Planck's Equation
Chem Worksheet 5-2

Name _____

Max Planck theorized that energy was transferred in chunks known as **quanta**, equal to *hν*. The variable *h* is a constant equal to 6.63×10^{-34} J·s and the variable *ν* represents the frequency in 1/s. This equation allows us to calculate the energy of photons, given their frequency. If the wavelength is given, the energy can be determined by first using the wave equation ($c = \lambda \times \nu$) to find the frequency, then using Planck's equation to calculate energy.

useful equations	
$c = \lambda \times \nu$	$c = 3.00 \times 10^{8}$ m/s
$E = h \times \upsilon$	$h = 6.63 \times 10^{-34}$ J·s
$1\ m = 1 \times 10^{9}\ nm$	1 kJ = 1000 J

Problem-Solving Strategy

Known				**Unknown**
Frequency (ν)		$E = h\nu$		Energy (E)
Wavelength (λ)	$\nu = \frac{c}{\lambda}$	Frequency (ν)	$E = h\nu$	Energy (E)
Energy (E)	$\nu = \frac{E}{h}$	Frequency (ν)	$\nu = \frac{c}{\lambda}$	Wavelength (λ)

example

Light with a wavelength of 525 nm is green. Calculate the energy in joules for a green light photon.

- find the frequency: $c = \lambda \times \upsilon$ $\quad \upsilon = \frac{c}{\lambda}$ $\quad \upsilon = \frac{3.00 \times 10^{8}\ m/s}{525\ nm \times \frac{1\ m}{1 \times 10^{9}\ nm}}$ $\quad \upsilon = 5.71 \times 10^{14} 1/s$

- find the energy: $E = h \times \upsilon$ $\quad E = (6.626 \times 10^{-34}\ J \cdot s)(5.71 \times 10^{14} 1/s)$ $\quad E = 3.78 \times 10^{-19}\ J\ /\ photon$

Use the equations above to answer the following questions.

1. Ultraviolet radiation has a frequency of 6.8×10^{15} 1/s. Calculate the energy, in joules, of the photon.
2. Find the energy, in joules per photon, of microwave radiation with a frequency of 7.91×10^{10} 1/s.
3. A sodium vapor lamp emits light photons with a wavelength of 5.89×10^{-7} m. What is the energy of these photons?
4. One of the electron transitions in a hydrogen atom produces infrared light with a wavelength of 7.464×10^{-6} m. What amount of energy causes this transition?
5. Find the energy in kJ for an x-ray photon with a frequency of 2.4×10^{18} 1/s.
6. A ruby laser produces red light that has a wavelength of 500 nm. Calculate its energy in joules.
7. What is the frequency of UV light that has an energy of 2.39×10^{-18} J?
8. What is the wavelength and frequency of photons with an energy of 1.4×10^{-21} J?