Chemistry Practice: "Frequency, Wavelength and Energy"

Directions: Solve the following problems. Show all work done in arriving at your answer. Give the correct units and significant figures in your answers.

\[ E = h \cdot \nu \quad \nu = \frac{c}{\lambda} \quad c = 3.00 \times 10^8 \text{ m/s} \quad h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s} \]

I. A photon of visible light has a wavelength of 520 nm.

1. Find the wavelength in meters

2. Find the frequency.

3. Find the energy of a photon of this light.

II. A photon of x-ray radiation has an energy of \(6.63 \times 10^{-17}\) J.

4. Find the frequency.

5. Find the wavelength in meters.

6. Find the wavelength in nanometers.

III. Solve the following problems. Show all work in the space provided.

7. Find the energy of a radio wave photon with a wavelength of 1.35 km.
8. Find the frequency of an FM radio wave with a wavelength of 3.32 m.

9. Find the energy of a radio wave with a frequency of $7.10 \times 10^5$ s$^{-1}$.

10. In a certain atom, when an electron drops from a higher energy level to a lower energy level, it gives off light with an wavelength of 440 nm. How much energy was released in this event?

11. Airport scanners use electromagnetic imaging to detect any illegal items that a passenger may be carrying as they board an airplane. Concerns have been raised about the health effects of these scanners, since they essentially expose a passenger's body to levels of energy that can cause chemical changes, which may lead to cancer cells being formed. This is also known as “ionizing radiation”.

One type of scanner is called an “x-ray backscattering scanner”. It emits radiation with an energy of $1.00 \times 10^8$ electron volts (abbreviated eV). $1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$

a. Find the energy of this scanner in Joules.

b. What is the wavelength of a photon of the radiation from this scanner?

12. Another type of airport scanner is called a “millimeter scanner”. It uses radiation with a wavelength of 1 mm. It is considered to be safer than an x-ray scanner.

a. Calculate the energy, in electron volts of a photon emitted by a millimeter scanner.

b. Explain why this type of scanner would be considered to be safer than an x-ray scanner.
Answers to: Chemistry Practice: "Frequency, Wavelength and Energy"

1. $5.2 \times 10^{-7}$ m
2. $5.8 \times 10^{14}$ s$^{-1}$
3. $3.8 \times 10^{-19}$ J
4. $1.00 \times 10^{17}$ s$^{-1}$
5. $3.00 \times 10^{-9}$ m
6. $3.00$ nm
7. $1.47 \times 10^{-28}$ J
8. $9.04 \times 10^{7}$ s$^{-1}$
9. $4.71 \times 10^{-28}$ J
10. $4.5 \times 10^{-19}$ J
11. a. $1.60 \times 10^{-14}$ J
   b. $1.24 \times 10^{-11}$ m = .0124 nm
12. a. $1.24 \times 10^{-3}$ eV
   b. The energy of an x-ray scanner photon is about $10^8$ times greater than the energy of a millimeter scanner photon. The energy of the x-ray scanner is high enough to cause chemical changes in your cells.