

Useful Information:

$$h = 6.626 \times 10^{-34} \text{ J s} \quad 1\text{J} = 1 \text{ kg m}^2/\text{s}^2 \quad c = 3.00 \times 10^8 \text{ m/s} \quad 1 \text{ nm} = 10^{-9} \text{ m}$$

1. Calculate the frequency for a light wave at 576 nm. (2 pts)

$$c = \lambda \nu$$

$$576 \text{ nm} = 5.76 \times 10^{-7} \text{ m}$$

$$\nu = \frac{c}{\lambda} = \frac{3.0 \times 10^8 \text{ m/s}}{5.76 \times 10^{-7} \text{ m}} = 5.21 \times 10^{14} / \text{s}$$

2. List the following in order of increasing wavelength from left to right. (2 pts)

Gamma rays, microwaves, radio waves, ultraviolet radiation

Gamma rays < ultraviolet radiation < microwaves < radio waves

Increasing wavelength



3. Determine the energy in kJ of one mole of photons for ultraviolet radiation at a wavelength of 150 nm. (3 pts)

$$1 \text{ mol} = 6.02 \times 10^{23} \text{ photons}$$

$$E_{\text{photon}} = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ J s})(3.0 \times 10^8 \text{ m/s})}{(1.50 \times 10^{-7} \text{ m})} = 1.33 \times 10^{-18} \text{ J per photon}$$

$$\frac{1.33 \times 10^{-18} \text{ J}}{\text{photon}} \times \frac{6.02 \times 10^{23} \text{ photons}}{\text{mol}} \times \frac{\text{kJ}}{1000 \text{ J}} = 798 \text{ kJ per mol}$$

4. A sodium flame has a characteristic yellow color due to emissions of wavelength 589 nm. What is the mass equivalence (in kg) of a photon of this wavelength? (3 pts)

de Broglie wavelength $c = \text{the velocity of light or speed of light}$

$$\lambda = \frac{h}{mv}$$

$$m = \frac{h}{\lambda c} = \frac{6.626 \times 10^{-34} (\text{kg m}^2/\text{s}^2) \text{s}}{(5.89 \times 10^{-7} \text{ m})(3.00 \times 10^8 \text{ m/s})} = 3.75 \times 10^{-36} \text{ kg}$$