CHAPTER 17 ATMOSPHERE	Name Period

Objectives:

- Describe the formation of Earth's early atmosphere and the composition of the lower atmosphere.
- Demonstrate how the Earth system continually recycles gases and how certain activities disturb an atmosphere in balance.

COMPOSITION OF THE ATMOSPHERE

- Scientists hypothesize that _____ played the main role in forming Earth's early atmosphere.**
- Gases released from _____ – primarily _____ _____ – probably made up nearly all of this early atmosphere.

WHAT ABOUT THE OXYGEN?…..

- Oxygen may have first entered the atmosphere as a result of sunlight splitting water vapor molecules into oxygen and hydrogen.
- The amount of oxygen in the atmosphere increased significantly as early life forms trapped the energy of sunlight through photosynthesis.
- _____ releases oxygen.
- Today Earth's lower atmosphere is a mixture of many gases called "air".
- The main gases in air are _____ (78%) and _____ (21%), which together form about 99% of dry air by volume.**
- The remaining 1% is mostly argon and carbon dioxide. Also present are tiny amounts of trace gases, such as helium, hydrogen, and neon.

	• The percentage of nitrogen and oxygen are _____ throughout the atmosphere up _____. • _____ _____. Water vapor concentration is higher near the surface. Like carbon dioxide, water vapor absorbs heat given off by Earth. It also absorbs some solar energy. Carbon dioxide in the air varies with the seasons. It is lowest during summer and highest during winter. Why? Photosynthesis is highest during the summer months (which removes carbon dioxide from the atmosphere). The atmosphere also contains a wide variety of dust particles. Dust includes: tiny grains of rocks, dirt, pollen, salt crystals from sea spray, and soot from fires.
RECYCLING OF ATMOSPHERIC MATERIALS	• The _____ has _____ _____ throughout Earth's recent history _____ our planet has an _____.** • Elements and compounds are constantly moving between the atmosphere and the other parts of the Earth system – the geosphere, hydrosphere, and biosphere. • An overall balance is maintained because the amount of a given substance leaving the atmosphere equals the amount of that same substance entering the atmosphere over the same period of time. • The carbon cycle and the water cycle help to maintain this balance. Here's how… **DIAGRAM OF EARTH'S ENERGY BUDGET – REQUIRED FOR CLASS NOTES GRADE**

RECYCLING OF ATMOSPHERIC MATERIALS	• Plants take carbon dioxide from the air for photosynthesis and release oxygen. • In contrast, animals and humans inhale oxygen and exhale carbon dioxide. • Carbon dioxide is also returned to the atmosphere through the decomposition of organic materials. • Water vapor enters the atmosphere through evaporation, transpiration from plants, and the exhaled breath of animals and humans. • Water leaves the atmosphere in the form of precipitation (rain, snow, and hail).
A DELICATE BALANCE	• The balance maintained in the atmosphere may be disturbed by a variety of factors, both natural and of human origin. • Evidence seems to show that carbon dioxide levels in the atmosphere have been steadily increasing in recent years. Data collected at the Mauna Loa Observatory in Hawaii shows a 16% increase between 1959 and 1999. **Why?** • The _____ seems to be due to human activities, especially the burning of _____ (such as coal, gasoline, and natural gas). • The atmosphere's sensitive balance also involves the energy from the sun. The movement of this energy plays a critical role in keeping Earth habitable.

17.1 SECTION REVIEW – NOTE CONTINUES ON NEXT PAGE

1. Describe how the composition of the atmosphere has changed over time.

2. Which two gases make up most of the atmosphere?

3. Draw a diagram showing some of the ways in which carbon dioxide enters and leaves the atmosphere.

4. In what ways might the loss of vegetation as a result of deforestation affect the atmosphere's balance?

SECTION 17.2 – HEAT AND THE ATMOSPHERE

Objectives:

- Describe how energy from the sun moves through the atmosphere by radiation, conduction, and convection.
- Identify the characteristics of each atmospheric layer.
- Analyze the Earth's heat budget.

Key Vocabulary:

- Radiation
- Conduction
- Convection
- Temperature
- Heat
- Troposphere

- Stratosphere
- Ozone
- Mesosphere
- Thermosphere
- Ionosphere
- insolation

HEAT AND THE ATMOSPHERE	• Energy from the sun drives the weather and is essential to almost all life on Earth. • How does energy from the sun reach Earth across nearly 150,000,000 kilometers of space? • What happens to the energy after it reaches Earth?
HEAT AND TEMPERATURE	• _____ is the _____ _____. • A large cup of tea has more heat than a small cup of tea at the same temperature. • Heat _____. • The _____ of a substance is a measure of the _____ _____or molecules in that substance.** • A substance that is boiling has atoms that are moving very fast. • A _____. • Scientists measure temperature using the Celsius scale. • 0° C => water freezes 100° C => water boils

HEATING THE ATMOSPHERE	**Energy Transfer as Heat** • Heat energy enters and moves through the atmosphere in three different ways: _____ _____. • _____ is the _____ _____. • **Example**: Heat moves by conduction from the hot sand to the soles of your feet.** • _____ is the _____ _____or gas caused by differences in density. • **Example**: In a pot of simmering water, the water at the bottom of the pot is heated (by conduction) and rises, cooler water sinks. **DIAGRAM WITH LABELS POT AND FIRE – REQUIRED FOR CLASS NOTES GRADE** **Electromagnetic Waves** • The sun emits light and heat as well as the ultraviolet rays that cause a suntan. These forms of energy are only part of a large array of energy emitted by the sun, called the electromagnetic spectrum. • _____ is the _____ _____ _____.

- Unlike conduction and convection, which need material to travel through, _____ _____.
- All objects, at any temperature, emit radiant energy. Hotter objects radiate more total energy per unit area than colder objects do.
- The _____ produce the _____ of maximum radiation.
- Objects that are _____ of radiation _____ as well.

WHAT HAPPENS TO SOLAR RADIATION?

When radiation strikes an object, there usually are three different results.

1. _____ by the object.
2. _____ such as water and air _____ to certain wavelengths of radiation.
3. _____ without being absorbed or transmitted.

- _____**

DIAGRAM OF SOLAR RADIATION – REQUIRED FOR CLASS NOTES GRADE

	REFLECTION AND SCATTERING • _____ occurs when _____. Reflection radiation has the same intensity as incident radiation. • _____ produces a _____that travel in different directions. • _____ - _____of the solar energy that strikes the top of the atmosphere _____.
STRUCTURE OF THE ATMOSPHERE	• The temperature of the atmosphere changes dramatically at varying altitudes. • Temperature differences are used to divide the atmosphere into four layers: • _____, • _____, • _____, and • _____.
TROPOSPHERE	• "_____" _____. • The _____ of our atmosphere. • _____. • The Troposphere contains about 80% of the total mass of the atmosphere and most of the water vapor in our atmosphere. • _____.**
TROPOPAUSE	• The _____. • Temperature stops decreasing here.

	• The altitude of the Tropopause varies according to latitude. At the equator, the Tropopause is at an altitude of about 16 kilometers, while at the poles is it at an altitude of about 9 kilometers. • _____.
STRATOSPHERE	• "_____" _____. • A clear, dry layer of the atmosphere. • _____. • _____ _____ . Ozone _____ from the sun and then releases some of this energy in the form of heat.**
STRATOPAUSE	• The area between the Stratosphere and the Mesosphere. • Located at approximately 50 kilometers above Earth's surface.
MESOSPHERE	• "_____" _____. • The Mesosphere extends between about 50 and 90 kilometers above Earth's surface. • Contains very little ozone, so _____ _____.
MESOPAUSE	• The area between the Mesosphere and the Thermosphere. • Located approximately 90 kilometers above Earth's surface.

THERMOSPHERE	• "_____" _____. • The _____ at this great altitude is _____, but the few molecules and atoms present receive such intense solar radiation that temperatures can rise above 1000°C. • The _____ _____, with heavier gases in the lower levels and lighter gases in the higher layers. • The lowest layer is composed primarily of nitrogen molecules. • Next, a layer of oxygen reaches to about 1000 kilometers. • Above that is a layer of helium that extends to about 2400 kilometers. • Finally, a layer of hydrogen thins out into space.
IONOSPHERE	• The portion of the Thermosphere between about 90 and 500 kilometers above the Earth is also called the _____. • **Why?** Because the air there is highly ionized. • These ions are formed when ultraviolet rays knock electrons off oxygen and nitrogen molecules and oxygen atoms. • The _____. Huge eruptions associated with sunspots send out large amounts of radiation and ionized particles. • Because the sun's particles are electrically charged, they are _____ _____. • The ionized particles sometimes interact with air molecules to form _____.
INSOLATION AND THE ATMOSPHERE	• _____ is _____. • Earth's system only receives about one two-billionth of the sun's rays. (1/2,000,000,000) • Some insolation is absorbed by gases in the atmosphere, some reaches the Earth's surface without interference. Much of it is scattered by collisions with gas molecules and dust in the atmosphere.

	• Where does the scattered insolation go? • A global heat budget monitors the overall flow of energy into and out of our atmosphere. A _____ _____ _____. • Out of 100 units of insolation, about 30 units returns to space, about 19 units are absorbed by the atmosphere, and about 51 units are absorbed by Earth's surface.** • When the budget is balanced, about 70 units of energy are radiated out to space; about 64 units are radiated by the atmosphere and about 6 units are radiated by the Earth's surface.
HEAT BUDGET OF EARTH	• Only a small percentage of insolation is absorbed by the atmosphere. • _____ _____ _____.** • This _____ _____.
GREENHOUSE EFFECT	• The _____ is the heating of Earth's surface and atmosphere from solar radiation being absorbed and emitted by the atmosphere, mainly by water vapor and carbon dioxide. • The greenhouse effect _____ _____. • The accumulation of carbon dioxide and water vapor in the atmosphere, absorbs most of the infrared radiation (that the Earth is trying to release back into the atmosphere), preventing it from radiating directly back into space. **IS THE GREENHOUSE EFFECT A BAD THING?** • _____ _____. • Earth's average temperature would be about 33°C cooler than it is now – _____!**

	• The greenhouse effect has helped Earth thrive as a planet. • However, recently we have seen a significant increase in levels of carbon dioxide in the atmosphere. We are watching to see if the global heat budget is getting out of balance.

17.2 REVIEW

1. Describe three ways heat is transferred through the atmosphere.

2. Why does temperature gradually decrease with altitude in the troposphere?

3. Compare the temperature changes in the stratosphere with those of the thermosphere. Include the role of the ozone in your explanation.

4. Describe at least two paths that a unit of energy could take from its arrival at Earth's atmosphere until it is reradiated out to space.

5. Based on what you have learned about the layers of the atmosphere, explain why jets generally fly at or above the tropopause.

SECTION 17.2 LOCAL TEMPERATURE VARIATIONS

Objectives

- Identify the factors that cause the intensity of insolation to vary from place to place.
- Describe how the characteristics of a material affect its rate of solar absorption.
- Analyze a temperature map.

Vocabulary

- Isotherm

LOCAL TEMPERATURE VARIATIONS	**WHY DOES TEMPERATURE VARY FROM PLACE TO PLACE?** • The basic reason is that _____(solar radiation) _____ _____.** • The intensity of _____with the _____, the _____, and the _____. • The characteristics of a material affect both how much insolation the material absorbs and how the absorbed energy affects the temperature.
INTENSITY OF INSOLATION (SOLAR RADIATION)	• _____. • When the sun is _____, the angle of insolation is 90°, and Earth's surface receives the _____.** • As the angle of insolation decreases, the energy of the rays is spread out over a larger area, so the energy per unit area decreases. Sunlight must also travel farther through the atmosphere, meaning more may be absorbed or reflected before it reaches Earth's surface.
TIME OF DAY	• _____ the sun's rays are closest to vertical, so the _____ _____then.** • However, the _____ is usually in the _____, when the lower atmosphere has received more heat from the ground than it loses for several hours. • The _____is usually _____ because the ground and the lower atmosphere have been losing heat all through the night.
LATITUDE	• _____ _____.** These areas have hot climates. • Near the poles, the sun's rays generally strike at low angles. Such areas may even have no sunlight for part of the year. These areas are cold year-round.

TIME OF YEAR	• Locations in middle latitudes get near-vertical rays in summer, so summers are hot. The angle of rays in the winter is much lower, so winters are cold. • The highest temperatures occur after the time of maximum insolation. The most direct sunlight occurs in late June, however, July is usually the warmest month. The weakest sunlight is usually in December, however, January is usually the coldest month.
TEMPERATURE VARIATIONS	• Factors other than latitude that exert a strong influence on temperature include heating of land and water, altitude, geographic position, cloud cover, and ocean currents.
CLOUD COVER	• _____ is the fraction of total radiation that is reflected by any surface. • Many clouds have a high albedo and therefore reflect back to space a significant portion of the sunlight that strikes them. • Since clouds can reflect a significant amount of insolation back into space, _____ _____. • Similarly, more radiation travels from Earth's surface out into space on clear nights than on cloudy nights.
HEATING OF WATER AND LAND	• _____ _____. In winter, the same continents are colder than the water. **WHY DOES THE TEMPERATURE OF LAND VARY MORE THAN THE TEMPERATURE OF WATER?** • Land and water warm up and cool off at different rates. • _____ does for many reasons. • On land, insolation warms only the top few centimeters of soil, but the sun's rays penetrate to a depth of many meters in water. • In water, some solar energy is used in the process of evaporation.

	• _____ _____** (about three times more than land). • Dark surfaces absorb more energy than light surfaces. • Rough surfaces absorb more energy than smooth surfaces. • Dry ground absorbs more energy than wet ground. • Snow and ice reflect sunlight and remain cold.
TEMPERATURE MAPS	• Look at the temperature maps on page 377 in your textbook. • Notice that the warmest temperatures are south of the equator in January and north of the equator in July. Think of the location of the sun's direct rays during these months. • _____ _____. • The lines separating the temperature zones on the maps are called _____. • _____- means "_____" and –_____ means "_____". • _____ lines on maps _____ _____.**

SECTION 17.3 REVIEW

1. How does the angle at which sunlight strikes Earth's surface affect the intensity of the sunlight?

2. When does the highest temperature of the day usually occur? Why?

3. Why is it warmer near the equator than near the poles?

4. In the United States, why is it colder in the winter and warmer in the summer?

5. Explain why water does not get as hot as land on a clear summer day.

6. The daily temperature range is the difference between the day's maximum and minimum temperatures. Why is the daily temperature range greater on clear days than on cloudy ones?

SECTION 17.4 HUMAN IMPACT ON THE ATMOSPHERE

Objectives:

- How does human activity affect the atmosphere?

Key Vocabulary:

- air pollutant
- temperature inversion

HUMAN IMPACT ON THE ATMOSPHERE	• The modern transportation and manufacturing technologies that provide many benefits for everyday life also have some _____. • These effects include local _____ as well as worldwide problems such as _____ _____and _____ . • Emissions from transportation vehicles account for nearly half the primary pollutants by weight.
COMMON AIR POLLUTANTS	• An _____ is any airborne gas or particle that occurs at a concentration capable of harming humans or the environment. • Some air pollutants are caused by natural sources such as volcanoes and forest fires.

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Human activities produces a significant amount of air pollutants that are of greatest concern today.
The Clean Air Act of 1970 identified six key pollutants as indicators of air quality.

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<tr><td>ACID RAIN</td><td>

_____ _____ _____.
Acid precipitation can fall as both rain and snow.
Pollution can significantly raise the acidity of rain in some areas.
_____, as well as damaging to structures (especially those build of limestone or marble).

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<tr><td>SMOG</td><td>

_____ originally referred to “smoky fog” _____ _____.
Today, smog refers to _____, a brownish haze that forms in air polluted with nitrogen oxides and hydrocarbons that _____ _____.**

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	• The _____ _____. While ozone in the stratosphere is good (protecting Earth from ultraviolet radiation), ground-level ozone is a _____ that can cause respiratory problems and illness. • Ground-level ozone also interferes with photosynthesis, reducing crop yields and hurting the agricultural industry. • The severity of smog depends on atmospheric conditions. • Usually, convection in the atmosphere keeps the air moving, diluting the pollutants. • Sometimes _____ _____ _____.** • During a temperature inversion, _____ _____ _____..
OZONE DEPLETION	• In the 1970s, scientists began to worry that the atmospheric ozone layer was being harmed by _____. • CFCs were widely used in products such as aerosol sprays, air conditioners, and solvents. • In 1987, more than 170 countries met in Montreal and signed a treaty to reduce and eventually eliminate the production of all CFCs and other ozone-depleting substances by 2006. • _____. An extremely thin area of the ozone layer (popularly called the ozone hole) forms over Antarctica each spring. • A smaller ozone hole is also being watched over the northern polar region. • Elimination of CFCs could help return the ozone layer to normal by about 2050.

GLOBAL WARMING	• Available _____ _____ • It is possible that this global warming is part of the natural cycle of temperature changes that have occurred throughout Earth's history. • So what is all the talk about? • Scientists are worried about human activities that may be contributing to global warming. • The level of greenhouse gases has risen significantly over the past two centuries. • Global deforestation contributes to higher carbon dioxide levels (cutting and burning of trees). • Models continue to predict that warming will continue. If that is true, what are the worries? • Preliminary evidence indicates that possible effects of global warming includes the following: • _____; • _____ and hurricanes; • _____; and • _____.

SECTION 17.4 REVIEW

1. List some examples of pollutants created by the burning of fossil fuels. What are the effects of these pollutants?

2. What are some of the damaging effects of acid rain?

3. Explain how a temperature inversion affects smog.

4. What are some human activities suspected of contributing to global warming