Light and Atomic Emission

Light

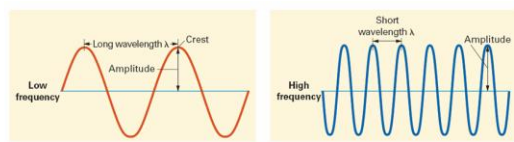
1. Behave like waves
2. Has particle-like characteristics

Properties of Waves

- The **amplitude** of a wave is the wave's height from zero to the crest.
- The **wavelength**, represented by λ (the Greek letter lambda), is the distance between the crests.
- The **frequency**, represented by ν (the Greek letter nu), is the number of wave cycles to pass a given point per unit of time.
- The SI unit of cycles per second is called a **hertz** (Hz).

How are the wavelength and frequency of light related?

- They are inversely proportional to each



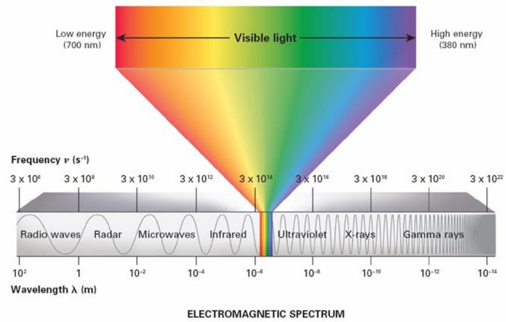
The product of the frequency and wavelength always equals a constant (c), the speed of light.

$$c = \lambda \nu$$

According to the wave model, light consists of electromagnetic waves.

- **Electromagnetic radiation** includes radio waves, microwaves, infrared waves, visible light, ultraviolet waves, X-rays, and gamma rays.
- All electromagnetic waves travel in a vacuum at a speed of 3.0×10^8 m/s.

The electromagnetic spectrum consists of radiation over a broad band of wavelengths.



Calculating the Wavelength of Light

Calculate the wavelength of the yellow light emitted by the sodium lamp shown above if the frequency of the radiation is 5.10×10^{14} Hz (5.10×10^{14}/s).

G: $\nu = 5.10 \times 10^{14}$ Hz
$c: 3.0 \times 10^{8}$ m/s

U: $\lambda = ?$

$c = \lambda\nu$ → $\frac{c}{\nu} = \frac{\lambda\nu}{\nu}$

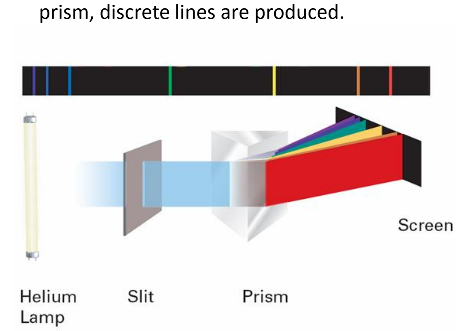
$\lambda = \frac{c}{\nu} = \frac{3.0 \times 10^{8} \text{ m/s}}{5.10 \times 10^{14} \text{ Hz}}$

$= 5.88 \times 10^{-7}$ m

Atomic Emission Spectra is caused…

–When atoms absorb energy, electrons move into higher energy levels. These electrons then lose energy by emitting light when they return to lower energy levels.

When light from a helium lamp passes through a prism, discrete lines are produced.



The frequencies of light emitted by an element separate into discrete lines to give the **atomic emission spectrum** of the element.

Mercury

Nitrogen

The light emitted by an electron moving from a higher to a lower energy level has a frequency directly proportional to the energy change of the electron.

E=hv

E is energy of a photon

h is Planck's constant (6.626×10^{-34} J·s)

Example

What is the energy of a photon with a frequency of 4.25 x 10^9 Hz?

G: $\nu = 4.25 \times 10^{9}$ Hz

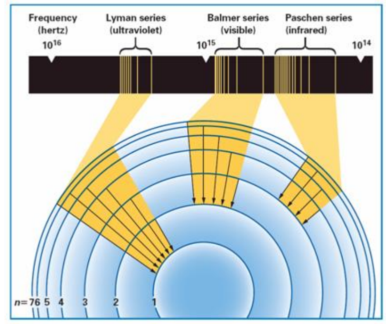
$h = 6.626 \times 10^{-34}$ J·s

U: $E = ?$

$E = h\nu = (6.626 \times 10^{-34}\ \text{J·s})(4.25 \times 10^{9}\ \text{Hz})$ ($\frac{1}{s}$)

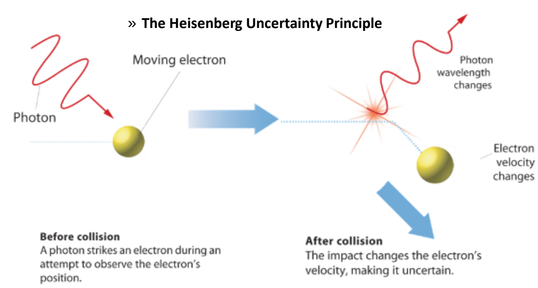
$= 2.82 \times 10^{-24}$ J

The three groups of lines in the hydrogen spectrum correspond to the transition of electrons from higher energy levels to lower energy levels.



The **Heisenberg uncertainty principle** states that it is impossible to know exactly both the velocity and the position of a particle at the same time.

Quantum Mechanics



5.3 Section Quiz.

1. Calculate the frequency of a radar wave with a wavelength of 125 mm.
   a. 2.40 10^9 Hz
   b. 2.40 10^{24} Hz
   c. 2.40 10^6 Hz
   d. 2.40 10^2 Hz

2. The lines in the emission spectrum for an element are caused by
   a. the movement of electrons from lower to higher energy levels.
   b. the movement of electrons from higher to lower energy levels.
   c. the electron configuration in the ground state.
   d. the electron configuration of an atom.

3. Spectral lines in a series become closer together as n increases because the

a. energy levels have similar values.
b. energy levels become farther apart.
c. atom is approaching ground state.
d. electrons are being emitted at a slower rate.