

Chapter 2: Warming the Earth and the Atmosphere

- Temperature and heat transfer
- Balancing act - absorption, emission and equilibrium
- Incoming solar energy



Temperature and Heat Transfer

Temperature Scales

- kinetic energy, temperature and heat
 - Kelvin scale
 - Celsius scale
 - Fahrenheit scale
 - temperature conversions
- Every temperature scale has two physically-meaningful characteristics: a zero point and a degree interval.

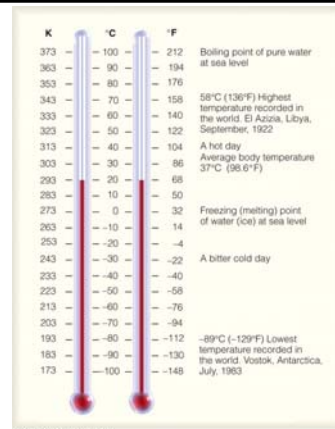
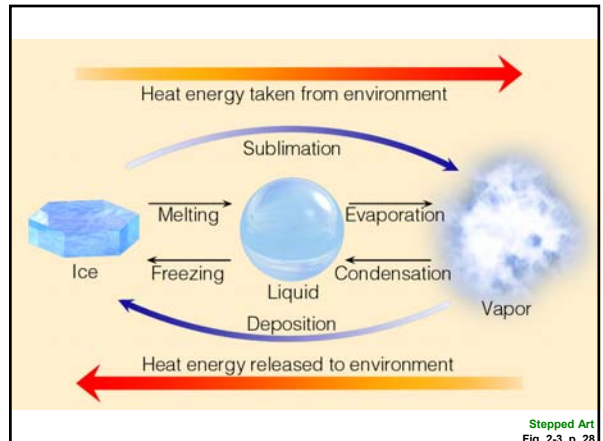


Fig. 2-2, p. 27

Latent Heat - The Hidden Warmth

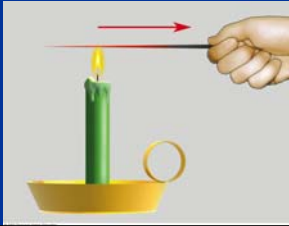
- phase changes and energy exchanges
 - sensible heat
- Latent heat explains why your skin feels cold when you step out of a warm shower, and why perspiration is an effective way to cool your body.



Stepped Art
Fig. 2-3, p. 28

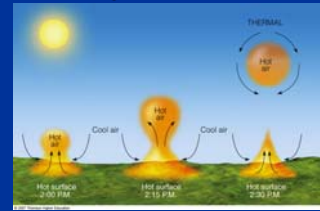
Conduction

- conduction and heat transfer
- good conductors and poor conductors
 - Why are feathers (down) used in winter parkas?



Convection

- convection and heat transfer
- thermals
 - Soaring birds, like hawks and falcons, are highly skilled at finding thermals.



Radiation

- radiation and energy transfer
- electromagnetic waves
- Wein's law
- Stefan-Boltzmann law
 - Cole's law: shredded cabbage and vinegar

TYPE OF RADIATION	RELATIVE WAVELENGTH	TYPICAL WAVELENGTH (meters)	ENERGY CARRIED PER WAVE OR PHOTON
AM radio waves	Wavelength	100	Increasing ↓
Television waves		1	
Microwaves		10^{-3}	
Infrared waves		10^{-6}	
Visible light		5×10^{-7}	
Ultraviolet waves		10^{-7}	
X rays		10^{-9}	

Fig. 2-7, p. 32

Radiation

- electromagnetic spectrum
- ultraviolet radiation
- visible radiation
- infrared radiation
 - Moderate amounts of ultraviolet radiation gives you a healthy-looking tan; excessive amounts give you skin cancer.

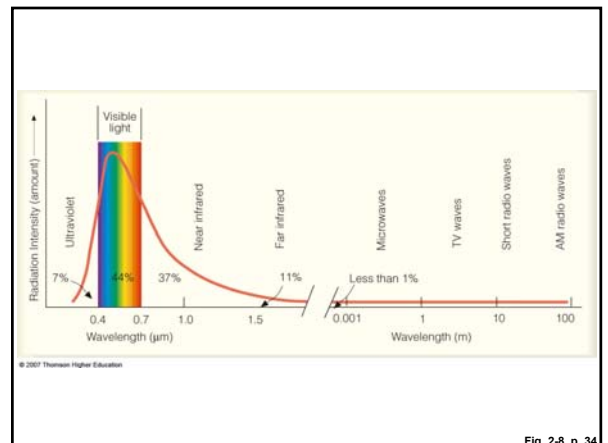
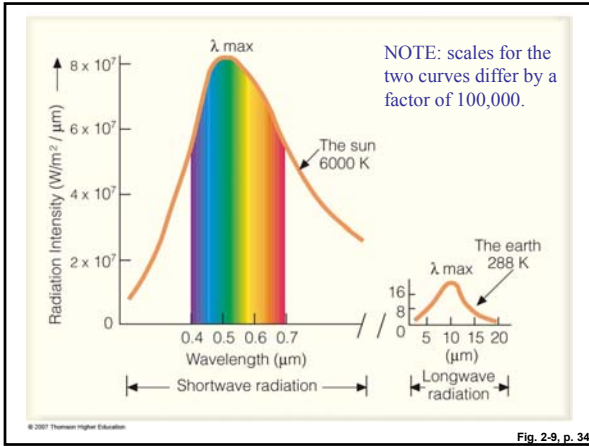


Fig. 2-8, p. 34



Balancing Act - Absorption, Emission, and Equilibrium

Selective Absorbers and the Atmospheric Greenhouse Effect

- blackbody radiation
- selective absorbers
- atmospheric greenhouse effect
 - The best greenhouse gas is water vapor.

The image shows a series of spectral graphs for different greenhouse gases: Methane, Nitrous oxide, Water vapor, Carbon dioxide, and Chlorofluorocarbons. Each graph plots intensity against wavelength, showing characteristic absorption bands.

Enhancement of the Greenhouse Effect

- global warming
- positive and negative feedbacks
 - Positive feedback: increasing temperatures lead to melting of Arctic sea ice, which decreases the albedo.

Warming the Air from Below

- radiation
- conduction
- convection

- Fog “burns off” from the bottom up.

The diagram illustrates the process of warming the air from below. It shows solar radiation (yellow arrows) hitting the ground. From the ground, heat is transferred to the air through conduction (red arrows) and convection (red arrows forming a loop). The air then radiates heat back to the ground and to the atmosphere (red arrows). A cloud is shown with 'Latent heat released' (red arrows) and 'Absorption and emission of infrared radiation by H₂O and CO₂' (red arrows). The sun is labeled 'Solar radiation'.

Incoming Solar Energy

Scattered and Reflected Light

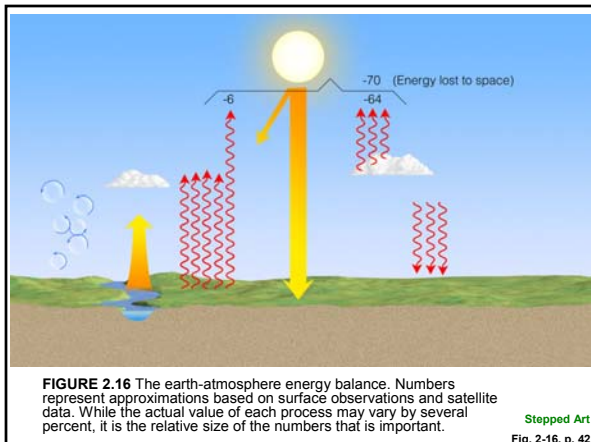
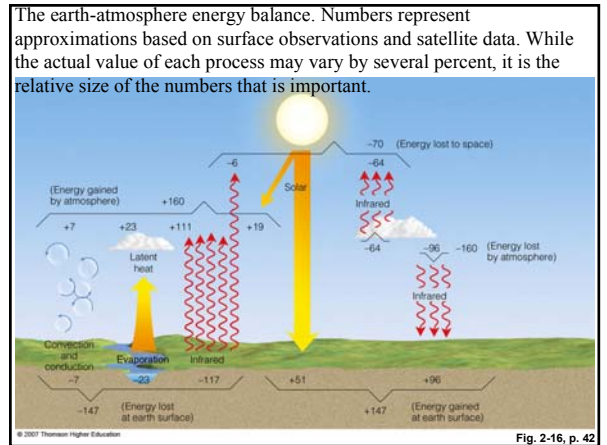
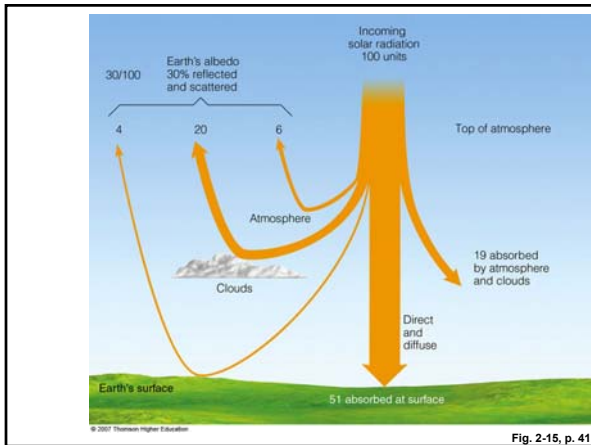
- scattering
- reflection
- albedo

• Scattering is responsible for sky color.



The Earth's Annual Energy Balance

- What happens to the solar energy that reaches the top of the earth's atmosphere?
- What happens to the solar energy that is absorbed by the earth's surface and by the atmosphere?



Why the Earth has Seasons

- earth-sun distance
- tilt of the earth's axis

• Earth-sun distance has little effect on atmospheric temperature.



Seasons in the Northern Hemisphere

- insolation
- summer solstice
- spring and autumn equinox



Seasons in the Southern Hemisphere

- tilt
- solstice
- equinox



Local Seasonal Variations

- slope of hillsides
- vegetation differences
- Homes can exploit seasonal variations: large windows should face south.

