Energy Transfer in the Atmosphere

Essential Questions

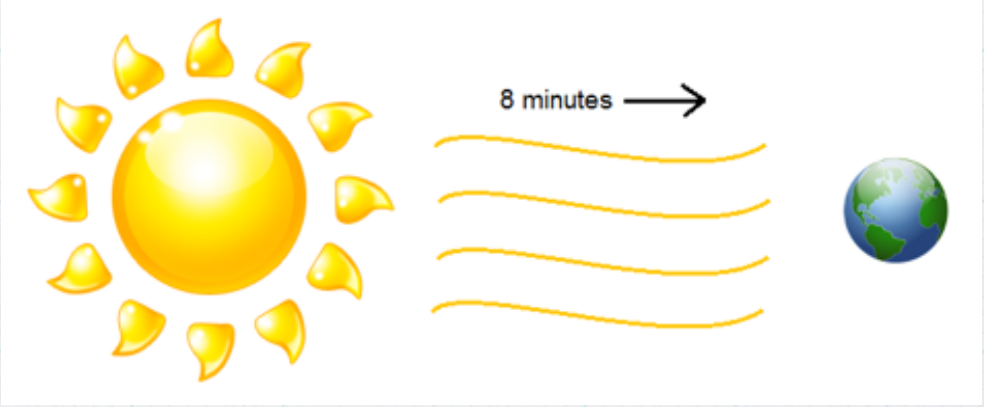
* How does energy transfer from the sun to Earth and the atmosphere?
* How are air circulation patterns with the atmosphere created?

Vocabulary

* **Radiation:** The transfer of energy by electromagnetic waves
* **Conduction:** The transfer of thermal energy by collision between particles of matter through touch
* **Convection:** The transfer of thermal energy by circulation or movement in a liquid or gas.
* **Stability**: whether circulating air motions will be strong or weak
* **Temperature Inversion:** a temperature increase as altitude increases in the troposphere.

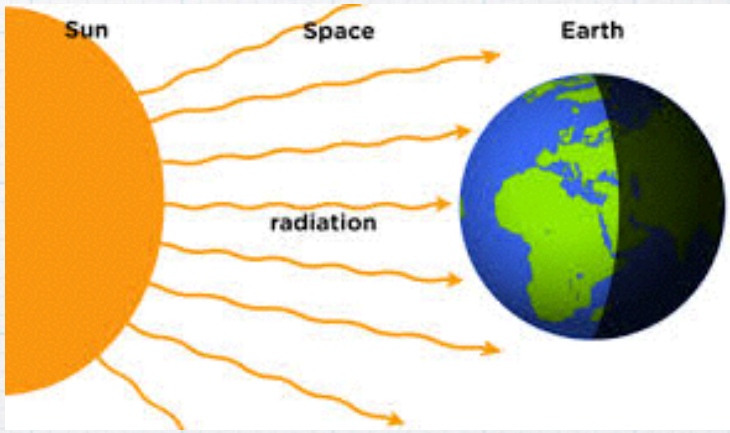
How does the sun's energy get to earth?

* the sun's energy travels 148 million km in only 8 minutes through the process of radiation (418)



What is Radiation

* the transfer of energy by electromagnetic waves (418)



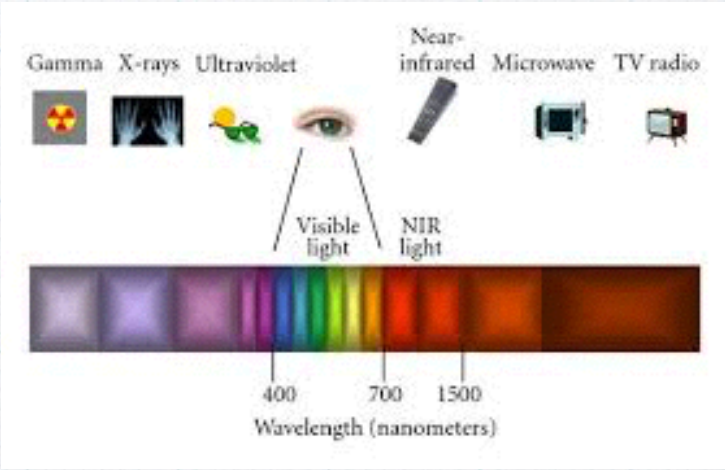
Visible Light as energy

* the atmosphere is like a window to visible light, allowing it to pass through, it is converted at the earth's surface to thermal energy, or heat (418)

Near-visible wavelengths

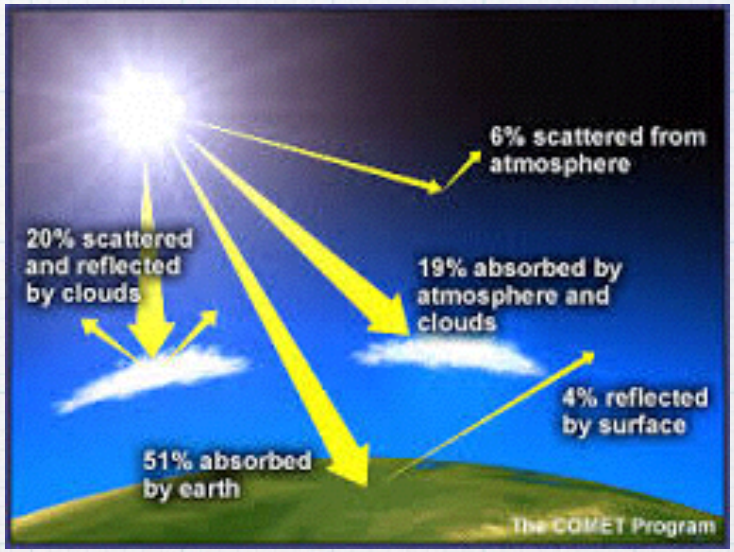
* Ultraviolet light (UV) has short wavelengths and can break chemical bonds. Excessive exposure will burn human skin and cause cancer. (418)

* Infrared radiation (IR) has longer wavelengths than visible light. It can be sensed as thermal energy or warmth. Earth absorbs energy from the sun and then radiates it into the atmosphere as infrared radiation. (418)



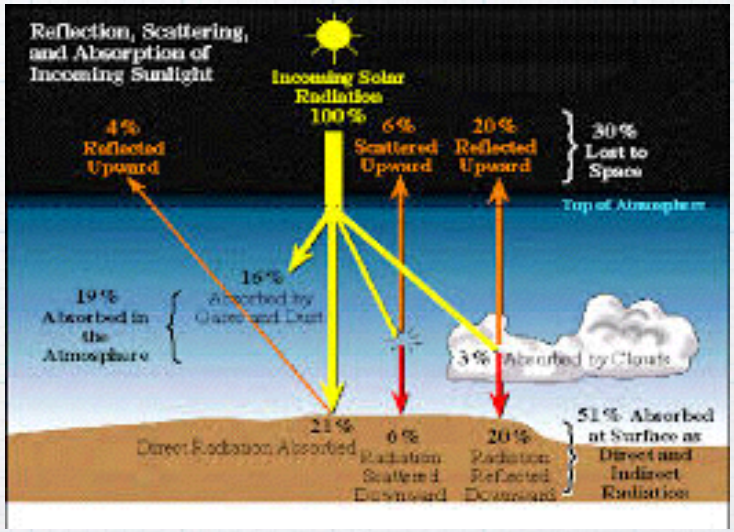
How is the sun's energy absorbed?

* * gases and particles absorb about 20% of incoming solar radiation
* * oxygen, ozone, and water vapor all absorb incoming UV light
* * water and carbon dioxide in the troposphere absorb some IR from the sun
* * earth's atmosphere does not absorb visible light, it must be converted to IR before it can be absorbed (419)



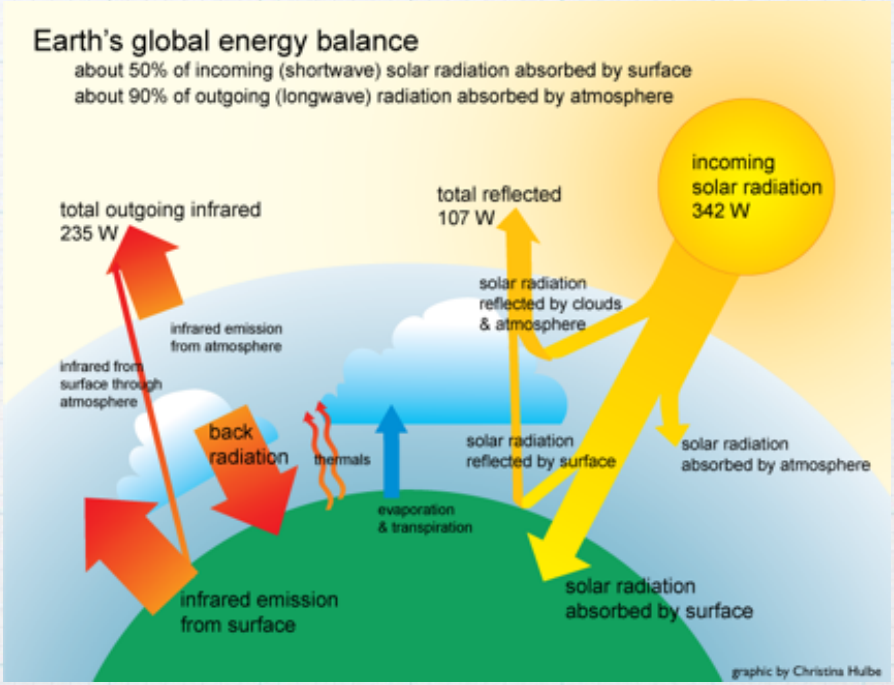
How is the sun's energy reflected?

* * clouds and other small particles in the air reflect about 25% of the sun's radiation (bright surfaces)
* * some radiation travels to earth's surface and is reflected by land and sea surfaces (especially snow-covered, icy, or rocky)
* * this accounts for about 5% of incoming radiation (419)
* About 30% of radiation is reflected and 20% of radiation is absorbed. The Earth's surface only receives and absorbs about 50% of incoming radiation from the sun. (419)



What is radiation balance?

* * a balance between incoming radiation from the sun and outgoing radiation from the earth- earth absorbs the sun's energy and then radiates energy away until a balance is achieved
* * land, water, plants, and other organisms absorb solar radiation that reaches earth's surface, then it is re-radiated, or bounced back into the atmosphere
* * most of the energy radiated from the earth is IR, which heats the atmosphere (420)

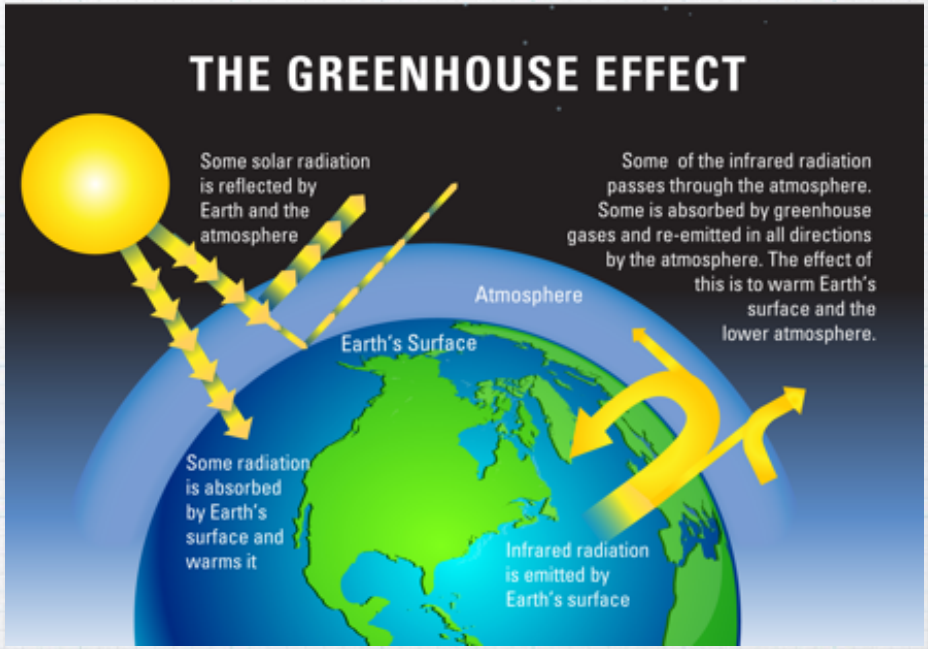


What is the greenhouses effect?

* some of the gases in the atmosphere, called greenhouse gases, act like the glass of a greenhouse, they allow sunlight to pass through, but the prevent some of earth's IR energy from escaping

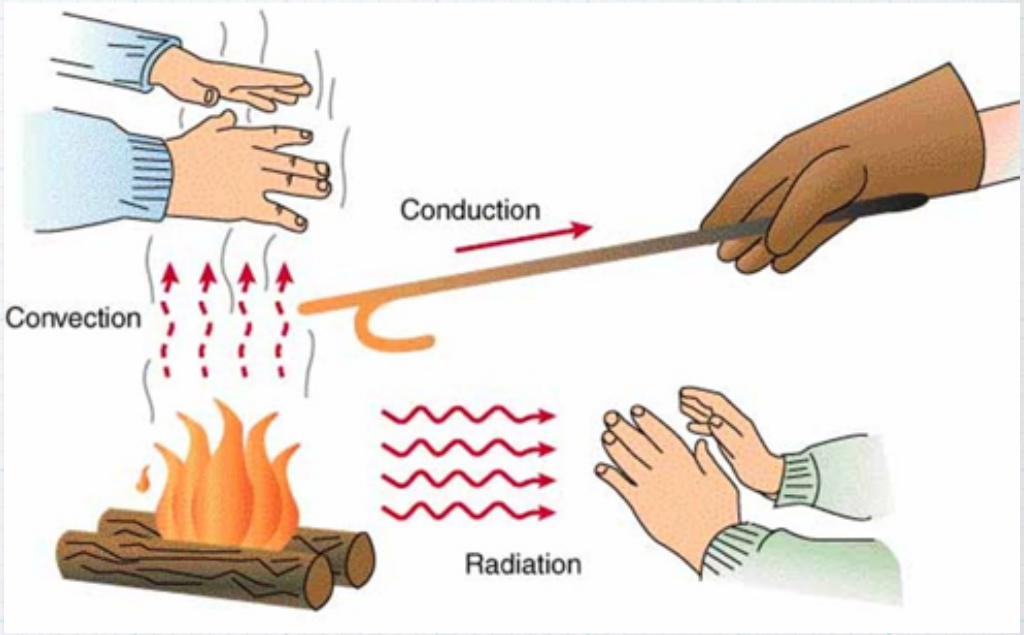
* greenhouse gases in the earth's atmosphere trap IR and direct it back to earth's surface, causing an additional buildup of thermal energy

* the gases that trap IR the best are water vapor (H20), carbon dioxide (C02), and methane (CH4) (420)



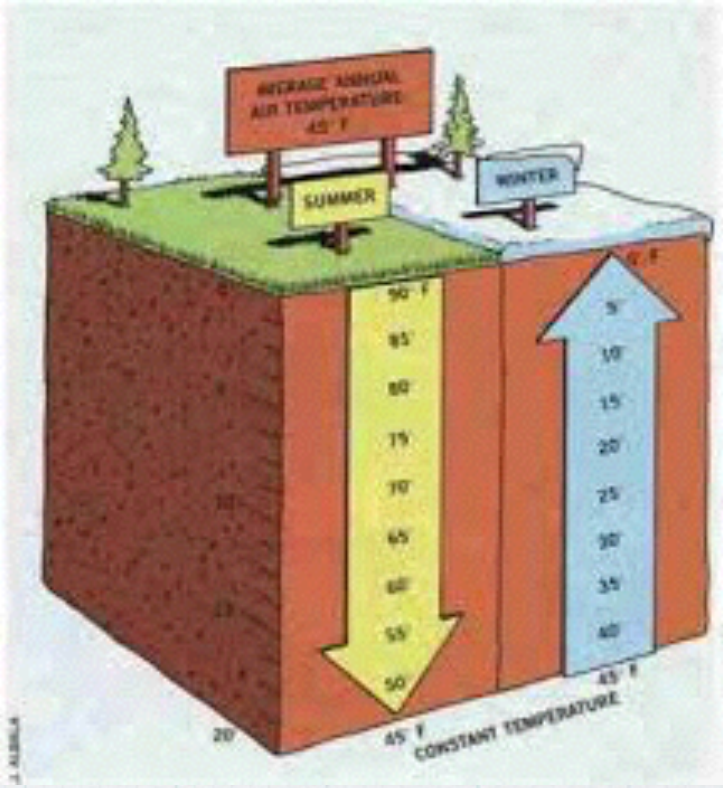
What are the 3 types of

* radiation, conduction, and convection (421)



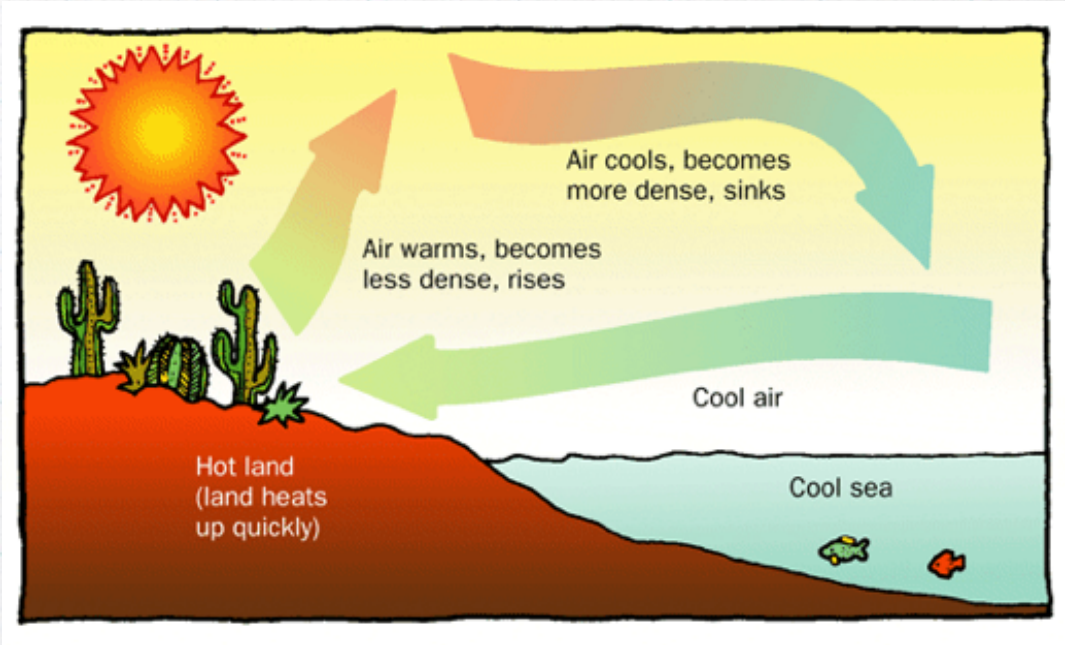
What is Conduction?

* the transfer of thermal energy by collision between particles of matter through touch
* particles must be close enough to touch to transfer energy by conduction
* Thermal energy moves from warm to cold areas. (High energy to low energy)
* * ex: touch a pot of water would transfer energy from the pot to your hand (421)
* Conduction occurs where the atmosphere touches earth. (421)



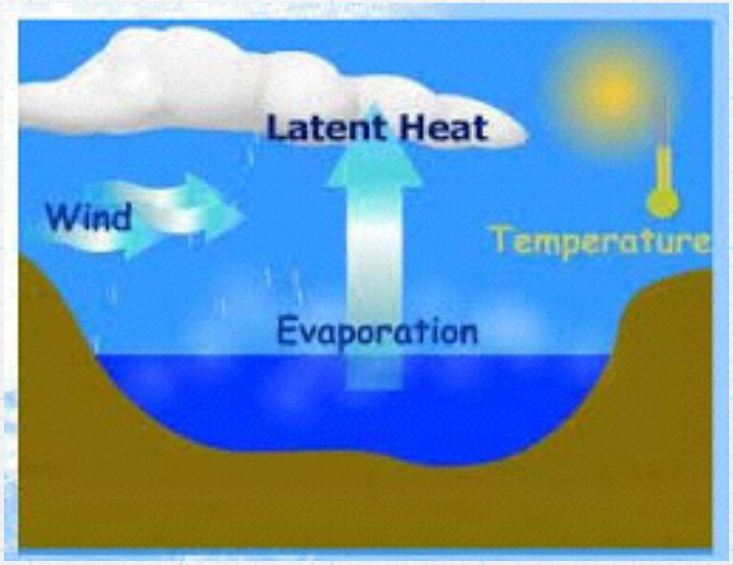
What is Convection?

* * Convection is the transfer of thermal energy by circulation or movement in a liquid or gas.
* * ex: boiling water circulates and steam rises (421)



What is Latent Heat?

* * latent heat is exchanged when water changes from on phase to another (421)
* * more than 70% of earth's surface is covered by water
* * water is the only substance that can exist as a solid, liquid, and gas within earth's temperature range (421)
* Latent heat energy is transferred from earth's surface to the atmosphere. (421)



How is energy transferred through circulating air?

* on a hot day, air that is heated becomes less dense, creating a pressure difference; cool, dense air pushes warm air out of the way; warm air is replaced by more dense air, and warm air is pushed upward

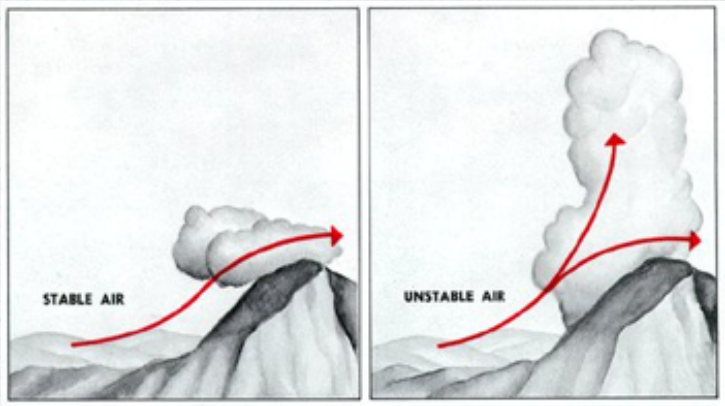
* * warmer, rising air is always accompanied by cooler, sinking air

DAY TIME

NIGHT TIME

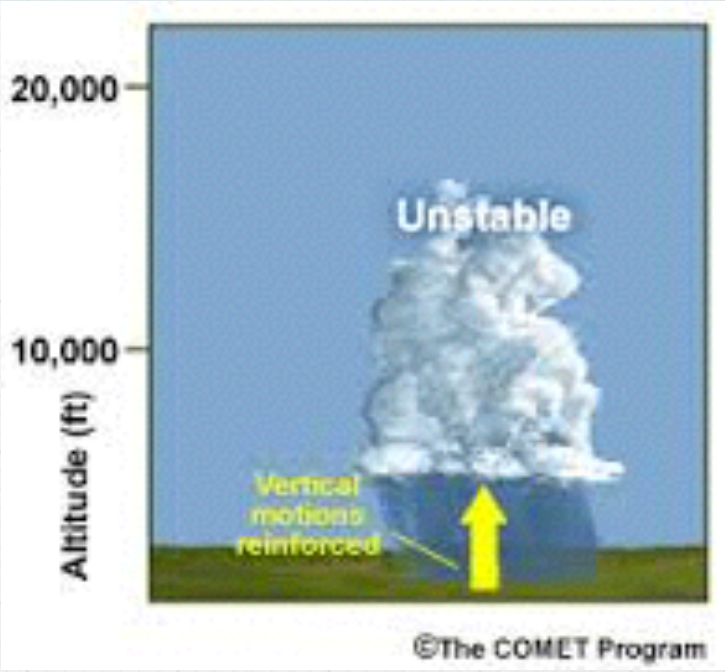
What is stability?

* describes whether circulating air motions will be strong or weak
* * ex: hills and buildings force some air to move up and over
* * when air is unstable, circulating motions are strong
* * when air is stable, circulating motions are weak (422)



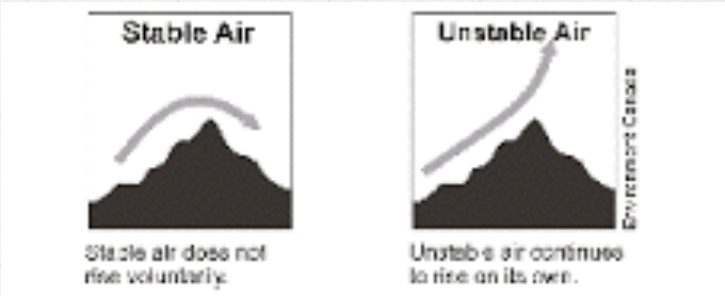
How are unstable conditions created?

* often occur on warm, sunny afternoons
* * ground-level air is much warmer than higher-altitude air, warm air rises rapidly in the atmosphere, it cools and forms large, tall clouds
* * latent heat, released as water vapor changes from a gas to a liquid, adds to instability, and produces a thunderstorm (423)



How are stable conditions created?

* * ground-level air is nearly the same temperature as higher-altitude air, the air is stable, and circulating motions are weak
* * a temperature inversion can occur under these conditions (423)



What is a temperature inversion?

* * occurs in the atmosphere when temperature increases as altitude increases
* * a layer of cooler air is trapped by a layer of warmer air above it
* * prevent air from mixing and and can trap pollution in the air close to earth's surface (423)