Answers to Exercise 3.1
Calculating Frequency, Wavelength and Energy of Light

<u>Always</u> check your work when you finish a calculation!
Is the answer reasonable? Check sig. fig.

1. $\boldsymbol{c = \nu\lambda}$

$$\boldsymbol{\nu = \frac{c}{\lambda} = \frac{2.997925\times10^{8}\frac{m}{s}}{365nm}\times\frac{10^{9}nm}{1m}\times\frac{1Hz}{1\frac{1}{s}} = 8.21\times10^{14}Hz}$$

2. $\boldsymbol{E_{photon} = h\nu}$

$$\boldsymbol{E_{photon} = \left(6.626070\times10^{-34}\frac{J}{Hz}\right)(2.4\times10^{16}Hz) = 1.6\times10^{-17}J}$$

3. $\boldsymbol{E_{photon} = h\nu}$ *and* $\boldsymbol{c = \nu\lambda}$

$$\boldsymbol{E_{photon} = \frac{hc}{\lambda} = \frac{\left(6.626070\times10^{-34}\frac{J}{Hz}\right)\left(2.997925\times10^{8}\frac{m}{s}\right)}{12\mu m}\times\frac{1Hz}{1\frac{1}{s}}\times\frac{10^{6}\mu m}{1m} = 1.7\times10^{-20}J}$$

4. **Step 1: Convert energy of photon into SI units**

$$\boldsymbol{E = 17.1400eV\times\frac{1.60217565\times10^{-19}J}{1eV} = 2.74613\times10^{-18}J}$$

Step 2: Calculate frequency from energy

$$\boldsymbol{E = h\nu}$$

$$\boldsymbol{\nu = \frac{E}{h} = \frac{2.74613\times10^{-18}J}{6.626070\times10^{-34}\frac{J}{Hz}} = 4.14443\times10^{15}Hz}$$

Step 3: Calculate wavelength from frequency

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

$$\boldsymbol{\lambda = \frac{c}{\nu} = \frac{2.997925\times10^{8}\frac{m}{s}}{4.14443\times10^{15}Hz}\times\frac{1Hz}{1\frac{1}{s}} = 7.23362\times10^{-8}m}$$

$$\boldsymbol{\lambda = \frac{c}{\nu} = 7.23362\times10^{-8}m\times\frac{10^{9}nm}{1m} = 72.3362nm}$$

5. **Step 1: Calculate the energy of <u>one</u> photon of blue light (λ = 475 nm)**

$\boldsymbol{E_{photon} = h\nu}$ *and* $\boldsymbol{c = \nu\lambda}$

$$\boldsymbol{E_{photon} = \frac{hc}{\lambda} = \frac{\left(6.626070\times10^{-34}\frac{J}{Hz}\right)\left(2.997925\times10^{8}\frac{m}{s}\right)}{475nm}\times\frac{1Hz}{1\frac{1}{s}}\times\frac{10^{9}nm}{1m} = 4.18\times10^{-19}J}$$

Step 2: Calculate the number of photons in the light beam

$$E_{total} = E_{photon}\times\#photons$$

$$\#photons = \frac{E_{total}}{E_{photon}} = \frac{2.50\times10^{-16}J}{4.18\times10^{-19}\frac{J}{photon}} = 598\ photons$$