

Chapter 10 — Environmental Chemistry

2. Questions for Short Answers

1. What is the main objective of environmental education?

Ans: Environmental chemistry is a part of environmental education. The main objective of environmental education is to enlighten the people, and particularly the students, about the importance of the protection and conservation of our environment. It makes people aware of how chemicals and other pollutants in the environment affect living and non-living things, so that they can take part in controlling the emission of pollutants. The need for this education, both formal and non-formal, is keenly felt at the national level.

2. How is particulate matter released in the atmosphere?

Ans: Particulate matter consists of dust, pollens and metallic compounds suspended in the air. It is released mainly by human activities, above all by the burning of fossil fuels — oil, natural gas and coal — which produces ash, smoke and suspended particles along with the gases. Industries, coal-fired power plants, vehicle emissions and crop burning all add particulates to the air. Many particulates are also released by natural processes: volcanic eruptions throw out large quantities of particulates along with CO_2 and SO_2 , and wind lifts dust and pollens into the atmosphere.

3. Which gas is more poisonous, CO_2 or CO?

Ans: Carbon monoxide (CO) is far more poisonous than carbon dioxide. CO is an extremely poisonous gas that can cause suffocation and death: it is very toxic because it stops the red blood cells in the blood from carrying the oxygen that the body needs. Carbon dioxide, on the other hand, is a normal constituent of clean air (about 0.04%) and is not poisonous in this way; its danger is of a different kind, because higher levels of CO_2 increase global warming and climate change. This is why a carbon monoxide detector should be installed where fuel-burning appliances are used.

4. How does acid rain affect forests?

Ans: Acid rain damages forests in several ways. It makes the soil more acidic and dissolves and washes away the nutrients present in the soil which the plants need, so many trees and plants cannot live or grow. It also dissolves toxic substances such as aluminium and mercury which are naturally present in the soil, and these harm the roots. The trees are therefore damaged and destroyed. This has a further effect, because the tree roots hold the soil together on hills and mountain areas; once the trees are destroyed the soil is washed away and new plants cannot grow there at all.

5. In what way does sulphur present in fossil fuels become dangerous?

Ans: Fossil fuels contain sulphur compounds. When these fuels are burnt, the sulphur burns to give sulphur dioxide: $\text{S(s)} + \text{O}_2(\text{g}) \rightarrow \text{SO}_2(\text{g})$. In the atmosphere, in the presence of the oxides of nitrogen, this sulphur dioxide is oxidised to sulphur trioxide, $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$, which then dissolves in the moisture always present in the air to give sulphuric acid, $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$. These acid droplets are carried by the wind to huge distances and return to the ground as acid rain, which corrodes buildings and statues, acidifies soil and lakes, and destroys forests and aquatic life. Sulphur dioxide itself also irritates the eyes, causes breathing difficulties and produces haze in the air.

6. Name any three major sources responsible for the greenhouse effect.

Ans: The three major sources are: (1) the burning of large amounts of coal, oil and natural gas, which has increased the amount of carbon dioxide in the atmosphere over the last 300 years; (2) the cutting down of forests, because it reduces the capacity of the trees to remove CO_2 from the air by photosynthesis; and (3) the sources of methane — the increased decay of vegetation matter, digestion in animals, and the increased farming of rice fields. Water vapours are also a greenhouse gas and are in fact responsible for about half of the Earth's greenhouse effect.

7. How is wind energy useful for us?

Ans: Wind energy is a renewable resource, that is a resource which continues to exist despite being consumed over a period of time. It is urgently required to use such renewable resources to meet our energy needs so that the excessive use of fossil fuels can be discouraged. Wind energy has been proved to be a very effective way of generating electricity without damaging the environment, because it produces no carbon dioxide, no oxides of sulphur or nitrogen and no particulates. Using it therefore reduces acid rain, smog and global warming at the same time.

3. Constructed Response Questions

1. How is the excessive use of insecticides and pesticides harmful for birds?

Ans: The excessive use of fertilizers, insecticides and pesticides for agricultural purposes has proved to be harmful for animals, birds and human beings. These chemicals are sprayed on crops, and the insects and seeds on which the birds feed become contaminated with them. The birds swallow the poison along with their food, and because the chemicals are not broken down easily, they build up in the birds' bodies. This can kill the birds directly, and in the birds which survive it damages breeding, so their numbers fall. The chemicals also destroy the insects which are the birds' natural food, so the food supply itself disappears.

2. The percentage of CO₂ in air is only 0.04%. Then how does it become harmful for the ecosystem?

Ans: Although carbon dioxide is only a minor constituent of the atmosphere, it is a greenhouse gas, and the harm it does depends not on how much of it there is but on what it does to radiation. The short-wave radiation from the Sun passes through it freely and heats the Earth's surface, but the long-wave thermal radiation which the hot Earth gives out at night is mostly absorbed by carbon dioxide. This absorption prevents the radiation from reaching space and reduces the speed at which the Earth can cool, so the average temperature of the Earth rises. Over the last 300 years the burning of coal, oil and natural gas has steadily increased this 0.04%, and even a rise of a few degrees is enough to melt ice caps, raise sea levels, cause floods, droughts and extreme weather, and damage agriculture and food production.

3. Why do only some pollutant gases present in the atmosphere cause greenhouse effect while others do not?

Ans: The greenhouse effect depends upon the ability of a gas to absorb the long-wave thermal radiation which the Earth's surface emits. Gases such as carbon dioxide, methane and water vapours are able to absorb this thermal radiation, hold the heat in the lower atmosphere and re-emit part of it back towards the Earth; they therefore act like the glass sheet of a greenhouse, which lets the incoming solar radiation in but does not let the heat escape. The main gases of the air, nitrogen and oxygen, cannot absorb this long-wave radiation, so the heat simply passes through them into space and they cause no greenhouse effect at all. This is why the higher the concentration of carbon dioxide and the other greenhouse gases, the greater is the absorption of thermal radiation and the greater is the global warming.

4. How can you reduce the emission of CO present in the gases emitted by the burning of fuel in the automobile engines?

Ans: Carbon monoxide is produced because there is not enough oxygen in the engine for the carbon fuel to burn completely into carbon dioxide and water, so toxic by-products like CO and hydrocarbons are formed. The emission is reduced by fitting a catalytic converter in the exhaust system of the automobile. A three-way catalytic converter, which uses platinum, palladium and rhodium as catalysts, oxidises the carbon monoxide to carbon dioxide: $2\text{CO(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{CO}_2\text{(g)}$. At the same time, it reduces the oxides of nitrogen to nitrogen and oxygen, $2\text{NO}_x\text{(g)} \rightarrow \text{N}_2\text{(g)} + x\text{O}_2\text{(g)}$, and oxidises the unburnt hydrocarbons to carbon dioxide and water. Keeping the engine properly tuned so that combustion is complete also reduces CO.

5. Mention three different ways in which solar energy can be useful for us.

Ans: Solar energy is a renewable resource — the Sun continues to exist despite being used — and it has been proved to be a very effective way of meeting our energy needs without damaging the environment. Three useful ways are:

- (1) generating electricity through solar panels, which produces no carbon dioxide, no oxides of sulphur or nitrogen and no particulates, so it does not add to global warming, acid rain or smog
- (2) replacing fossil fuels for heating purposes in homes and industry, such as solar water heaters and solar cookers, which directly reduces the burning of coal, oil and natural gas
- (3) driving the natural process of photosynthesis, in which plants use sunlight to absorb carbon dioxide and release oxygen, cleaning the air for us.