Chem 130, Eppley

KEY

In Class 4: The Electromagnetic Spectrum, Units, Scientific Notation

1. a. Put the following types of electromagnetic radiation in order from the highest frequency to the lowest (4 pt):

2 Yellow light from a sodium lamp
1 Gamma rays coming from deep outer space
4 Radiowaves from a nuclear magnetic resonance (NMR) spectrometer operating at 270 MHz (that is ours!)
3 The infrared (IR) radiation associated with a C=O bond stretch

(should know the general electromagnetic spectrum)

b. Calculate the wavelength of the photons from the NMR in nm.

$$270\ \text{MHz} \times \frac{1\times10^{6}\ \text{Hz}}{1\ \text{MHz}} = 2.70\times10^{8}\ \text{Hz} = 2.70\times10^{8}\ \text{s}^{-1}$$

$$\frac{2.998\times10^{8}\ \text{m}}{\text{s}} \div \frac{2.70\times10^{8}}{\text{s}} = 1.11\ \text{m} \times \frac{1\times10^{9}\ \text{nm}}{1\ \text{m}} = \boxed{1.11\times10^{9}\ \text{nm}}$$

c. Calculate the energy of one of these photons.

$$E = \frac{hc}{\lambda} = 6.626\times10^{-34}\ \text{J}\cdot\text{s} \times \frac{2.998\times10^{8}\ \text{m}}{\text{s}} \times \frac{1}{1.11\ \text{m}}$$

$$= \boxed{1.79\times10^{-25}\ \text{J}}$$

2. The energy required to break a C-C bond in a molecule is 348 kJ/mol. What wavelength of light (in nm) would be required to carry out this chemical process using only light as the energy source? (8 pt)

$$\frac{348\ \text{kJ}}{\text{mol}} \times \frac{1\ \text{mol}}{6.022\times10^{23}\ \text{photons}} \times \frac{1000\ \text{J}}{1\ \text{kJ}} = 5.78\times10^{-19}\ \text{J}$$

$$\lambda = \frac{hc}{E} = \frac{(6.626\times10^{-34}\ \text{J}\cdot\text{s})(2.998\times10^{8}\ \text{m/s})}{5.78\times10^{-19}\ \text{J}}$$

$$= 3.44\times10^{-7}\ \text{m} \times \frac{1\times10^{9}\ \text{nm}}{1\ \text{m}} = \boxed{343\ \text{nm}}$$