

# 7

# POLLUTION OF AIR AND WATER



## THEORY

### INTRODUCTION

Air and water are the two important natural resources. Human beings are responsible for changing the natural environment to fulfil their needs of food, clothing, housing, transport and industry. In fact, the uncontrolled activities of human beings are damaging the balanced and healthy environment. Most of the environmental problems are related to the increasing pollution which occur due to the increasing population and development in agriculture, transport and industry.

**Pollution** is the addition of substances in the environment in the quantities that are harmful to living beings.

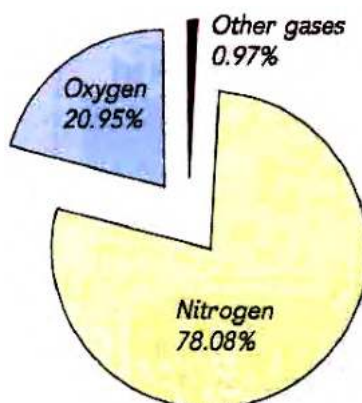
*Air or water containing substances that are harmful to us and our environment is said to be polluted, and the harmful substance present in it are known as pollutions.*

In this chapter, you will study the various environmental problems caused by air and water pollution and ways and means of controlling pollution.

### AIR POLLUTION

The air around us is a mixture of various gases such as nitrogen, oxygen, carbon dioxide, argon, methane, ozone and water vapour. All these gases are present in the air in a particular ratio. If some other unwanted substances are added to air, then an imbalance is caused in the air. The addition of unwanted and harmful substances in the air leads to air pollution.

The contamination of air by the addition of unwanted and harmful substances is known as **air pollution**.



Composition of air

- **Air Pollutants**

The substances which contaminate the air are called **air pollutants**.

**Examples :** dust, flyash, harmful gases such as carbon monoxide (CO) and sulphur dioxide (SO<sub>2</sub>).

## TYPES OF AIR POLLUTANTS

- Air pollutants are of two types :
    1. Gaseous air pollutants
    2. Particulate air pollutants
1. **Gaseous air pollutants** : Pollutants which are in the gaseous state at normal temperature and pressure are called gaseous pollutants.  
**Examples:** SO<sub>2</sub>, CO<sub>2</sub>, NO<sub>2</sub>, CO.
  2. **Particulate air pollutants** : Pollutants that are in the form of tiny particles are called particulate pollutants. They may be solid or liquid. Particulate matter usually remains suspended in the atmosphere and is therefore also termed as **suspended particulate matter (SPM)**.  
Some typical air pollutants are mentioned in Table.

**Table : Some Typical Air Pollutants**

Gaseous pollutants	Particulate pollutants
Sulphur dioxide (SO <sub>2</sub> )	Smoke
Carbon monoxide (CO)	Dust
Carbon dioxide (CO <sub>2</sub> )	Sand
Nitrogen dioxide (NO <sub>2</sub> )	Cement dust
Ozone (O <sub>3</sub> )	Flyash (coal dust)
Hydrogen sulphide (H <sub>2</sub> S)	Asbestos dust
Methane (CH <sub>4</sub> )	Unburnt hydrocarbons smog (smoke + fog)

## SOURCES OF AIR POLLUTION

- The various sources of air pollution can be classified into two groups :
  1. Natural sources of air pollution
  2. Man-made sources of air pollution

### 1. Natural sources of air pollution

- (i) The blowing of strong winds during **dust storms** puts dust particles into the air and pollute it.
- (ii) **Forest fires** release soot (carbon particles) and ash into the air and pollute the air.



*Forest fire leads to air pollution*

- (iii) **Volcanic eruption** releases various gases and ash into the atmosphere.
  - (iv) Decay of organic matter releases **ammonia** gas into the air.
  - (v) Decay of organic matter lying under water releases methane gas as air pollutant.
  - (vi) The **pollen grains** released by plants remain floating in the air and pollute it.
- The effect of air pollution caused by natural resources on human beings is negligible.



*Volcanic eruption releases gases and ash*

## 2. Man-made sources of air pollution

- (i) **Burning Fuels** : Burning of fuels like wood, cowdung cake, coal, and kerosene in homes pollute the air by producing pollutant like carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>), carbon dioxide (CO<sub>2</sub>), smoke, soot and ash.

**Table : Products obtained upon the combustion of fossil fuels**

Product	How formed	Effect
Carbon dioxide	Combustion of carbon in fuels in a sufficient supply of air.	Increase in greenhouse effect
Carbon monoxide	Combustion of carbon in fuels in an insufficient supply of air.	Air pollution
Nitrogen dioxide	Burning of nitrogen compounds.	Air pollution and acid rain
Sulphur dioxide	Burning of sulphur compounds.	Air pollution and acid rain
Soot	Incomplete combustion of fuels.	Air pollution
Water vapour	Burning of petroleum fuels.	No adverse effect

- (ii) **Vehicles** : Exhaust gases emitted by motor vehicles pollute the air by producing harmful pollutants like sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), unburnt hydrocarbons, lead compounds and soot.  
Thus, vehicles are the major sources of air pollution in big cities.



*Vehicular pollution is a major source of air pollution*



### ACTIVITY - 1

*Compare the quality of air in a village and a town. At which place would you like to live and why? Write a brief report on your observation.*

- (iii) **Industries** : Various industries pollute air by releasing pollutants such as  $\text{SO}_2$ , NO, chlorine, cement dust, asbestos dust, etc.



*Industries pollute air*

- (iv) **Thermal Power Plants** : Thermal power plants pollute air by emitting sulphur dioxide ( $\text{SO}_2$ ) and flyash.
- (v) **Nuclear Power Plants** : Nuclear power plants pollute air by releasing radioactive radiation .
- (vi) **Fertilisers and Pesticides** : Use of fertilisers and pesticides in agriculture pollutes the air.
- (vii) **Deforestation** : Deforestation pollutes air by increasing the amount of carbon dioxide in it.
- (viii) **Chlorofluorocarbons (CFCs)** : Use of chlorofluorocarbons pollutes air by depleting the ozone layer. As a result of this, harmful ultraviolet rays reach the earth. CFCs are used in refrigerators, air conditioners and aerosol sprays.
- (ix) **Mining** : Mining of coal and stone releases coal dust and stone dust to cause air pollution.
- (x) **Smoking** : Smoking pollutes air by emitting carbon monoxide (CO) and nicotine.

**Table : Sources of the chief pollutants of air**

S.N.	Pollutant	Source
1	Carbon monoxide	(i) The incomplete combustion* of fuel in vehicles. (ii) The incomplete combustion of coal in thermal power plants.
2	Oxides of sulphur (mainly $\text{SO}_2$ ; $\text{SO}_3$ is formed by the slow reaction of $\text{SO}_2$ with oxygen in the presence of soot)	(i) Volcanic eruptions (ii) The burning of sulphur and fossil fuels. (iii) The extraction of metals from minerals containing sulphides.
3	Oxide of nitrogen	The combustion of fuels like petrol, diesel, kerosene or coal.
4	Chlorofluorocarbons (CFCs)	(i) Leaking refrigerators and air conditioners. (ii) Spray cans
5	Soot	The combustion of fuels.
6	Dust Particles	(i) Wind-blown particles of soil, plant spores, etc. (ii) The processing of minerals.
<p>*The complete combustion of a fuel containing carbon gives <math>\text{CO}_2</math>, which is not poisonous.  <math>2\text{C} + \text{O}_2 \rightarrow 2\text{CO}</math> (Incomplete combustion)  <math>\text{C} + \text{O}_2 \rightarrow \text{CO}_2</math> (Complete combustion)</p>		

## EFFECT OF AIR POLLUTION

### 1. Effect on health

Air pollution causes many health problems.

- (i) **SO<sub>x</sub> and NO<sub>x</sub>** : The oxides of sulphur and nitrogen cause breathing problems and increase vulnerability to respiratory infections. They also trigger asthma attacks.
- (ii) **Carbon monoxide** : Carbon monoxide (CO) is a poisonous gas. It can kill a person without warning as it is colourless and odourless. As you know, blood transports oxygen in our body. When we inhale air, the oxygen of the air combines with haemoglobin of the blood to form **oxyhaemoglobin**. Oxyhaemoglobin runs through blood vessels and gives up its oxygen to cells, which use it for respiration. But CO displaces oxygen from oxyhaemoglobin to form **carboxyhaemoglobin**. The affinity CO for haemoglobin is 325 times greater than that of oxygen. So the displacement takes place easily. The formation of carboxyhaemoglobin cuts off oxygen supply to cells, and adverse effects are seen. The severity of the symptoms depends on the amount of CO in the blood.

As we have just said inhaling air with a high CO level may even be fatal. A person may die if he or she sleeps in a closed room heated by a coal fire.

CO (ppm)*	Effect
100	Headache, disorientation
300	Loss of consciousness
600	Coma
800	Death

\*ppm = parts per million, e.g., 1 ppm CO means 1 L of CO in 1,00,000 L of air.

Carboxyhaemoglobin slowly loses CO on being exposed to an excess of oxygen, and oxyhaemoglobin is again formed. So, a person suffering from CO poisoning should be kept on oxygen till he or she recovers.

The CO level in cities can vary from 5 to 100 ppm-mainly due to motor vehicles.

- (iii) **Depletion of ozone** : CFC's convert ozone to oxygen : Chlorofluorocarbon is a harmful chemical which is widely used in industries. While using, it escapes into the atmosphere and destroys **ozone**. Ozone gas present in the upper atmosphere absorbs harmful ultraviolet radiations coming from the Sun and protects plants and animals on the earth.

The ultraviolet radiations cause skin cancer, cataract and damage immune system of our body. The destruction of ozone layer has led to the development of **ozone hole**. These ozone holes are the areas where ozone is not present.

- (iv) **SPM** : The SPM (Suspended Particulate Matter) solid particles that pollute the air get inhaled by us. These particles irritate and damage the lungs. They cause frequent attacks of asthma and bronchitis.
- (v) **Hydrogen Sulphide** : It causes headache in humans when inhale in large quantity.

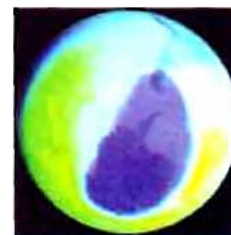


#### Ozone hole over Antarctica

There is a massive hole in the ozone layer right above Antarctica. The hole over Antarctica has been expanding for many years now, exposing the populated areas of South America to harmful UV rays of the sun.

The above image was created by the US government's National Aeronautics and Space Administration (NASA) in September 2004.

NASA creates images to depict the amount of ozone based on the data provided by its satellite instruments that monitor the ozone hole on a regular basis.



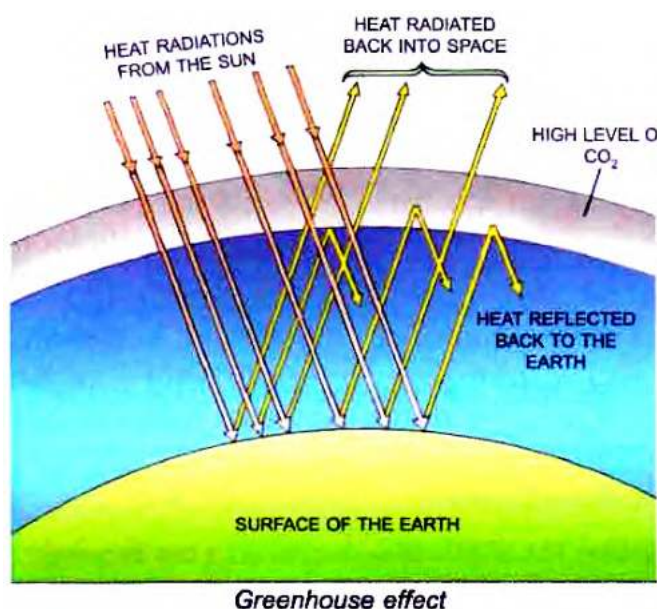
## 2. Effect on Plant

Air pollution can have lasting and harmful effect on the growth and development of plants. Some of these are discussed below.

- (i) Photochemical smog is said to have an adverse effect on plant growth because it forms a layer on leaves and, along with dust, blocks sunlight from being absorbed by the leaf surface. This layer blocks the absorption of carbon dioxide by the leaves and also affects the functioning of stomata, thereby reducing the rate of photosynthesis.
- (ii) Acid rain damages plants and can also cause premature leaf fall.
- (iii) Dust and smoke get deposited on the leaves of the plants and thus affect the rate of photosynthesis.

## 3. Greenhouse Effect

The burning of fossil fuels like coal, and petroleum products in homes, transport and industry releases a lot of carbon dioxide gas into the air. Deforestation and agricultural practices also help in increasing the amount of carbon dioxide in air. The increased level of carbon dioxide gas in the air traps the heat radiated from the earth. Carbon dioxide traps heat but does not allow it to escape into the space.



This process of trapping of radiated heat due to increased concentration of carbon dioxide in the air is called **greenhouse effect**. It leads to increased heating of earth. The phenomenon of rise in temperature of the earth's surface is called **global warming**.

Remember



### What are greenhouses?

Botanists and many commercial plant growers in cold climatic conditions use glasshouses or greenhouses for growing plants. Glass has a peculiar property that it allows the sun's energy to enter through it but prevents the heat inside from leaving the glasshouse. The temperature inside a greenhouse is higher than the temperature outside because the solar energy absorbed by the interiors of the greenhouse is remitted back into the greenhouse, thus keeping it warm. This is what helps plants grow.



The gases which produce greenhouse effect are called **greenhouse gases**. Carbon dioxide and methane are examples of greenhouse gases.

Global warming has become a major concern all over the world. Many countries have reached an agreement to reduce the emission of greenhouse gases in the atmosphere.

Environmentalists feel that global warming leads to changes in the climatic pattern worldwide causing frequent floods and cyclones. Some also feel that it may lead to the melting of the polar ice caps, raising the sea level and submerging many coastal areas.

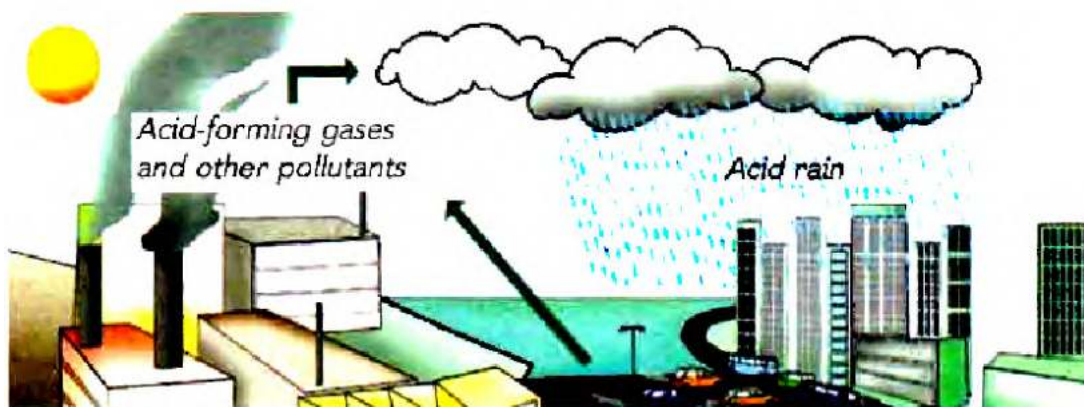
#### 4. Acid Rain

Atmospheric air is polluted due to high concentration of gases like carbon dioxide, sulphur dioxide, oxide of nitrogen, etc. in the vicinity of an industrial town. These gases are soluble in water.

When it **rains**, these gases get dissolved in rainwater and produce sulphuric acid and nitric acid is called **acid rain**. The rainwater is carried to rivers, lakes and ponds. Thus the natural water becomes acidic and the aquatic life becomes uncomfortable.

##### ➤ Harmful Effects of Acid Rain

1. Acid rain is very corrosive and harmful for both living and non-living things.
2. It gradually destroys living tissues, eats up cement, limestone and marble of buildings, and corrodes steel and other metals.
3. It is quite harmful for the survival of fishes and other aquatic lives. Several species of fishes have become extinct due to acid rain.
4. Acid rain damages old statues, old monuments, etc.
5. It causes premature leaf fall in plants and makes the soil acidic.



##### Remember



#### Taj Mahal and acid rain

The structure of Taj Mahal in Agra, India, has for the last few decades been under severe threat due to fumes emitted from an oil refinery in Mathura, iron foundries, and other chemical industries situated around Agra. Taking this into account the Supreme Court of India has passed several judgments to protect this wonder monument from toxic pollutants.



## PREVENTION AND CONTROL OF AIR POLLUTION

1. Better designed fuel burning equipment should be used in homes and industries so that fuel is burnt completely.
2. Tall chimneys should be installed in factories to reduce air pollution on the ground level.
3. Install electrostatic precipitators in the chimneys of industries.
4. Coal should be made free of sulphur before being burnt in power plants.
5. Low sulphur coal should be used for burning.
6. Fumes released from industries should be freed of sulphur and its oxides before being emitted from the chimneys.
7. Shift to less polluting fuels such as CNG (compressed natural gas).
8. Use LPG for domestic use.
9. Use of unleaded petrol should be encouraged.
10. The exhaust gases in vehicles should be passed through a **catalytic converter**, which converts, harmful carbon monoxide and nitrogen oxides to harmless carbon dioxide, nitrogen and water before releasing the exhaust in the air.
11. Regular pollution-check on vehicles should be made mandatory.
12. Shift to less polluting energy resources such as hydroelectric energy, nuclear energy, etc., should be encouraged.
13. Make use of public transport and car pools to the extent possible.
14. Plant samplings in your school and locality after getting the required permission.
15. Design posters and organize awareness campaigns in your locality on the need to reduce air pollution.

## CHIPKO MOVEMENT

The popular movement that took place in the Terai Himalayas in the early '70s to prevent the felling of trees by hugging them was called 'Chipko Movement'. It was perhaps the first well known development programme initiated by the common people.

It started in March 1973, in the remote hill town of **Gopeshwar** in the Chamoli district of Uttarakhand. The movement was led by reputed environmentalist **Sundar Lal Bahuguna**. An interesting aspect of this movement was that the women of the villages were in the forefront to participate in this movement.

**Vana Mahotsava** : The Vana mahotsava programme was started by the Government of India to revive lost forest. It is celebrated throughout the country in the first week of July every year. Every year, lakhs of saplings of different tree species are planted with the active involvement of government agencies. However, it needs to be made more popular, meaningful and effective.



## WATER POLLUTION

Water is one of the most abundant compounds on earth. About 75% of the earth's surface is covered with water. The three main types of water sources are:

- (i) Surface water : obtained from springs, streams, waterfalls, rivers, and lakes
- (ii) Ground water : obtain through wells
- (iii) Salty water : from seas and oceans



All living beings need water to carry out their life processes. Thus, water can be called a supporter of life. Most of the water which we use comes from rivers and lakes. Everyday many unwanted and harmful substances are thrown into the rivers. This makes the water impure. This is how water gets polluted.

The contamination of water with unwanted and harmful substances such as sewage, toxic chemicals, industrial wastes, etc., is called **water pollution**.

Water is said to be polluted when there are undesirable changes in the physical, chemical and biological condition of water that make it unfit for human consumption.

### What indicates water pollution?

A given sample of water is polluted if

- (i) it tastes bad.
- (ii) it smells bad,
- (iii) oil or grease is floating over it .
- (iv) there has been a decrease in the population of fish in the water body from which it has been taken, or
- (v) there has been unchecked growth of weeds in the water body from which it has been taken.

Such water is unfit for human consumption.

### Is clear, transparent water always pure?

No, clear transparent water; is not necessarily pure. It may contain harmful colourless chemicals and microorganisms.

**Water Pollutants :** The unwanted and harmful substances which pollute water are called **water pollutants**.

**Examples:** sewage, industrial waste, synthetic detergents, chemical fertilisers, oils, heavy metals, radioactive waste, etc.

## TYPE OF WATER POLLUTION

Water pollution can be broadly classified into two types--chemical and biological.

### 1. Chemical Pollution

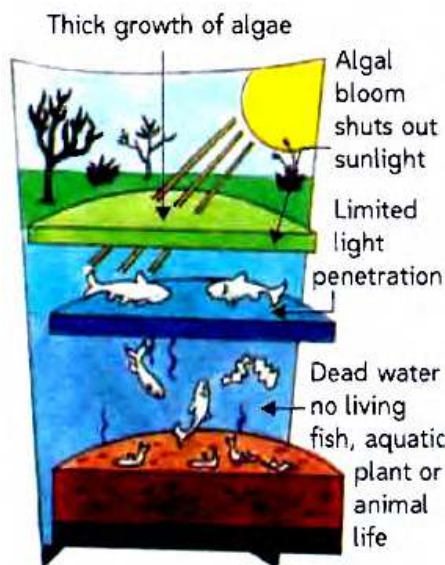
Chemical pollution of water is caused by the discharge of harmful chemical substances into water bodies. Chemical pollutants can be one or more of the following substances.

- (i) Pesticides and fertilisers
- (ii) Synthetic chemicals
- (iii) Oils and grease
- (iv) Mineral acids
- (v) Metals and their compounds
- (vi) Phosphates from detergents

- (i) **Pesticides and fertilisers :** These are discharged into water bodies by the run-off from agricultural land. The process of washing away of fertilizers into water bodies is called leaching. Pesticides are particularly injurious to us as they can affect the nervous system. They are not easily broken down into harmless substances either. Fertilisers help aquatic weeds to grow fast. The unchecked growth of weeds makes the water body extremely deficient in dissolved oxygen, badly affecting aquatic life. This process is called **eutrophication**.

***Eutrophication** may be defined as the process of nutrient enrichment of aquatic ecosystems and the subsequent overgrowth of plants on the surface of water.*

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Consequences of eutrophication: Increase in nutrient level in water bodies stimulates rapid growth of algae on the surface of water. The algae use up so much oxygen that aquatic animals and other plants die due to lack of the life sustaining gas. Algal bloom also blocks sunlight from reaching the submerged plants.

Certain pesticides such as DDT can enter the bodies of aquatic animal and eventually reach human beings by way of food chain.

- (ii) **Synthetic chemicals** :Synthetic (i.e., man-made) chemicals are in great demand these days. They are used in the manufacture of plastics, synthetic fibres, paints. dyes, drugs, pesticides, food additives, etc. Their production has increased manifold in recent years. The disposal of these chemicals into water bodies has caused a great increase in water pollution. Some of them are extremely harmful to living beings, more so because they persist for a long time. i.e., they are not broken down quickly.
- (iii) **Oils and grease** : Oil tankers carry petroleum by sea from one country to another. Oil spills out in tanker accidents or otherwise. The film of oil that floats over the water badly affects the transmission of light through the water body. This affects the process of photosynthesis in aquatic plants. Moreover, petroleum produces many chemicals that are extremely harmful to marine animals. Some of these chemicals cause cancer too.  
Grease comes out of ships and ferries and pollutes water in much the same way as oil does.
- (iv) **Mineral acids** : Mineral acids enter water bodies from mineral acid plants and abandoned coal mines, besides acid rain. They render the water unfit for aquatic life.
- (v) **Metals and their compounds** : Metals and their compounds enter water bodies from metallurgical units. Some metals, like mercury, arsenic, antimony, bismuth, lead and copper, are highly toxic.
- (vi) **Phosphates from detergents** : The phosphate radical comes from detergents and phosphatic fertilisers. It promotes the growth of aquatic weeds to such an extent that the water body gets choked, and the amount of dissolved oxygen decreases (eutrophication).

## 2. Biological Pollution

Biological pollution of water is caused by the discharge of big-wastes into water bodies.

Biological pollutants are of two type oxygen-demand.ing wastes and disease-causing microorganisms.

- (i) **Oxygen-demanding wastes** : Many organic substances break up into simpler substances by taking up dissolved oxygen in the presence of some bacteria. As they consume the dissolved oxygen, oxygen runs short for aquatic life, which is then badly affected. Moreover. many hannful products are formed.

Such oxygen-demanding substances are

- (a) domestic sewage and animal excreta.
- (b) wastes from food-processing industries, tanneries etc..
- (c) dead bodies thrown into water. and
- (d) wastes from hospitals.

- (ii) **Disease-causing microorganisms :** Water is the carrier of several microorganisms that cause common water-borne diseases like typhoid, dysentery, cholera and hepatitis. The microorganisms responsible for these diseases are present in the excreta of infected persons. When the excreta are discharged into a water body, the water body becomes a source of infection and the disease spreads, often taking the form of an epidemic. Wastes from hospitals carry not only microorganisms but also hazardous chemicals.

## EFFECT OF WATER POLLUTION

Let us now discuss the effects of water pollution on living beings.

- (i) Industrial wastes discharged into the waters contain a lot of toxic substances that make water unfit for drinking and bathing.
- (ii) Untreated domestic sewage when released into water bodies becomes a breeding ground to a number of water-borne disease carriers, which cause water-borne diseases like typhoid, cholera, dysentery, jaundice and hepatitis.
- (iii) Oil spills are very harmful to aquatic animals, and lead to destruction of marine life. Moreover, the cleaning up process also causes a lot of damage to marine habitat.
- (iv) Pollution of water also leads to a reduction in the number of aquatic plants and animals due to destruction of habitat and nesting places.
- (v) Ignition of arms and weapons releases large amounts of mercury. When water contaminated with mercury is used for drinking by animals and human beings, it causes numbness of limbs, lips, and tongue. It can also lead to blurred vision and mental disorders.
- (vi) An important adverse effect of water pollution is the eutrophication of water bodies.

## PREVENTION OF WATER POLLUTION

Water pollution can be prevented or minimised by adopting following measures :

1. The toxic industrial wastes should be treated chemically to neutralise the harmful substances present in it before discharging into rivers and lakes.
  2. The sewage should not be dumped into rivers. It should first be treated at the sewage treatment plant to remove the organic matter from it in the form of manure.
  3. The use of excessive fertilisers and pesticides should be avoided.
  4. The use of synthetic detergent should be minimised or biodegradable detergents should be used.
  5. Dead bodies of human beings and animals should not be thrown into rivers.
  6. The excreta and other garbage should be treated in a biogas plant to get fuel as well as manure.
  7. The water of rivers, streams, ponds and lakes should be purified or cleaned. This can be done both by the industries and the government. One such example is the Ganga Action Plan launched by the Indian Government.
  8. There should be general awareness among the masses regarding the harmful effects of water pollution and the ways of preventing it.
  9. Waste paper, plastics, waste food material, and rotten food and vegetables should not be thrown into open drains.
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## CASE STUDIES ON AIR POLLUTION AND WATER POLLUTION

### ● Case Study : Bhopal Gas Tragedy

On December 3, 1984, poisonous methyl isocyanate vapour accidentally leaked from the Union Carbide pesticide plant in Bhopal, India, immediately killing thousands of people and injuring more than 300,000 others. The smoke that engulfed the city was so poisonous that the aftermath of the accident has seen generations suffer from multiple ailments (see below). Further, tons of toxic material dumped at the old plant is believed to have seeped into the groundwater, thereby contaminating the water with poisonous substances.

#### Some of the adverse effects of this gas tragedy on the victims included:

1. Diseases of the eyes such as cataracts, conjunctivitis, poor vision, and complete blindness in many cases
2. Reduction in memory skills and motor skills
3. Skeletal and muscular problems
4. High body temperature and low immunity
5. Lung diseases such as bronchitis, breathlessness, and cough.
6. Gastrointestinal disorders
7. Poor functioning of the reproductive organs leading to abnormal birth and genetic disorders.

### ● Case Study : Ganga Action Plan

Did you know that an estimated quantity of about 5300 million litres of waste water is discharged into the waters of rivers Ganga and Yamuna every day? If this is the state of two of the main rivers of India, think about the thousands of big and small water bodies across the country. The government of India has launched and implemented many programmes in the past to keep water pollution under control. One such programme, is the Ganga Action Plan (GAP), which was launched in 1986.

Since river Ganga flows through many temple towns and industrial cities, human activities such as bathing and washing clothes, and discharge of industrial wastes are the main sources of pollution of this river. The industries that discharge waste water into the Ganges include leather factories and other industries in Kanpur and West Bengal.

The GAP aimed at interception and diversion of waste water reaching the Ganga and installation of sewage treatment plants for its treatment. Other pollution control activities included under the GAP were solid waste management, installation of crematoria, river front development, and provisions of low cost sanitation facilities. The plan also laid emphasis on public awareness and involvement to keep the Ganga clean. This programme has to a great extent helped to reduce pollution, although we still have a long way to go before River Ganges is absolutely free of pollution.

Later, many river plants such as the Yamuna Action Plan were launched modelled on the GAP.

## POTABLE WATER

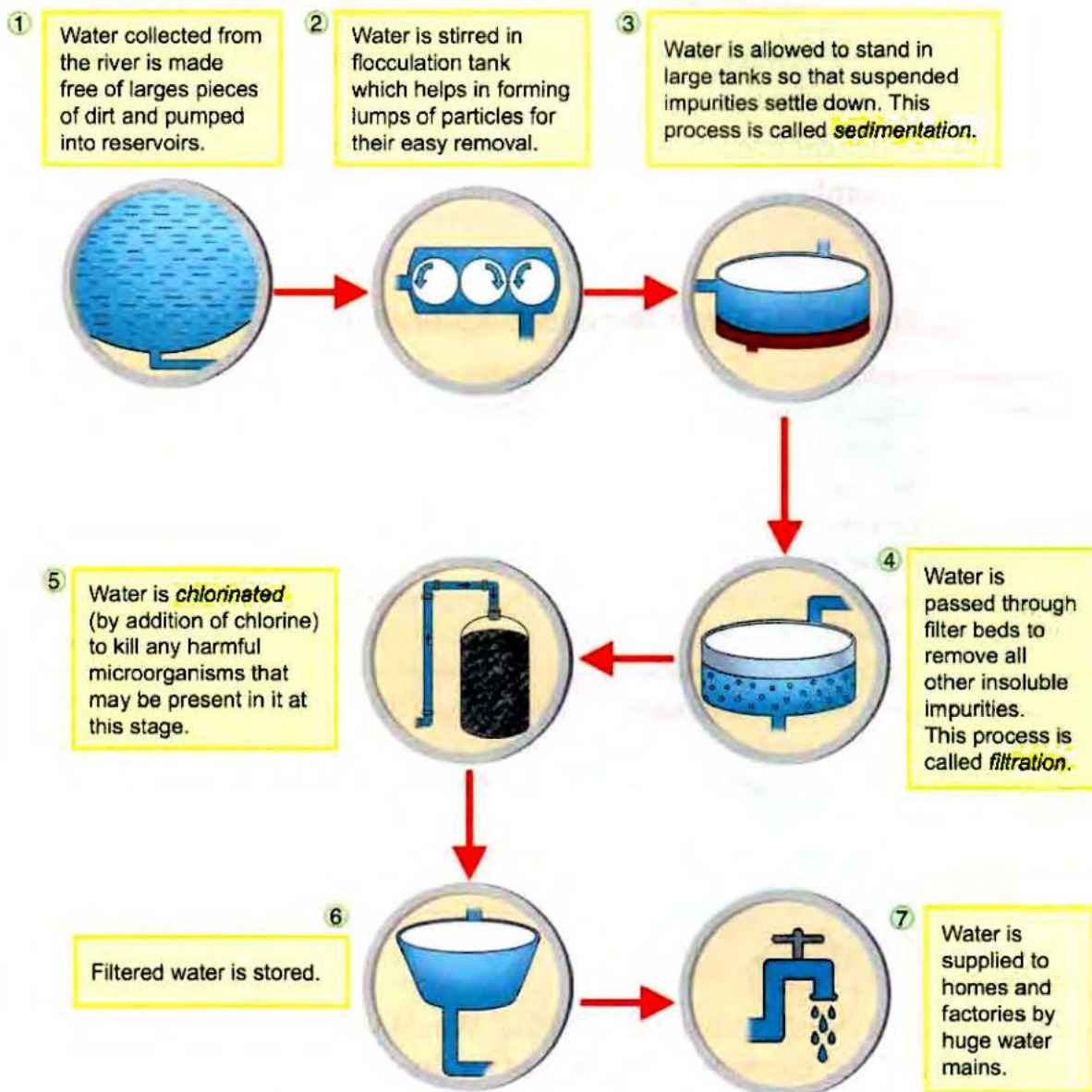
Suppose you feel thirsty while walking on the road. Would you drink water from a muddy puddle on the ground? Of course, not! Water used for drinking and cooking purposes should be pure and free of harmful germs and chemicals. *The water suitable for drinking by human beings is called **potable water**.*

To be considered fit for human consumption, a sample of water should

- be transparent, colourless, and odourless;
  - contain sufficient amount of dissolved oxygen and salts; and
  - be free from harmful chemicals and microorganisms.
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### PURIFICATION OF WATER

Water supplied in our homes generally comes from rivers and is contaminated with suspended impurities like sand, silt, and clay; soluble impurities like salts; and also microorganisms. Water, therefore, has to be cleaned in big purification plants before it reaches our homes. The three main processes through which water undergoes during purification are **sedimentation**, **filtration**, and **chlorination**. Figure outlines the various processes employed in purification of water.

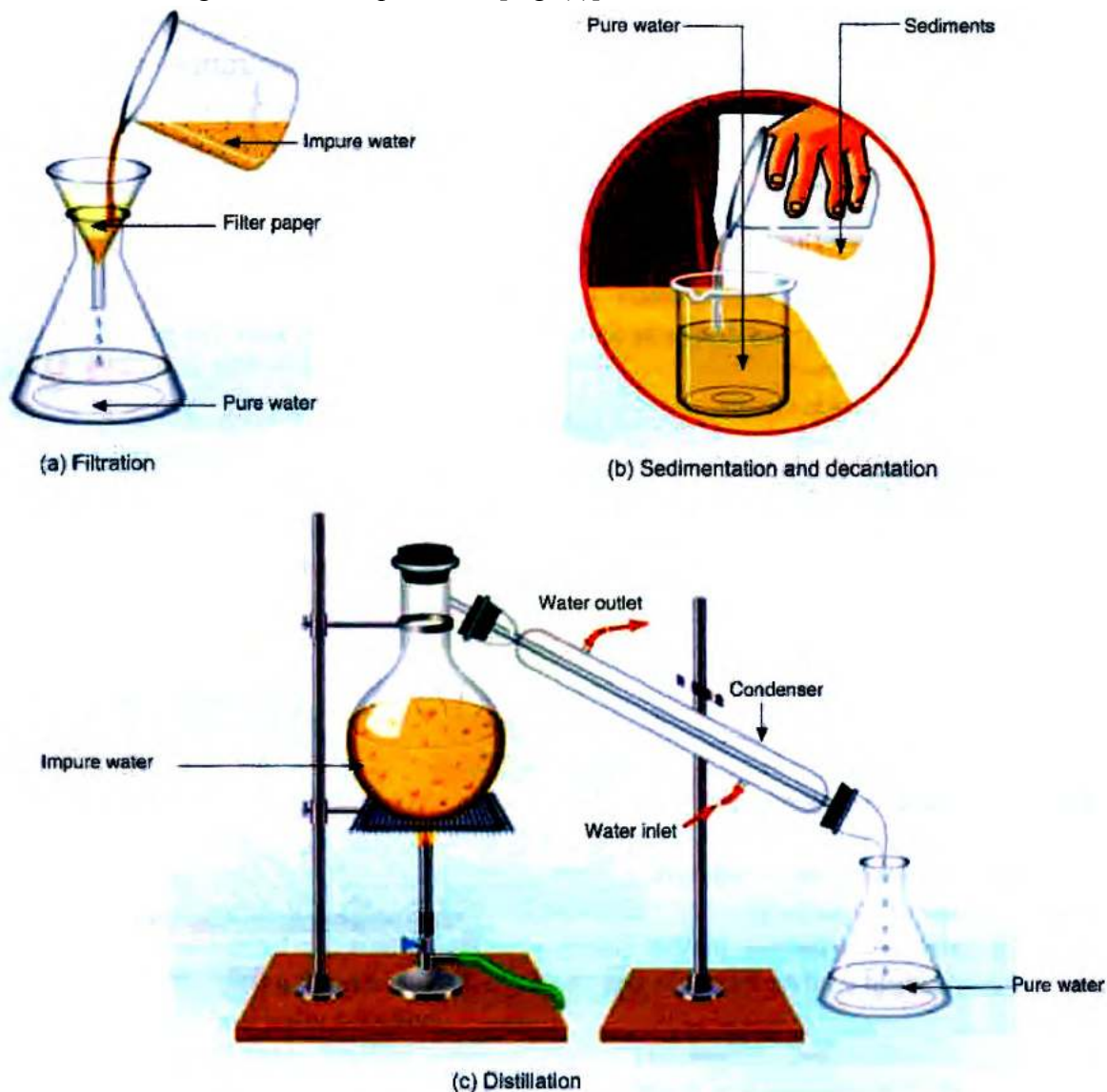


Diagrammatic representation of stages of purification of water

Impure water can be purified by various methods like filtration, distillation, and sedimentation.

- (i) **Filtration** : In this method, insoluble impurities are removed by passing impure water through a filter or a filter paper [Fig.(a)].
- (ii) **Sedimentation and decantation** : In this method, impure water is allowed to stand undisturbed in a container, which allows insoluble impurities like mud to settle at the bottom as sediments. This process is called sedimentation. Clean water can thereafter be transferred into a clean container by the process of decantation [Fig.(b)].

- (iii) **Distillation** : In this method, impure water is first heated to its boiling point to convert water into steam. The impurities are left behind in the container. The steam is then passed through a condenser, where it cools and changes back into liquid water [Fig. (c)].



Methods of purification of water

### Purification of Water at Home

The water supplied to our homes may not be entirely free from undesirable impurities. Also, in villages and small towns water is directly taken from wells, hand pumps, and rivers. Thus, purification of water at home becomes necessary. This can be done by both physical (e.g., boiling) and chemical (e.g., chemical tablets and electric water filters) means. Let us discuss some of these.

- (i) **Boiling** Boiling water is one of the easiest ways of purifying water. It is, however, very important that water is boiled at  $100^{\circ}\text{C}$  for at least 10-15 minutes to kill harmful microorganisms.
- (ii) **Addition of chemical tablets** : Chemicals like chlorine tablets or potassium permanganate can be added to water from wells and water tanks to kill harmful microorganisms and germs.
- (iii) **Use of electric water filters** : Electric water filters have a micro-porous filter, carbon, and a source of ultraviolet radiation. The micro-porous filter strains out physical impurities present in the water, like dust, rust, dirt, and mud. Carbon absorbs organic impurities and removes unwanted taste and odour. Ultraviolet radiation kills microorganisms.

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## KEY WORDS

- **Pollution** : Contamination of the environment with substances that are harmful to living beings.
  - **Pollutants** : Pollutants are the substances which cause pollution.
  - **Air Pollution** : When the air is contaminated by unwanted substances which have a harmful effect on both the living and non-living components, it is referred to as air pollution.
  - **Global Warming** : The average temperature of the earth's atmosphere is gradually increasing due to increasing levels of greenhouse gases like CO<sub>2</sub>. This is called global warming.
  - **Green House Effect** : The trapping of radiations by the earth's atmosphere due to increasing levels of gases like CO<sub>2</sub> is called greenhouse effect.
  - **Water pollution** : Water pollution is the contamination of water by those substances which are harmful to life.
  - **Chemical Contamination** : Discharge of harmful chemicals into rivers and streams causing pollution of water is called chemical contamination.
  - **Acid Rain** : Rain water mixed with pollutants such as oxides of sulphur and nitrogen which results in the formation of sulphuric and nitric acids.
  - **Eutrophication** : The process of nutrient enrichment of aquatic ecosystems and the subsequent overgrowth of plants and algae on the surface of water.
  - **Potable water** : Water suitable for drinking by human beings.
  - **Sedimentation** : The process of allowing suspended impurities present in water to settle down by allowing water to stand undisturbed in a tank or a container.
  - **Distillation** : The process in which water is converted into its vapour state by heating and the vapour cooled and condensed to the liquid state and collected.
  - **Chlorination** : Process of adding chlorine in water to kill harmful germs.
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## POINTS TO REMEMBER

- Air consists of a mixture of gases. By volume about 78% of this mixture has nitrogen gas and about 21% is oxygen. Carbon dioxide, argon, methane, ozone, water vapour are also present in very small quantities.
  - **Air Pollutants:** The substances which contaminate the air are called. Air pollutants.
  - Pollutants may come from natural sources (as forest fires or volcanic eruptions) as well as by human activities.
  - Carbon monoxide, nitrogen oxides, carbon dioxide, methane and sulphur dioxide are the major pollutants of air.
  - **Carbon Monoxide**
    - It is produced by incomplete burning of fuels such as petrol and diesel.
    - It is poisonous gas, it reduces the capacity of the blood to carry oxygen.
  - **Smog**
    - Oxides of nitrogen combine with other air pollutants and contributing to the formation of smog.
    - It causes the breathing difficulties such as asthma, cough and wheezing in children.
  - **Sulphur Dioxide**
    - It is produced by combustion of fuels like coal in power plants.
    - It can cause respiratory problems including permanent lung damage.
  - **Chlorofluorocarbons (CFCs)**
    - These are used in refrigerators, air conditioners, and aerosol sprays.
    - CFCs damage the ozone layer of the atmosphere.
  - **Tiny Particles**
    - These particles are produced by industrial processes like steel making and mining.
    - These remain suspended in the air for long periods and reduce visibility.
  - **Acid Rain:** Oxides of sulphur and nitrogen react with water vapour present in the atmosphere to form sulphuric acid and nitric acid. When these come down with the rain, it makes the rain acidic. This is called acid rain.
  - **Marble Cancer**
    - Acid rain has resulted in corrosion of the marble of the Taj. The phenomenon is called Marble cancer.
    - Suspended Particulate Matter (SPM) emitted by the Mathura Oil Refinery, has contributed to the yellowing of the marble.
  - CO<sub>2</sub> is one of the gases responsible for this effect.
  - Greenhouse gases: Besides CO<sub>2</sub>, other gases like methane, nitrous oxide, water vapour also contribute to greenhouse effect. They are also called Greenhouse gases.
  - **Water Pollutants:** Sewage, agricultural chemicals and industrial waste are some of the major contaminants of water.
  - **Ganga Action Plan:** It is an ambitious plan to save the river, Ganga. It was launched in 1985.
  - **Water Conservation:** Water is a precious natural resource. We must learn how to conserve it.
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