Useful information: \( c = 3.00 \times 10^8 \text{ m/s} \) \( h = 6.626 \times 10^{-34} \text{ J s} \) \( R_n = 2.179 \times 10^{18} \text{ J} \) \( R = 1.0967 \times 10^7 \text{ m}^{-1} \)

1. What is the frequency (in Hz) of light having a wavelength of 566 nm? (2 pts)

   \[
   v = \frac{c}{\lambda} = \frac{3.0 \times 10^8 \text{ m/s}}{566 \times 10^{-9} \text{ m}} = 5.30 \times 10^{14} \text{ s}^{-1}
   \]

2. A photon has a wavelength of 705 nm. Calculate the energy of the photon in joules. (2 pts)

   \[
   E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ J s})(3.0 \times 10^8 \text{ m/s})}{705 \times 10^{-9} \text{ m}} = 2.82 \times 10^{-19} \text{ J}
   \]

3. What is the wavelength (in nm) of the photon needed to excite an electron in a hydrogen atom from \( n_1 \) to \( n_2 \)? Is the light energy absorbed or emitted by the atom? (3 pts)

   Rydberg Equation

   \[
   \frac{1}{\lambda} = R \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)
   \]

   Light energy is absorbed.

   \[
   \frac{1}{\lambda} = 1.0967 \times 10^7 \text{ m}^{-1} \left( \frac{1}{1^2} - \frac{1}{4^2} \right) = 10281562.5 \text{ m}^{-1}
   \]

   \[
   \lambda = 9.73 \times 10^8 \text{ m} = 97.3 \text{ nm}
   \]

4. What is the de Broglie wavelength (in cm) of a 12.4 g hummingbird flying at 1.20 \times 10^2 \text{ mph}? (3 pts)

   (1 mi = 1.61 km)

   \[
   \text{de Broglie Wavelength}
   \]

   \[
   \lambda = \frac{h}{mv}
   \]

   \[
   \text{velocity} = 1.20 \times 10^2 \frac{\text{mi}}{\text{hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ s}} \times \frac{1.61 \text{ km}}{1 \text{ mi}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 53.7 \text{ m/s}
   \]

   \[
   \lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34} \text{ J s}}{(12.4 \times 10^{-3} \text{ Kg})(53.7 \frac{\text{m}}{\text{s}})} = 9.95 \times 10^{-34} \text{ m} = 9.95 \times 10^{-32} \text{ cm}
   \]