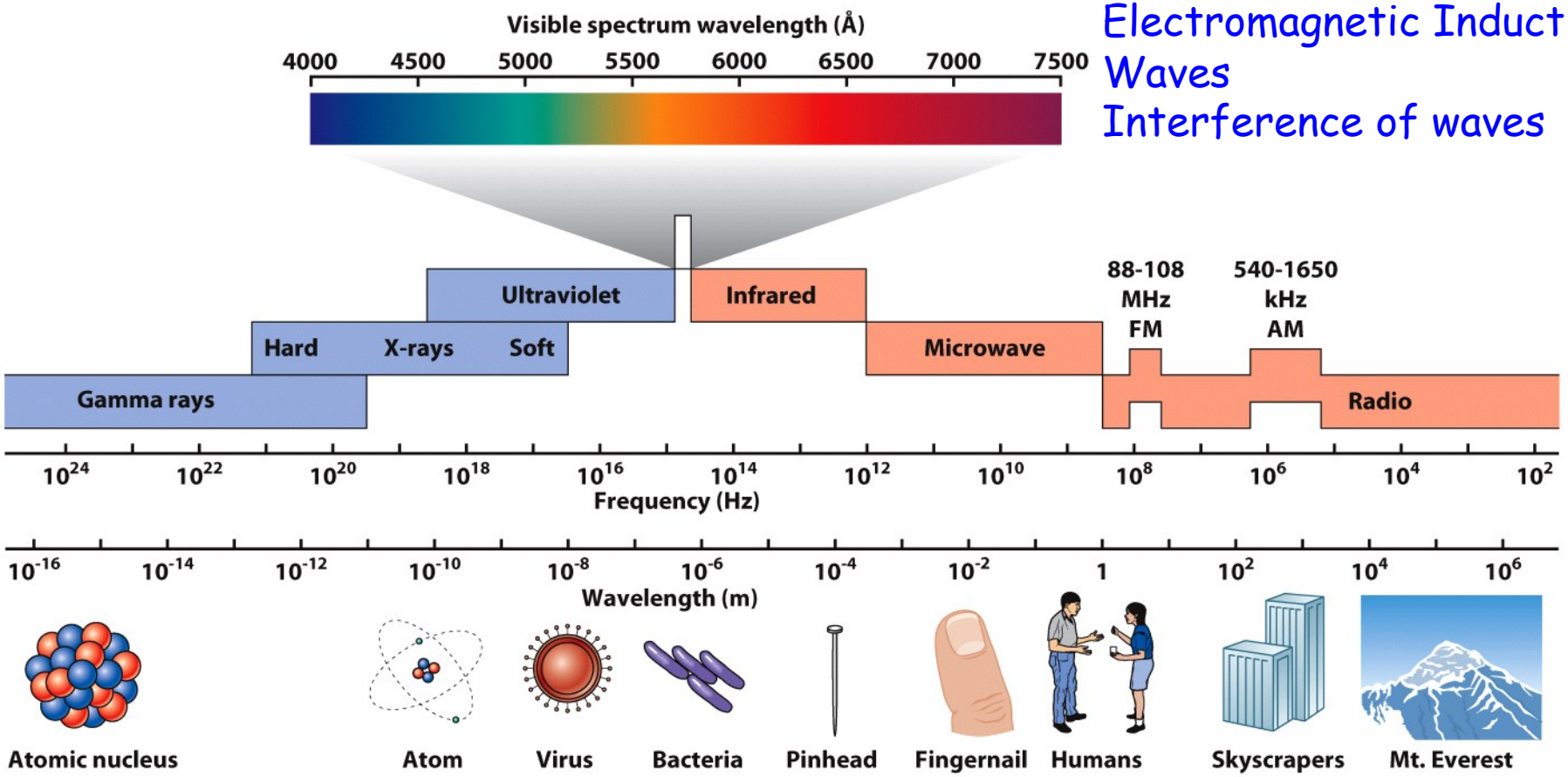
The Electromagnetic Spectrum –Chapter 6

Demonstrations:
Electromagnetic Induction
Waves
Interference of waves

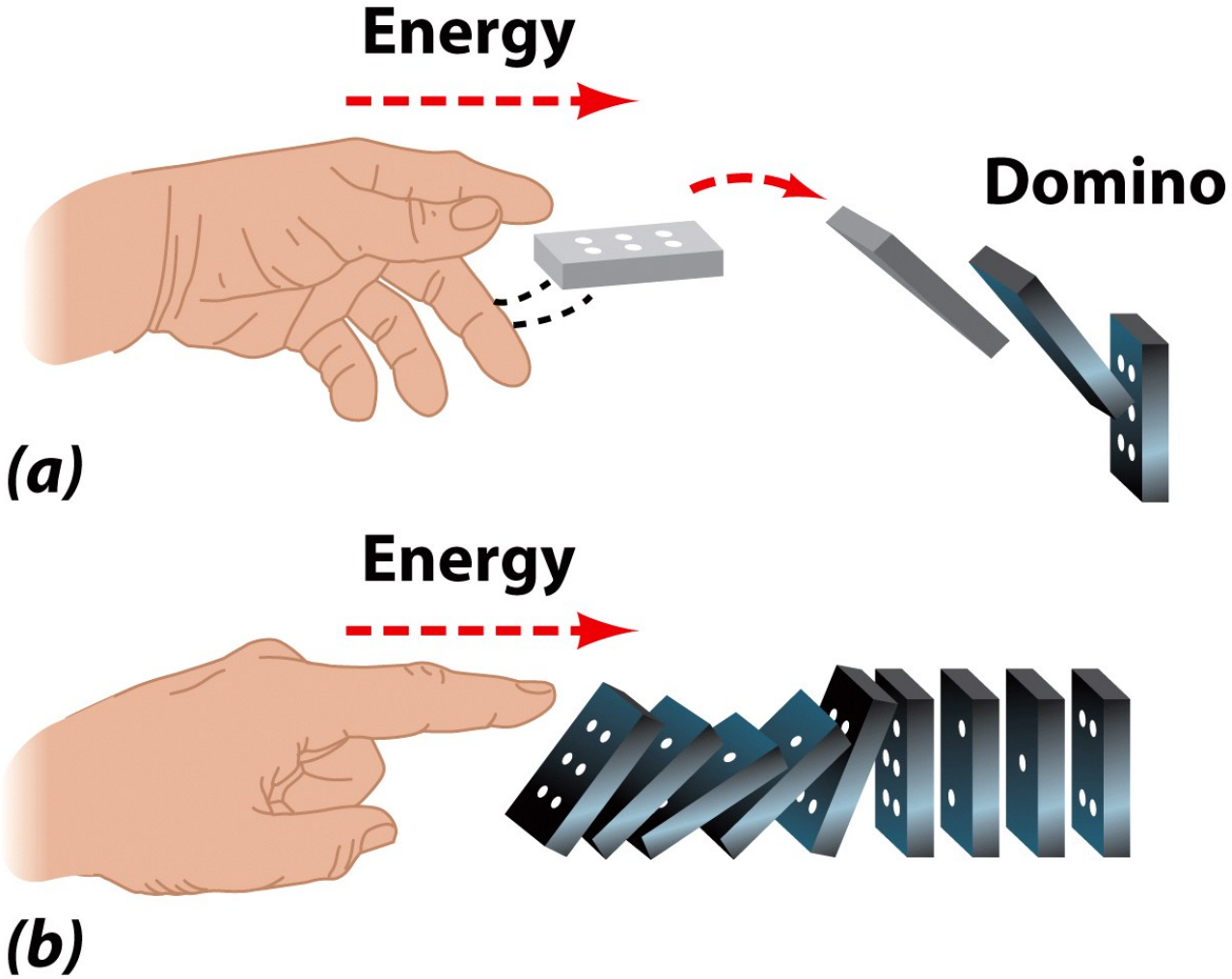


Energy Transfer by Waves

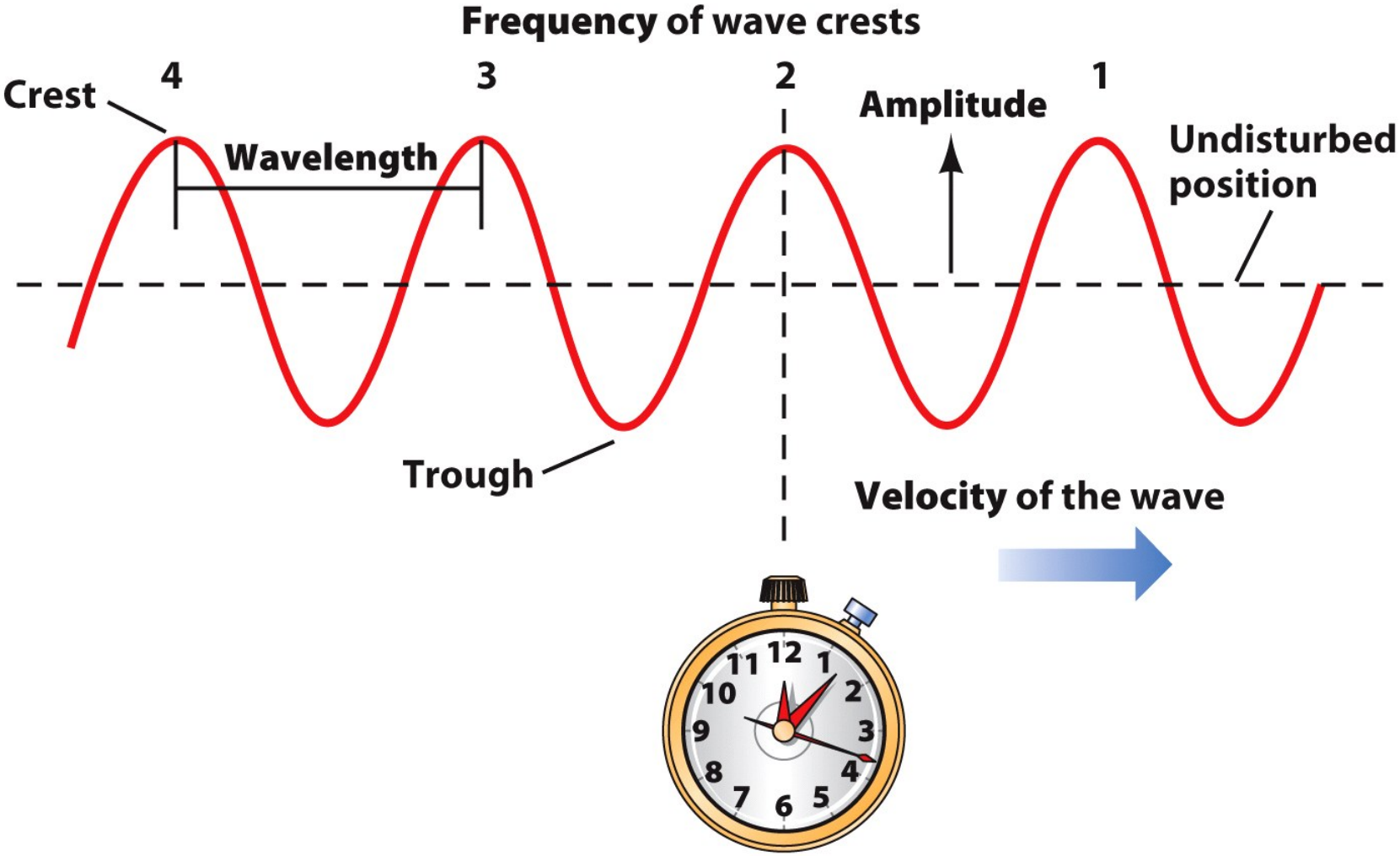
- Wave
  - A traveling disturbance

- Properties of waves
  - Wavelength
  - Frequency
  - Velocity
  - Amplitude

Energy Transfer



The Properties of a Wave



The Relationship among Wavelength, Frequency, & Velocity

- Velocity of a wave
  - Equation:

$$v = \lambda f$$

Waves Passing a Sailboat

Science by the Numbers

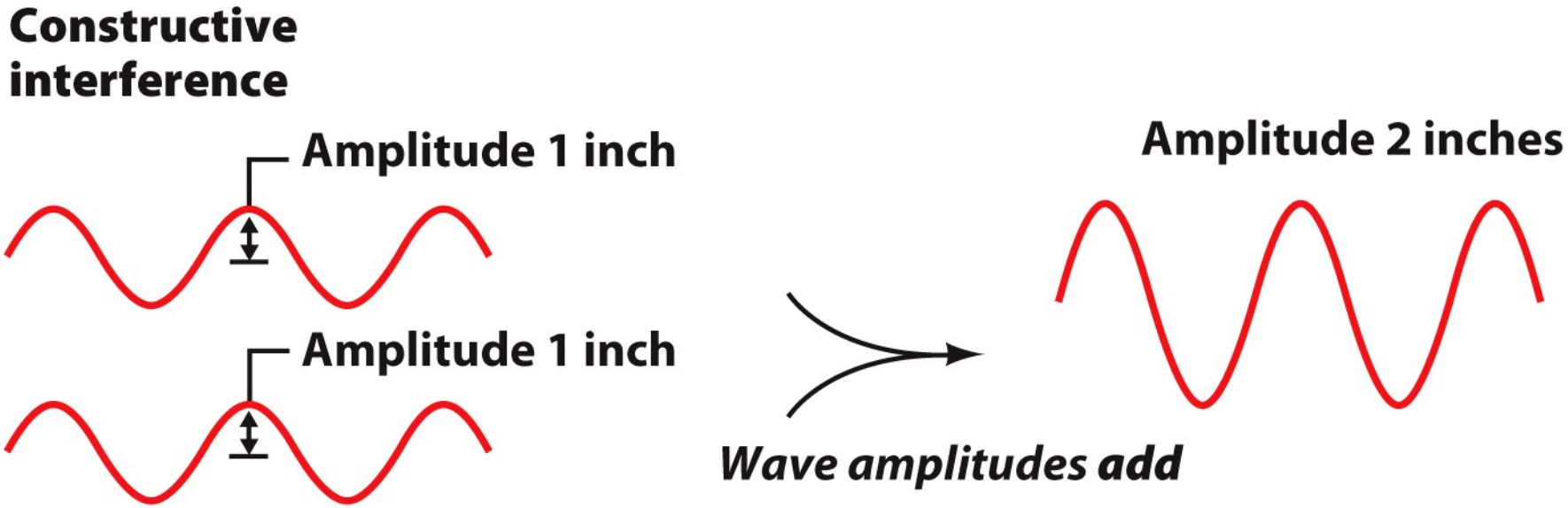
- The Sound of Music

The Science of Life

- Use of Sound by Animals

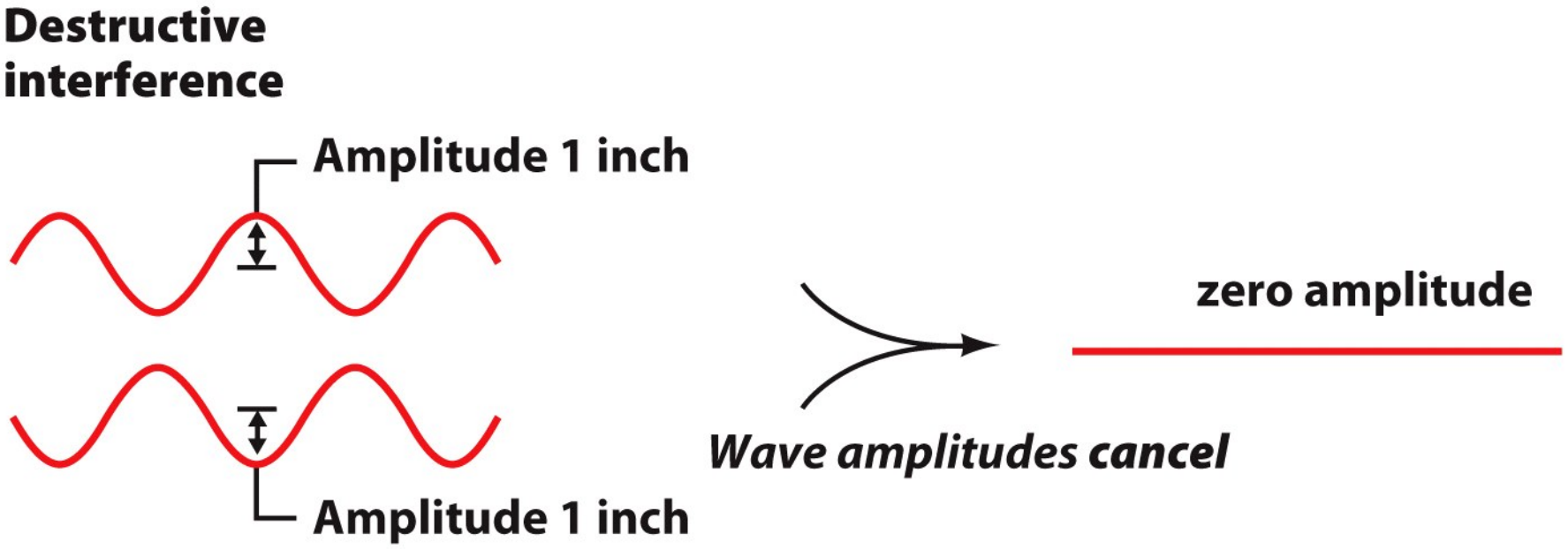
Interference

- Interference
  - Constructive interference
    - Act together



Interference

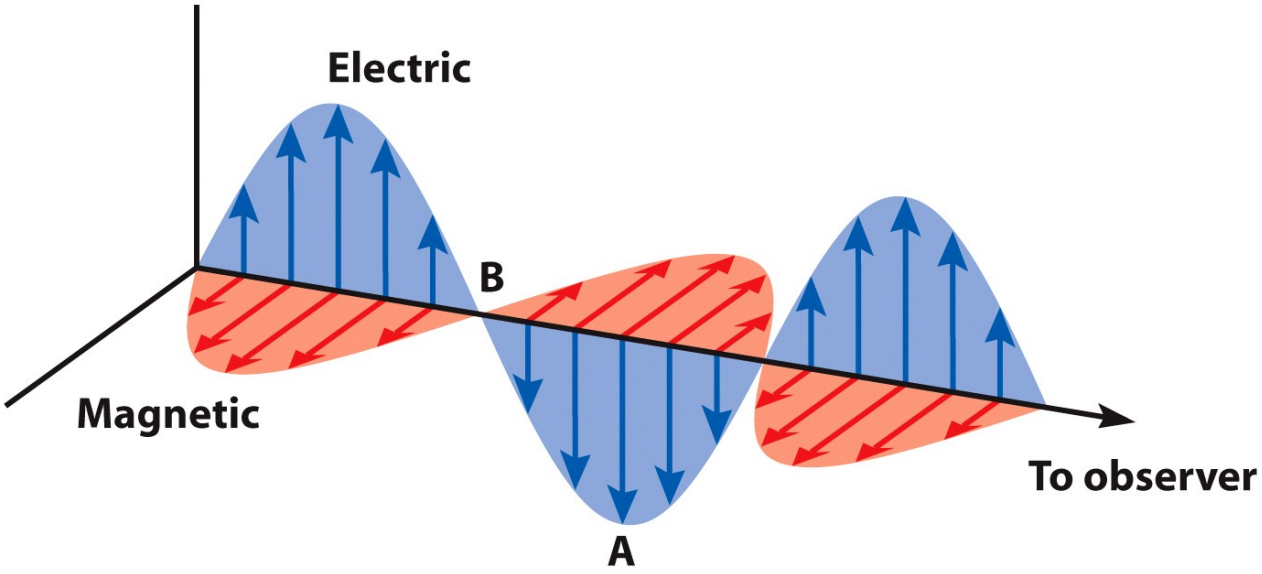
- Interference
  - Destructive interference
    - Cancellation



The Electromagnetic Wave

The Anatomy of the Electromagnetic Wave

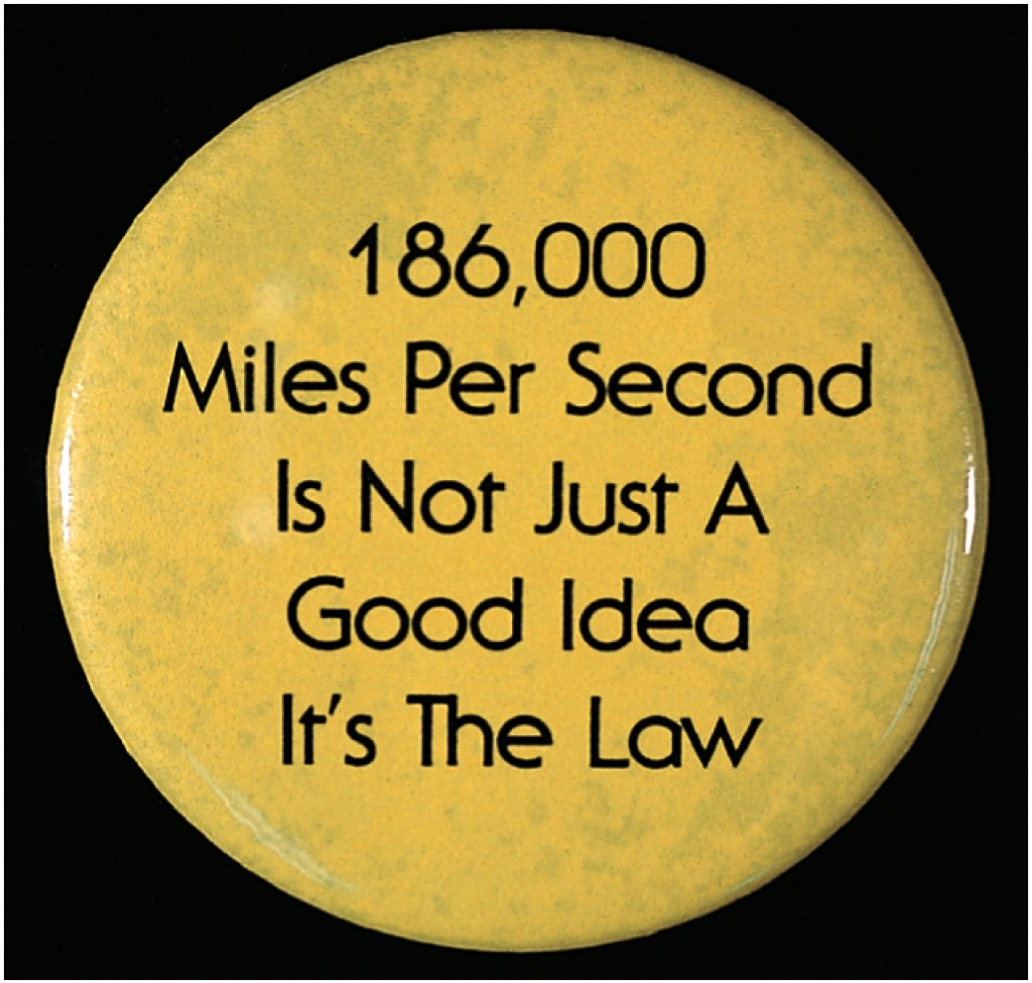
- Electromagnetic waves continue through internal mechanisms and transfer energy as they travel



Light and the Energy of Electromagnetic Waves

- Speed of light
  - All electromagnetic waves have same velocity
  - c = 300,000km/s
- Energy
  - Higher frequency = blue color
  - Lower frequency = red color

The Speed of Light



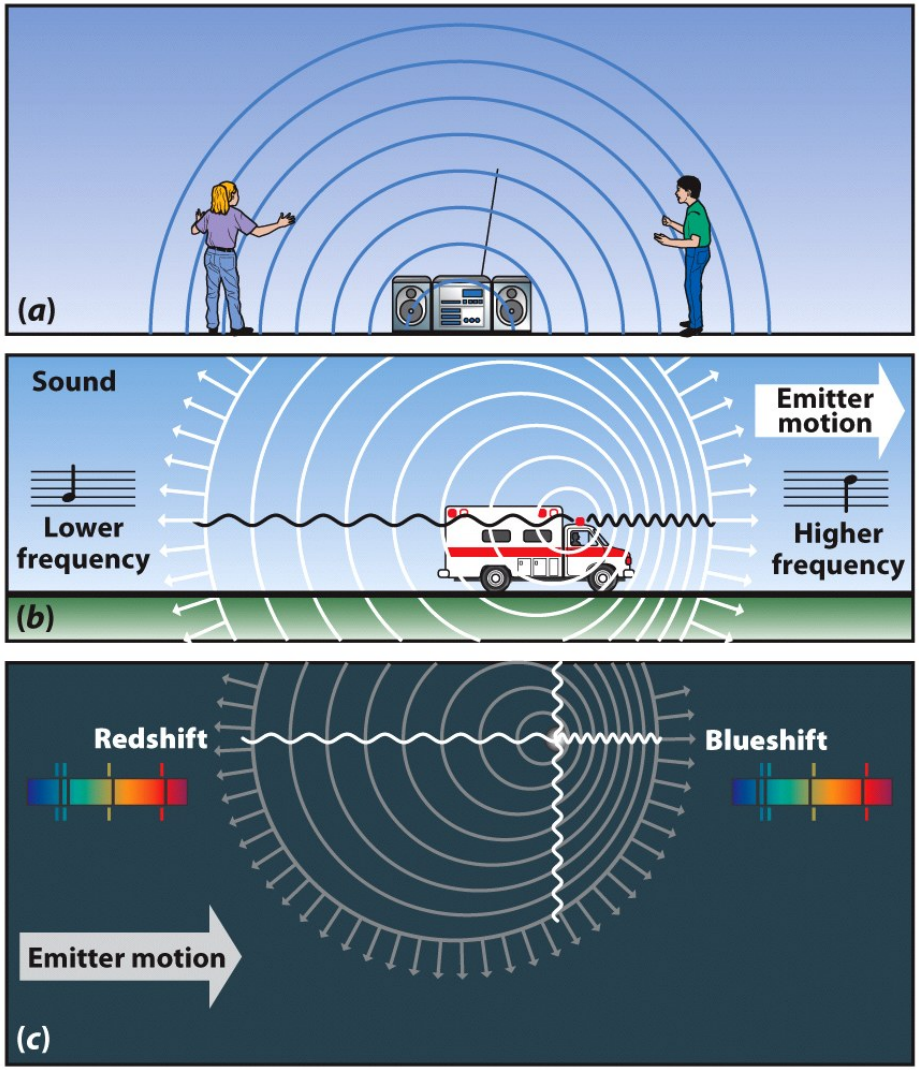
The Doppler Effect

- Doppler effect
  - Wave motion is independent of its source
  - If source moves, frequency appears to change

The Doppler Effect

http://www.youtube.com/watch?v=ZRGg7e9b5wY&NR=1&feature=fvwp

http://www.youtube.com/watch?v=-d9A2oq1N38 Sonic Boom



An echocardiogram uses sound waves to produce images of your heart. This commonly used test allows your doctor to see how your heart is beating and pumping blood. Your doctor can use the images from an echocardiogram to identify various abnormalities in the heart muscle and valves.

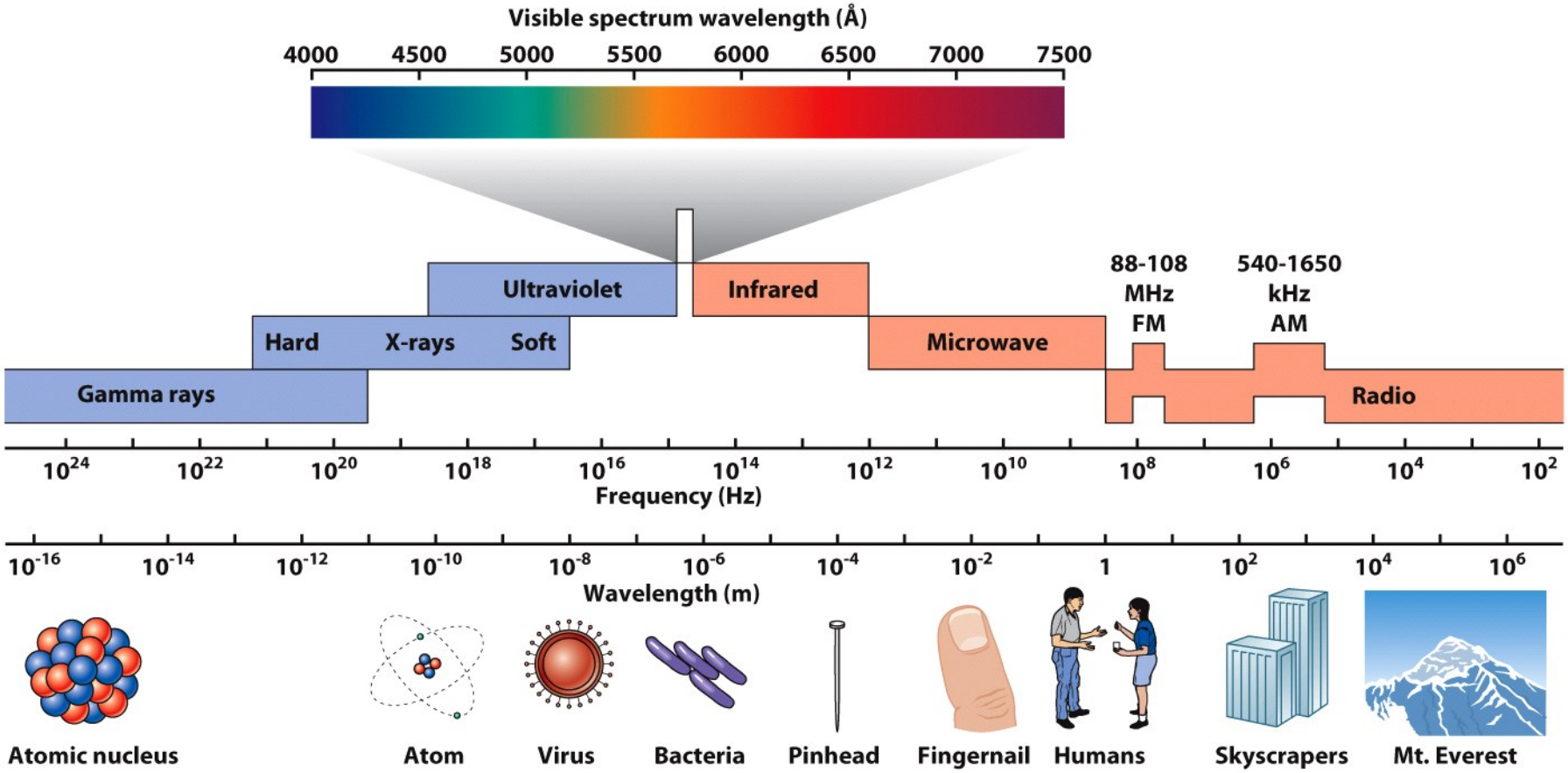
http://youtu.be/4cCk1MXJHm0

Evidence that everything is moving away from us

Refraction

The Electromagnetic Spectrum

The Electromagnetic Spectrum



Radio Waves and Microwaves

- Radio waves
  - Range: kilohertz to hundreds of megahertz
  - Longest waves
- Microwaves
  - Range: 1mm–1m

Example….Radio and TV transmissions are being emitted to space, so new episodes of the Big bang Theory are streaming out into the universe.

The nearest star is 9.5×10^{17} meters away. If there was civilized life on a planet near this star, how long would they have to wait for the next episode?

9.5×10^{17} m/ 3×10^{8} m/s = 3.17×10^{9} s

31,536 000 in an "ordinary" calendar year
31,622,400 in a "Leap" calendar year

3.17×10^{9} s / 3.1536×10^{7} s/year = 100 years

The Stealth Fighter

Stealth technology also termed LO technology (low observable technology) is a sub-discipline of military tactics and passive electronic countermeasures…

techniques used with personnel, aircraft, ships, submarines, and missiles, to make them less visible (ideally invisible) to radar, infrared,[2] sonar and other detection methods. It corresponds to camouflage for these parts of the electromagnetic spectrum.

http://science.howstuffworks.com/stealth-bomber.htm

Northrop Grumman's primary goal for the B-2 was **stealth**, or **low observability**.

Simply put, stealth is the ability to fly undetected through enemy airspace. Ideally, a stealth aircraft will be able to reach and destroy desired targets without ever engaging the enemy in combat.

To do this, the aircraft needs to be nearly invisible in a number of different ways. Obviously, it needs to blend in with the background visually, and it needs to be very quiet. More importantly, it needs to hide from enemy radar as well as **infrared sensors.**

It also needs to conceal its own electromagnetic energy.

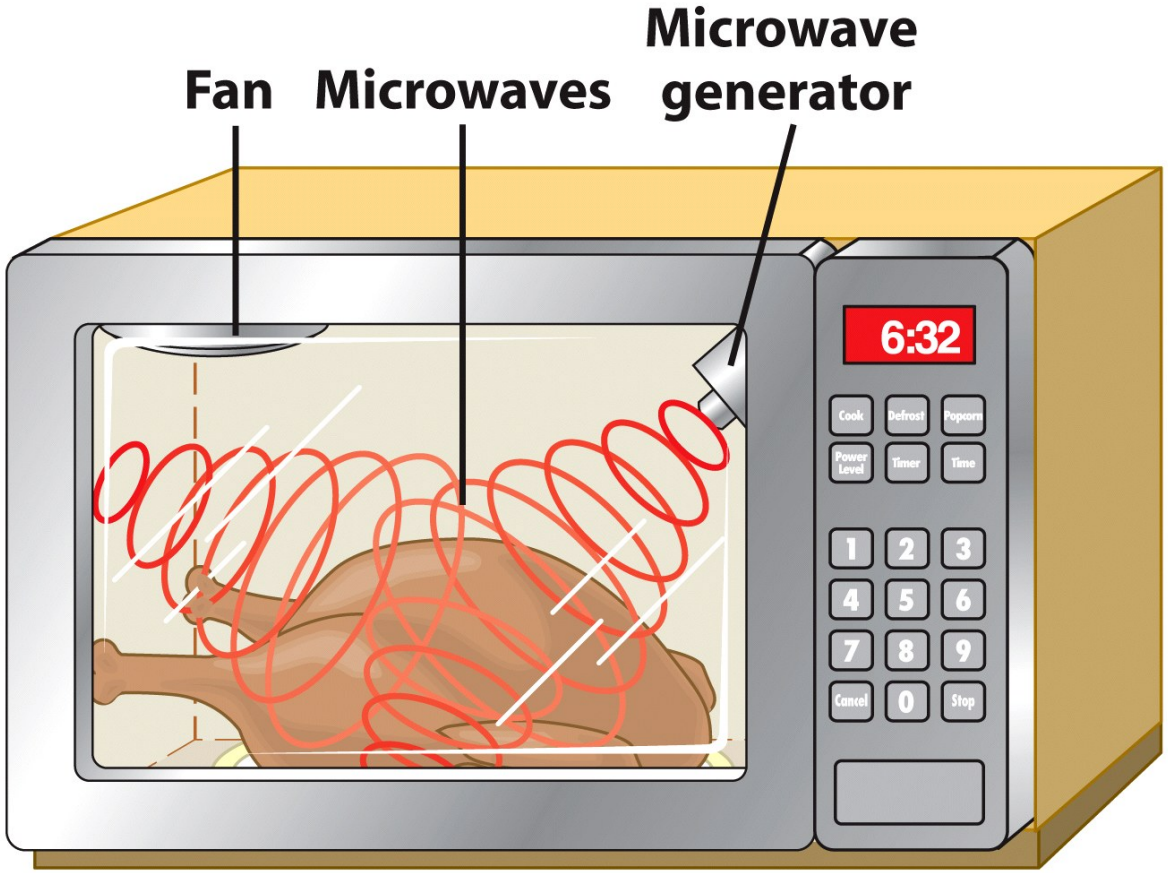
The B-2's flat, narrow shape and black coloration help it fade into the night. Even in the daytime, when the B-2 stands out against blue sky, it can be hard to figure out which way the plane is going The B-2 emits minimal exhaust, so it doesn't leave a visible trail behind it.
As with most planes, the B-2's noisiest component is its engine system. But unlike a passenger jet or B-52, the B-2's engines are buried inside the plane. This helps muffle the noise. The efficient aerodynamic design helps keep the B-2 quiet as well, because the engines can operate at lower power settings.

The engine system also works to minimize the plane's infrared (heat) signature. Infrared sensors, including those on
heat-seeking missiles, typically pick up on hot engine exhaust.

In the B-2, all of the exhaust passes through cooling vents before flowing out of the rear ports. Putting the exhaust ports on the top of the plane further reduces the infrared signature, since enemy sensors would most likely scan below the plane.

Technology

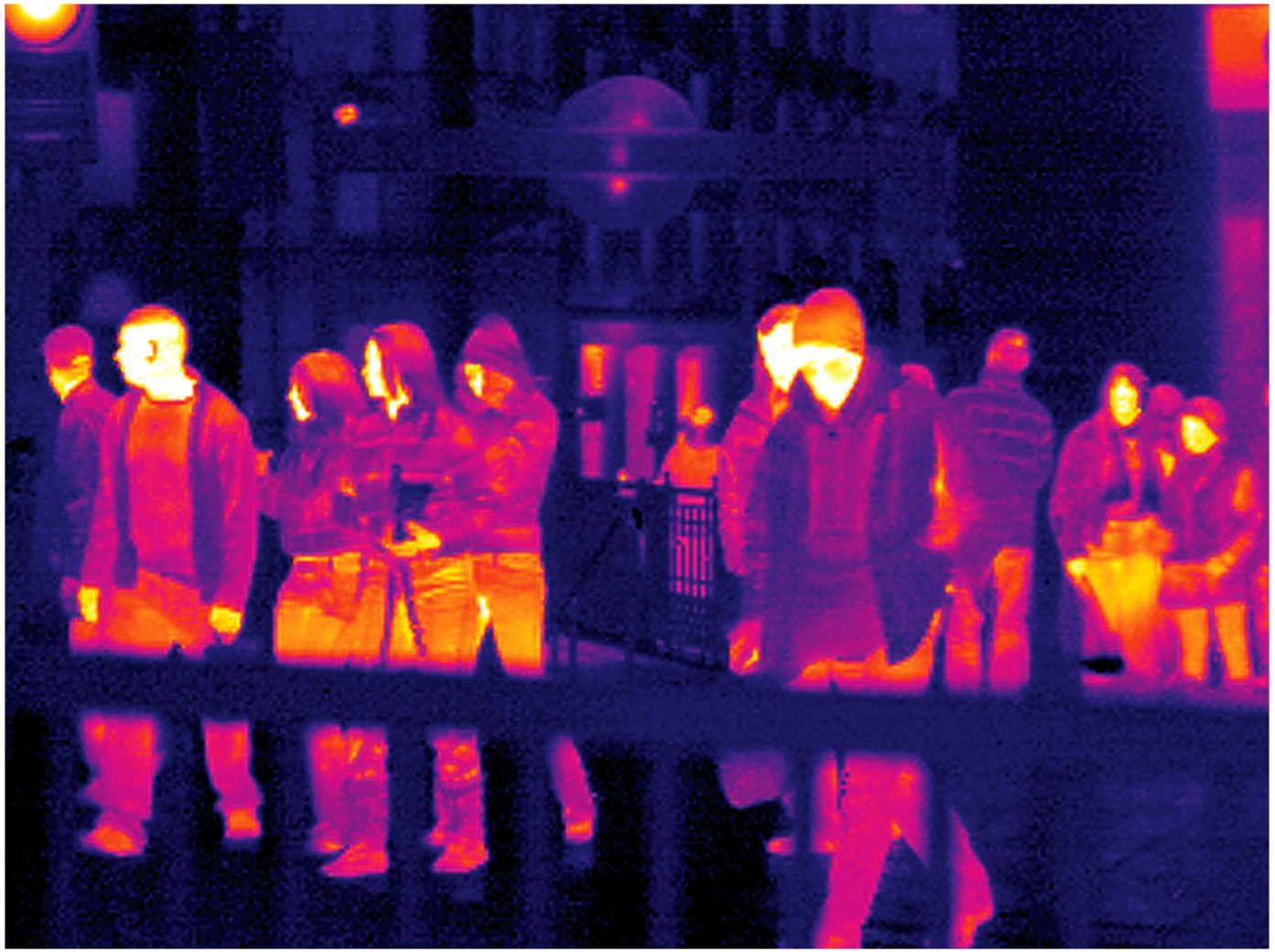
- Microwave ovens



Infrared Radiation

- Infrared radiation
  - Range: 1mm–1μ
- All warm objects emit radiation

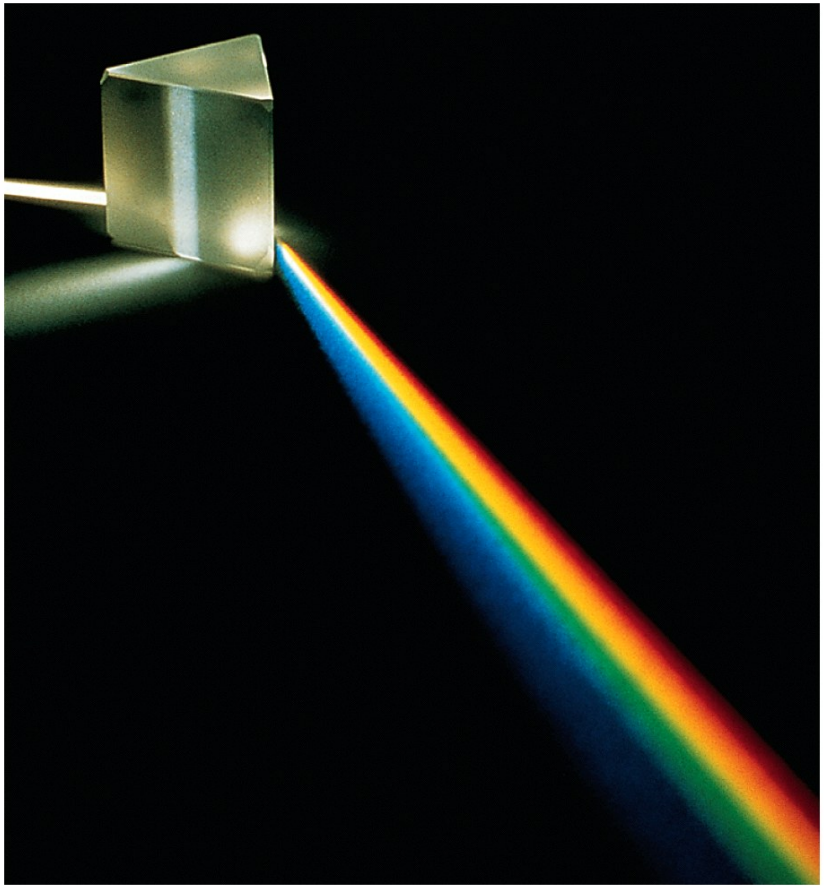
Heat Escaping from People

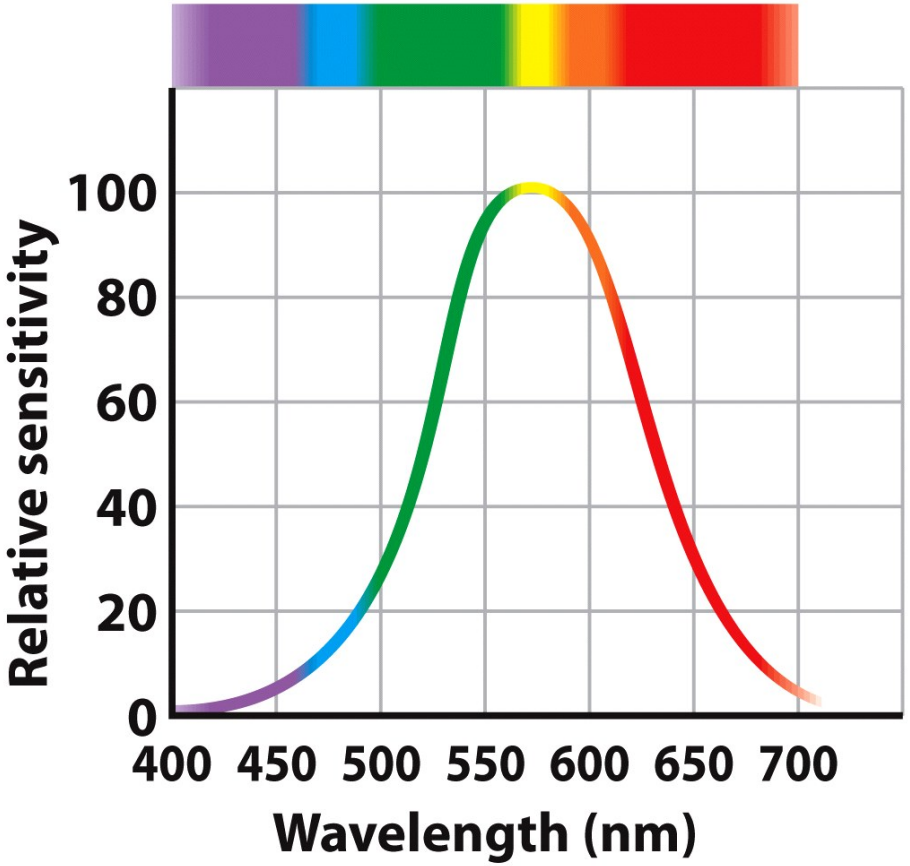


Visible Light

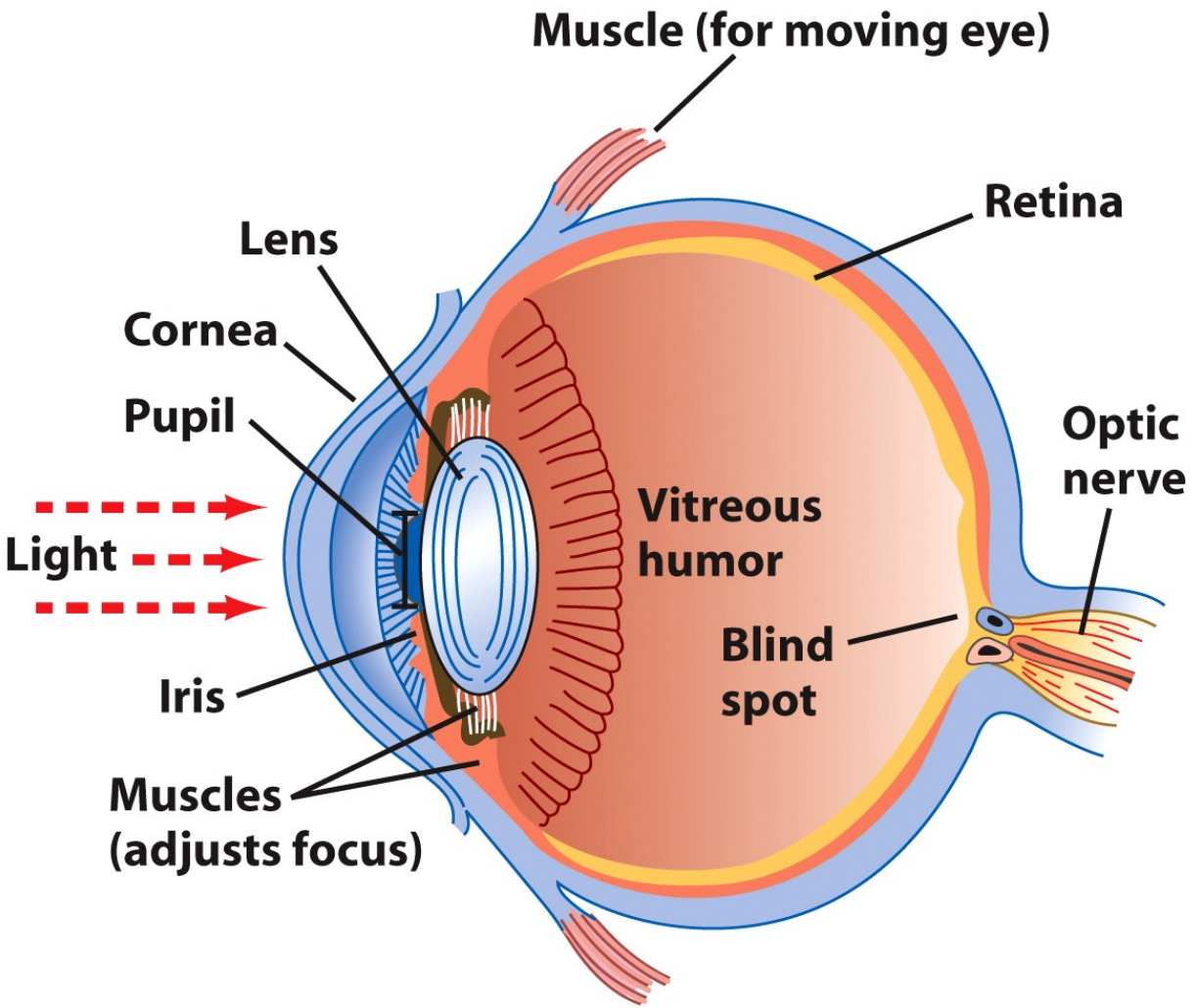
- Visible light
  - Range: 700nm–400nm
- Colors
  - Slices of electromagnetic spectrum

A Glass Prism Separating White Light





Path of Light through the Human Eye



Ultraviolet Radiation

- Ultraviolet radiation
  - Range: 400nm–100nm
  - Shorter wavelength=more energy
    - Damage to cells

- Fluorescence

Protect Skin with Sunblock

X-rays and Gamma Rays

- X-rays
  - Range: 100nm–0.1nm
  - High-frequency
  - Medicine
- Gamma Rays
  - Range: 0.1nm (10^{-10}m)–10^{-12}m
  - Highest frequency
  - Medicine
  - Astronomy

X-rays