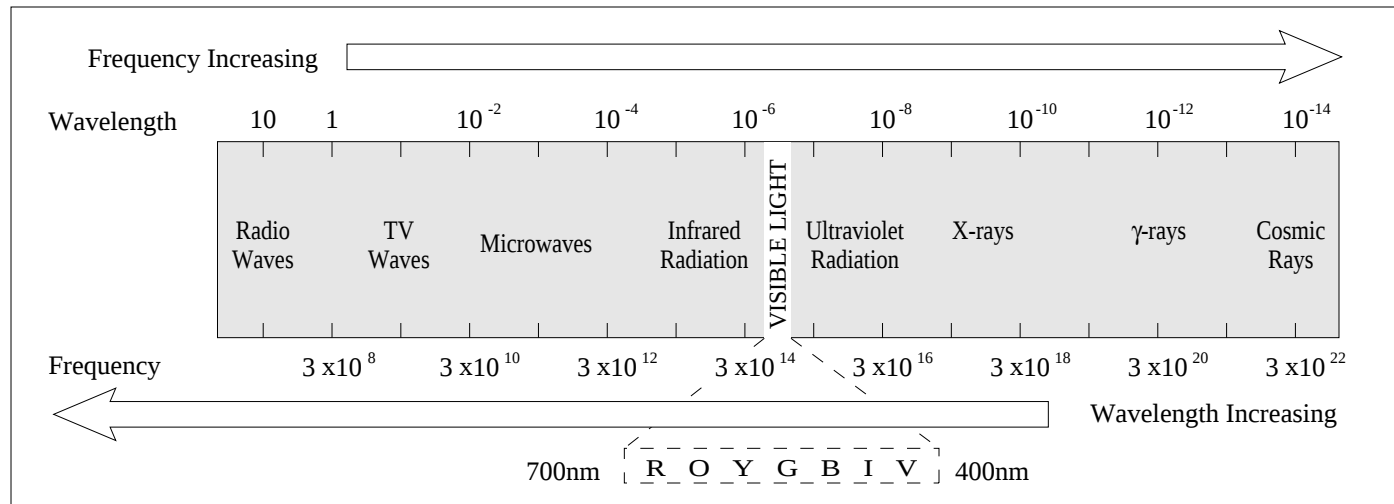




Fundamental Relation:  $c = \lambda \nu$

$c$  = speed of light =  $2.998 \times 10^8$  m/s

$\lambda$  = wavelength

$\nu$  = frequency

Plank's Equation:  $E = h\nu = \frac{hc}{\lambda}$

$E$  = energy

$h$  = Plank's constant =  $6.626 \times 10^{-34}$  J•s =  $4.14 \times 10^{-15}$  eV•s

(Know how to convert between Joules and electron volts.)

## Photoelectric effect:

In 1905, Einstein further solidified the idea of quantized energy packets. Basically, he showed that it took a certain specific amount of energy to kick an electron out of a metal and that energy could only come from a single photon. The photoelectric effect states that it takes a single photon of energy equal to or greater than the work function,  $\phi$ , to emit an electron. Any energy greater than  $\phi$  goes into the kinetic energy of the emitted electron.

$$E_{\text{kinetic}} = \frac{1}{2} m v^2 = \underbrace{h\nu}_{\text{photon energy}} - \underbrace{\phi}_{\text{work function}}$$

Diagram illustrating the photoelectric effect equation:

- $E_{\text{kinetic}}$  is labeled as Kinetic Energy of an emitted electron.
- $\frac{1}{2} m v^2$  is labeled as mass electron and velocity electron.
- $h\nu$  is labeled as photon energy.
- $\phi$  is labeled as work function.

## Student Packet: 1.1: Light and Energy: AssessMe questions

- 1) What is the wavelength of the radiation emitted from a mercury arc sunlamp if the frequency of the radiation is about  $1.2 \times 10^{15} \text{ sec}^{-1}$ ? ( $c = 3.0 \times 10^{10} \text{ cm/sec}$ )
- A)  $2.0 \times 10^{-5} \text{ cm}$   
B)  $4.0 \times 10^{-4} \text{ cm}$   
C)  $2.5 \times 10^{-6} \text{ cm}$   
D)  $2.5 \times 10^{-5} \text{ cm}$   
E) I'm clueless
- 2) The first line in the hydrogen spectrum is very difficult to see. It is the kind of light that causes skin cancer, and it has a dark purple color with a wavelength of 410.18 nm. Calculate the change in energy that produces this color.
- $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s/particle}$                        $c = 2.998 \times 10^8 \text{ m/s}$
- A)  $2.0 \times 10^{-19} \text{ J}$   
B)  $4.0 \times 10^{-14} \text{ J}$   
C)  $4.8 \times 10^{-19} \text{ J}$   
D)  $2.5 \times 10^{19} \text{ J}$   
E) I'm clueless
- 3) The microgram is a unit of
- A) mass                      B) energy                      C) acceleration                      D) length                      E) I'm clueless
- 4) The  $\text{g}\cdot\text{cm/s}^2$  is a unit of
- A) mass                      B) force                      C) acceleration                      D) length                      E) I'm clueless
- 5) Light is composed of
- A) neutrons                      B) quarks                      C) photons                      D) lumons                      E) I'm clueless
- 6) Electrons have a relative charge of
- A) 1                      B) 1/2                      C) -1                      D) -1/2                      E) I'm clueless

**Student Packet: 1.1: Light and Energy: ShowMe questions**

- 1) What is the energy of 1 photon with frequency  $5.09 \times 10^{14} \text{ s}^{-1}$ ? How much energy is contained in a mole of photons all with a wavelength of 2 cm?
  
  
  
  
  
  
  
  
  
  
- 2) How many photons of 8.0 nm wavelength are needed to equal the energy present in one photon of light with wavelength of 500 nm?
  
  
  
  
  
  
  
  
  
  
- 3) What is the kinetic energy of an electron with a wavelength of .22 nm?
  
  
  
  
  
  
  
  
  
  
- 4) The first ionization energy of phosphorous is 1060 kJ/mol. What is the lowest frequency of light that can be used to ionize phosphorous?

**Student Packet: 1.1: Light and Energy: TestMe questions**

- 1) An electron (mass =  $9.11 \times 10^{-31}$  kg) has a wavelength of 0.2 nm. How fast is it traveling?
- A)  $1.00 \times 10^6$  m/s  
B)  $2.83 \times 10^6$  m/s  
C)  $3.64 \times 10^7$  m/s  
D)  $8.31 \times 10^8$  m/s  
E)  $3.00 \times 10^8$  m/s
- 2) A laser emits light of frequency  $6.15 \times 10^{14} \text{ s}^{-1}$  in pulses with 0.01 J of energy per pulse. How many photons are in each pulse?
- A) 100                      B)  $2 \times 10^{13}$                       C)  $1.89 \times 10^{15}$                       D)  $2.45 \times 10^{16}$                       E)  $4.32 \times 10^{18}$
- 3) Order the following types of radiation in order of increasing wavelength: Radio waves, visible light, x-rays, infrared.
- A) IR, radio, visible, x-ray  
B) IR, visible, radio, x-ray  
C) x-ray, visible, IR, radio  
D) x-ray, IR, visible, radio  
E) radio, IR, visible, x-ray
- 4)  $\text{H}_2$  molecule has bond strength of 436 kJ/mol. What is the longest wavelength of light that can be used to break an H - H bond?
- A) 150 mm                      B) 275 mm                      C) 300 mm                      D) 350 mm                      E) 800 mm
- 5) Which of the following effects is an example of the photoelectric effect?
- A) Current through a tungsten wire causes it to glow.  
B) The sky is blue.  
C) The hydrogen spectrum is composed of distinct lines.  
D) Electrons are ejected from a metal when exposed to 500 nm light, but not with 700 nm light.  
E) Light from a laser is monochromatic.