

Water and Air Pollution

Grade 9 Science

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Name _____ Class _____ Date _____

Land, Water, and Air Resources • Section Summary

Air Pollution and Solutions**Key Concepts**

- What are the causes of smog and acid rain?
- What are the causes of indoor air pollution?
- What is the key to reducing air pollution?

Air pollution is a change to the atmosphere that has harmful effects. Substances that cause pollution are called pollutants. Air pollutants can be solid particles or gases. Particles and gases that are released into the air are called **emissions**. Most emissions are produced by human activities.

Photochemical smog is a thick, brownish haze formed when certain gases in the air react with sunlight. **The major sources of smog are the gases emitted by automobiles and trucks.** The gases react in sunlight and produce a form of oxygen called **ozone**. Pollutants are usually carried high into the atmosphere as warm air rises from Earth's surface. But during a **temperature inversion**, a layer of warm air prevents the rising air from escaping. The polluted air is trapped close to Earth's surface. Ozone in smog can cause lung problems and harm the body's defenses against infection.

Precipitation that is more acidic than normal is called **acid rain**. **Acid rain is caused by the emissions from power plants and factories that burn coal and oil.** These fuels produce gases when they are burned. These gases react with water vapor in the air, forming acids. The acids return to Earth's surface in precipitation. Acid rain harms organisms and damages stone and metal.

Indoor air can be polluted, too. **Some substances that cause indoor air pollution, such as dust and pet hair, bother only those people who are allergic to them.** Other indoor air pollutants, such as toxic chemicals, can affect anyone. Carbon monoxide is a colorless, odorless gas that forms when fuels are incompletely burned. Carbon monoxide that builds up in an enclosed space can be deadly. **Radon** is a colorless, odorless, radioactive gas that forms in rocks underground. Breathing radon may cause lung cancer and other health problems.

In the United States, laws regulate the amount of certain pollutants that can be released into the environment and how these pollutants must be handled. One major law is the Clean Air Act. This law also encourages the development of new technology to reduce air pollution.

The major role of technology in controlling air pollution is to reduce emissions. Factories install devices in smokestacks to treat emissions. For example, a filter traps particles of soot and ash. A device called a scrubber removes pollutants from emissions using a stream of water droplets. Cars and trucks also contain pollution control devices. A catalytic converter is a device that reduces carbon monoxide emissions. Another way to reduce emissions is to carpool, walk, bike, or take public transportation.

Land, Water, and Air Resources • *Enrich*

Ozone

Ozone is a gas that can be found in both the upper layer of Earth's atmosphere as well as at ground level. In the upper atmosphere, ozone occurs naturally. The gas is beneficial to humans and other life on Earth because it absorbs the Sun's harmful ultraviolet rays. Exposure to ultraviolet light can increase a person's risk of developing skin cancer. At the ground level, ozone is formed from pollutants released by motor vehicles. It is toxic and is a major component of smog. Ozone can cause lung infections and damage the body's defenses against infection. The following scale of Air Quality Index (AQI) was created by the Environmental Protection Agency (EPA) in order to report ground levels of ozone and other air pollutants. Each day, local air quality is rated according to the scale and is reported in local newspapers or on local news and weather forecasts.

Air Quality Index

Index Values	Descriptions	Cautionary Statements for Ozone
0 to 50	Good	None
51 to 100	Moderate	Unusually sensitive people should consider limiting prolonged outdoor exertion.
101 to 150	Unhealthy for Sensitive Groups	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
151 to 200	Unhealthy	Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children, should limit prolonged outdoor exertion.
201 to 300	Very Unhealthy	Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.

Answer the following questions on a separate sheet of paper.

1. What is ozone?
2. Explain how ozone is both beneficial and harmful to humans.
3. What does it mean if the AQI value for a particular day is 125?
4. Suppose the AQI value for a particular day is 167. What precautions should a person with asthma take on this day?
5. Suppose you are an active adult with no sensitivities or respiratory disease. At what AQI value would you want to limit prolonged outdoor exertion?

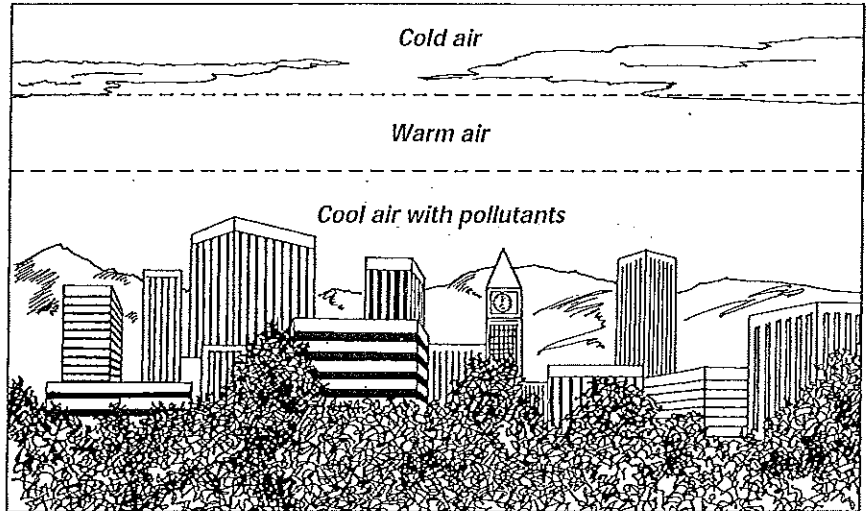


SECTION 5-1 REVIEW AND REINFORCE

Air Pollution

◆ Understanding Main Ideas

Answer the following questions on a separate sheet of paper.



1. What condition is shown in the figure above? Why is this condition dangerous to people?
2. How is photochemical smog formed?
3. How is acid rain formed?
4. What are two effects of acid rain?
5. Why is carbon monoxide such a dangerous form of indoor air pollution?
6. How does the ozone layer in the atmosphere help protect people?

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◆ Building Vocabulary

Define each of the following terms on a separate sheet of paper.

7. air pollution
8. emissions
9. greenhouse effect
10. global warming

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Global Changes in the Atmosphere

Key Concepts

- How have human activities damaged the ozone layer?
- How might human activities be linked to global climate changes?

The ozone layer is a layer of the upper atmosphere about 30 kilometers above Earth's surface. The ozone layer protects people from the effects of too much ultraviolet radiation. Ozone is constantly made and destroyed in the ozone layer. During this cycle, ultraviolet energy is absorbed. In the late 1970s, scientists observed that the ozone layer over Antarctica was growing thinner each spring. The amount of ozone in the ozone layer was decreasing, causing an ozone hole. Scientists determined that the major cause of the ozone hole is a group of gases called CFCs, which were used in many household products. Chlorofluorocarbons are human-made gases that contain chlorine and fluorine.

Water vapor, carbon dioxide, and certain other gases in the atmosphere let sunlight reach Earth's surface but prevent the heat from escaping back into space. The trapping of heat near Earth's surface is called the greenhouse effect. Human activities that increase carbon dioxide levels may be intensifying the greenhouse effect. A theory called global warming predicts that an increase in carbon dioxide will cause Earth's average temperature to rise. Most scientists base their climate predictions on computer models that calculate the effects of changes in the atmosphere.

SECTION 5-1**ENRICH**

Is Earth's Climate Getting Warmer?

The table above lists the average global temperature on Earth every year from 1961 to 1995. Use the table to answer questions 1 and 2.

Average Global Temperatures, 1961–1995

Year	Temp. (°C)	Year	Temp. (°C)	Year	Temp. (°C)	Year	Temp. (°C)	Year	Temp. (°C)	Year	Temp. (°C)	Year	Temp. (°C)
1961	15.08	1966	14.95	1971	14.93	1976	14.84	1981	15.29	1986	15.16	1991	15.36
1962	15.02	1967	14.99	1972	15.00	1977	15.11	1982	15.08	1987	15.27	1992	15.11
1963	15.02	1968	14.93	1973	15.11	1978	15.06	1983	15.24	1988	15.28	1993	15.14
1964	14.74	1969	15.05	1974	14.92	1979	15.09	1984	15.11	1989	15.22	1994	15.23
1965	14.88	1970	15.02	1975	14.92	1980	15.18	1985	15.09	1990	15.38	1995	15.39
Average 61–65	_____	Average 66–70	_____	Average 71–75	_____	Average 76–80	_____	Average 81–85	_____	Average 86–90	_____	Average 91–95	_____

- Calculate the average global temperature for each block of 5 years. (*Hint:* Add the 5 temperatures for 1961 through 1965, and divide that total by 5. Repeat for each of the other 5-year blocks.) Write your answers in the table.
- Use the 5-year average temperatures you just calculated to make a line graph on a sheet of graph paper. Plot the temperatures on the vertical axis. Plot the years on the horizontal axis.

Answer the following questions on a separate sheet of paper.

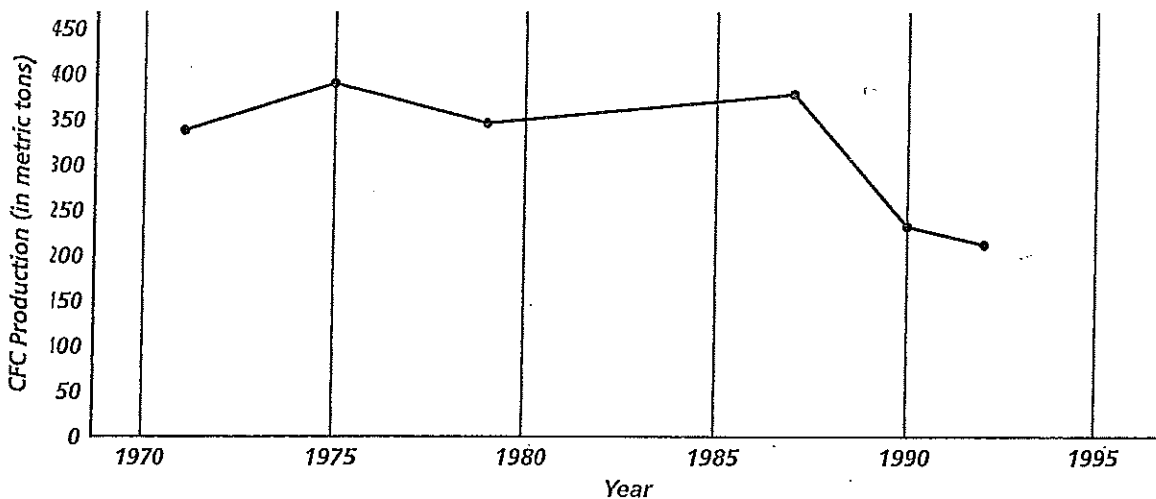
- Examine your graph. What overall change do you see in Earth's average temperatures between 1961 and 1995?
- Describe the theory that explains this change.
- Suppose this pattern continues. Predict what the average global temperature would be for the 5-year block 1996–2000.
- Predict what the average global temperature would be in the year 2095. Explain your prediction.

Global Changes in the Atmosphere

Understanding Main Ideas

Answer the following questions on a separate sheet of paper.

1. How does the ozone layer in the atmosphere help protect people?



The graph above shows the production of CFCs in the United States from 1971 to 1992. Use the graph to answer questions 2–4.

2. In which year did CFC production reach its highest level?
3. In which year did CFC production reach its lowest level?
4. What happened to CFC production after 1987? Why?
5. What substitutes for CFCs came into being after scientists discovered that CFCs were harming the atmosphere?
6. Why is it difficult for scientists to predict how Earth's climate will be affected by changes in the atmosphere?

Building Vocabulary

Define each of the following terms on a separate sheet of paper.

7. ozone layer
8. chlorofluorocarbons
9. greenhouse effect
10. global warming

Air Pollution Quiz Review

Know the meaning of the following terms:

acid rain

carbon dioxide

carbon monoxide

CFC's

emissions

global warming

greenhouse effect

ozone

photochemical smog

temperature inversion

methane

Be able to name the number one source of outdoor air pollution:

Be able to name 3 countries that have a city which is one of the 10 most polluted cities in the world:

Be able to name 3 major sources of outdoor air pollution:

Be able to state 2 reasons why you think humans are or are not the main cause of global warming:

Water Pollution and Solutions

Key Concepts

- Why is fresh water a limited resource?
- What are the major sources of water pollution?
- How can water pollution be reduced?

Water is a scarce resource in much of the world. The reason is that most of the water on Earth—about 97 percent—is salt water. Salt water cannot be used for drinking or watering crops. In addition, about three quarters of the fresh water on Earth is in the form of ice. Finally, supplies of liquid fresh water are not always close to where people live. The water that is stored in layers of soil and rock beneath Earth's surface is called groundwater.

Water pollution is any change to water that has a harmful effect on people or other living things. The substances that cause pollution are called pollutants. Most pollution is the result of human activities. Wastes produced by households, agriculture, industry, mining, and other human activities can end up in water. The water and human wastes that are washed down sinks, toilets, and showers are called sewage. If sewage is not treated to kill disease-causing organisms, these organisms quickly multiply. If untreated sewage mixes with water used for drinking or swimming, people can get very ill.

Animal wastes and farm chemicals also can pollute water. Fertilizers are chemicals that provide nutrients to help crops grow better. Pesticides are chemicals that kill crop-destroying organisms. These chemicals are usually spread over a large area and can travel in runoff to nearby water. Industries and mining operations produce metal wastes and chemicals that can pollute water. Even low levels of chemicals in the water can build up to harmful concentrations as they move through the food chain.

When water runs off bare ground, it carries particles of rock and sand called sediments. As sediments wash into bodies of water, the particles cover the food sources, nesting sites, and eggs of organisms. The sediments also block sunlight in the water so algae and plants cannot grow.

The keys to keeping water clean are proper sewage treatment, the reduction of pollutants, and the effective cleanup of oil and gasoline spills. Most communities treat wastewater before returning it to the environment. In a typical sewage plant, primary treatment removes solid materials and secondary treatment involves using bacteria to break down the wastes. Finally, the water is treated with chlorine to kill disease-causing organisms.

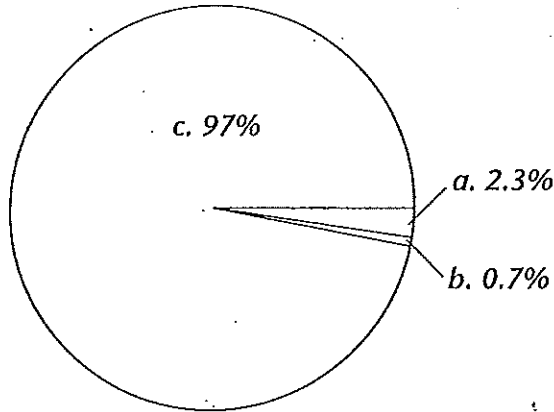
Instead of releasing wastes to the environment, industries can recycle their wastes to recover useful materials. Other industries can change their processes to produce less waste or less harmful waste. Farmers can use alternatives to toxic pesticides and fertilizers. Small changes in people's behavior can help keep water clean.

Water Pollution and Solutions

Understanding Main Ideas

Answer the following questions on a separate sheet of paper.

Water on Earth



1. Which section of the circle graph above represents Earth's salt water? Which section represents ice? Which section represents usable fresh water?
2. How does the water cycle purify Earth's water?
3. What is sewage? Why is it important to treat sewage?
4. How can farm chemicals pollute water? Why is it hard to keep these chemicals from getting into nearby water?
5. What are the keys to keeping water clean?

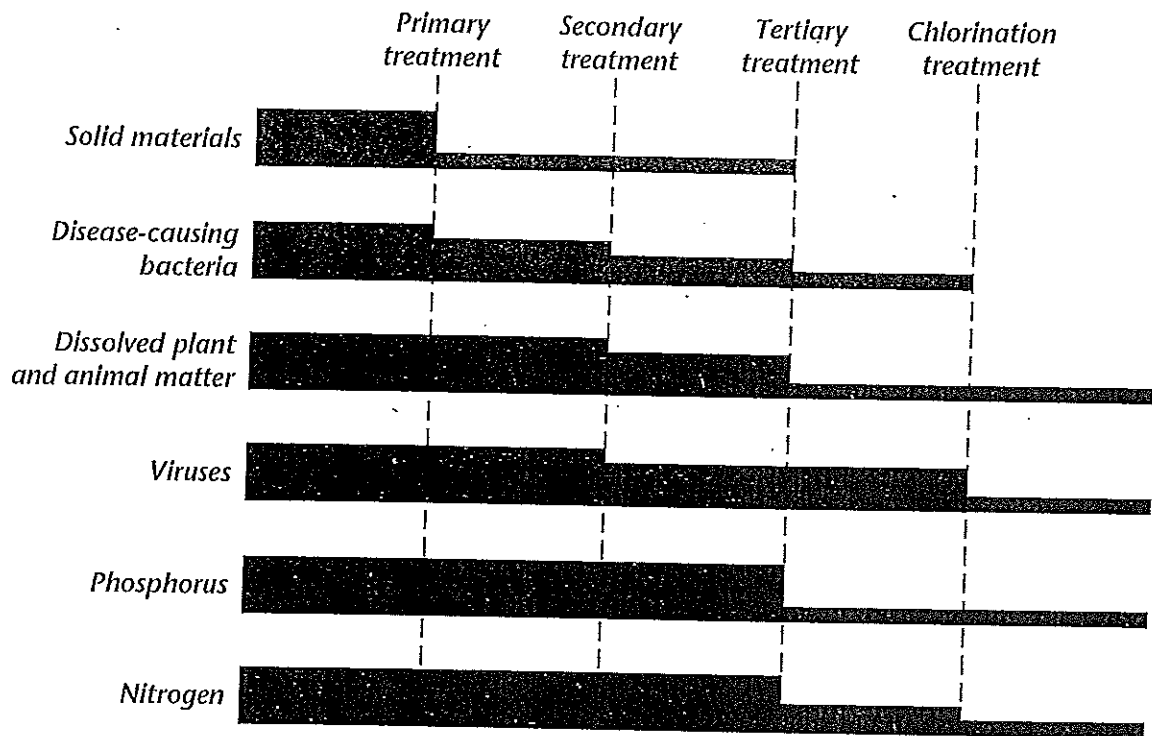
Building Vocabulary

Write the correct term to complete each sentence below.

6. Water that is stored in layers of soil and rock beneath Earth's surface is called _____.
7. Substances that cause pollution are called _____.
8. The water and human wastes that are washed down sinks, toilets, and showers are called _____.
9. Chemicals that kill crop-destroying organisms are known as _____.
10. Water that causes erosion picks up _____, or particles of rock and sand.

Sewage Treatment

In addition to primary and secondary treatment, many sewage plants use tertiary treatment to clean wastewater. (*Tertiary* means "third.") The chart below shows which materials are removed in each treatment step. The thickness of the black bar shows how much of each substance remains in the water.



Use the chart to answer the following questions on a separate sheet of paper.

1. Which materials are mostly removed by primary treatment?
2. Which materials are partly removed by secondary treatment?
3. Which materials does tertiary treatment help remove?
4. If a sewage plant did not use tertiary treatment, which material(s) would not be removed at all?
5. Which materials are completely removed before the treated water is released into the environment after chlorination treatment?
6. Phosphorus and nitrogen are nutrients that help algae and plants grow. Why is it important to reduce these materials before treated water is released?

Land, Water, and Air Resources ▪ *Key Terms*

Key Terms

Use the clues to help you unscramble key terms from the chapter. Then put the numbered letters in order to answer the riddle.

Clues

Key Terms

Substances that include nutrients that help crops grow better

refzeritil

_____ 1 _____ 2

Construction of buildings, roads, and other structures

endlovepmet

_____ 3

Layer of soil below topsoil

ouslibs

_____ 4

Polluted liquid that forms when rainwater falls on solid waste

ehcatale

_____ 5 _____ 6

The water stored in soil and rock beneath Earth's surface

woundgrate

_____ 7 _____ 8

Substance that causes pollution

tolluptan

_____ 9

Chemicals that kill crop-destroying organisms

stepedici

_____ 10 _____ 11

Process by which water, wind, or ice moves particles of rocks or soil

roonise

_____ 12

Process of reclaiming and reusing raw materials

gleccyrni

_____ 13 14 15

Rock that makes up Earth's crust

dkbrcoe

_____ 16

Upper layer of soil that contains decaying animal and plant matter

poolsit

_____ 17

The burning of solid waste

rationenniic

_____ 18

Riddle: What are the "three R's"?

Answer:

_____ 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ 9 _____ 10 _____ 11 _____ 12 _____ 13 _____ 14 _____ 15 _____ 16 _____ 17 _____ 18



Name _____ Class _____ Date _____

Pollution Test Review

Know all vocabulary terms.

Know at least 3 countries have a city which is one of the 10 most polluted cities in the world.

Know at least 3 major sources of outdoor air pollution:

Be able to describe how acid rain forms.

Know at least 2 things you can do to reduce air pollution.

Know at least 2 consequences of rain forest depletion.

Know at least 2 reasons why humans may or are may not be the main cause of global warming.

Know what percentage of Earth water is saltwater, ice, and freshwater:

Know the three parts of the water cycle.

Know at least 3 human activities that cause water pollution.