

How to Figure the Energy of One Mole of a Photon

Light is a unique form of energy in that it displays properties of both particles and waves. The fundamental unit of light that has this “wave-particle” duality is called a photon. More specifically, photons are wave packets that contain a certain wavelength and frequency according to the type of light. Both wavelength and frequency affect the energy of a photon.

Therefore, you can calculate the energy of one mole of photons from either the light's wavelength or frequency.

1. Identify Wavelength in Meters

Identify the wavelength or frequency of the beam of light. You normally state wavelength in nanometers (nm) and convert it to meters for energy calculation purposes. Note that it is easy to convert between frequency and wavelength using the equation, the speed of light, c , equals the frequency times the wavelength. For example, assume light has a given wavelength of 500 nm; convert this measurement to meters by multiplying by 10^{-9} .

Thus, 500 nm is equal to 5.0×10^{-7} m.

2. Calculate Photon Energy

Substitute this value into the equation for the energy of photon. The energy of a photon is equal to the product of the speed of light, or 3.0×10^8 m/s, and Planck's constant, identified as 6.63×10^{-34} , divided by the wavelength. Therefore, using the example problem the energy of a photon would be equal to 3.9×10^{-19} Joules.

3. Multiply by Avogadro's Number

Multiply the photon energy value by Avogadro's number to find the energy of one mole of photons. Avogadro's number is the quantity of the number of molecules or particles in one mole of a particular substance and is equal to 6.02×10^{23} . Therefore, the value calculated in the previous step is the energy of one particle; multiply it by Avogadro's number to determine the energy of one mole.