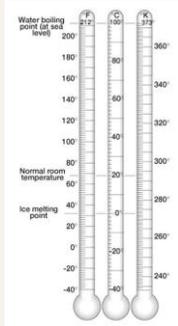


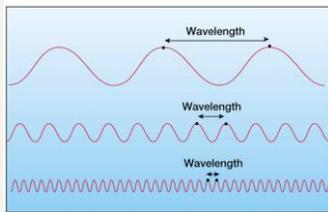
Measuring Temperature

- ❑ Fahrenheit Scale
- ❑ Celsius Scale
- ❑ Kelvin Scale



Solar Energy Electromagnetic Waves

- ❑ The sun is the most imp't source of energy for the earth's atmosphere – it drives most atmospheric processes.
- ❑ Energy from the sun is in the form of electromagnetic waves.
- ❑ They come in different wavelengths, and the waves travel at the speed of light – 186,000 miles per second.



Solar Energy Electromagnetic Waves

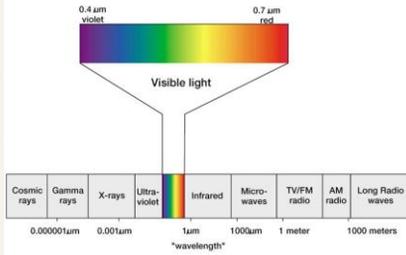
- ❑ Only 2 billionth of the solar output reaches the earth's outer limits, where it's hottest. We receive an even lesser amt at ground level.
- ❑ But the amount received in one second is still equal to all the electric power generated everywhere on earth, in a whole week!

Solar Energy - The Electromagnetic Spectrum

Electromagnetic waves of different wavelengths make up the spectrum.

Only 3 of them are of imp't to a physical geographer:

1. Ultra-violet waves. 0.01 to 0.4 micrometers.
2. Visible light. 0.4 to 0.7 micrometers.
3. Infrared radiation. Btw 0.7 to 1000 micrometers.



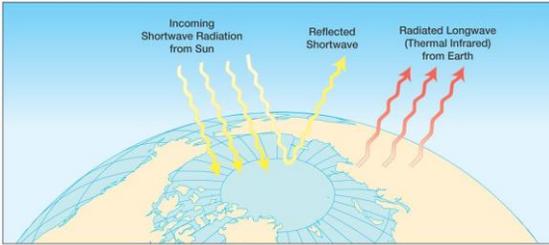
Solar Energy - The Electromagnetic Spectrum

- Ultra-violet (UV) waves are considerable in the outer atmosphere. Much of this is absorbed by the Ozone Layer. 0.01 to 0.4 micrometers. Too short to be seen by human eye.
- Visible light – in a narrow band btw 0.4 to 0.7 micrometers. A large portion of the sun's energy comes this in the form.
- Infrared radiation (IR) – 0.7 to 1000 micrometers. Too long to be seen by the human eye.
- There are 2 types of infrared radiation: short infrared and thermal infrared. Only a small portion of solar radiation arrives as short infrared. Thermal infrared is ONLY emitted by the earth (terrestrial radiation from magma), NOT by the sun.

Solar Energy - The Electromagnetic Spectrum

- Insolation
 - Incoming solar radiation
 - Shortwave energy
- Terrestrial Energy
 - Longwave energy

Solar Energy - The Electromagnetic Spectrum



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Basic Processes of Heating & Cooling

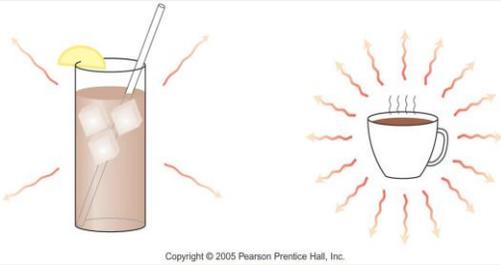
- Radiation
- Absorption
- Reflection
- Scattering
- Transmission
- Conduction
- Convection
- Adiabatic Heating and Cooling

Radiation

- The process by which radiant energy is emitted/flows from an object.
- All objects radiate energy, but the hotter the object, the more intense it's radiation and vice-versa.
- Also, the hotter the object, the shorter it's wavelength. See next slide.
- The sun is the ultimate hot body of our solar system, so solar radiation is often called "shortwave radiation".

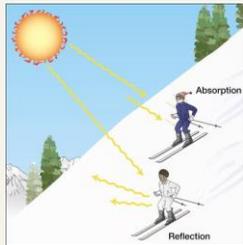


Radiation



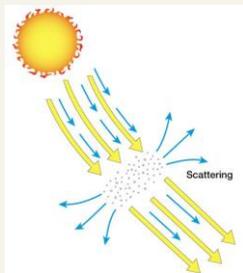
Absorption and Reflection

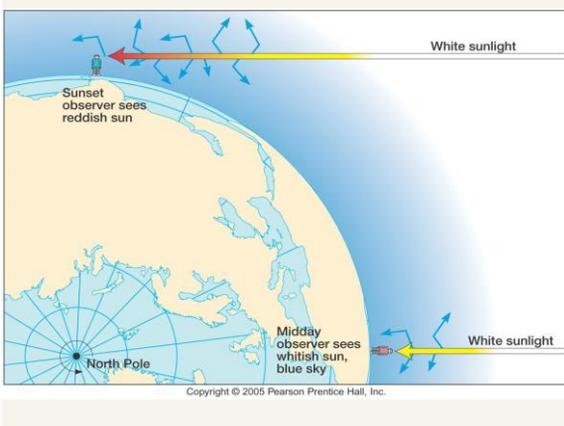
- ❑ Absorption is when radiant energy is assimilated by an object.
- ❑ A good radiator is a good absorber (vice-versa). The earth and water are good absorbers, but not ice.
- ❑ Dark colors are more efficient absorbers than light colors.
- ❑ Reflection is the ability of an object to repel electromagnetic waves. E.g. a mirror.
- ❑ If an object is a good reflector, it's a poor absorber (vice-versa). That's why snow takes a long time to melt.



Scattering

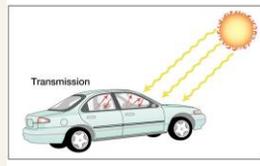
- ❑ This is when particulate matter and gas molecules deflect light waves and re-directs them. It's a kind of reflection. It changes the direction of a wavelength.
- ❑ That's what makes the SKY blue during the day and orange, at sunset and sunrise.





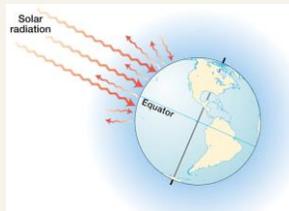
Transmission

- The process by which electromagnetic waves pass completely thru a medium, e.g. clear glass, water.
- The earth is a poor transmitter because even though it absorbs, the heat does not pass completely thru (e.g. caves).
- The figure shows why cars get hot. This process is called the "Greenhouse Effect". The same thing happens in the atmosphere.



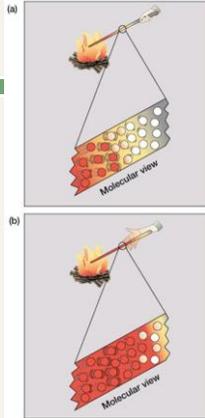
Transmission - The Greenhouse Effect

- CO₂ and other greenhouse gases in the atmosphere act like glass in a car.
- These gases keep the earth livable. Without the greenhouse effect, the average temp of the earth will be 5 degrees F, instead of the current average of 59 degrees F (averaged across all climates – both hot & cold).



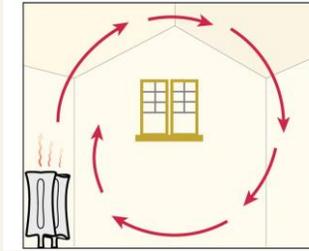
Conduction

- The movement of energy from one molecule to another without changes in their positions, i.e. from a stationary object.
- It happens by molecular collision. Hot molecule becomes increasingly agitated and collides with a cooler, calmer molecule.
- The principle is that when 2 molecules of unequal temps are in contact, the heat passes from the warmer to the cooler molecule, until they attain the same temp.
- Some materials are better conductors e.g. metal vs. wood



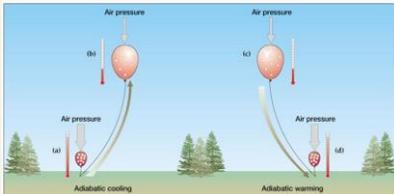
Convection

- Heated air expands and rises, then cools down, contracts and descends - and the process is repeated again.

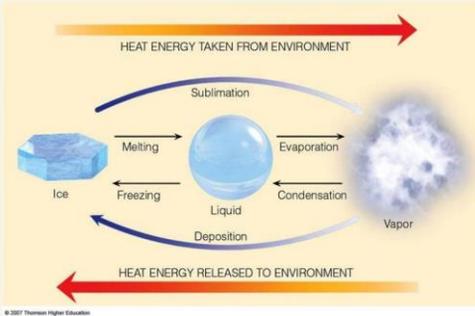


Adiabatic Heating/Cooling

- Whenever air ascends/ descends, the temp changes.
- As air rises, the molecules spread over a greater volume and so cool down due to infrequent collisions i.e. adiabatic cooling.
- As air descends, it warms up because of above pressure compressing down on the molecules i.e. adiabatic warming (with no heat from external sources).



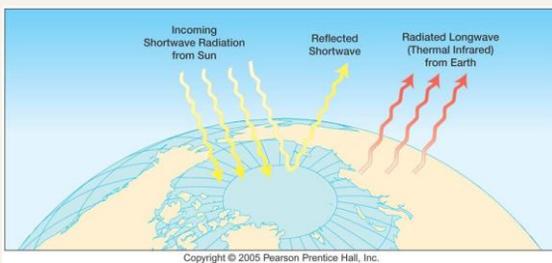
Phase Changes (Latent Heat)



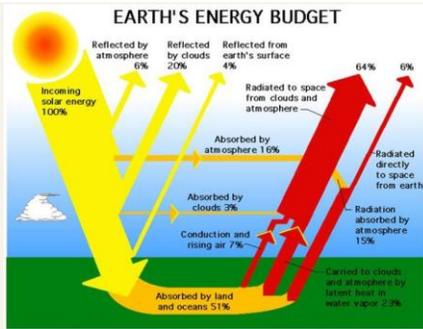
Heating the Atmosphere

- The Earth's Energy Budget
- Spatial and Seasonal Heating Variations
 - Latitudinal Differences
 - Day length
 - Atmospheric obstruction
 - Land and Water Contrasts

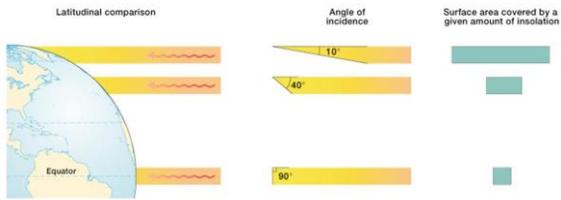
Heating the Atmosphere



Earth's Energy Budget



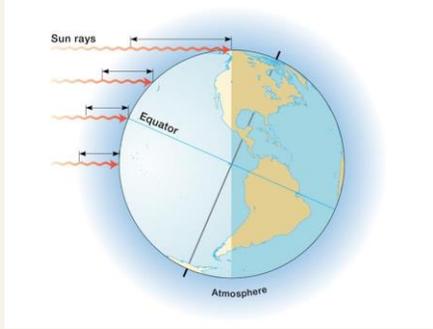
Spatial/Seasonal Variations Latitudinal Differences



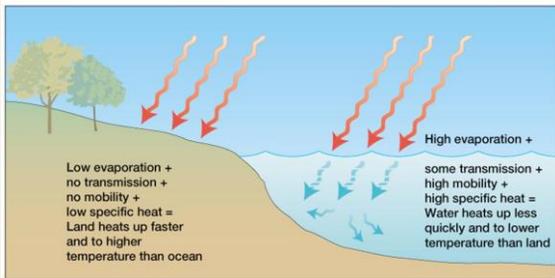
Day Length



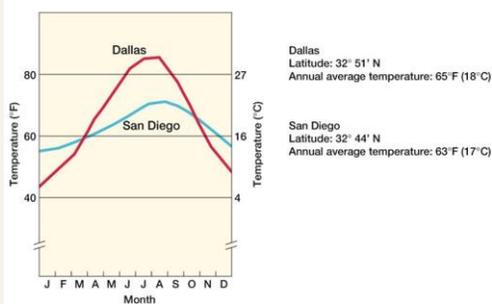
Atmospheric Obstruction



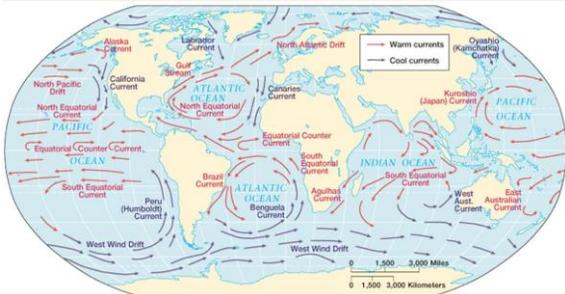
Land and Water Contrasts Heating Characteristics



Land and Water Contrasts Annual Temperature Curves



Heat Transfer Mechanisms Atmospheric and Oceanic Circulation



Temperature Patterns

- Vertical Temperature Patterns
 - Average Lapse Rate: the rate at which temp drops with height i.e. 3.6 degrees F per 1000 feet (or 6.5 degrees C per km or 1000m).
 - Temperature Inversions: a temp inversion is an exception to the av. laspe rate. This is when temp increases with height (in the troposphere). See pg 98. these could be surface or upper air inversions. Inversions are common but short-lived.
- Global Temperature Patterns
 - Temperature Controls

Global Temperature Controls

- Altitude
- Latitude
- Land-Water Contrasts
- Ocean Currents

Global Average Annual Temperature Range

The difference btw the warmest and coldest months (July & January).

