

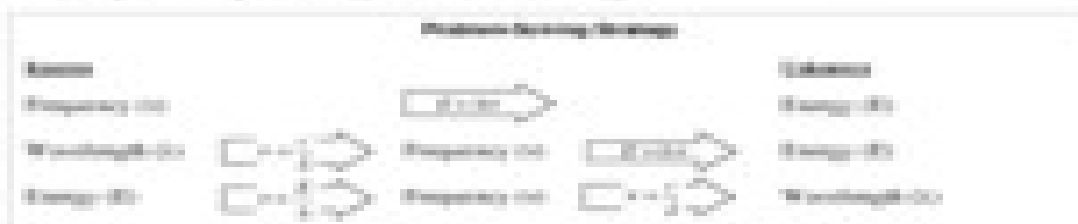
# Planck's Equation

## Chem Worksheet 5-2

Name \_\_\_\_\_

Max Planck showed that energy was transferred in discrete amounts called quanta, equal to  $h\nu$ . The variable  $h$  is a constant equal to  $6.63 \times 10^{-34}$  J·s and the variable  $\nu$  represents the frequency in Hz. 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  $c = \lambda\nu$  to calculate the frequency. Then using Planck's equation to calculate energy.

Unit Conversions	
1 m = 100 cm	1 cm = $1.00 \times 10^{-2}$ m
1 nm = $10^{-9}$ m	1 m = $1.00 \times 10^9$ nm
1 $\mu\text{m} = 1 \times 10^{-6}$ m	1 nm = $1.00 \times 10^{-9}$ m



**Example**

Light with a wavelength of 450 nm is given. Calculate the energy in joules of a given light photon.

- Given frequency:  $\nu = 6.67 \times 10^{14}$  Hz  
 - Wanted energy:  $E = 4.42 \times 10^{-19}$  J

$$\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \text{ m/s}}{450 \times 10^{-9} \text{ m}} = 6.67 \times 10^{14} \text{ Hz}$$

$$E = h\nu = (6.63 \times 10^{-34} \text{ J}\cdot\text{s}) (6.67 \times 10^{14} \text{ Hz}) = 4.42 \times 10^{-19} \text{ J per photon}$$

Use the equations above to answer the following questions.

- Electromagnetic radiation has a frequency of  $6.63 \times 10^{14}$  Hz. Calculate the energy, in joules, of the photon.
- Find the energy, in joules, per photon, of electromagnetic radiation with a frequency of  $1.00 \times 10^{15}$  Hz.
- A certain type of long-wavelength light photons with a wavelength of  $1.00 \times 10^7$  m. What is the energy of these photons?
- One of the photons responsible for ultraviolet tanning produces ultraviolet light with a wavelength of  $1.40 \times 10^7$  m. What amount of energy does the photon have?
- Find the energy in joules of a ray photon with a frequency of  $3.4 \times 10^{14}$  Hz.
- A red laser produces red light that has a wavelength of 700 nm. Calculate the energy in joules.
- What is the frequency of UV light that has an energy of  $2.00 \times 10^{-18}$  J?
- What is the wavelength and frequency of photons with an energy of  $1.4 \times 10^{-18}$  J?