Planck's Equation

Chem Worksheet 5-2

Name _____

Max Planck discovered that energy was transferred in discrete forms in as **quanta** equal to $h\nu$. The variable h is a constant equal to 6.63×10^{-34} J·s and the variable ν represents the frequency in s^{-1}. 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
$E = h \times \nu$	$h = 6.63 \times 10^{-34}$ J·s
1 Å = 1×10^{-10} m	1 eV = 1600 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)	$\lambda = \frac{c}{\nu}$	Wavelength (λ)

example:

Light with a wavelength of 1000 nm is given. Calculate the energy in joules for a given light photon.

find the frequency:	$\nu = c / \lambda$	$\nu = \frac{c}{\lambda}$	$\nu = \frac{3.00 \times 10^{8}\ m/s}{1000\ nm \times \frac{1\ m}{1 \times 10^{9}\ nm}}$	$\nu = 3.0 \times 10^{14}\ s^{-1}$
find the energy:	$E = h \times \nu$	$E = 6.63 \times 10^{-34}\ J \cdot s \times 3.0 \times 10^{14}\ s^{-1}$		$E = 2.0 \times 10^{-19}$ J / photon

Use the equations above to answer the following questions.

1. A blue-violet radiation has a frequency of 6.8×10^{14} s^{-1}. Calculate the energy, in joules, of the photons.
2. Find the energy, in joules per photon, of microwave radiation with a frequency of 7.90×10^{10} s^{-1}.
3. A uniform super lamp emits light photons with a wavelength of 5.00×10^{-7} m. What is the energy of these photons?
4. One of the photons transitions in a hydrogen atom produces infrared light with a wavelength of 7.4×10^{-7} 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} s^{-1}.
6. A ruby laser produces red light that has a wavelength of 694 nm. Calculate its energy in joules.
7. What is the frequency of UV light that has an energy of 2.04×10^{-18} J?
8. What is the wavelength and frequency of photons with an energy of 1.4×10^{-19} J?

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