

Preview of Period 16: Uses of Chemical Energy

16.1 Sources of Pollution

What human activities cause the most pollution?

How is pollution detected?

16.2 Sources of Pollution

What causes acid rain?

What causes smog?

What causes depletion of the ozone layer?

16.3 Global Warming

What are greenhouse gases?

How can greenhouse gases cause an increase in the average temperature of the Earth?

Incomplete and Complete Combustion

Complete Combustion produces

- ✓ carbon dioxide (CO_2) and
- ✓ water (H_2O)

Incomplete Combustion produces compounds that can react further with oxygen:

- ✓ carbon
- ✓ carbon monoxide (CO) and
- ✓ hydrocarbons from burning fossil fuels.

Dangers of Carbon Monoxide

- **Carbon monoxide (CO) molecules in the blood take away oxygen from the hemoglobin molecules. This lowers the oxygen-carrying ability of the blood.**
- **High enough levels of carbon monoxide can result in oxygen starvation and death.**
- **CO can be produced by any source of incomplete combustion, such as gas or oil furnaces, kerosene space heaters, or fireplaces.**
- **CO from the exhaust of car motors running in an attached garage can seep into a home and be fatal.**

Never run an automobile in a closed garage!

Symptoms of CO poisoning include flu-like symptoms of headaches, nausea, and fatigue. At higher concentrations: drowsiness, confusion, convulsions, unconsciousness, and even death.

Acid Rain

- ◆ Burning high sulfur coal emits sulfur oxide gases (SO_2 and SO_3) into the atmosphere. These oxides of sulfur combine with water molecules to form sulfuric acid molecules.
- ◆ Oxides of nitrogen (NO , NO_2 , NO_3) emitted from gasoline and diesel engines combine with water to form nitric acid molecules
- ◆ When these molecules precipitate, the result is weakly acidic rain.

Effects of sulfur and nitrous oxides:

- 1) In the atmosphere, these oxides are harmful to human health.
- 2) As acid rain, sulfur and nitric acid damage trees and other plants.
- 3) Acid rain increases the acidity of lakes and streams, harming aquatic organisms.
- 4) Buildings are damaged by acid rain.

Sources of sulfur oxides:

Coal-burning power plants are a major source of acid rain, particularly plants that use soft (bituminous) coal.

Photochemical Smog

- ◆ The heat and pressure in gasoline and diesel engines produce oxides of nitrogen: **NO, NO₂, NO₃**
- ◆ Oxides of nitrogen and hydrocarbons can interact with oxygen to form smog.
- ◆ These pollutants react photochemically when exposed to ultraviolet radiant energy from the Sun.
- ◆ Oxides of nitrogen decompose slowly into **N₂** and **O₂**. Automobile catalytic converters speed up this decomposition.

Inversion Layers

Temperature inversions trap pollution near the Earth's surface.

- ◆ **Inversions occur when a layer of warm air lies above cooler air.**
- ◆ **Since warm air rises and cool air sinks, there is no mixing of the layers of warm and cool air.**

The Ozone Layer

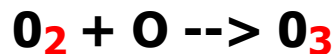
Atmospheric ozone forms a layer in the stratosphere, 20 km to 30 km above the Earth's surface.

- ◆ Ozone molecules contain three atoms of oxygen: O_3

- ◆ Ozone forms when ultraviolet light splits oxygen molecules into two oxygen atoms:



- ◆ These oxygen atoms combine with O_2 molecules to form ozone.



- ◆ Ozone molecules can absorb ultraviolet light, reducing the amount of UV radiation that penetrates the Earth's atmosphere.



- ◆ Since UV radiation can cause skin cancer, the ozone layer is beneficial to human health.

Ozone Layer Depletion:

Oxides of nitrogen from aircraft and CFCs (chlorinated fluorocarbons) from freon and aerosol cans combine with ozone to deplete the protective ozone layer.

Greenhouse Effect and Global Warming

- ◆ If **all** of the energy influx from the Sun is not radiated away from the Earth, the average temperature of the Earth increases.
- ◆ **Global Warming** occurs if less energy is radiated away from the Earth than is absorbed by the Earth.
- ◆ **Carbon dioxide and water vapor** in the atmosphere act as greenhouse gases and absorb far infrared radiation.
- ◆ **Complete combustion of fuels** increases CO_2 in the atmosphere.
- ◆ **Other greenhouse gases** include CFCs and methane.

Summary of Types of Pollution

- 1) **Nitrogen oxides** from aircraft and **chlorinated fluorocarbons (CFCs)** from freon and aerosol cans combine with ozone to **deplete the protective ozone layer** in the stratosphere.
- 2) **SMOG**: nitrogen oxides from gasoline engines combine with oxygen, and hydrocarbons in the presence of ultraviolet light to pollute air.
- 3) **Sulfur oxides** from burning soft coal react with water in the atmosphere to produce **acid rain**.
- 4) **Particulate pollution** is soot (carbon) from incomplete combustion. Particles can be removed from air by an electrostatic precipitator.

Period 16 Summary

Incomplete Combustion of fuels produces carbon, carbon monoxide (CO), and hydrocarbons

Complete Combustion produces carbon dioxide (CO₂) and water.

Types of pollution:

- 1) **Oxides of nitrogen** from aircraft and **chlorinated fluorocarbons (CFCs)** from freon and aerosol cans combine with ozone to **deplete the protective ozone layer** in the stratosphere.
- 2) **SMOG:** oxides of nitrogen from gasoline engines combine with oxygen and hydrocarbons in the presence of ultraviolet light to pollute air.
- 3) **Oxides of sulfur** from burning soft coal react with water in the atmosphere to produce **acid rain**.
- 4) **Particulate pollution**, mostly soot (carbon), from combustion. Particles can be removed from air by an electrostatic precipitator.

Period 16 Summary, continued

Temperature inversions trap pollution near the Earth's surface.

- ◆ Inversions occur when a layer of warm air lies above cooler air.
- ◆ Since warm air rises and cool air sinks, there is no mixing of the layers of warm and cool air.

The Greenhouse Effect:

- ◆ Carbon dioxide and water vapor in the atmosphere allow incoming visible light from the Sun to pass through, but absorb far infrared radiation emitted by the Earth.
- ◆ Complete combustion of fuels increases CO₂ in the atmosphere.

Global Warming occurs if less energy is radiated away from the Earth than is absorbed by the Earth.

- ◆ Even small increases in the amount of carbon dioxide in the atmosphere can produce global warming by absorbing and trapping far infrared radiation.
- ◆ If the average temperature of the Earth increases, the oceans could hold less dissolved carbon dioxide. More carbon dioxide would be released into the atmosphere, increasing global warming.

Period 16 Review Questions

- R.1** What consequences might result if all high sulfur content coal was banned from use?
- R.2** What can be done to reduce smog?
- R.3** What are some possible consequences of depleting the ozone layer?
- R.4** Is ozone a harmful or a useful substance?
- R.5** What are some possible consequences of drilling oil wells near the Arctic?
- R.6** What type of regulations on industry and business would you consider reasonable in order to reduce atmospheric pollution?

Type of pollution	Effect on environment	Substances involved	Sources
Ozone layer depletion			
Acid rain			
Particulate matter			
Smog			
Greenhouse Effect			

Type of pollution	Substances involved	Sources of Pollutants	Effect on environment
Ozone layer depletion	Nitrogen oxide (NO) and CFCs	Jet engine exhaust (NO). Use of CFCs in coolants and aerosols	Depletion of the ozone layer allows more ultraviolet radiation from the Sun to reach the Earth.
Acid rain	Sulfur oxides and nitrogen oxides with H₂O vapor	Combustion of soft coal (SO₂). Gasoline and diesel engine exhaust (NO)	Acidic rain is harmful to plant and animal life and damages buildings.
Particulate matter	Soot (carbon)	Incomplete combustion of hydrocarbons	Harmful to human health. Can block incoming radiation from the Sun.
Smog	Nitrogen oxides, ultraviolet light, and ozone	Gasoline and diesel engine exhaust	Harmful to human health
Global Warming	CO₂, CFCs, H₂O vapor, and methane	Combustion of fossil fuels, use of CFCs	Increase in avg. temperature of the Earth can result in coastal inundation and disruption of agriculture
Thermal Pollution	Waste thermal energy	Electric generating plants and other industrial plants	Damage to aquatic environment.