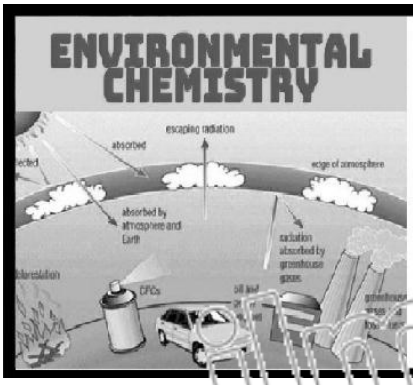


CHAPTER 14

ENVIRONMENTAL CHEMISTRY - I THE ATMOSPHERE

INTRODUCTION

SHORT QUESTIONS

Q.1 What are natural systems of the earth? ***(Knowledge Base)*** **(BWP 2017)**

Ans: **NATURAL SYSTEMS OF EARTH**

Our planet the Earth has four natural systems: lithosphere, hydrosphere, atmosphere and biosphere.

(i) Lithosphere:

"Rigid rocky part of the Earth is called lithosphere".

(ii) Hydrosphere:

"The part of environment which includes all water bodies is called hydrosphere".

Examples:

- Oceans
- Rivers
- Lakes
- Glaciers

(iii) Atmosphere:

"*The envelope of gases around the Earth is called atmosphere".*

(iv) Biosphere:

"*The part of environment which can support life is called biosphere".*

Examples:

- Lower atmosphere
- Ocean
- Rivers
- Soils etc.

Q.2 What is the significance of study of composition of atmosphere? ***(Knowledge Base)***

Ans: **SIGNIFICANCE OF STUDY OF COMPOSITION OF ATMOSPHERE**

The study of composition of atmosphere provides us the knowledge about the gases present in atmosphere and their significance.

MULTIPLE CHOICE QUESTIONS

1. In how many natural systems Earth is divided? ***(K.B)***

(A) 4 (B) 3

(C) 2 (D) 1

2. The layer of gases around the earth is called: ***(K.B)***

(A) Troposphere (B) Stratosphere

(C) Atmosphere (D) Thermosphere

3. The part of environment which can support life is called: ***(K.B)***

(A) Lithosphere (B) Biosphere

(C) Atmosphere (D) Hydrosphere

14.1 COMPOSITION OF ATMOSPHERE

14.2 LAYERS OF ATMOSPHERE

LONG QUESTION

Q.1 What is atmosphere? Explain the composition of dry atmosphere. ***(Knowledge+Understanding Base)***

(FSD 2016 G-I, MTN 2016 G-II)

Ans:

ATMOSPHERE

Definition:

"Atmosphere is the ***envelope of different gases*** *around the Earth".*

Location:

It extends continuously from the Earth's surface outwards without any boundary.

Composition:

About **99% of atmospheric mass** lies within **30 kilometres** of the surface and **75%** lies within the **lowest 11 kilometres.**

Table: Composition of Dry Air

Gas	% By Volume
Nitrogen	78.09
Oxygen	20.94
Argon	0.93
Carbon dioxide	0.03

Q.2 Describe the layers of atmosphere in detail. ***(Knowledge+Understanding Base)***

Ans:

LAYERS OF ATMOSPHERE

Atmosphere consists of four spheres (layers) extending from the surface of the Earth upwards.

Change in Concentration of Gases:

The concentration of the component gases decreases gradually upwards, that results in gradual decrease of pressure.

Change in Temperature:

Temperature of the atmosphere does not change in a gradual way. It varies in a complex way.

Region of Atmosphere:

Depending upon the temperature variation, atmosphere is divided into four regions.

(i) Troposphere

(ii) Stratosphere

(iii) Mesosphere

(iv) Thermosphere

(i) Troposphere:

*"The **region of** the **atmosphere** from earth's surface upto **12 km** above is called troposphere"*

Characteristics:

- It is lowest region of the atmosphere in which we live.
- Temperature decreases from **17°C** to **-58°C** regularly in the lowest layer extending upto **12 km**.

(ii) Stratosphere:

*"The **region of** the **atmosphere** which is **up to 50 km** is called stratosphere"*

Characteristics:

- In this layer temperature rises upto 2°C.
- Ozone is present in this layer at a height of about 25 km.

(iii) Mesosphere:

*"The **region of** the **atmosphere** between **50–85 kilometers** is called mesosphere"*

Characteristic:

- In this region again **temperature decreases** down to **-93°C.**

(iv) Thermosphere:

*"The **region of** the **atmosphere** between **85–120 kilometers** is called thermosphere"*

Characteristic:

- In this region temperature goes on increasing upwards.

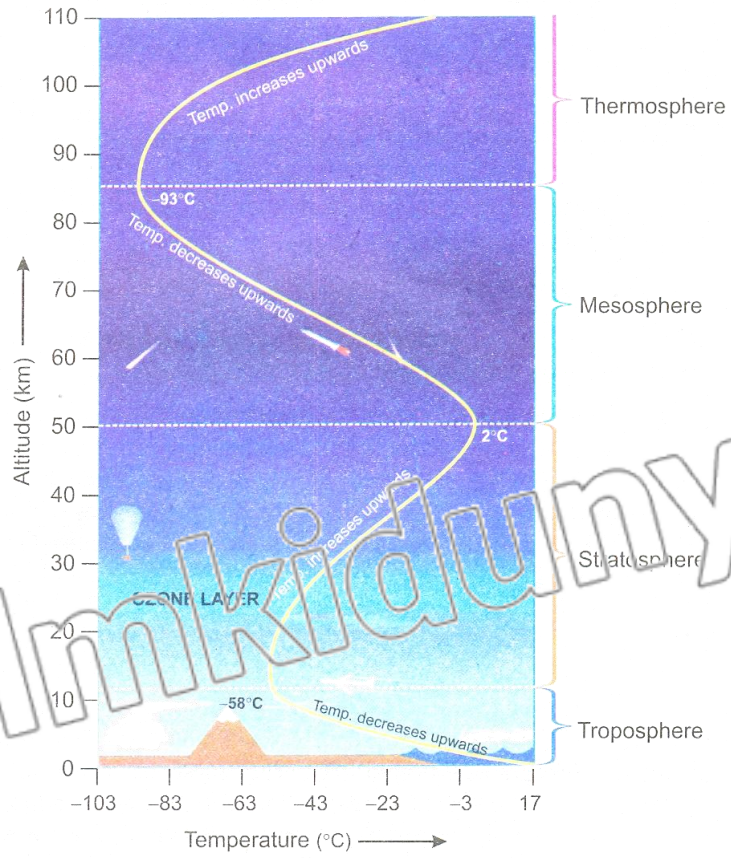


Figure: Different Spheres of Atmosphere

Characteristics of Regions of the Atmosphere:

The characteristics of four regions of atmosphere are as follows:

Name of Region	Height Above the Earth's Surface	Temperature Range and Trend
Troposphere	0km –12km	17°C – –58°C (decreases)
Stratosphere	12km – 50km	-58°C – 2°C (increases)
Mesosphere	50km – 85 km	2°C – -93°C (decreases)
Thermosphere	85kms –120km	> –93°C (increases)

Distribution of atmospheric mass:

- About 99% of the atmospheric mass lies within 30 kilometers of the surface
- 75% of the mass lies within the lowest 11 km.
- Similarly, about 50% of the atmospheric mass lies within 5–6 cm of surface.

Q.3 Give the characteristics of troposphere. Why temperature decreases upwards in this sphere? *(Knowledge+Understanding Base)*

(Ex-Q.2) (SGD 2014, FSD 2016 G-I, II, SGD 2016 G-II, BWP 2016 G-II)

Ans:

TROPOSPHERE

Definition:

"The region of the atmosphere from the earth surface upto 12km is called troposphere"

Characteristics:

The characteristics of troposphere are as follows:

- It is the lowest region of the atmosphere in which we live.
- It is the region in which most of the earth weather or phenomenon occurs.
- Almost all air crafts fly in this region.

Major Components:

The major constituents of troposphere are nitrogen and oxygen gases. Nitrogen and oxygen form 99% by volume of the earth's atmosphere.(No role in temperature maintenance)

Concentration of CO_2 and Water Vapours and their Role:

Although concentration of carbon dioxide and water vapours is negligible in atmosphere, yet they play a significant role in maintaining temperature of the atmosphere.

Temperature Maintenance:

Both of these gases (CO_2 and water vapours) allow visible light to pass through but absorb infrared radiations emitted by the Earth's surface. Therefore, these gases absorb much of the outgoing radiations and warm the atmosphere.

DECREASE IN TEMPERATURE UPWARD

As the concentration of gases decreases gradually with the increase of altitude, correspondingly temperature also decreases in troposphere at a rate of 6 °C per kilometer.

Q.4 What are the characteristics of stratosphere? Why temperature increases upwards in this sphere?

(Ex-Q.3) (GRW 2015, LHR 2014, FSD 2016 G-II)

Ans:

STRATOSPHERE

Definition:

"The region of atmosphere which is present upto 50 km is called stratosphere".

Rise in Temperature:

The presence of ozone (due to absorption of radiation) in this region is responsible for the

rise of temperature in stratosphere.

Within this region, temperature increases as altitude increases, such as lower layer temperature is about **-58°C and upper layer is about 2°C.**

The fate of ozone and different regions of stratosphere can be described as follows:

(i) Ozone in Upper Stratosphere (Destruction of Ozone):

Since ozone in the upper layer absorbs high energy ultraviolet radiations from the Sun, it breaks down into monoatomic (O) and diatomic oxygen (O_2).

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

(ii) Ozone in the Mid Stratosphere: (Formation of Ozone): **(GRW 2014)**

The mid stratosphere has less UV light passing through it. Here O and O_2 recombine to form ozone which is an exothermic reaction. Ozone formation in this region results in the formation of ozone layer. Thus, ozone layer exists in mid stratosphere.

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

(iii) Ozone in the Lower Stratosphere:

The lower stratosphere receives very low UV radiations, thus monoatomic oxygen is not found here and ozone is not formed here.

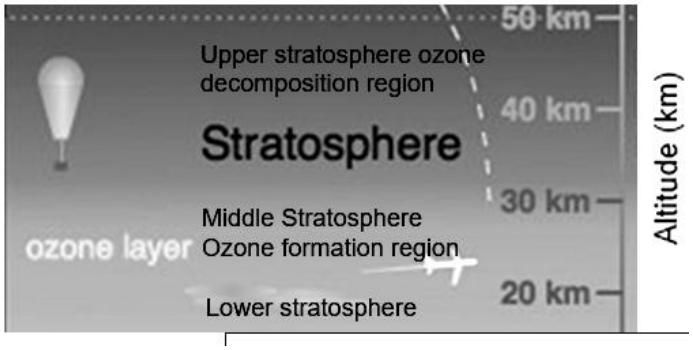


Figure: Stratosphere Regions

14.1 COMPOSITION OF ATMOSPHERE

SHORT QUESTIONS

Q.1 What do you know about wavelength of solar radiations? *(Knowledge Base)*
(Do you know Pg. # 118)

Ans: **WAVELENGTH OF SOLAR RADIATIONS**

Sunlight has short wavelength radiations. Solar energy absorbed by the Earth surface is transformed into heat energy which is of longer wavelength.

Q.2 What do you know about reflection and absorption of solar radiations by the earth?
(Knowledge Base)**(Do you know Pg. # 118)**

Ans: **REFLECTION AND ABSORPTION OF SOLAR RADIATIONS**

Reflection:

On the average there is total 32% reflection of light out of which:

- 6% being reflected from the Earth's surface
- 26% being reflected back into space because of clouds, gases and dust particles in the atmosphere.

Absorption:

- 18% of sunlight is absorbed by atmospheric gases.
- The remaining 50% reaches upto the Earth and is absorbed by it.

Fate of Heat Energy Radiated From Earth:

- The energy is radiated as heat energy of longer wavelength which is absorbed by water vapours and CO_2 in atmosphere.

Q.3 How is ozone produced in troposphere? *(Knowledge Base)*(Interesting Information Pg. # 121)

Ans: **PRODUCTION OF OZONE**

Ozone is quite a well-known gas. Photocopiers and any other source of static electricity can cause it to form from oxygen. You may have noticed a strange bitter smell near photocopiers; this is ozone. It is a poisonous gas and is formed on hot days in badly polluted cities.

Q.4 What are the major components of troposphere? *(Knowledge Base)*

Ans: *Answer given on Page # 256*

Q.5 Name the layers of atmosphere. *(Knowledge Base)*

Ans: **LAYERS OF ATMOSPHERE**

Depending upon the temperature variation, atmosphere is divided into four regions.

- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere

Q.6 How is ozone formed in stratosphere? *(Knowledge Base)*

Ans: **FORMATION OF OZONE IN STRATOSPHERE**

The mid stratosphere has less UV light passing through it. Here O and O_2 recombine to form ozone which is an exothermic reaction. Ozone formation in this region results in the formation of ozone layer. Thus, ozone layer exists in mid stratosphere.

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

14.1 COMPOSITION OF ATMOSPHERE
14.2 LAYERS OF ATMOSPHERE
MULTIPLE CHOICE QUESTIONS

1. % of sunlight absorbed by atmospheric gases is: *(K.B)* **(SGD 2014, DGK 2017)**

(A) 19 (B) 18
(C) 20 (D) 30

2. Percentage of argon in atmosphere by volume is: *(K.B)*

(A) 0.93 (B) 0.03
(C) 0.21 (D) 78.09

3. Percentage of carbon dioxide in atmosphere by volume is: *(K.B)*

(A) 0.93 (B) 0.21
(C) 0.03 (D) 78.09

4. Solar energy absorbed by Earth is converted into: *(K.B)*

(A) Heat energy (B) Light energy
(C) Both A and B (D) None of these

5. How much energy is absorbed by Earth? *(K.B)*

(A) 6% (B) 23%
(C) 50% (D) 32%

6. How much energy is reflected from Earth's surface? *(K.B)*
(A) 32% (B) 23%
(C) 50% (D) 6%

7. Percentage of nitrogen in the composition of atmosphere by volume is : *(K.B)*
(A) 78.09% (B) 20.94%
(C) 0.03% (D) 0.93%

8. About 99% atmosphere mass lies within: *(K.B)* **(SWL 2017)**
(A) 35km (B) 30km
(C) 15km (D) 11km

9. Temperature decreases from 17°C to -58°C regularly in the lowest layer extending upto kilometers: *(K.B)*
(A) 12 (B) 13
(C) 14 (D) 15

10. Height above the Earth surface of troposphere is: *(K.B)*
(A) 12-50km (B) 0-12km
(C) 50-85km (D) 85-120km

11. Height above the Earth surface of stratosphere is: *(K.B)*
(A) 12-50km (B) 50-85km
(C) 85-120km (D) 120-130km

12. Temperature of atmosphere decreases by _____ °C per kilometer as the concentration of gases decreases gradually with the increase of altitude. *(K.B)*
(A) 4 (B) 2
(C) 3 (D) 6

13. Formula of ozone is: *(K.B)* **(LHR 2014, MTN 2017)**
(A) O (B) O_2
(C) SO_3 (D) O_3

14. A group of gases that maintains the temperature of atmosphere is: *(K.B)*
(A) Carbon dioxide and water vapours (B) Nitrogen and carbon dioxide
(C) Oxygen and water vapours (D) Nitrogen and oxygen

15. The Earth's atmosphere is getting hotter because of increasing concentration of: *(K.B)*
(A) CO (B) CO_2
(C) O_2 (D) SO_2

16. Temperature range of troposphere is: *(K.B)*
(A) 10°C – -80°C (B) 17°C – -58°C
(C) -58°C – 2°C (D) 2 – 93°C

17. Stratosphere extends upto: *(K.B)*
(A) 12 km (B) 50 km
(C) 85 km (D) 110 km

18. The major constituents of troposphere are: *(K.B)*
(A) O_2 & N_2 (B) CO_2 & CO
(C) SO_2 & SO_3 (D) NO_x

19. Which is responsible for rise in temperature in stratosphere? *(K.B)*
(A) O_3 (B) CO_2
(C) CO (D) O_2

20. Mid of stratosphere contains: ***(K.B)***

(A) O_3 (B) CO_2
(C) CO (D) H_2SO_4

14.1 TEST YOURSELF

i. What do you mean by atmosphere? ***(Knowledge Base)*** **(GRW 2013, LHR 2013, SWL 2017)**

Ans:

ATMOSPHERE

"Atmosphere is the envelope of different gases around the Earth".

Layers of atmosphere:

Atmosphere consists of four layers extending from the surface of the Earth upwards which are as follows:

- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere

ii. What is difference between atmosphere and environment? ***(Knowledge+Understanding Base)*** **(LHR 2014)**

Ans:

DIFFERENTIATION

The differences between atmosphere and environment are as follows:

Atmosphere	Environment
Definition	
• Atmosphere is the envelope of different gases around the Earth. It extends continuously from the Earth's surface outwards without any boundary.	• Environment is the sum of all social, biological, physical and chemical factors which constitutes the surroundings of man.
Composition	
• It consists of four layers i.e., troposphere, stratosphere, mesosphere, thermosphere.	• It consists of air, water, food and sunlight.

iii. Name the major constituents of troposphere? ***(Knowledge Base)*** **(LHR 2015, MTN 2016 G-I)**

Ans:

MAJOR CONSTITUENTS

The major constituents of troposphere are:

- Nitrogen (78 %)
- Oxygen (21 %)

Both Nitrogen and oxygen constitute 99 % of atmosphere by volume.

iv. How the temperature of atmosphere is maintained? ***(Knowledge Base)*** **(GRW 2015)**

Ans:

MAINTENANCE OF TEMPERATURE

CO_2 and water vapours maintain the temperature of atmosphere. Both these gases allow visible light to pass through but absorb infrared radiations emitted by the Earth's surface. So, temperature of atmosphere is maintained.

v. Where the ozone layer exists? ***(Knowledge Base)***

Ans:

EXISTENCE OF OZONE LAYER

Ozone layer exists in mid of stratosphere about 25 to 30 kilometers away from the Earth surface. In this region formation of ozone takes place.

$$O_2 + O \longrightarrow O_3$$

vi. Why the temperature of upper stratosphere is higher? ***(Knowledge Base)***

Ans:

TEMPERATURE OF UPPER STRATOSPHERE

The temperature of upper stratosphere is higher due to the presence of ozone in this region.

Mechanism:

Ozone absorbs ultraviolet radiations coming from the sun. As the altitude increases the temperature also increases from **–58°C** to **2°C.**

14.3 POLLUTANTS

LONG QUESTIONS

Q.1 Write a note on pollutants. *(Knowledge Base)* **(GRW 2015)**

OR

What is meant by pollutants? Write down the type and sources of pollutants. **(SGD 2016 G-II)**

Ans: **POLLUTANTS**

Definition:

*"A pollutant is a **waste material** that pollutes air, water or soil (environment) and this phenomenon is called pollution".*

Characteristics:

The characteristics of pollutants are as follows:

- They make the environment (air, water or soil) harmful to life.
- They cause pollution.
- The contaminants are those substances that make something impure.
- A beneficial substance beyond a specific concentration may be harmful.

Air Pollutants: **(DGK 2016 G-II)**

"*The harmful substances present in air are called air pollutants".*

Effects:

Air pollutants have following effects:

- Change the weather
- Badly affect the human health
- Damage the plants
- Destroy buildings

Factors Affecting Severity of a Pollutant:

Three factors determine the severity of a pollutant.

- Chemical nature of pollutant
- Concentration of pollutant
- Persistence of pollutant.

Types of Pollutants:

Major air pollutants are classified as:

(i) Primary pollutants

(ii) Secondary pollutants.

Primary Pollutants: **(MTN 2017)**

*"Primary pollutants are the **waste** or **exhaust products** driven out because of **combustion** of **fossil fuels** and organic matter".*

Examples:

- Oxides of sulphur (SO_2 and SO_3)
- Oxides of carbon (CO_2 and CO)
- Oxides of nitrogen (specially nitric oxide NO)
- Hydrocarbon (CH_4)
- Ammonia
- Compounds of fluorine etc.

(ii) Secondary Pollutants:

"Secondary pollutants are produced by ***various reactions of primary pollutants".***

Examples:

- Sulphuric acid
- Carbonic acid
- Nitric acid
- Hydrofluoric acid
- Ozone
- **Peroxy acetyl nitrate (PAN) etc.**

Sources of Air Pollutants:

99% of atmosphere consists of N_2 and O_2. Although other gases are minor constituents they can have major effects on our environment. Because atmosphere determines the environment in which we live. So, these minor constituents are safe up to concentration limit. But human activities disrupt the environment. So, limit has been crossed considerable during the last 60 years.

Different sources of air pollutants are described as:

- Carbon oxides
- Sulphur compounds
- Nitrogen compounds
- Ozone

Q.2 State the major sources of CO and CO_2 emission. ***(Knowledge Base)*** **(Ex-SQ. 3) (GRW 2015, 16, MTN 2017, FSD 2016 G-I, DGK 2016 G-II)**

Ans: **SOURCES OF OXIDES OF CARBON (CO_2 AND CO)**

Sources of oxides of carbon (CO and CO_2) are as follows:

(i) Volcanic Eruption:

These gases are emitted due to volcanic eruption.

(ii) Decomposition of Organic Matter:

These gases are also emitted due to decomposition of organic matter.

(iii) Combustion of Fossil Fuels:

The major source for the emission of these gases is combustion of fossil fuels (coal, petroleum and natural gas). Fossil fuels burnt in combustion engine of any type of automobile, kiln of any industry, or open air fires emit CO_2 and CO.

(iv) Forest Fires and Burning of Wood:

Forest fires and burning of wood also emit CO_2 and CO. Especially, when supply of oxygen is limited, emission of CO dominates.

Q.3 Compounds of sulphur are air pollutants. Describe the sources of these compounds along with their effects. ***(Knowledge Base)*** **(Ex-Q.7) (GRW 2014)**

Ans: **SOURCES AND EFFECTS OF SULPHUR COMPOUNDS**

Sources:

a. Natural Production of Sulphur Compounds:

Naturally occurring sulphur containing compounds are emitted in the

- Bacterial decay of organic matter
- In volcanic gases
- Forest fires

b. Production of Sulphur Compounds due to Human Activities:

These compounds are emitted by fossil fuel combustion in automobiles and industrial units.

Comparison of SO_2 Production Naturally and By Combustion of Fossil Fuels:

The concentration of sulphur containing compounds in the atmosphere because of natural sources is very small as compared to the concentration of those compounds emitted by fossil fuel combustion in automobiles and industrial units. About 80% of the total SO_2 is released by the combustion of coal and petroleum products.

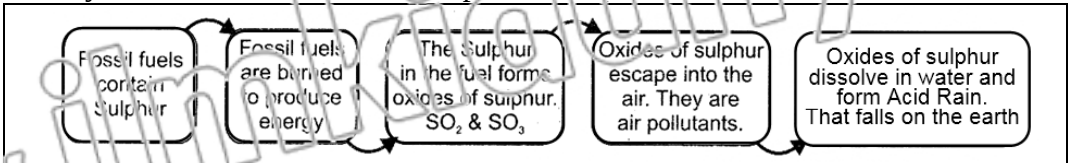


Figure: Formation of SO_3 and SO_2 on Combustion of Fossil Fuels and Causing Air Pollution

Effects of SO_2: **(RWP 2017)**

(i) Respiratory Problems:

SO_2 is a colourless gas having irritating smell. It causes suffocation, irritation and severe respiratory problems to asthmatic people.

(ii) Sulphuric Acid:

SO_2 forms sulphuric acid which damages buildings and vegetations.

Control of Sulphur Pollution:

To control pollution because of SO_2, it is necessary to remove sulphur from fossil fuels before they are burnt.

Q.4 Oxides of nitrogen cause air pollution. Describe the sources of these compounds. ***(Knowledge+Understanding Base)***

(SWL 2016 G-I)

Ans: **SOURCES OF NITROGEN COMPOUNDS (NOx)**

(i) Production of NO:

Natural Production:

Naturally occurring **oxides of nitrogen, mainly nitric oxide (NO),** is produced by the electrical lightening in air.

Combustion of Fossil Fuels:

Combustion of fossil fuels in internal combustion engines, in thermal power stations and factories where huge amount of coal is burnt, NO is formed by the direct combination of nitrogen and oxygen.

$$N_2 + O_2 \rightarrow 2NO$$

(ii) Production of NO_2:

NO quickly reacts with air to form nitrogen dioxide. **NO is highly toxic gas.**

$$2NO + O_2 \rightarrow 2NO_2$$

Effects of NO_x:

Mixture of these gases represented as NOx, enter in the air through automobile exhaust and chimneys of thermal power stations and factories. These gases have following effects:

- It irritates breathing passage.
- These oxides form nitric acid combining with water vapours in air.
- Nitric acid is a component of acid rain.
- Acidic gases (pollutants) from nearby industrial units contribute to the wearing away of the famous marble building the Taj Mahal in India.

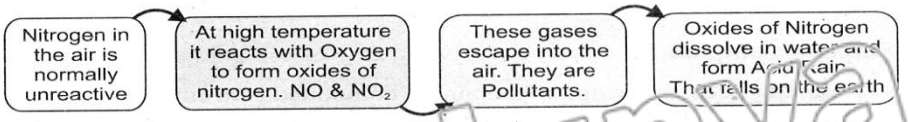


Figure: Formation of NO and NO_2 on Combustion of Fossil Fuels and Causing Air Pollution

Q.5 Write a complete note on greenhouse effect and global warming.
(Knowledge+Understanding Base) **(SWL 2016 G-II)**

OR

CO_2 is necessary for plants but why its increasing concentration is alarming for?
(Ex-Q.4)(LHR 2015, BWP 2016 G-I)

Ans:

GREEN HOUSE EFFECT

Definition:

*"The **concentration** of **CO_2** in air increases, less heat energy is lost from the surface of the Earth. Therefore, the average temperature of the surface gradually increases. This is called greenhouse effect".*

Explanation:

The CO_2 forms a layer around the Earth like an envelope. It allows the heat rays of the Sun to pass through it and reaches upto the Earth. These rays are reflected from the Earth surface and go back to upper atmosphere.

Importance of CO_2 Layer Around the Earth:

Normal concentration of CO_2 layer retains enough heat to keep the atmosphere warm. So, normal concentration of CO_2 is necessary and beneficial for keeping the temperature warm. Otherwise, the Earth would have been uninhabitable. The Earth's average temperature would be about -20°C, rather than presently average temperature 15°C.

Recycling of CO_2 and O_2:

CO_2 is not an air pollutant. Rather, it is an essential gas for plants as O_2 is essential for animals. Plants consume CO_2 in photosynthesis process and produce O_2.While animals use O_2 in respiration and give out CO_2. In this way, a natural balance exists between these essential gases as represented here.

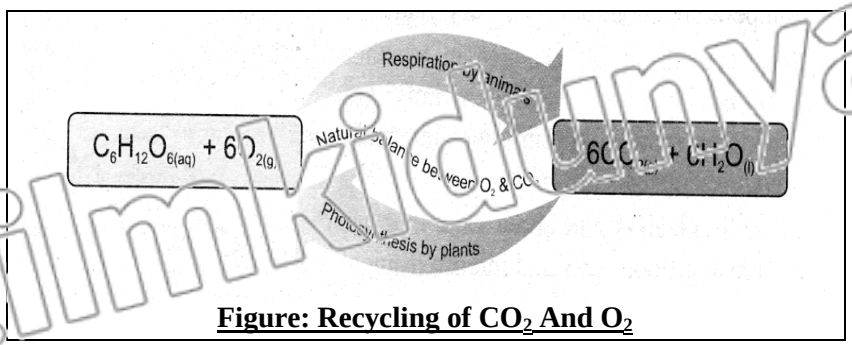


Figure: Recycling of CO_2 And O_2

Disturbance in Balance of CO_2 in Atmosphere:

But this balance is being disturbed by emitting more and more CO_2 in air through different human activities.

Role of CO_2 in Global Warming (CO_2 as Glass Wall in Atmosphere):

(Ex. Q.4)(LHR 2015)

(i) Disadvantage:

CO_2 is not a poisonous gas, yet its increasing concentration due to burning of fossil fuels in different human activities is alarming because CO_2 in the atmosphere acts like a glass wall of a green house.

Mechanism of Global Warming:

CO_2 in the atmosphere acts like a glass wall of a green house. It allows UV radiations to pass through it but does not allow the IR radiations to pass through it. It traps some of the infrared radiations emitted by the Earth. Hence, increased concentration of CO_2 layer absorbs the infrared radiations emitted by the Earth's surface and prevents heat energy escaping from the atmosphere.

(ii) Advantage:

It helps to stop surface from cooling down during night.

GLOBAL WARMING

"The increase in average temperature of Earth's atmosphere and oceanic temperature due to green house effect (resulting especially due to pollution) is called global warming".

Relationship between CO_2 and Green House Effect:

Green house effect $\propto$ amount of CO_2 in air

If the concentration of CO_2 in air increases, less heat energy is lost from the surface of the Earth. Therefore, the average temperature of the surface gradually increases. This is called greenhouse effect. This effect is proportional to amount of CO_2 in air. Trapping of heat or warming is greater with increase of CO_2. This phenomenon due to increased warming is also called global warming.

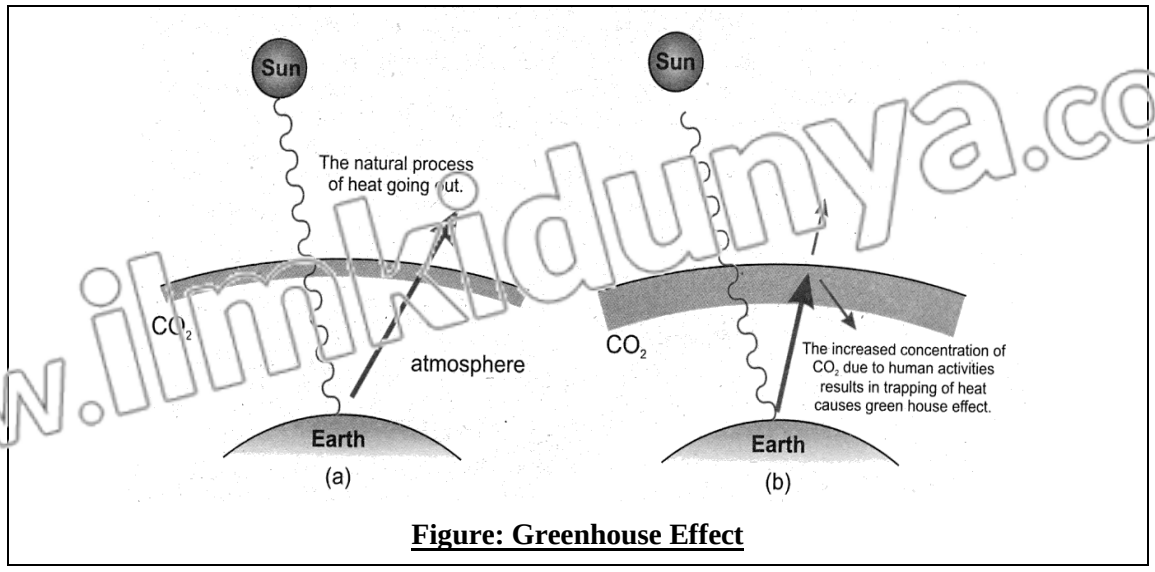


Figure: Greenhouse Effect

Effects of Global Warming:

(GRW 2014, DGK 2017, MTN 2016 G-II, BWP 2016 G-I, II, DGK 2016 G-I)

The effect of global warming are as follows:

(i) Rising of Temperature:

Accumulation of carbon dioxide in air is resulting in increasing atmospheric temperature about **0.05 °C** every year.

(ii) Weather Changes:

It is causing major changes in weather patterns. Extreme weather events are occurring more commonly and intensely than previously.

(iii) Melting of Glaciers and Snow Caps:

It melts glaciers and snow caps that are increasing flood risks and intense tropical cyclones.

(iv) Rise of Sea Level:

Sea-level is rising due to which low lying areas are liable to be submerged, turning previously populated areas no longer habitable.

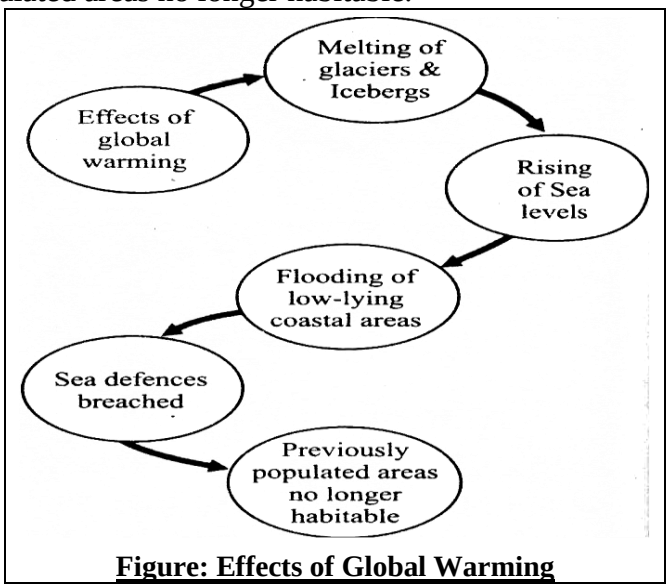


Figure: Effects of Global Warming

14.3 POLLUTANTS
SHORT QUESTIONS

Q.1 CO_2 is the life gas for plants and animals. Comment it. *(Knowledge Base)*

(Interesting Information Pg. # 125)

Ans:

CO_2 AS LIFE GAS

CO_2 is the life gas for plants as well as for the human beings and animals.

Comments:

CO_2 absorbs infrared radiations emitted by the Earth. Although CO_2 is negligible as compared to N_2 and O_2, yet its heat retaining capacity is tremendous. Without CO_2, life on earth would have been impossible.

Q.2 What are catalytic converters? *(Knowledge Base+Application Base)*

(Do you know Pg. # 124)

Ans:

CATALYTIC CONVERTERS

Definition:

"An instrument which is used to ***convert harmful gases (CO, NO_x hydrocarbons etc) present in automobile exhaust into harmless substances (CO_2, N_2 and H_2O),*** *in the presence of some catalyst like Pd, Cd etc is called catalytic converter".*

Importance:

Converters should be used in automobile exhaust so that they convert **CO to CO_2** and oxides of nitrogen **NO_x to N_2** before it enters in air. Catalytic converters are attached to automobile exhausts.

Q.3 Describe working of catalytic converters. ***(Application Base)*** **(Do you know Pg. # 124)**

Ans: **WORKING OF CATALYTIC CONVERTERS**

When hot gases pass through the converters, harmful pollutants are converted to harmless substances.

Examples:

- Carbon monoxide is oxidized to carbon dioxide.
- Unburnt hydrocarbons are oxidized to carbon dioxide and water, while oxides of nitrogen are reduced to nitrogen.

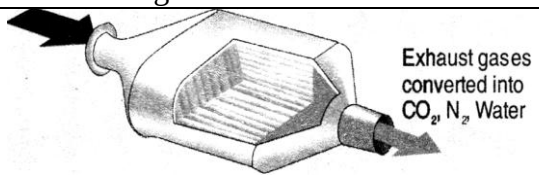


Figure: Catalytic Converter Used in Automobile Vehicle

Q.4 What are effects of SO_2? ***(Knowledge Base)*** **(RWP 2017)**

Ans: *Answer Given on Page # 263*

Q.5 Define global warming? ***(Knowledge Base)*** **(RWP 2016 G-II)**

Ans: **GLOBAL WARMING**

Definition:

"The increase in average temperature of earth's atmosphere and oceanic temperature due to green house effect (resulting especially due to pollution) is called global warming".

Effects of Global Warming:

- Rising of temperature
- Weather changes
- Melting of glaciers and snow caps
- Rise of sea level

Q.6 What are life gases for plants and animals? ***(Knowledge Base)***

(Interesting Information Pg. # 125)

Ans: **LIFE GASES**

- CO_2 is the life gas for plants used for photosynthesis.
- O_2 is for the respiration of human beings and animals.

Q.7 How CO_2 is responsible for existance of life on earth? ***(Knowledge Base)***

(Interesting Information Pg. # 125)

Ans: **ROLE OF CO_2**

CO_2 is responsible for existance of life on earth. It absorbes infrared radiations emitted by the Earth. Although CO_2 is negligible as compared to N_2 and O_2 yet its heat retaining capacity is tremendous. Without CO_2, life on Earth would have been impossible.

14.3 POLLUTANTS

MULTIPLE CHOICE QUESTIONS

1. A group of gases that maintains the temperature of atmosphere is: *(K.B)*
(A) Carbon dioxide and water vapours (B) Nitrogen and carbon dioxide
(C) Oxygen and water vapours (D) Nitrogen and oxygen

2. Which one is primary pollutant? *(K.B)*
(A) HNO_3 (B) CH_4
(C) O_3 (D) H_2SO_4

3. Which one of the following is a greenhouse effect? *(K.B)*
(A) Increasing atmosphere temperature (B) Both A and C
(C) Increasing flood risks (D) None of these

4. Formula of nitrogen dioxide is: *(K.B)*
(A) H_2SO_4 (B) NO_2
(C) HNO_3 (D) NO

5. Infrared radiations emitted by the Earth are absorbed by: *(K.B)*
(A) CO_2 and H_2O (B) N_2 and O_2
(C) CO_2 and N_2 (D) O_2 and CO_2

6. Cause of global warming is: *(K.B)* **(LHR 2014, GRW 2014, MTN 2017)**
(A) CO_2 (B) SO_2
(C) NO_2 (D) SO_3

7. The harmful substances present in air are called: *(K.B)*
(A) Air pollutants (B) Ozone
(C) Carbondioxide (D) Water

8. Which is not a primary pollutant? *(K.B)*
(A) SO_3 (B) CO_2
(C) CH_4 (D) O_3

9. Which is not a secondary pollutant? *(K.B)*
(A) H_2SO_4 (B) HNO_3
(C) PAN (D) NH_3

10. When wood burns in limited supply of oxygen which gas is produced? *(K.B)*
(A) CO_2 (B) CO
(C) SO_2 (D) SO_3

11. PAN is the abbreviation of: *(K.B)*
(A) Perhydroxy acetyle nitrate (B) Polyhydroxy acetyle nitrite
(C) Polyalkyl nitrate (D) Perhydroxyle acetyle nitrite

12. Which pollutant is not found in car exhaust gases? *(K.B)* **(LHR 2014)**
(A) CO (B) O_3
(C) NO_2 (D) SO_2

13. Which gas is inert? *(K.B)* **(GRW 2014, LHR 2016)**
(A) O_2 (B) CO
(C) N_2 (D) O_3

14. Photosynthesis process produces: *(K.B)* **(GRW 2015)**
(A) Starch (B) Cellulose
(C) Sucrose (D) Glucose

15. Carbon monoxide gas is harmful to us because: *(K.B)* **(DGK 2016 G-I)**
(A) It paralysis the lungs
(B) It damages lung tissues
(C) It reduces oxygen carrying ability of hemoglobin
(D) It makes the blood coagulate

14.2 TEST YOURSELF

i. What do you mean by an air pollutant? ***(Knowledge Base)*** **(BWP 2016 G-II, SGD 2017)**

Ans: **AIR POLLUTANT**

"*The harmful substances present in air are called air pollutants*".

Examples:

- H_2SO_4
- HNO_2
- SO_2
- CO etc.

ii. Name three primary air pollutants. ***(Knowledge Base)***

Ans: **THREE PRIMARY AIR POLLUTANTS**

Following are the names of three primary air pollutants:

- Sulphurdioxide : SO_2
- Sulphur trioxide : SO_3
- Carbon monoxide : CO etc.

iii. Identify as primary or secondary air pollutants. SO_2, CH_4, HNO_3, NH_3, H_2SO_4, O_3. ***(Knowledge Base)***

Ans: **IDENTIFICATION OF AIR POLLUTANTS**

The primary and secondary air pollutants are as follows:

Primary Pollutants	Secondary Pollutants
NH_3	HNO_3
CH_4	H_2SO_4
SO_2	O_3

iv. Why CO_2 is called a greenhouse gas? ***(Knowledge Base)***

(LHR 2013, DGK 2016 G-I, GRW 2017)

Ans: **CO_2 AS A GREENHOUSE GAS**

Carbon dioxide is called as a greenhouse gas because it acts like a glass wall of green house.

Mechanism:

It allows UV radiations to pass through it but does not allow the IR radiations to pass through it. As concentration of CO_2 increases, less heat is lost from the surface. So, average temperature of earth's surface gradually increases. This is called green house effect.

v. Why the flood risks are increasing? ***(Knowledge Base)*** **(SWL 2016 G-II)**

Ans: **INCREASING FLOOD RISKS**

Flood risks are increasing because Global Warming is melting the glaciers and snow caps.

vi. Comment burning in open air is preferred. ***(Knowledge Base)***

Ans: **BURNING IN OPEN AIR IS PREFERRED**

Burning in open air is preferred because in open air, burning produces CO_2 gas which is not poisonous and becomes part of atmosphere where as in closed places, CO is produced due to limited supply of oxygen, CO is poisonous gas and can be fatal.

vii. How sulphur containing compounds are emitted naturally? ***(Knowledge Base)***

Ans: **EMISSION OF SULPHUR COMPOUNDS**

Sulphur containing compounds are emitted naturally in the following ways:

- Bacterial decay of organic matter
- Volcanic gases
- Forest fires

viii. How combustion of fossil fuels in internal combustion engine produces oxides of nitrogen? ***(Knowledge Base)***

Ans: **COMBUSTION OF FOSSIL FUELS**

Combustion of fossil fuels in internal combustion engines, in thermal power stations and factories where huge amount of coal is burnt, NO is formed by the direct combination of nitrogen and oxygen. NO combines with O_2 to form NO_2.

$$N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$$

$$2NO + O_2 \longrightarrow 2NO_2$$

ROLE OF GOVERNMENT TO CONTROL POLLUTION

LONG QUESTIONS

Q.1 What is the role of government to control pollution? ***(Application Base)***

(Science, Technology and Society Book Pg. # 127)

Ans: **ROLE OF GOVERNMENT TO CONTROL POLLUTION**

Causing air pollution through auto exhaust is almost the most common air polluting act which an average citizen commits daily for hours without considering its consequences. One is poisoning the air, creating a big problem that has local, regional and global effects.

Responsibility of Government:

Government should do short term as well as long term planning to preserve the natural world. Because without a healthy natural environment, there will be no healthy human, plant, or animal.

Quality of Fuel:

Quality of fuel must be improved by adding anti-knocking agents in fuels. At the same time, automobiles combustion engines must be efficient so that they should burn the fuel completely. No unburned hydrocarbon molecules (fuel) should come out of the exhaust. So government must guide the people to use converters in auto exhausts.

(i) Alternative Fuels:

Fossil fuels produce a number of air pollutants because of impurities and complex molecule and nature of hydrocarbons

Examples:

Government should promote the use of alternative fuels such as:

- Methanol
- ethanol
- Bio-diesel

Advantages:

- These fuels are less polluting than hydrocarbons fuel, as their molecules are simple, and burn completely in the engine.
- Their burning produces less carbon monoxide, soot and other pollutants.

(ii) Bettery Powdered Electric Vehicles:

The government must plan to avoid using carbon dioxide producing fuels as it is a greenhouse gas. It should go to battery-powered electric vehicles.

(iii) Efficient Transport:

Government should provide efficient transport in the big cities, so that people should avoid using their own vehicles.

ROLE OF GOVERNMENT TO CONTROL POLLUTION

SHORT QUESTIONS

Q.1 How can we improve the quality of fuel? ***(Knowledge+Application Base)***

Ans:

TO IMPROVE THE QUALITY OF FUEL

Quality of fuel must be improved by adding anti-knocking agents in fuels. At the same time, automobiles combustion engines must be efficient so that they should burn the fuel completely. No unburned hydrocarbon molecules (fuel) should come out of the exhaust. So government must guide the people to use converters in auto exhausts.

Q.2 What are alternative fuels? Give their advantages. ***(Knowledge+Application Base)***

Ans:

ALTERNATIVE FUELS

The fuels produced by human other than fossil fuels are called alternative fuels.

Examples:

- Methanol
- ethanol
- Bio-diesel

Advantages:

- These fuels are less polluting than hydrocarbons fuel, as their molecules are simple, and burn completely in the engine.
- Their burning produces less carbon monoxide and other pollutants.

MULTIPLE CHOICE QUESTIONS

1. The government must plan to avoid using the fuels which produce greenhouse gas called: ***(K.B+A.B)***

(A) CO_2 (B) CO

(C) NO (D) NO_2

2. No unburned _____ molecules (fuel) should come out of the exhaust. ***(K.B+A.B)***

(A) Hydrocarbon (B) Ethanol

(C) O_2 (D) N_2

3. Which fuels are less polluting than hydrocarbon fuel? ***(K.B+A.B)***

(A) Ethanol (B) Methanol

(C) bio-diesel (D) All of these

4. Quality of fuel must be improved by adding: ***(K.B+A.B)***

(A) Water (B) Hydrocarbon

(C) Acid (D) Anti-knocking agents

14.4 ACID RAIN AND ITS EFFECTS

LONG QUESTIONS

Q.1 Explain how rain water is acidic and what are the effects of acidic rain? ***(Knowledge+Understanding Base)***

How rain water is acidic?

OR

Define acid rain. How it forms and what are its effects? **(Ex-Q.6) (LHR 2014, 15)**

Ans:

ACID RAIN

Definition:

"A rain having a pH lower than that of ***normal rain water*** *due to the presence of H_2SO_4 and HNO_3 is called acid rain".*

Formation of Acid Rain:

Burning of fossil fuels produces oxides of sulphur and nitrogen in air. Rain water converts SO_2 into H_2SO_4 and NO_x to HNO_2 and HNO_3.

$$H_2O + SO_2 \longrightarrow H_2SO_4$$

$$NO_2 + H_2O \longrightarrow HNO_2 + HNO_3$$

Normal Rain Water: Normal rain water is weakly acidic because it consists of dissolved CO_2 of the air. Its pH is about **5.6 to 6.**

Acid Rain Water:

Rain water on dissolving air pollutants (acids) becomes more acidic and its **pH reduces to 4**. Thus, acid rain is formed on dissolving acidic air pollutants such as sulphur dioxide and nitrogen dioxide by rain water. These oxides dissolve in rain water and damage soil, animals and aquatic life.

$$H_2O + SO_2 \longrightarrow H_2SO_4$$

$$H_2O + CO_2 \longrightarrow H_2CO_3$$

$$NO_2 + H_2O \longrightarrow HNO_2 + HNO_3$$

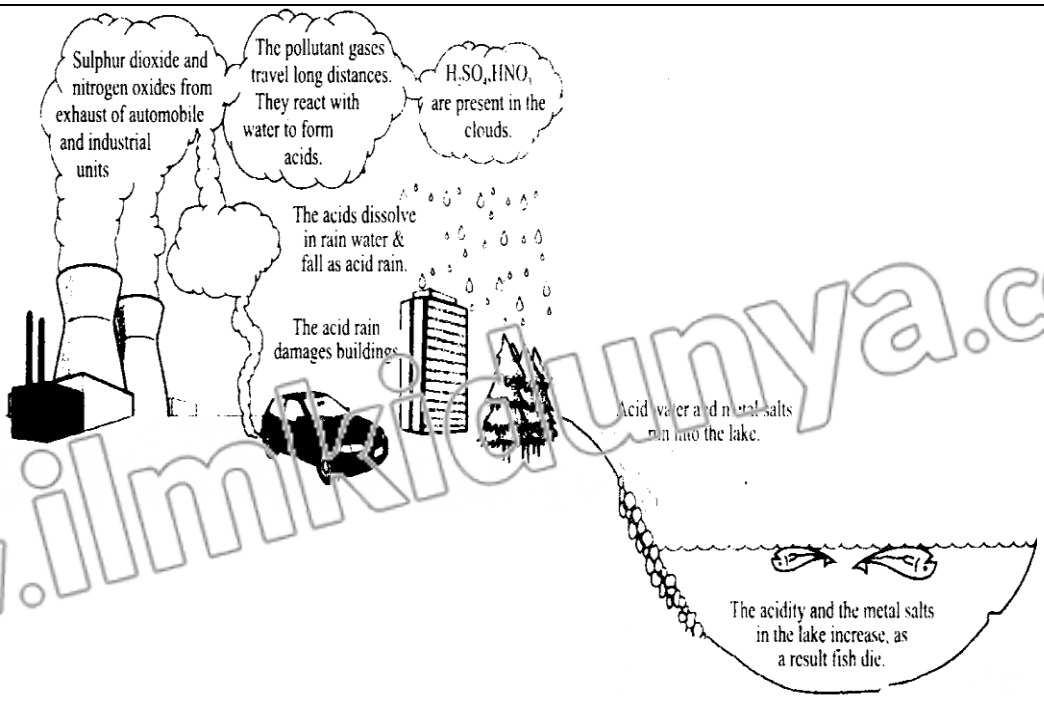


Figure: Acid Rain Formation And Its Effects

Effects of Acid Rain: **(SWL 2016 G-I, MTN 2016 G-II, DGK 2016 G-I)**

The effects of acid rain are as follows:

(i) Leaching of Soil:

Acid rain on soil and rocks leaches heavy metals (Al, Hg, Pb, Cr, etc) with it and discharges these metals into rivers and lakes.

Effect on Humans:

This water is used by human beings for drinking purpose. These metals accumulate in human body to toxic level.

Effect on Aquatic Life:

Aquatic life present in lakes also suffers because of high concentration of these metals. Especially high concentration of aluminum metal clogs the fish gills. It causes suffocation and ultimate death of fish.

(ii) Effect on Marble and Limestone of Buildings:

Acid rain attacks the calcium carbonate present in the marble and limestone of buildings and monuments. Thus, these buildings are getting dull and eroded day by day.

(iii) Increase in Acidity of Soil:

Acid rain increases the acidity of the soil. Many crops and plants cannot grow properly in such soil. It also increases the toxic metals in the soil that poison the vegetation. Even old trees are being affected due to acidity of soil. Their growth is retarded. They get dry and die.

(iv) Effect on Growth of Plants:

Acid rain directly damages the leaves of trees and plants, thus limiting their growth. Depending upon the severity of the damage, plants growth can be hampered. Plants ability to bear cold or diseases reduces and ultimately die.

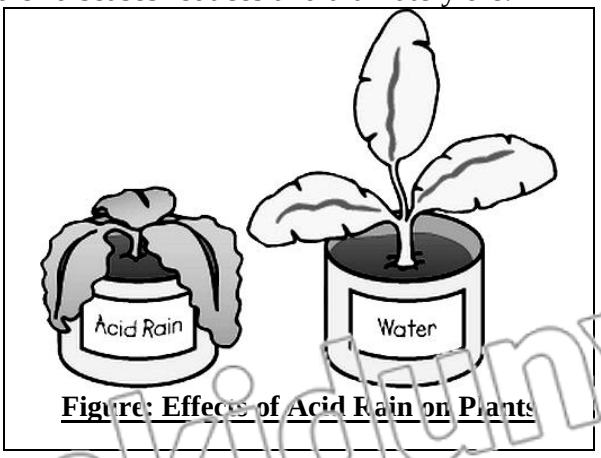


Figure: Effects of Acid Rain on Plants

14.4 ACID RAIN AND ITS EFFECTS

SHORT QUESTIONS

Q.1 What is meant by acid rain? ***(Knowledge Base)***

Ans: **ACID RAIN**

Definition:

"A rain having a pH lower than that of natural rain due to the presence of H_2SO_4 and HNO_3 is called acid rain".

Formation:

Burning of fossil fuels produces oxides of sulphur and nitrogen in air. Rain water converts SO_2 into H_2SO_4 and NO_x to HNO_2 and HNO_3.

Q.2 How does aluminium harm the fish? ***(Knowledge Base)*** **(RWP 2017)**

Ans:

HARM OF ALUMINIUM TO THE FISH

High concentration of aluminium metal clogs fish gills. It causes suffocation and ultimately death of fish.

14.4 ACID RAIN AND ITS EFFECTS MULTIPLE CHOICE QUESTIONS

1. Which one is heavy metal? ***(K.B)***

(A) Na (B) Hg
(C) K (D) Both A and C

2. Buildings are being damaged by acid rain because it attacks: ***(K.B)*** **(SWL 2017)**

(A) $CaSO_4$ (B) $Ca(NO_3)_2$
(C) $CaCO_3$ (D) CaC_2O_4

3. pH of normal rain water is: ***(K.B)***

(A) 5.6 to 6 (B) 6 to 7
(C) 8 (D) 9

4. pH of acid rain is: ***(K.B)***

(A) 7 (B) 5
(C) 6 (D) 4

5. Acid rain attacks on: ***(K.B)***

(A) $CaCO_3$ (B) K_2CO_3
(C) Na_2CO_3 (D) HNO_3

14.3 TEST YOURSELF

i. How acid rain is produced? ***(Knowledge Base)*** **(GRW 2013, SWL 2016 G-I, 17, SGD 2017)**

Ans:

PRODUCTION OF ACID RAIN

Definition:

"*Acid rain means the presence of excessive acids in rain waters".*

Production:

This rain is produced when normal rain water dissolves oxides of sulphur and nitrogen in air. The rain water converts SO_2 into H_2SO_4, NOx into HNO_2 and HNO_3.

ii. Why acid rain damages buildings? ***(Knowledge Base)*** **(GRW 2014, FSD 2016 G-II)**

Ans:

ACID RAIN DAMAGES BUILDINGS

Acid rain attacks the calcium carbonate present in the marble and limestone of buildings and monuments. Thus, these buildings are getting dull and eroded day by day.

iii. How aquatic life is affected by acid rain? ***(Knowledge Base)***

Ans:

EFFECTS OF ACID RAIN

Acid rain on soil and rocks dissolves heavy metals (Al, Hg, Pb, Cr, etc.) with it and discharges these metals into rivers and lakes. The high concentration of these metals, especially high concentration of aluminium metal clogs the fish gills. It causes suffocation and ultimately death of fish.

iv. Why plants are dying day by day? Comment. ***(Knowledge Base)***

OR

How acid rain affect the trees and plants? **(GRW 2017)**

Ans:

DYING OF PLANTS DAY BY DAY

Acid rain directly damages the leaves of trees and plants, thus limiting their growth. Depending upon the severity of the damage plants growth can be hampered. Plants capability to bear cold or diseases reduces and ultimately die.

14.5 OZONE DEPLETION AND ITS EFFECTS

LONG QUESTION

Q.1 (a) What is ozone layer? Explain the functions of ozone layer in stratosphere. ***(Knowledge Base+Understanding Base)***

(b) How ozone layer is depleted and what are the effects of ozone depletion? **(GRW 2014)**

Ans: (a)

OZONE LAYER

Definition:

"The region of stratosphere (25-30 kilometers away from the earth surface) in which there is maximum concentration of ozone is called ozone layer."

Ozone:

"*An allotropic form of oxygen consisting of tri-atomic molecules is called ozone".*

Formation of Ozone in Atmosphere:

It is formed in atmosphere by the association of an oxygen atom with an oxygen molecule in the mid of stratosphere.

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

Maximum Concentration of Ozone (Ozone Layer): **(MTN 2017)**

Ozone is present throughout the atmosphere. But its maximum concentration called ozone layer lies in stratosphere region about 25 to 30 km away from the Earth's surface.

FUNCTIONS OF OZONE LAYER

Ozone layer surrounds the globe and protects Earth like a shield from harmful ultraviolet radiations of sunlight. Otherwise, ultraviolet radiations would cause skin cancer. Thus ozone layer in stratosphere is beneficial for life on the Earth.

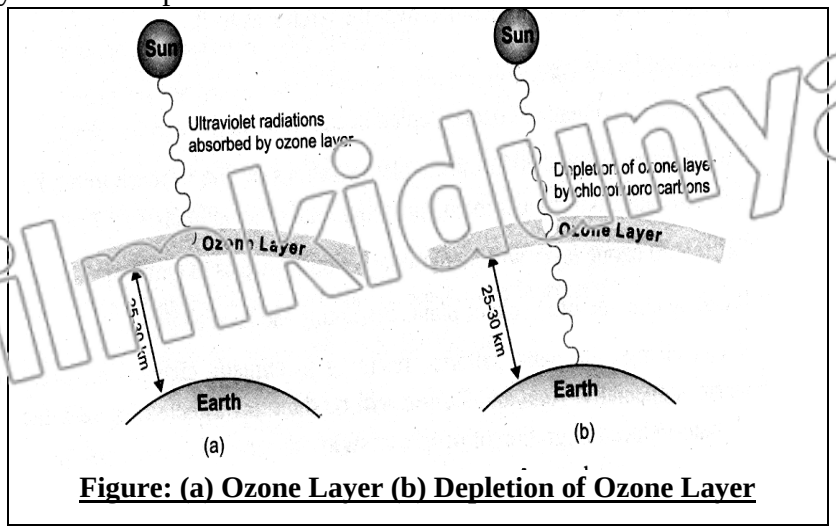


Figure: (a) Ozone Layer (b) Depletion of Ozone Layer

Maintenance of Balance of Ozone Concentration:

Under normal conditions ozone concentration in stratosphere remains nearly constant through a series of complex atmospheric reactions. Two reactions that maintain a balance in ozone concentrations are as follows:

$$O_{2(g)} + O_{(g)} \longrightarrow O_{3(g)} \quad \textbf{(formation)}$$

$$O_{3(g)} \longrightarrow O_{2(g)} + O_{(g)} \quad \textbf{(decomposition)}$$

(b) DEPLETION OF OZONE LAYER

Following are ways in which ozone is being depleted:

(i) Solar Radiations:

The ozone molecule absorbs solar radiations and dissociates readily, i.e., self dissociation of ozone takes place.

(ii) Chlorofluorocarbons:

Chlorofluorocarbons (CFCs) (used as refrigerants in air conditioners and refrigerators) are major cause of depletion of ozone layer. These compounds leak in one way or other escape and diffuse to stratosphere. These ultraviolet radiations break the **C-Cl bond in CFCs** and generate chlorine free radicals as:

$$CFCl_3 \xrightarrow{UV} CFCl_2 + \dot{Cl}$$

These free radicals are very reactive. They react with ozone to form oxygen.

$$O_{3(g)} + \dot{Cl} \longrightarrow O_{2(g)} + O\dot{Cl}$$

$$O\dot{Cl} \longrightarrow \dot{O} + \dot{Cl}$$

$$\dot{O} + \dot{O} \longrightarrow O_{2(g)}$$

A single chlorine free radical released by the decomposition of CFCs is capable of destroying upto many lacs of ozone molecules.

Ozone Hole:

"The region in which ozone layer depletes is called ozone hole".

Signs of Ozone Depletion:

Signs of ozone depletion were first noticed over Antarctica in 1980s. Since1990s ozone depletion have also been recorded over the Arctic.

EFFECTS OF OZONE DEPLETION

(GRW 2016, DGK 2016, MTN 2016 G-II)

Even minor problems of ozone depletion can have major effects. The major effects of ozone depletion are as follows:

(i) Skin Cancer:

Depletion of ozone enables ultraviolet radiations of Sun to reach to the Earth that can cause skin cancer to human beings and other animals.

(ii) Infectious Diseases:

Decreased ozone layer will increase infectious diseases like malaria.

(iii)Disruption of Food Chain:

It can change the life cycle of plants disrupting the food chain.

(iv)Climatic Change:

It can change the wind patterns, resulting in climatic changes all over the world. Especially, Asia and Pacific will be the most affected regions, facing climate-induced migration of people crisis.

Q.2 What is incineration? Describe its advantages and disadvantages. ***(Application Base)***
(Science, Technology and Society Pg. #131)

Ans:

INCINERATION

Definition:

"Incineration is a waste treatment process that involves the ***burning of solid waste*** *at high temperatures between* ***650^oC to 1100^oC*** *in incinerators".*

ADVANTAGES

Incinerators reduce the solid mass of the original waste by **80-85%** and convert the waste materials into ash, flue gas and heat.

DISADVANTAGES

Although, the volume of solid waste is reduced effectively by incineration, it produces highly poisonous gases and toxic ash. The flue gas includes, dioxins, furans, sulphur dioxide, carbon dioxide, carbon monoxide, hydrochloric acid and a large amount of particulate matter.

14.5 OZONE DEPLETION AND ITS EFFECTS

SHORT QUESTIONS

Q.1 What is incineration? ***(Application Base)*** **(Science, Technology and Society Book Pg. #131) (SWL 2016 G-I)**

Ans: *Answer given above*

Q.2 What are disadvantages of incineration? ***(Knowledge Base)***
(Science, Technology and Society Book Pg. # 131)(GRW 2014)

Ans: *Answer given above*

Q.3 Write composition of flue gas produced during incineration of waste material. ***(Knowledge Base)*** **(Science, Technology and Society Book Pg. #131)**

Ans:

COMPOSITION OF FLUE GAS

The flue gas includes:

- Dioxins
- Furans
- Sulphur dioxide
- Carbon dioxide
- Carbon monoxide
- Hydrochloric acid
- Large amount of particulate matter

Q.4 Define ozone and ozone layer. ***(Knowledge Base)*** **(MTN 2016 G-II)**

Ans: *Answer given on Page# 275*

MULTIPLE CHOICE QUESTIONS

1. Ozone is beneficial for us as it absorbs: ***(K.B)***

(A) Infra radiations (B) Ultra violet radiations

(C) Chlorofluorocarbons (D) Air pollutants

2. Decreased ozone layer will increase infectious disease like: ***(K.B)***

(A) Fever (B) Cholera

(C) Malaria (D) Headache

3. Ozone is an allotropic form of: ***(K.B)***

(A) Carbon (B) Oxygen

(C) Sulphur (D) Chlorine

4. The region in which ozone layer depletes is called: ***(K.B)***

(A) Ozone wall (B) Ozone hole

(C) Ozone deficiency (D) Ozone downfall

5. It destroys ozone molecules: ***(K.B)***

(A) Chlorocarbons (B) Trichlorocarbons

(C) CFCs (D) PAN

6. A strange bitter smell noticed near photocopier machine is of: ***(K.B)*** **(DGK 2016 G-II)**

(A) H_2S (B) SO_2

(C) O_3 (D) O_2

14.4 TEST YOURSELF

i. Justify, ozone is beneficial for human kinds. ***(Understanding Base)*** **(GRW 2015, FSD 2017)**

Ans: **BENEFITS OF OZONE**

It protects from harmful ultraviolet radiations of sun. It protect us from skin cancer.

ii. Why ozone is depleting in atmosphere? ***(Knowledge Base)***

Ans: **OZONE DEPLETION**

Following are ways in which ozone is being depleted:

(i) Solar Radiations: The ozone molecule absorbs solar radiations and dissociate readily, i.e., self dissociation of ozone takes place.

(ii) Chlorofluorocarbons: Chlorofluorocarbons (CFCs) (used as refrigerants in air conditioners and refrigerators) are major cause of depletion of ozone layer. These compounds leak in one way or other escape and diffuse to stratosphere. These ultraviolet radiations break the C-Cl bond in CFCs and generate chlorine free radicals as:

$$CFCl_3 \xrightarrow{UV} CFCl_2 + \dot{Cl}$$

These free radicals are very reactive. They react with ozone to form oxygen.

$$O_{3(g)} + \dot{Cl} \longrightarrow O_{2(g)} + O\dot{Cl}$$

$$O\dot{Cl} \longrightarrow \dot{O} + \dot{Cl}$$

$$\dot{O} + \dot{O} \longrightarrow O_{2(g)}$$

A single chlorine free radical released by the decomposition of CFCs is capable of destroying upto many lacs of ozone molecules.

iii. What do you mean by ozone hole? Where was it noticed first? ***(Knowledge Base)***

(GRW 2017, FSD 2016 G-II, 17)

Ans: **OZONE HOLE**

"*The region in which ozone layer is depleted is called ozone hole"*

Signs of Ozone Depletion:

Signs of ozone depletion were first noticed over Antarctica in 1980s. Since, 1990s depletion have also been recorded over the Arctic, as well.

iv. Where the ozone layer is found? ***(Knowledge Base)***

(FSD 2016 G-I, SGD 2016 G-II, SWL 2016 G-II, MTN 2017)

Ans: **OCCURRENCE OF OZONE LAYER**

Ozone layer lies in stratosphere region from 25–30 km from earth's surface.

Skills

Q.1 What is meant by filtration? Describe process for filtration of suspended impurities.

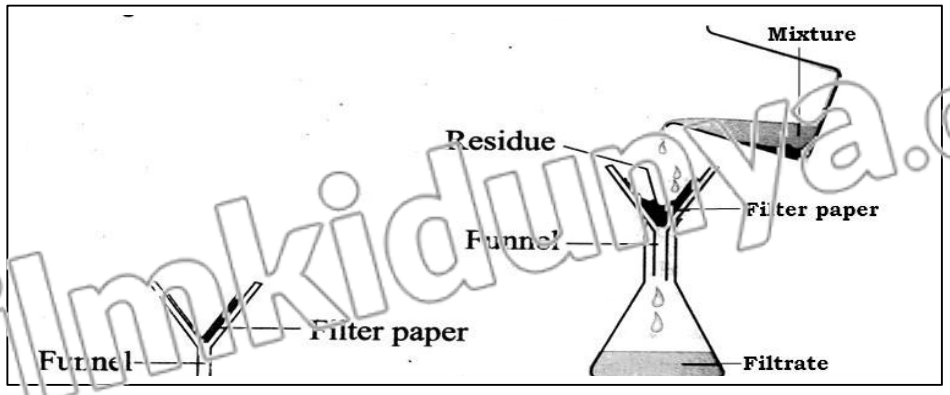
Ans: **FILTRATION**

"Filtration is separation of insoluble solid particles (sand, clay, dust or precipitates) from a liquid."

It is carried out by filtering a mixture.

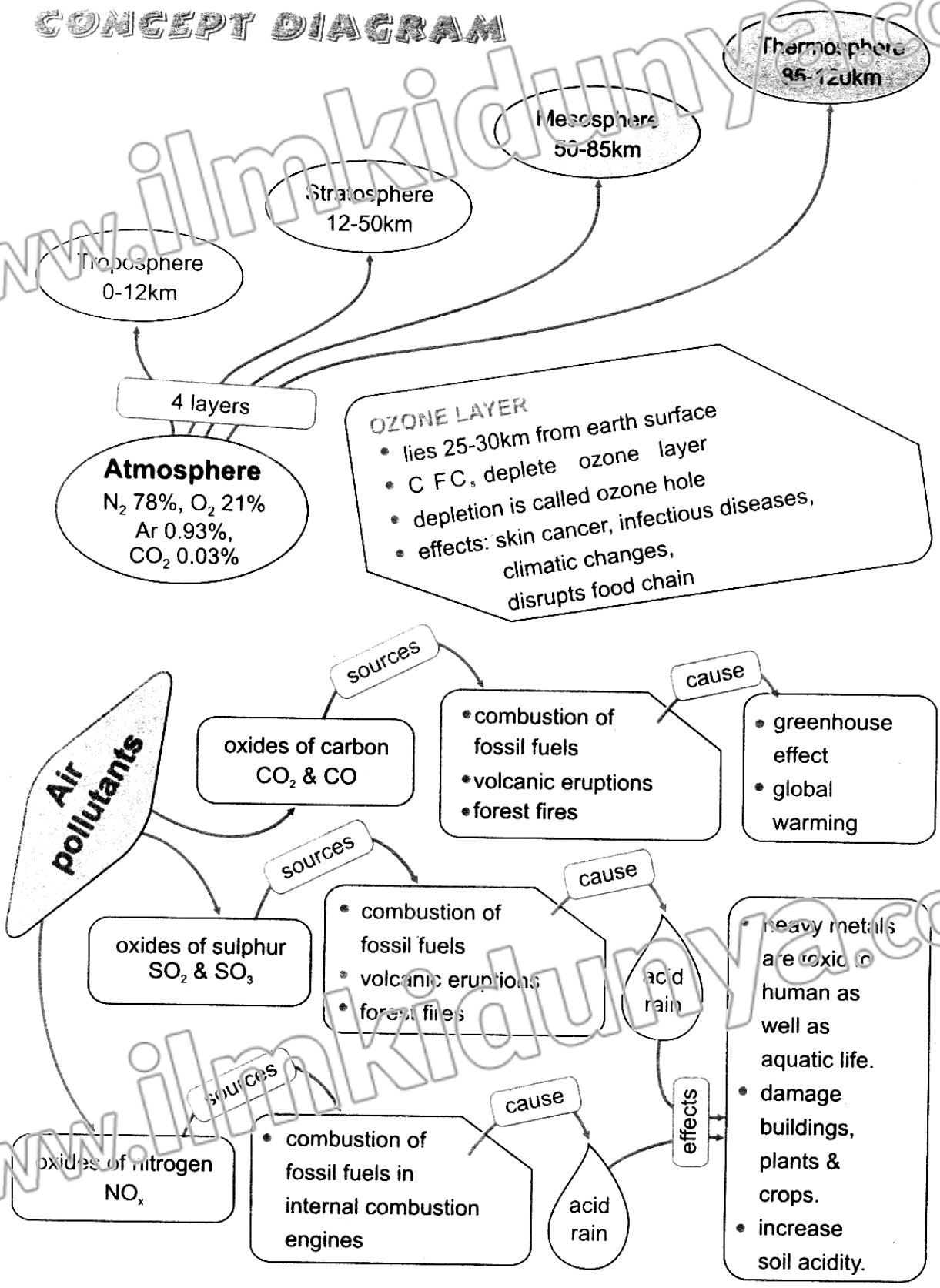
FILTRATION OF SUSPENDED IMPURITIES

Filtration is separation of insoluble solid particles (sand, clay, dust or precipitates from a liquid. It is carried out by filtering a mixture. A filter paper is first folded half way, then another fold is made, so that a filter paper gets four folds. This folded filter paper is placed in a filter funnel in such a way that on one side are three layers and on the other side is one layer as shown in figure. The mixture (sand in water or chalk in water) is poured into the filter paper as shown in figure.



Filtrate passes through the filter paper and is collected in a conical flask. The solid particles (residue) deposit on the filter paper. It is then dried.

Concept Diagram



ANSWER KEY

MULTIPLE CHOICE QUESTIONS

INTRODUCTION

1	A
2	C
3	B

14.1 COMPOSITION OF ATMOSPHERE
14.2 LAYERS OF ATMOSPHERE

1	B	6	D	11	A	16	B
2	A	7	A	12	D	17	B
3	C	8	B	13	D	18	A
4	A	9	A	14	A	19	A
5	C	10	B	15	B	20	A

14.3 POLLUTANTS

1	A	6	A	11	A
2	B	7	A	12	B
3	B	8	D	13	C
4	B	9	D	14	D
5	A	10	B	15	C

ROLE OF GOVERNMENT TO CONTROL POLLUTION

1	A
2	A
3	D
4	D

14.4 ACID RAIN AND ITS EFFECTS

1	B
2	C
3	A
4	D
5	A

14.5 OZONE DEPLETION AND ITS EFFECTS

1	B	6	C
2	C		
3	B		
4	B		
5	C		

EXERCISE SOLUTION

MULTIPLE CHOICE QUESTIONS

1. About 99% atmosphere's mass lies within: *(K.B)*

(LHR 2013, FSD 2016 G-I&II, 2017 G-II, DGK 2017, SWL 2017)

(a) 30 kilometres (b) 35 kilometres
(c) 15 kilometres (d) 11 kilometres

2. Depending upon temperature variation, atmosphere is divided into how many regions? *(K.B)*

(GRW 2013, BWP 2016 G-II, MTN 2016 G-II, SGD 2017, FSD 2017 G-I)

(a)One (b) Two
(c) Four (d) Three

3. Just above the Earth's surface is: ***(K.B)*** **(LHR 2014, SWL 2016 G-II, MTN 2017, RWP 2017)**

(a) Mesosphere (b) Stratosphere

(c) Thermosphere (d) Troposphere

4. A group of gases that maintains temperature of atmosphere is: ***(K.B)***

(a) Carbon dioxide and water vapours (b) Nitrogen and carbon dioxide

(c) Oxygen and water vapours (d) Nitrogen and oxygen

5. The Earth's atmosphere is getting hotter because of: ***(K.B)***

(a) Increasing concentration of CO (b) Increasing concentration of CO_2

(c) Increasing concentration of O_3 (d) Increasing concentration of SO_2

6. Which one of the following is not a Greenhouse Effect? ***(K.B)***

(a) Increasing atmospheric temperature (b) Increasing food chains

(c) Increasing flood risks (d) Increasing sea-level

7. Normally rain water is weakly acidic because of: ***(K.B)***

(LHR 2015, SGD 2016 G-II, MTN 2016 G-I, GRW 2017)

(a) SO gas (b) CO_2 gas

(c) SO_2 gas (d) NO_2 gas

8. Buildings are being damaged by acid rain because it attacks: ***(K.B)*** **(SWL 2017)**

(a) Calcium sulphate (b) Calcium nitrate

(c) Calcium carbonate (d) Calcium oxalate

9. Acid rain affects the aquatic life by cloging fish gills because of: ***(K.B)***

(SGD 2016 G-II, RWP 2016 G-I)

(a) Lead metal (b) Chromium metal

(c) Mercury metal (d) Aluminium metal

10. Ozone is beneficial for us as it: ***(K.B)***

(a) Absorbs infrared radiations (b) Absorbs ultraviolet radiations

(c) Absorbs chloroflourocarbons (d) Absorbs air pullutants

11. Which one of the following is not an air pollutant? ***(K.B)***

(a) Nitrogen (b) Carbon monoxide

(c) Nitrogen dioxide (d) Ozone

12. Iron and steel structures are damaged by: ***(K.B)*** **(GRW 2014, LHR 2014)**

(a) Carbon monoxide (b) Sulphur dioxide

(c) Methane (d) Carbon dioxide

13. Infrared radiations emitted by the Earth are absorbed by: ***(K.B)***

(a) CO_2 and H_2O (b) $N_2$and O_2

(c) CO_2 and N_2 (d) O_2 and CO_2

14. Global warming causes rising of the sea level. The cause of global warming is: ***(K.B)***

(a) CO_2 gas (b) SO_2 gas

(c) NO_x gases (d) O_3 gas

15. Which gas protects the Earth's surface from ultraviolet radiations? ***(K.B)***
(LHR 2014, BWP 2017. RWP 2017, SGD 2017)

(a) CO_2 (b) CO
(c) N_2 (d) O_3

16. Effects of ozone depletion are following except the one: ***(K.B)*** **(GRW 2014)**

(a) Increases infectious diseases (b) Increases crops production
(c) Can cause skin cancer (d) Can cause climatic changes

17. Which one of these pollutants are not found in car exhaust fumes? ***(K.B)***

(a) CO (b) O_3
(c) NO_2 (d) SO_2

18. **The process by which atmospheric nitrogen is turned into nitrates in the soil is called:** ***(K.B)***

(a) Nitration (b) Oxidation
(c) Fixing (d) Reduction

19. Global warming is because of: ***(K.B)***

(a) Absorption of infrared radiations emitted by the Earth's surface
(b) Absorption of infrared radiations coming from the Sun
(c) Absorption of ultraviolet radiation coming from the Sun
(d) Emission of ultraviolet radiation from the Earth's surface

20. Carbonmonoxide is harmful to us because: ***(K.B)***

(a) It paralyses
(b) It damages lung tissues
(c) It reduces oxygen carrying ability of haemoglobin
(d) It makes the blood coagulate

ANSWER KEY

1	a	**6**	b	**11**	a	**16**	b
2	d	**7**	b	**12**	b	**17**	b
3	d	**8**	c	**13**	a	**18**	b
4	a	**9**	d	**14**	a	**19**	a
5	b	**10**	b	**15**	d	**20**	c

EXERCISE SHORT QUESTIONS

1. Explain the phenomenon of decreasing temperature in troposphere. ***(Knowledge Base)*** **(LHR 2013)**

Ans:

DECREASING OF TEMPERATURE

In troposphere the concentration of gases (CO_2 and water vapours) decreases gradually with the increase of altitude, correspondingly temperature also decreases at a rate 6k per kilometer. This is the region where all weather occurs and air crafts fly in this region.

2. Differentiate between primary and secondary air pollutants. ***(Understanding Base)***
(LHR 2013, RWP 2016 G-I, MTN 2016 G-II, SWL 2017)

Ans:

DIFFERENTIATION

The differences between primary pollutants and secondary pollutants are as follows:

Primary Pollutants	Secondary Pollutants
Definition	
• Primary pollutants are those wastes and exhaust products driven out because of combustion of fossil fuels and organic matter.	• Secondary pollutants are produced by various reactions of primary pollutants.
Examples	
• Oxides of sulphur (SO_2 & SO_3) • Oxides of carbon (CO, CO_2) • Oxides of nitrogen (NO_x)	• Sulphuric acid • Carbonic acid • Nitric acid • Ozone, Peroxy acetyl nitrate etc.

3. State the major sources of CO and CO_2 emission. ***(Knowledge Base)*** **(Ex-SQ. 3)**
(GRW 2015, 16, MTN 2017, FSD 2016 G-I, DGK 2016 G-II)

Ans:

SOURCES OF OXIDES OF CARBON (CO_2 AND CO)

Sources of oxides of carbon (CO and CO_2) are as follows:

(i) Volcanic Eruption:

These gases are emitted due to volcanic eruption.

(ii) Decomposition of Organic Matter:

These gases are also emitted due to decomposition of organic matter.

(iii) Combustion of Fossil Fuels:

The major source for the emission of these gases is combustion of fossil fuels (coal, petroleum and natural gas). Fossil fuels burnt in combustion engine of any type of automobile, kiln of any industry, or open air fires emit CO_2 and CO.

(iv) Forest Fires and Burning of Wood:

Forest fires and burning of wood also emit CO_2 and CO. Especially, when supply of oxygen is limited, emission of CO dominates.

4. CO_2 is responsible for heating up atmosphere, how? ***(Knowledge+Understanding Base)***
(LHR 2013, GRW 2013, 14, DGK 2016 G-II)

Ans:

HEATING UP OF ATMOSPHERE

Carbon dioxide is called as a greenhouse gas because it acts like a glass wall of green house.

Mechanism:

It allows UV radiations to pass through it but does not allow the IR radiations to pass through it. As concentration of CO_2 increases, less heat is lost from the surface. So, average temperature of Earth's surface gradually increases. This is called green house effect.

5. CO is a hidden enemy, explain its action. ***(Understanding Base)***

(LHR 2013, GRW 2013, 14, BWP 2017, FSD 2017, MTN 2017)

Ans: **CO AS A HIDDEN ENEMY AND ITS ACTION**

Hidden Enemy:

CO is an air pollutant. It is a health hazard being a highly poisonous gas. Being a colourless and odourless. Its presence cannot be noticed easily and readily.

Action and Effects of CO:

- When inhaled it binds with hemoglobin most strongly than oxygen thus hindering the supply of oxygen in body.
- Exposure to the higher concentration of CO causes headache and fatigue.
- If inhaled for the longer time it results in breathing difficulties and ultimately death.

6. What threats are to human health due to SO_2 gas as air pollutant?

(Knowledge Base) **(GRW 2014)**

Ans: **THREATS DUE TO SO_2**

SO_2 is a colorless gas having irritating smell. It has following threats to human health:

- Irritation
- Suffocation
- Severe respiratory problems to asthmatic patients

7. Which air pollutant is produced on anaerobic decomposition of organic matter?

(Knowledge Base) **(LHR 2015)**

Ans: **AIR POLLUTANT FROM ANAEROBIC DECOMPOSITION**

CH_4 is an air pollutant produced on anaerobic decomposition of organic matter.

8. How acid rain increases the acidity of soil? ***(Knowledge Base)***

(BWP 2016 G-I, 17, SGD 2016 G-II, RWP 2016 G-I, MTN 2016 G-II)

Ans: **INCREASE IN ACIDITY OF SOIL**

Acid rain increases the acidity of the soil due to the presence of a number of acids like H_2SO_4, HNO_3 and H_2SO_3 present in it. These acids decrease the pH and increase the acidity of soil.

9. Point out two serious effects of ozone depletion. ***(Knowledge Base)***

(GRW 2014, LHR 2015, SWL 2016 G-II, MTN 2016 G-I, BWP 2016 G-I)

Ans: **TWO SERIOUS EFFECTS OF OZONE DEPLETION**

Two serious effects of ozone depletion are as follows:

(i) Decreased ozone layer will increase infectious diseases like malaria.

(ii) It can change the life cycle of plants disrupting the food chain.

10. How ozone layer forms in stratosphere? ***(Knowledge Base)***

(GRW 2014, LHR 2015, RWP 2016 G-I &II, SWL 2016 G-I)

Ans: **FORMATION OF OZONE LAYER**

Ozone layer forms in atmosphere by the association of an oxygen atom with an oxygen molecule in the mid of stratosphere.

$$O_{(g)} + O_{2(g)} \longrightarrow O_{3(g)}$$ (exothermic reaction)

11. Why the 75% of the atmospheric mass lies within the troposphere?

(Understanding Base) **(LHR 2013, 15, GRW 2014)**

Ans: **ATMOSPHERIC MASS IN TROPOSPHERE**

About 75% of the atmospheric mass lies within the troposphere which extends 11 kilometers from earth surface and this is due to gravitational force of attraction of Earth.

12. How ozone layer is being depleted by chloroflourocarbon? *(Knowledge Base)*

(LHR 2013, SGD 2016 G-II, BWP 2016 G-II, FSD 2017)

Ans: **DEPLETION OF OZONE LAYER BY CFCs**

Chlorofluorocarbons (CFCs) (used as refrigerants in air conditioners and refrigerators) are major cause of depletion of ozone layer. These compounds leak in one way or other escape and diffuse to stratosphere. These ultraviolet radiations break the C–Cl bond in $CFCl_3$ and generate chlorine free radicals as:

$$CFCl_3 \xrightarrow{uv} CFCl_2 + \dot{Cl}$$

$$O_{3(g)} + \dot{Cl} \longrightarrow O_{2(g)} + O\dot{Cl}$$

$$O\dot{Cl} \longrightarrow \dot{O} + \dot{Cl}$$

$$\dot{O} + \dot{O} \longrightarrow O_{2(g)}$$

A single chlorine free radical released by the decomposition of CFCs is capable of destroying upto many lacs of ozone molecules.

Ozone Hole:

"The region in which ozone layer depletes is called ozone hole".

EXERCISE LONG QUESTIONS

Q.1 Write down the significance of atmospheric gases. *(Knowledge Base)* (SGD 2014)

Ans: **SIGNIFICANCE OF ATOMOSPHEREIC GASES**

Atmosphere:

"Atmosphere is the envelope of different gases around the Earth. It extends continuously from the earth's surface outwards without any boundary."

Atmosphere Gases:

The percentage composition of atmosphere by volume is as follows:

Gas	%by Volume
Nitrogen	78.09
Oxygen	20.94
Argon	0.93
Carbon dioxide	0.03

Significance of Atmospheric Gases:

(i) Nitrogen:

78% of atmosphere is nitrogen. It is necessary for the safety of life on earth. It controls

the fire and combustion processes, otherwise all the things around us could burn with a single flame.

(ii) Oxygen:

Oxygen is a life gas for animals. Animals take in oxygen during respiration. It is necessary for burning process.

(iii) CO_2:

The CO_2 forms a layer around the Earth like an envelope. It allows the heat rays of the Sun to pass through it and reaches upto the earth. These rays are reflected from the Earth surface and go back to upper atmosphere.

Normal concentration of CO_2 layer retains enough heat to keep the atmosphere warm. So, normal concentration of CO_2 is necessary and beneficial for keeping the temperature warm. Otherwise, the Earth would have been uninhabitable. The Earth's average temperature would be about –20°C, rather than presently average temperature 15°C.

It is a life gas for plants because they synthesize their food by using CO_2

(iv) Ozone:

Ozone layer surrounds the globe and protects Earth like a shield from harmful ultraviolet radiations of sunlight which can cause skin cancer.

Q.2 Give the characteristics of troposphere. Why temperature increases upwards in this sphere?

Ans: See LQ.3 (Topic 14.2)

Q.3 What are the characteristics of stratosphere? Why temperature increases upwards in this sphere?

Ans: See LQ.4 (Topic 14.2)

Q.4 CO_2 is necessary for plants but why its increasing concentration is alarming for us?

Ans: See LQ.5 (Topic 14.3)

Q.5 Why CO is considered a health hazard?

Ans: See SQ.12 (Topic 14.3)

Q.6 Define acid rain. How it forms and what are its effects?

Ans: See LQ. 1 (Topic 14.4)

Q.7 Compounds of sulphur are air pollutants. Describe the sources of these compounds along with their effects.

Ans: See LQ. 3 (Topic 14.3)

Q.8 Where does ozone layer lie in atmosphere? How it is depleting and how we can prevent its depletion?

Ans: See LQ.1 (Topic 14.5)

Q.9 Oxides of nitrogen cause air pollution. Describe the sources of these compounds.

Ans: See LQ.4 (Topic 14.3)

ADDITIONAL CONCEPTUAL QUESTIONS

Q.1 What is a relationship between green house effect and carbondioxide?

Ans: Green house effect and carbondioxide are directly proportional to each other, Greater the carbondioxide, more the green house effect. If the concentration of CO_2 in air increase, less heat energy is lost from the surface of the Earth. Therefore, the average temperature of the surface gradually increases.

Green house effect $\propto$ Amount of CO_2 in air.

Q.2 How can we determine the severity of a pollutant?

Ans: Three factors determine the severity of a pollutant.

- Chemical nature of pollutant
- Concentration of pollutant.
- Persistence of pollutant.

Q.3 Why normal rain water pH is 5.6-6?

Ans:

NORMAL RAIN WATER

Normal rain water is weakly acidic because it consists of dissolved CO_2 of the air. Its pH is about 5.6 to 6. When CO_2 dissolve with water it produces carbonic acid (H_2CO_3) which itself is a weak acid therefore it reduces the pH of water from 7 to 5.6-6.

Q.4 Why is the pH of acid rain is reduced to 4?

Ans:

ACID RAIN WATER

Rain water on dissolving air pollutants (acids) becomes more acidic and its pH reduces to 4. Thus, acid rain is formed on dissolving acidic air pollutants such as sulphur dioxide and nitrogen dioxide by rain water. These oxides dissovlve in rain water and reduces its pH to 4.

Q.5 What do you know about leaching of soil?

Ans: Acid rain on soil and rocks leaches heavy metals (Al, Hg, Pb, Cr, etc) with it and discharges these metals into rivers and lakes. This water is used by human beings for drinking purpose which causes diseases.

TERMS TO KNOW

Terms	Definitions
Environmental Chemistry	Branch of chemistry which deals with the chemicals and other pollutants in the environment is called environmental chemistry.
Atmosphere	Atmosphere is the envelope of different gases around the Earth.
Troposphere	The region of the atmosphere from Earth's surface upto 12 km above is called troposphere.
Stratosphere	The region of the atmosphere which is up to 50 km is called stratosphere.
Mesosphere	The region of the atmosphere between 50–85 kilometers is called mesosphere.
Thermosphere	The region of the atmosphere between 85–120 kilometers is called thermosphere.
Pollution	A pollutant is a waste material that pollutes air, water or soil and this phenomenon is called pollution.
Pollutant	The harmful substances present in environment (air) are called air pollutants.
Primary Pollutants	Primary pollutants are the waste or exhaust products driven out because of combustion of fossil fuels and organic matter.
Secondary Pollutants	Secondary pollutants are produced by various reactions of primary pollutants.
Green House Effect	The concentration of CO_2 in air increases, less heat energy is lost from the surface of the Earth. Therefore, the average temperature of the surface gradually increases. This is called greenhouse effect.
Global Warming	The increase in average temperature of Earth's atmosphere and oceanic temperature due to green house effect (resulting especially due to pollution) is called global warming.
Catalytic Converter	An instrument which is used to convert harmful gases (CO, NO_x hydrocarbons etc) present in automobile exhaust into harmless substances (CO_2, N_2 and H_2O), in the presence of some catalyst like Pd, Cd etc is called catalytic converter.
Acid Rain	A rain having a pH lower than that of natural rain due to the presence of H_2SO_4 and HNO_3 is called acid rain.
Ozone Layer	The region of stratosphere (25-30 kilometers away from the earth surface) in which there is maximum concentration of ozone (10ppm) is called ozone layer.
Ozone	An allotropic form of oxygen consisting of tri-atomic molecules is called ozone.
Incineration	Incineration is a waste treatment process that involves the burning of solid waste at high temperatures between 650°C to 1100°C in incinerators.
Ozone Hole	The region in which ozone layer is depleted is called ozone hole.

SELF TEST

Time: 35 Minutes **Marks: 25**

Q.1 Four possible answers (A), (B), (C) and (D) to each question are given, mark the correct answer. (6×1=6)

1. Normally rain water is weakly acidic because of:

(A) SO_3 gas (B) CO_2 gas

(C) SO_2 gas (D) NO_2 gas

2. Infrared radiations emitted by the Earth are absorbed by:

(A) CO_2 and H_2O (B) N_2 and O_2

(C) CO_2 and N_2 (D) O_2 and CO_2

3. The percentage of sunlight absorbed by atmospheric gases is:

(A) 2% (B) 10%

(C) 18% (D) 25%

4. Which gas is also known as life gas for plants?

(A) CO (B) O_2

(C) CO_2 (D) NO_2

5. The range of temperature in burning solid waste in incinerators is:

(A) 650°C to 1000°C (B) 650°C to 1100°C

(C) 1000°C to 2000°C (D) 500°C to 1000°C

6. The stratosphere layer above the Earth's surface is at the height of:

(A) 85 – 120 km (B) 50 – 85 km

(C) 12 – 50 km (D) 0 – 12 km

Q.2 Give short answers to the following questions. (5×2=10)

(i) Write the composition of air?

(ii) Why CO_2 is called a green house gas?

(iii) CO is an hidden enemy, explain its action.

(iv) What are the effects of SO_2?

(v) Differentiate between primary and secondary air pollutants.

Q.3 Answer the following questions in detail. (5+4=9)

(i) Define Acid Rain how it forms and what are its effects? **(5)**

(ii) What are the effects of global warming? **(4)**

NOTE: Parents or guardians can conduct this test in their supervision in order to check the skill of students.