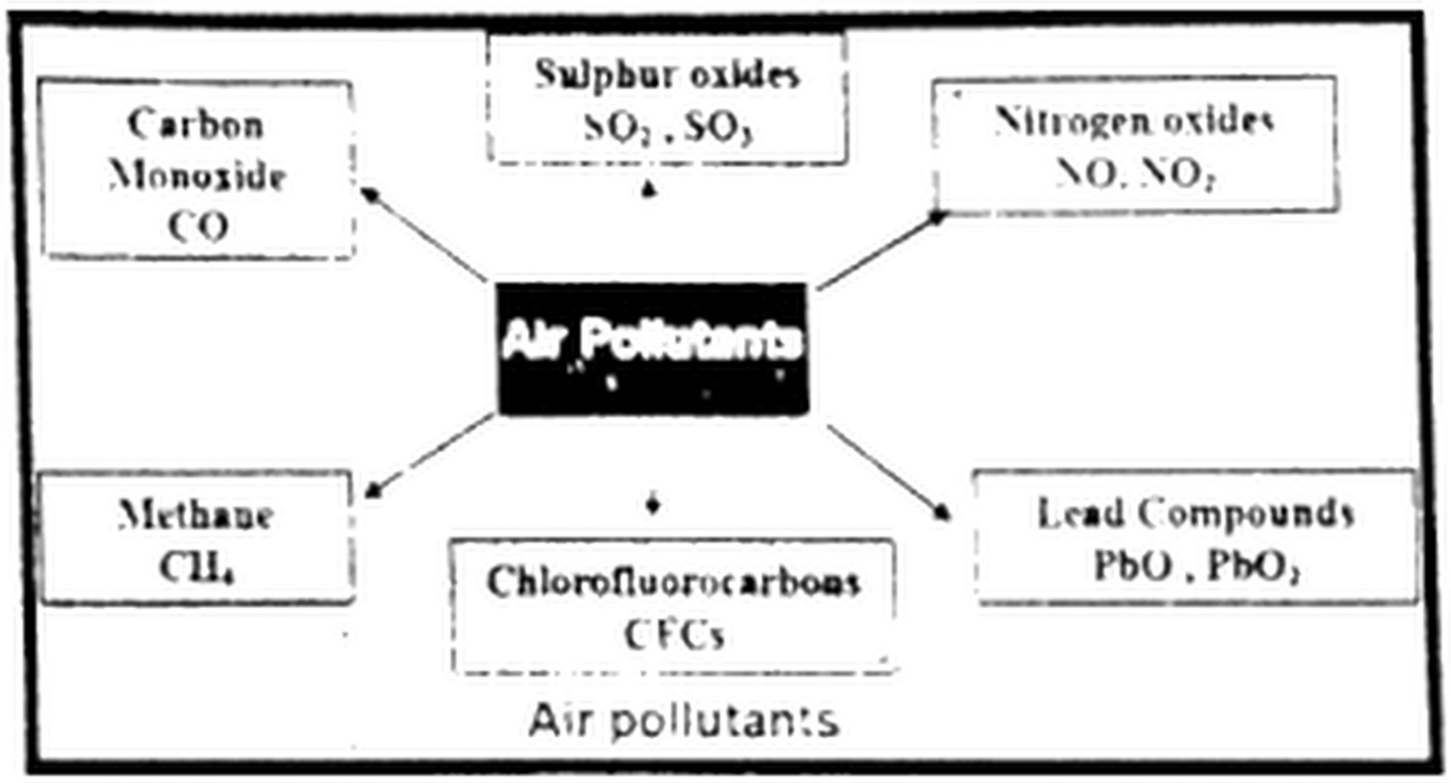
Q12. Explain sources and effects of air pollutants ozone?

Ans: Ozone:

Ozone is a light blue gas and has an unpleasant odour. In the troposphere ozone causes breathing difficulties, asthama and eye irritation.

Q13. Draw flow diagram to represent air pollutants?

Ans:



Air pollutants

Self-Assessment Exercise 14.4

1. Write names of main pollutants in the air.

2. Complete the following reactions.

a) $SO_{2\,(g)}$ + $O_{2\,(g)}$ ⟶

b) $C_{\,(g)}$ + $O_{2\,(g)}$ ⟶

c) $CO_{\,(g)}$ + $O_{2\,(g)}$ ⟶

Solution:

1. **Write names of main pollutants in the air.**

Important air pollutant are as follows:

i. Sulphur oxides (SO_x)

ii. Carbon monoxide

iii. Nitrogen oxides (NO_x)

iv. Methane

v. Chlorofluorocarbons (CFC's)

vi. Lead compounds

vii. Ozone

2. Complete the following reactions.

a) $SO_{2\,(g)}$ + $O_{2\,(g)}$ ⟶

$SO_{2\,(g)}$ + $O_{2\,(g)}$ ⟶ $2SO_3$

b) $C_{\,(g)}$ + $O_{2\,(g)}$ ⟶

$C_{\,(g)}$ + $O_{2\,(g)}$ ⟶ $2CO$

c) $CO_{\,(g)}$ + $O_{2\,(g)}$ ⟶

$CO_{\,(g)}$ + $O_{2\,(g)}$ ⟶ $2CO_2$

Q14. Which gas is emitted by volcanoes?

Ans: The largest porion of gases released in the atmosphere is water vapour. Other gases include carbon dioxide (CO_2), Sulphur dioxide (SO_2), Hydrochloric acid (HCl), Hydrogen flouride (HF), Hydrgen sulphide (H_2S), carbon monoxide (CO), Hydrogen gas (H_2), NH_3, Methane (CH_4) and SiF_4.

Self-Assessment Exercise 14.5

1. Write three human activities that are responsible for air pollution.
2. Write three natural processes that are contributing in air pollution.
3. List main sources of the following air pollutants.

(a) SO_2 (b) CO (c) NO_2

Solution:

1. Write three human activities that are responsible for air pollution.

Human activities that damage the environment:

i. Burning Fossil Fuel **ii.** Cutting trees **iii.** Use of Freon gas

2. Write three natural processes that are contributing in air pollution.

Natural sources:

Many natural processes such as forest fires or dust storms release smoke and dust particles into the air. Volcanoes emit clouds of dust and poisonous gases along with ash. Termites and cows also release large amount of methane in air. Considerable electrical discharges in the atmosphere produce nitrogen oxides.

3. List main sources of the following air pollutants.

(a) SO_2 (b) CO (c) NO_2

(a) **SO_2** Power stations and industries using fossil fuels

(b) **CO** Incomplete burning of wood, fuels and vehicle exhaust

(c) **NO_2** Exhaust fumes of motor vehicles, poer stations and industries using fossil fuels.

Q15. Describe sources and harmful effects of air pollutants?

Ans: Effect produced by air pollutants:

Air pollutant	Physical properties	Sources	Harmful effects
Carbon monoxide **(CO)**	Colorless, odourless and poisonous gas	Incomplete burning of woods, fuels and vehicle exhaust	Headache, brain, damage, death
Sulphur Dioxoide **(SO_2)**	Colorless gas with unpleasant and irritating odour	Power stations and industries using fossil fuels	Breathing difficulties, Bronchitis, Emphysema, lung cancer, acid rain and green house effect

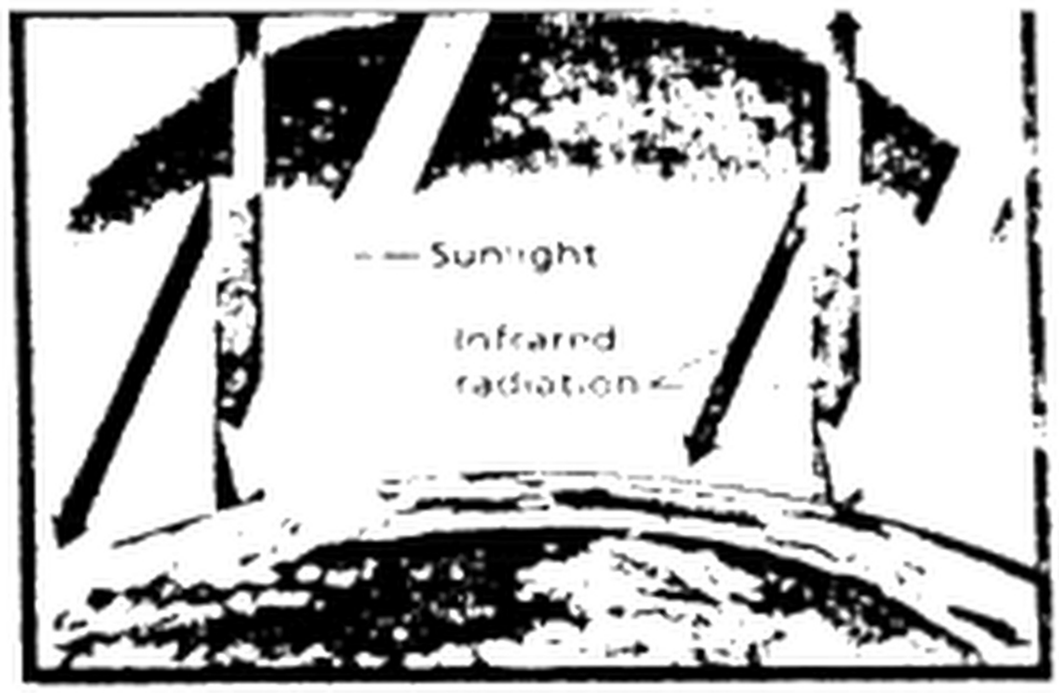
Oxides of nitrogen **(NO, NO_2)**	NO is colorless odourless gas soluble in water. NO_2 is reddish brown gas with pungent odour soluble in water. Both are highly toxic gases	Exhaust fumes of motor vehicles, poer stations and industries using fossil fuels.	Coughs, Headaches, lung diseases, acid rain and green house effect (global warming)
CFCs Chlorofluorocarbons	Colourless gases	Aerosol sprays, foams, referigerants, air-conditioning systems	Green house effect (global warming), thinning of ozone layer
Lead compounds	Poisonuos solid particles	Exhaust fumes from motor vehicles	Brain damage, forest decline

Q16. What do you understand by green house gases?

Ans: Green house gases:

The increasing use of fossil fuels and the deforestation have led to an increase in the levels of CO_2 in the air. Gases like water vapour, methane and CFCs also act in a similar way in the atmosphere. These gases are called green house gases. Molecules of these gases absorb much of the infrared radiation given out by the surface of Earth. This increase there kinetic energy. So the atmosphere becomes hotter.

The higher the concentration of green house gases in the air, the greater is the effect of green house effect, and greater will be the increase in temperature. The green house effect is a natural phenomenon of energy distribution mechanism of Earth.



Greenhouse effect

Q17. Certain human activity is threatening to cause a significant increase in the green house effect. What are such activities?

Ans: Certain human activities add to the levels of most of these naturally occuring gases

Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas and coal) and wood and wood products are burned.

Methane emissions results from the rise production, the decomposition of organic wastes in solid municipal solid waste landfills and the raising of livestock. Methane also is emitted during the production and transport of coal natural gas and oil.

Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.

Greenhouse gases that are not naturally occuring include by products of foam production, referigeration and air conditioning called chlorofluorocarbons **(CFCs)** as well as hydrofluorocarbons **(HFCs)** and perfluorocarbons **(PFCs)** generated by industrial processes.

DO YOU KNOW?

Green Houses:

Green houses are constructed from glass or transparent polymer films. Sunlight can pass through these materials and is used by the plants for photosynthesis. The plants radiate some energy in the form of infrared and heat radiations which cannot pass through these materials and is reflected back. As a result the atmosphere inside the green house becomes hot enough to promote plant growth. The temperature inside a green house can be 10°C to 15°C from outside.

Self-Assessment Exercise 14.6

1. Define global warming.
2. List some effects of global warming.
3. List some substances that are responsible for global warming.

Solution:

1. **Define global warming.**

The warming of the atmosphere which is due to our influence on the greenhouse effect is known as global warming.

2. List some effects of global warming.

Effects of global warming:

Global warming is due to an upset in the natural balance of the concentration of greenhouse gases in the atmosphere. If global warming continues, then

- Temperature of the Earth will gradually increase
- The earth climate may change, affaecting both where there is rainfall and how much there is of it. These could cause increased risk of flooding in some regions and drought in others.
- Polar ice may melt and cause significant increase in sea levels.
- So the atmosphere becomes hotter.

3. List some substances that are responsible for global warming.

The main causes of global warming, in order of the magnitude of their impact, are:

1. **Carbon dioxide from**
   - **i.** Fossil fuel **ii.** Deforestation
2. **Methane from**
   - **i.** Cattle and rice paddies
3. **Nitrogen oxides from farming**

   Nitrogen oxides have 3000 times more heat trapping capacity per unit of volume then does carbon dioxide, and we release them every time we apply fertilizer to soil.

4. CFCs and HCFs (Chloroflourocarbons and hydrofluorocarbons) used in referigeration are also green house gases. These gases occur in lower concentrations in the atmosphere, but because they are so much potent then carbon dioxide in some cases hundreds of times more potent per unit of volume they contribute to global warming as well.

Society, technology and Science

Incineration:

Incineration is a waste treatment process in which solid waste is burned at high temperature. Incineration consumes all combustible materials, leaving behind ash residue and non-combustible material. The process generally reduces the volume of waste by two-third, but it is not a clean process. It produces air pollution. It generates considerable smoke and odour. This smoke may contains oxides of nitrogen and sulphur.

Self-Assessment Exercise 14.7

1. Define acid rain.
2. Write names of gases that cause acid rain.
3. What is the effect of acid rain on iron and marble? Give balanced chemical equation.
4. List some effects caused by acid rain .

Solution:

1. Define acid rain.

Acid rain is defined as rain having pH less then 5.6.

2. Write names of gases that cause acid rain.

SO_2 and NO_2.

3. What is the effect of acid rain on iron and marble? Give balanced chemical equation.

Sulphuric acid and metals:

Sulphuric acid eats away metals to form water soluble salts and hydrogen

$$Fe_{(s)} + H_2SO_{4\,(aq)} \longrightarrow FeSO_{4\,(aq)} + H_{2\,(g)}$$

Marble buildings and statues:

Marble buildings and statues are disintegrated by acid rain.

$$CaCO_{3\,(s)} + H_2SO_{4\,(aq)} \longrightarrow CaSO_{4\,(aq)} + H_2O_{(g)} + CO_{2\,(g)}$$

$$CaCO_{3\,(s)} + 2HNO_{3\,(aq)} \longrightarrow Ca(NO_3)_{2\,(aq)} + H_2O_{(g)} + CO_{2\,(g)}$$

4. List some effects caused by acid rain.

Acid rain corrodes metals, stone buildings and statues. Marble statues are slowly eroded by acid rain.

Society, technology and Science

Catalytic converter:

A catalytic converter converts CO into CO_2 ,NO into N_2 and O_2 and unburned hydrocarbons to CO_2 and H_2O. Metals like platinum, palladium and rhodium are used as catalyst in the converter. Government of Pakistan should direct car manufacturers to install catalytic converters in car exhaust system. Government should make strict laws in this regards.

Q18. Is chlorine a free radical, a catalyst in the destruction of ozone?

Ans: Yes, chlorine free radical is a catalyst in the destruction of ozone.

Q19. Suggest reason for the presence of CO in the car's exhaust fumes.

Ans: carbon monoxide consits of a single carbon atom and a single oxygen atom linked together (CO), and it is the product of incomplete combustion of fuel. Most carbon monoxide is produced when air-to-fuel ratios are too low in the engine during vehicle starting or when the vehicle is not turned properly, and at higher altitudes, when thin air reduces the amount of oxygen availible for combustion.