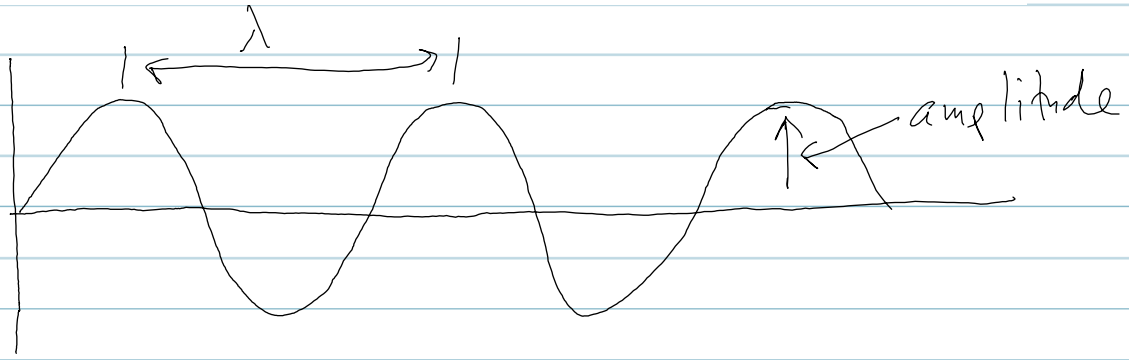
Chapter 7: The Quantum-Mechanical Model of the Atom

7.2 Properties of Waves:



1. Wavelength (λ - lambda) units: m

2. speed (u) units m/s

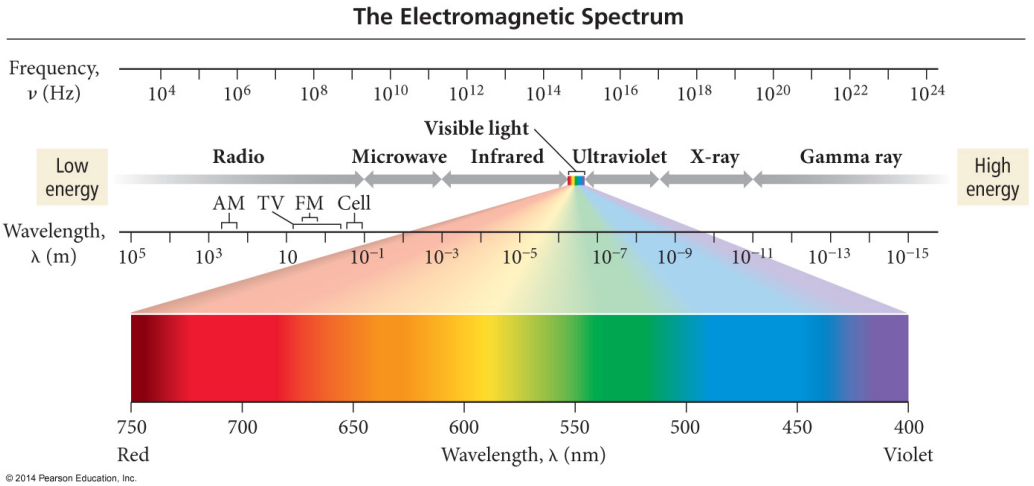
for electromagnetic radiation:
$u = 3.00 \times 10^8$ m/s (c - speed light)

3. frequency (ν - nu) units: s^{-1} or Hertz (Hz)

$u = \lambda \nu$ for electromagnetic radiation

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

4. Amplitude - intensity of waves



Electromagnetic Radiation

Radio waves
Microwaves

low freq.
long wavelength
low energy

IR
visible light
UV

X-rays
Gamma Rays

high freq.
short λ
high energy

$\lambda = 400\text{–}750$ nm

$1\text{ nm} = 10^{-9}$ m

$\lambda = 4 \times 10^{-7} \rightarrow 7.5 \times 10^{-7}$ m

Quantum Theory:

Three phenomena could not be explained by the laws of classical physics:

1) Blackbody radiation (glow of solids when hot)
2) The photoelectric effect.
3) Atomic spectra

- Max Planck: a substance can only emit certain amounts (quanta) of energy.
- The amount of energy emitted is proportional to the **frequency** of the light:

$$\Delta E = h\nu$$

h: Planck's constant

6.626×10^{-34} J·s

The Photoelectric Effect

- Photoelectric effect: Shining light on a metal surface can cause electrons to be ejected from the metal.
- The light must have a minimum *frequency*, called the **threshold frequency** (not a minimum *amplitude* as would have been predicted).
- **Einstein** explained the photoelectric effect by proposing that light travels in packets of energy known as **photons**.
  - ➢ Light has particle as well as wave nature.

$E_{photon} = h\nu = \frac{hc}{\lambda}$

The Photoelectric Effect