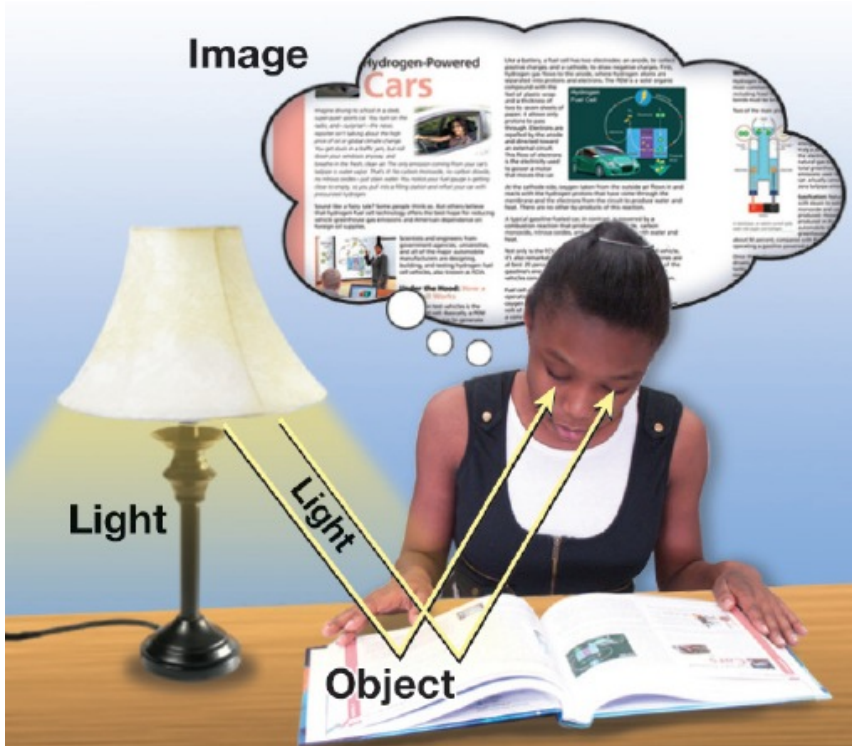
Chapter 14 Learning Goals

- Describe the properties of light.
- Explain the relationship between energy and the colors of light.
- Describe waves included in the electromagnetic spectrum in terms of energy, frequency, and wavelength.

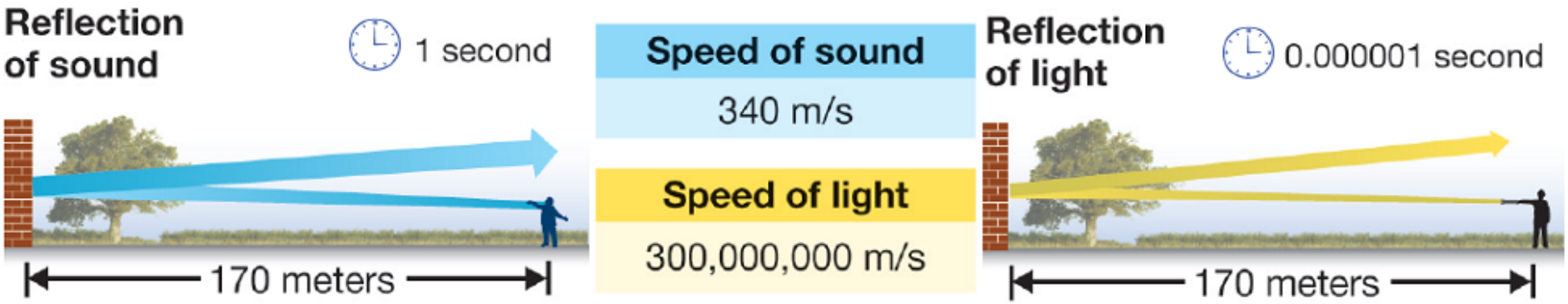
Properties of light

- You see book pages because light in the room reflects from the page to your eyes.
- Your eyes and brain use the information carried by the light to make a mental picture.



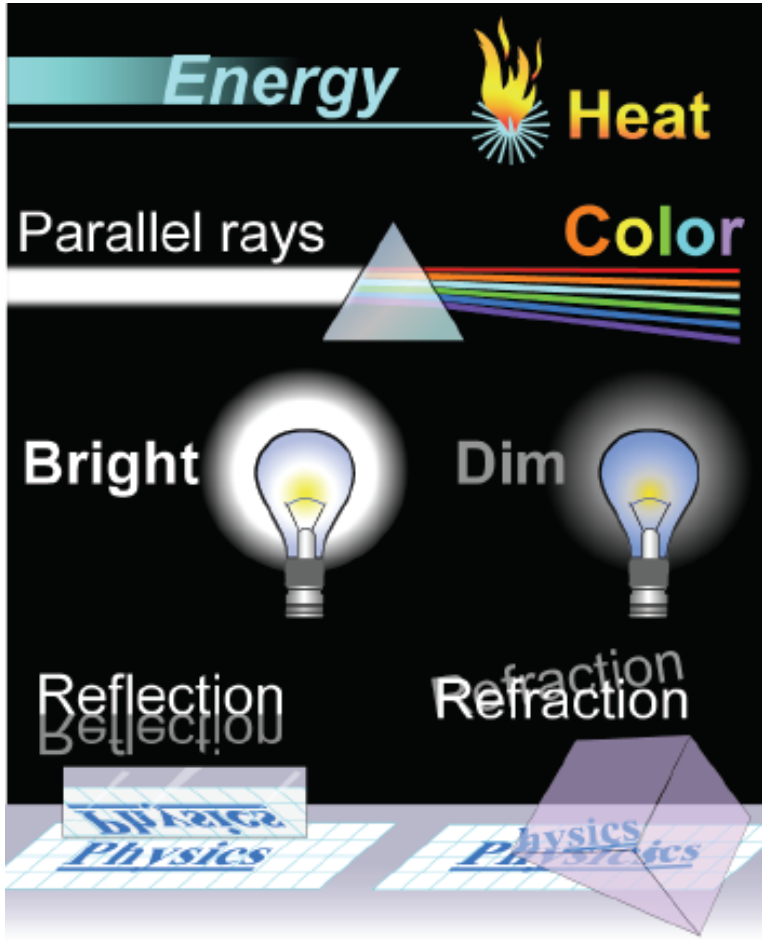
Properties of light

- Light is fast moving energy.
- The speed at which light travels through air is about 300 million meters per second.
- The *speed of light* is so important in physics that it is given its own symbol, a lower case "*c*".



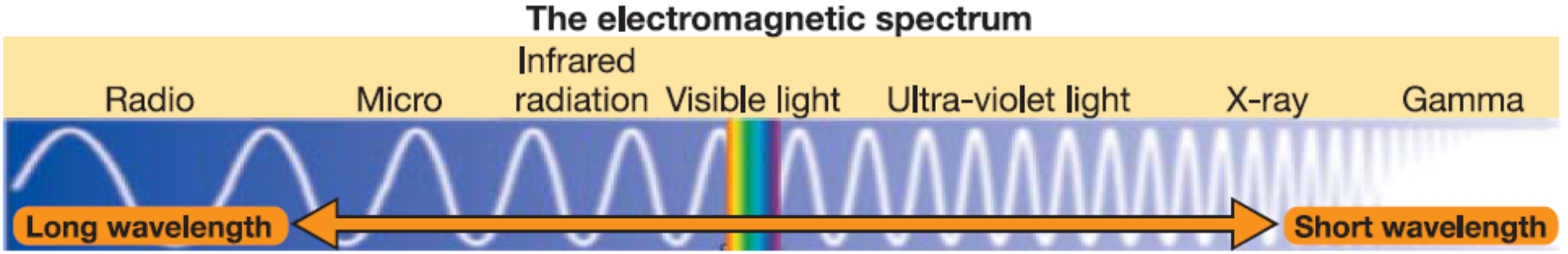
Properties of light

- **Light:**
  - ✓ travels extremely fast and over long distances;
  - ✓ carries energy and information;
  - ✓ has color;
  - ✓ varies in intensity, which means it can be bright or dim;
  - ✓ travels in straight lines; and
  - ✓ bounces and bends when it comes in contact with objects.



The electromagnetic spectrum

- **Light, like sound and heat, is a form of electromagnetic energy.**
- **The *visible light* we see is part of the *electromagnetic spectrum.***

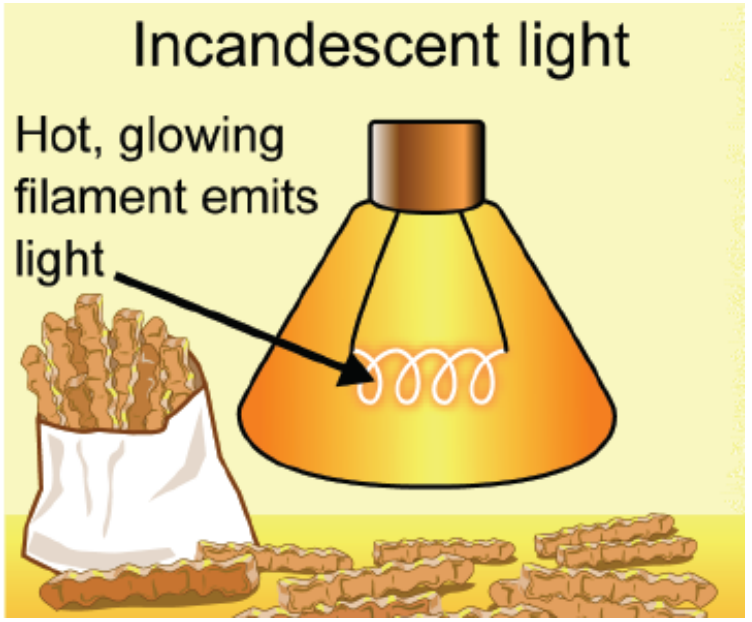


Light is produced by atoms

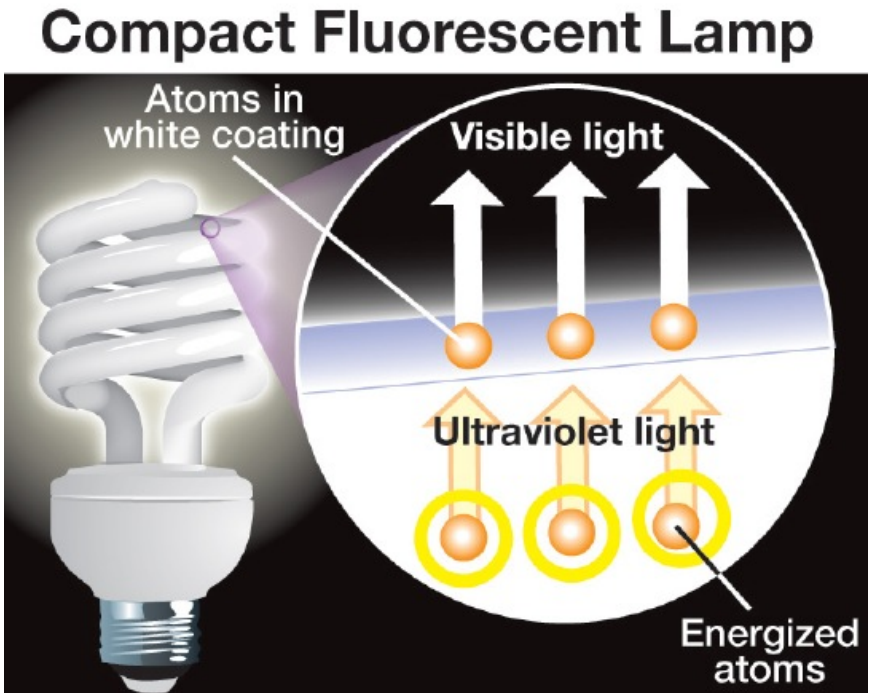
- Most light is produced by atoms.
- Atoms release light when they have extra energy.
- In order to get light *out* of an atom you must put some energy *into* the atom first.
- Adding heat is one way to give atoms extra energy.

Incandescent light

- **Making light with heat is called *incandescence.***
- **Atoms in the filament convert electrical energy to heat and then to light.**
- **Incandescent bulbs are inefficient, but their waste heat can be useful.**



Fluorescent light



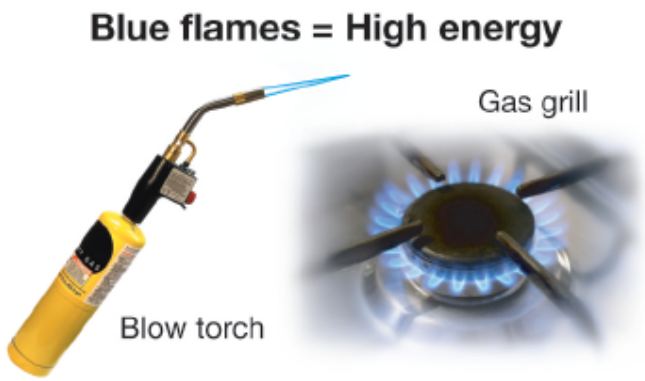
- To make light, fluorescent bulbs use high-voltage electricity to energize atoms of gas in the bulb.
- These atoms release the electrical energy directly as light (not heat), in a process called *fluorescence.*

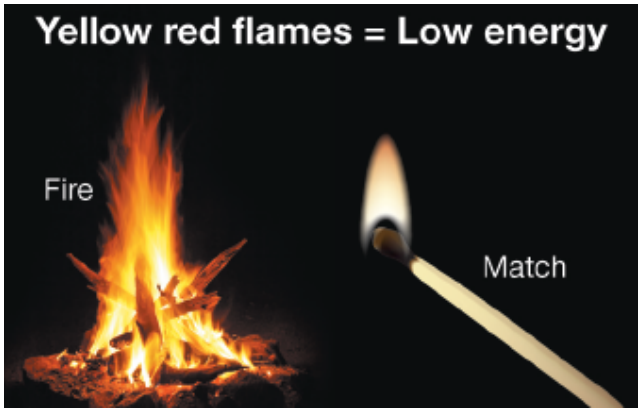
Color and energy

- *Color* is how we perceive the energy of light.
- When all the colors of the rainbow are combined, we see light without *any* color.
- We call the combination of all colors *white light.*

Color and energy

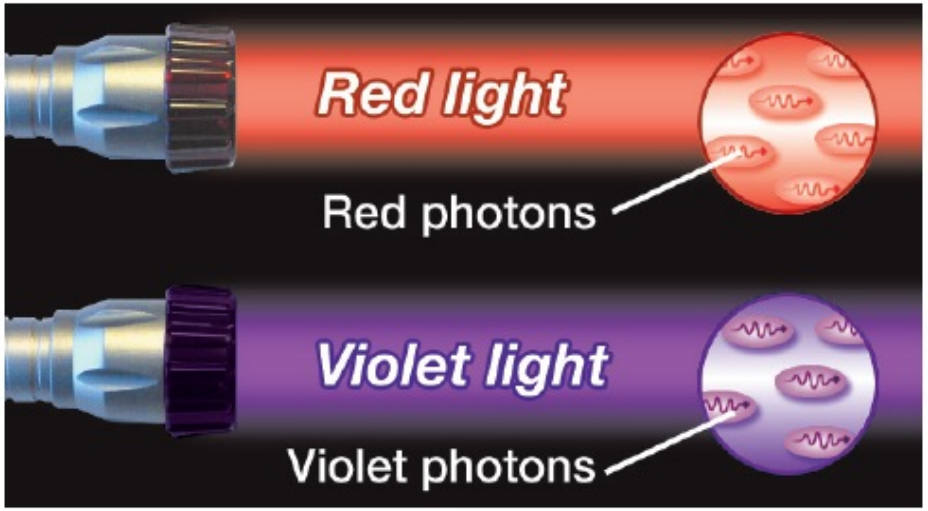
- Compare the hot, blue flame from a gas stove to the orange flame of a match.
- The light from a gas flame is blue (high energy) and the light from a match is red-orange (low energy).



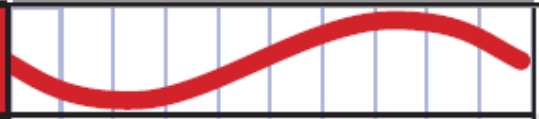
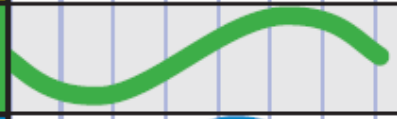


Photons and light

- Light energy comes in tiny wave bundles called *photons*.
- Each photon has its own energy.
- The energy of photons is seen as color.



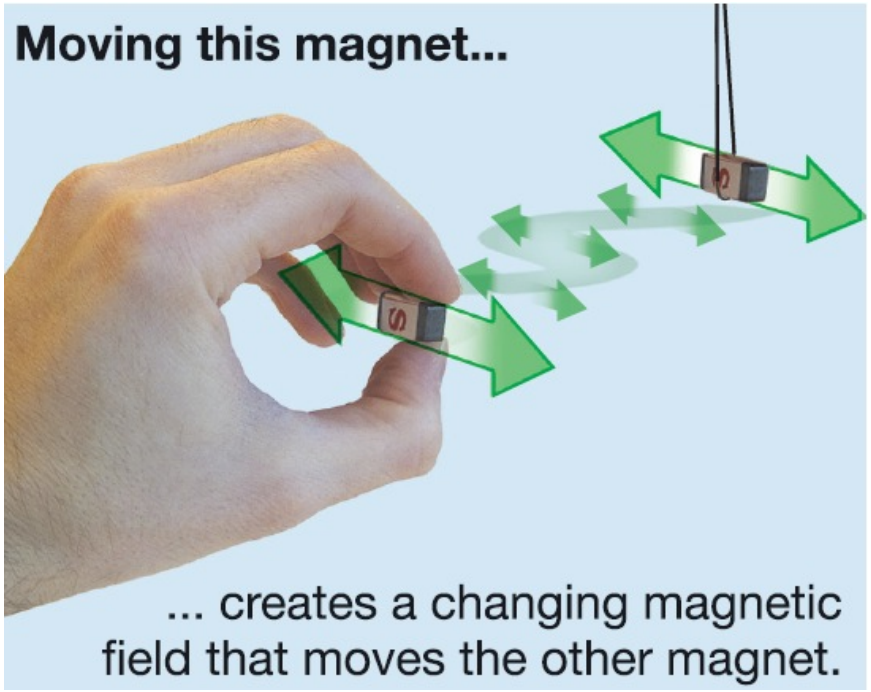
Wavelength and Frequency of Light

Energy	Color	1×10^{-6} m	Wavelength (nanometers)	Frequency (THz)
Low	Red		650	462
	Orange		600	500
	Yellow		580	517
	Green		530	566
	Blue		470	638
High	Violet		400	750

What kind of wave is light?

- A sound wave is a oscillation of air.
- A water wave is an oscillation of the surface of water.
- An oscillation of electricity or magnetism creates electromagnetic waves.

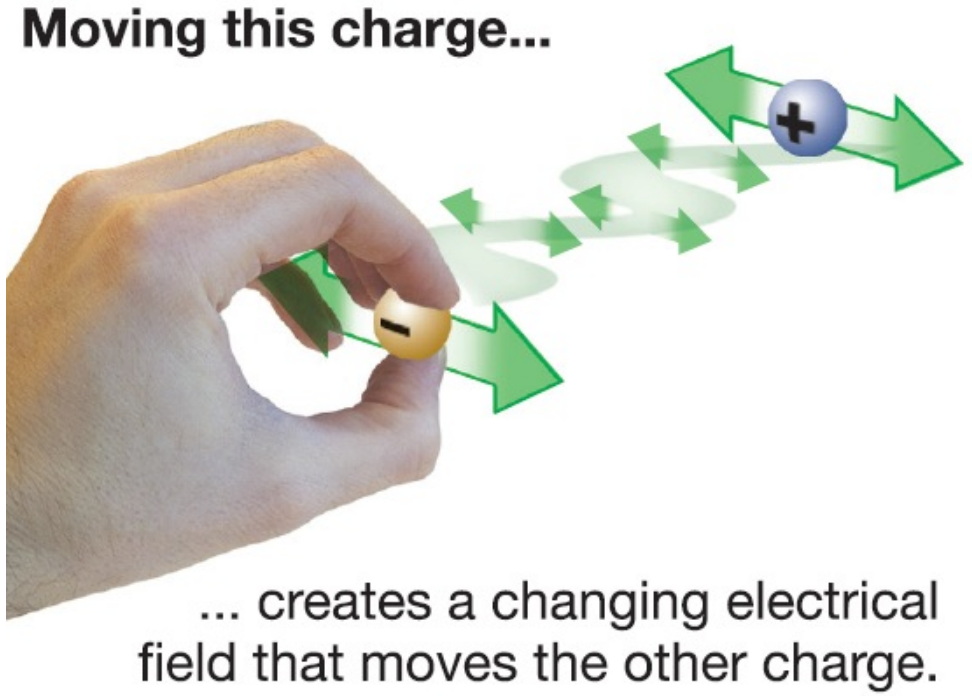
Electromagnetic waves



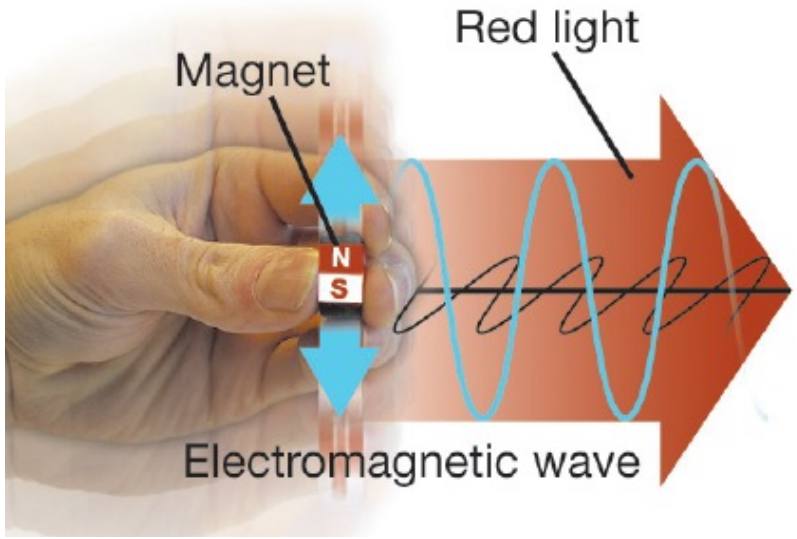
- When you move a magnet in your hand back and forth, you make a change in the magnetic field.
- The changing magnetic field causes the other magnet to move.

Electromagnetic waves

- In a similar way, the force between two electric charges is carried by an electric field.



Electromagnetic waves



- If you could shake the magnet up and down 100 million times per second, you would make FM radio waves at 100 million Hz (100 MHz).

Electromagnetic spectrum

- The entire range of electromagnetic waves, including all possible frequencies, is called the *electromagnetic spectrum.*
- This spectrum includes *visible light* and invisible waves:
  - radio wave
  - microwaves
  - infrared light
  - ultraviolet light
  - X-rays
  - gamma rays

Electromagnetic Spectrum