

# Physics Notes

Name: \_\_\_\_\_

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## Chapter 22: Heat Transfer

1. It can be said that all matter is *seeking* a state of **equilibrium**, an “energetically favorable state” – that is the state of lowest possible energy given a set of conditions.

*This is echoed in the following passage:*

Romans 8:22-23

“For we know that **the whole creation groaneth and travaileth in pain together** until now.”

“And not only [they], but ourselves also, which have the firstfruits of the Spirit, even we ourselves groan within ourselves, waiting for the adoption, [to wit], the redemption of our body.”

2. **Conductors:** these are materials that transfer heat energy quickly. Most **metals are considered excellent conductors.**

Graphic: Conductors vs. Insulators

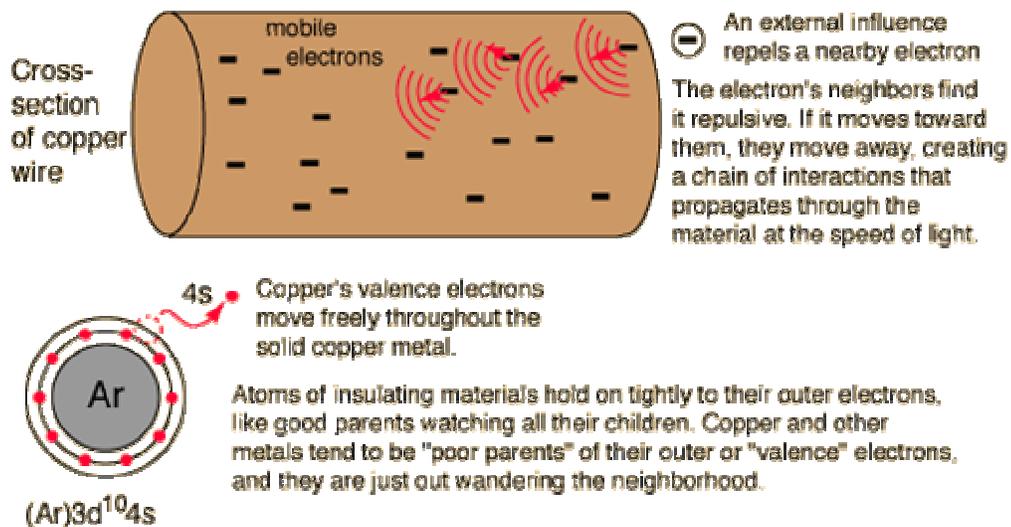


Image: GATech / <http://hyperphysics.phy-astr.gsu.edu>

3. **Insulators:** although “all” substances transfer heat energy, insulators transfer it slowly when compared to materials called conductors. It can be said that **insulators delay the transfer of heat energy.**

Examples of good insulators: **ceramics** (because of numerous air pockets), **fleece** (because of numerous air pockets), **fur** (because of numerous air pockets), **feathers** (because of numerous air pockets)...notice a trend? *Is air a good conductor?* Can you think of others?

→ Jackets keep you warm by retarding the flow of heat away from your body!

**Materials that do not conduct well are good insulators!**



4. Heat is energy. **Cold is the absence of heat energy.** It's that simple. (see pg. 326 for more...)

5. **Convection:**

It is commonly said that “heat rises”. This is not entirely true. Heated air rises because it becomes less dense than air of a lower temperature. **Convection is all about the varying densities of fluids** (gases or liquids). All fluids can experience convection. (pg. 327)

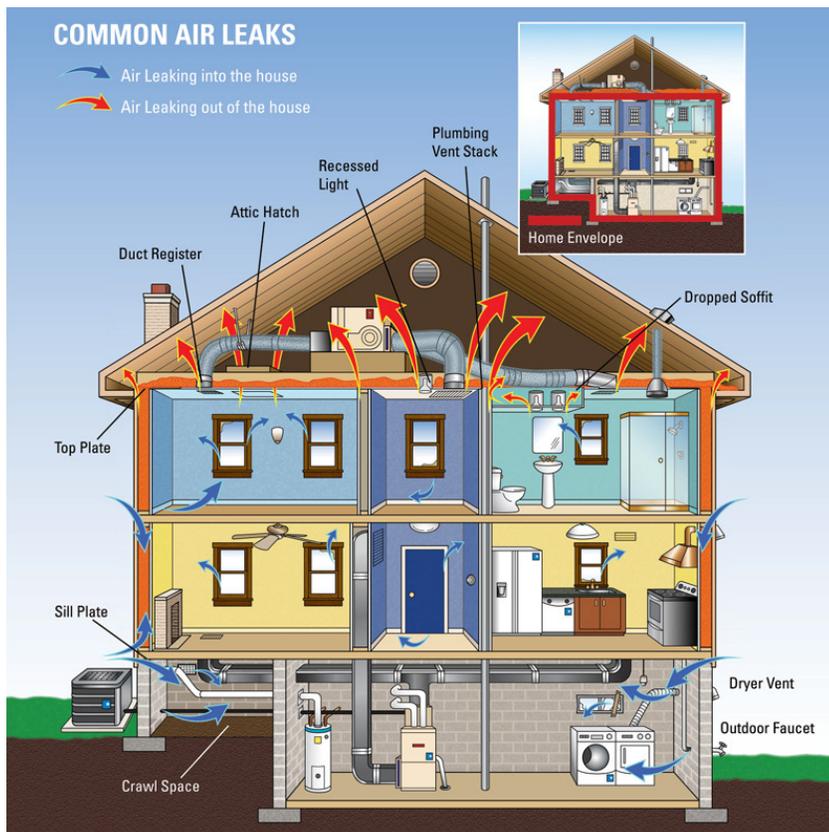


Image: US DOE / EPA

**Convection can result in thermal losses/gains in your home.**

6. Winds on Earth's surface are, for the most part, caused by pressure differences between air masses. Air masses of higher temperature have a lower density ( $\rho$ ) than that of cooler temperatures. Why is this?
7. If there is empty space between Earth and its Sun, how is heat conducted to Earth? It *isn't!* **Conduction and convection require a medium.** Heat energy from the Sun is received by the Earth as **radiation.**

Page 331 states "All objects continually emit radiant energy in a mixture of wavelengths. **Objects at low temperatures emit long waves...Higher-temperature objects emit waves of shorter wavelengths.**" This explains why very "hot" stars are bluish in color, while those that are not as hot appear red, orange, or yellow...

8. Radiant energy is **electromagnetic energy** – the kind of energy we loosely term to be *light*. **Electromagnetic energy requires no medium** through which to pass – thus it can be emitted from a source and travel to the farthest reaches of space in a vacuum at a speed faster than anything else known in the universe! ( $\sim 3.0 \times 10^8$  m/s)

#### Electromagnetic Wave Types:

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

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9. Things that appear black in color to humans are items that **absorb** radiant energy well. Things that appear lighter in color or shiny are things that **reflect** some radiant energy away from themselves (thus not absorbing all of the energy). **The pupils of our eyes appear black because they do not allow much light to exit the eye** – the light that enters the eye doesn't escape easily.



Image: wikipedia.org

10. **Objects that absorb radiant energy well are also efficient emitters of radiant energy.** Areas experiencing daytime sunlight on Earth will absorb that energy and then re-emit the energy during the nighttime.

#### 11. NEWTON'S LAW OF COOLING:

Newton proposed that the rate an object cools is proportional to the temperature difference between it and its surroundings.

Simply said, the greater the temperature difference between an object and its surroundings the faster it will seek a state of equilibrium. If an object and its surroundings are of similar temperature, cooling will be much slower (hence our frustration trying to stay cool in summertime...).

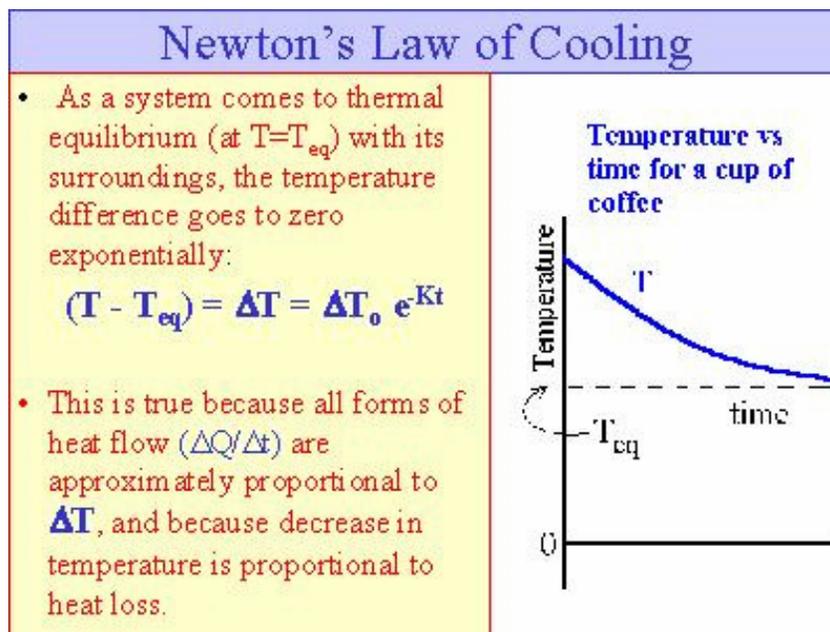
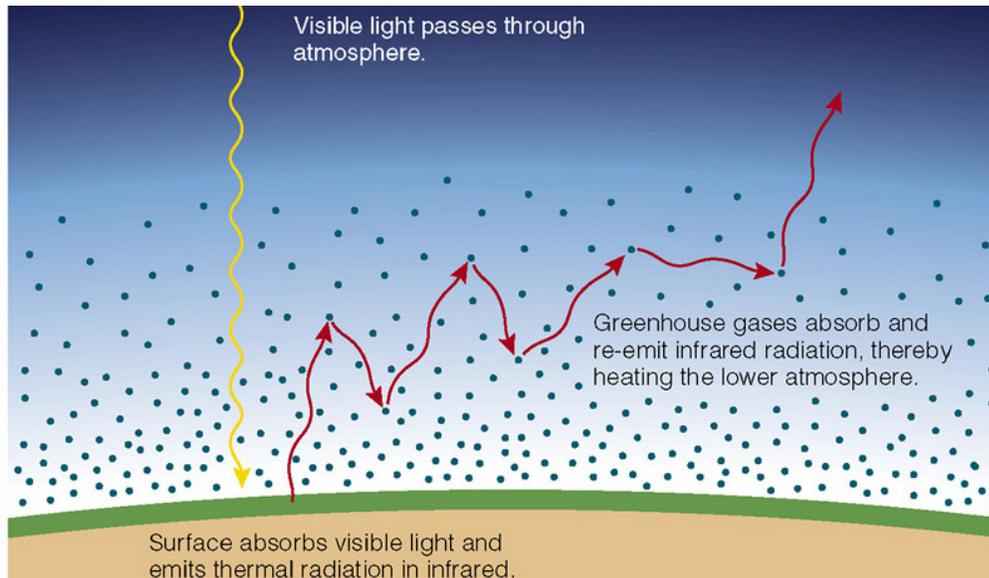


Image: physics.bgsu.edu

## 12. The Greenhouse Effect:

Earth receives light energy from the Sun in wavelengths that are shorter than those that the Earth re-emits. The longer waves can become “trapped” within Earth’s atmosphere by gases (particularly CO<sub>2</sub>), thus warming Earth’s atmosphere.



## 13. Earth’s Energy Budget:

Earth “uses” the energy it receives from the Sun in various ways. An approximation made by NASA’s Earth Observatory is shown here:

