Name: _____ Date: _____

m_r^{β} **Physics Practice: Photons**

We can hear because our ears react to a range of frequencies of pressure waves in the air. We refer to waves in that range of frequencies as *audible sound.* We can see because our eyes can react to a range of frequencies of electromagnetic radiation (EMR), which we refer to as *light.* Einstein demonstrated that a particle (later called a *photon*) is associated with EMR, and we say that the photon acts as the force carrier for electromagnetic force.

   Radio, infrared, ultraviolet, x-rays, and gamma-rays have frequencies our eyes cannot detect. Like pressure waves in air, EMR has a frequency ν (nu), wavelength λ (lambda), and speed. The speed of EMR is $c = 299{,}792{,}458$ m/s. These quantities are related by $c = \lambda\nu$.

1. Find the frequency ν of EMR in a vacuum for a given λ.

2. Find the wavelength of EMR in a vacuum for a given frequency ν.

3. Visible red light has wavelengths in the range 620 to 750 nanometers. What is the range of frequencies of visible red light?

4. SETI (the Search for Extraterrestrial Intelligence) listens to radio waves that have frequencies in the range of 1 GHz to 10 GHz. What is the range of wavelengths they are looking for?

5. A photon's energy varies directly with its frequency. The constant of direct variation h is Planck's constant h, so $E = h\nu$.

a. What is the value of Planck's constant?

b. Express E in terms of wavelength, rather than frequency.

c. Microwave ovens have a *magnetron*, which emits EMR with a wavelength of 12.2cm. What is the energy of a microwave oven photon?

d. It requires 4.186J to warm a gram of water 1°C. Assuming perfect efficiency, how many microwave oven photons are needed to warm a liter of water from near freezing (0°C) to near boiling (100°C)?