SCH3U7 Chemistry Worksheet:

Wavelength, frequency, & energy of electromagnetic waves.

Show ALL equations, work, units, and significant figures in performing the following calculations. Identify the type of radiation in each problem. (Use your electromagnetic spectrum)

$C = \lambda\nu$ $E = h\nu$

$C = 3.00 \times 10^{8}$ m/s $h = 6.626\ 2 \times 10^{-34}$ J-s (or J/Hz)

$1\ eV = 1.602 \times 10^{-19}$ J

1. What is the wavelength of a wave having a frequency of $3.76 \times 10^{14}\ s^{-1}$?
2. What is the frequency of a 6.9×10^{-13} m wave?
3. What is the wavelength of a 2.99 Hz wave?
4. What is the wavelength of a 1.28×10^{17} Hz wave?
5. What is the frequency of a 7.43×10^{-5} m wave?
6. What is the frequency of a 2,600 cm wave?
7. What is the wavelength of a 4.34×10^{15} /s wave?
8. What is the frequency of a 5.6×10^{10} μm wave?
9. What is the wavelength of 109.6 MHz wave?
10. What is the energy of a 7.66×10^{14} Hz wave?
11. What is the frequency of a wave carrying 8.35×10^{-18} J of energy?
12. What is the energy of a $3.12 \times 10^{18}\ s^{-1}$ wave?
13. What is the frequency of a 1.31×10^{-22} J wave? What is its wavelength?
14. What is the wavelength of a 7.65×10^{-17} J wave?
15. What is the energy of a 9,330 cm wave?
16. What is the wavelength of a 1.32×10^{-6} eV wave?
17. What is the energy in electron-volts (eV) of a 4.22 μm wave?
18. What is the wavelength of a 1.528×10^{-13} J wave?

Chemistry Worksheet – Wavelength, frequency, & energy of electromagnetic waves.
ANSWER KEY

Show ALL equations, work, units, and significant figures in performing the following calculations. Identify the type of radiation in each problem. (Use your electromagnetic spectrum)

$C = \lambda\nu$ $\quad\quad$ $E = h\nu$

$C = 3.00 \times 10^{8}$ m/s $\quad\quad$ $h = 6.626\ 2 \times 10^{-34}$ J-s (or J/Hz)

1 eV $= 1.602 \times 10^{-19}$ J

1. What is the wavelength of a wave having a frequency of $3.76 \times 10^{14}\ s^{-1}$?

$$\lambda = c/\nu = \frac{3.00 \times 10^{8}\ m/s}{3.76 \times 10^{14}\ s^{-1}} = \frac{3.00 \times 10^{8}\ m}{s} \times \frac{s}{3.76 \times 10^{14}} = 7.98 \times 10^{-7}\ m$$

2. What is the frequency of a 6.9×10^{-13} m wave?

$$\nu = c/\lambda = \frac{3.00 \times 10^{8}\ m/s}{6.9 \times 10^{-13}\ m} = \frac{3.00 \times 10^{8}\ \cancel{m}}{s} \times \frac{1}{6.9 \times 10^{-13}\ \cancel{m}} = 4.35 \times 10^{20}\ s^{-1}$$

3. What is the wavelength of a 2.99 Hz wave?

$$\lambda = c/\nu = \frac{3.00 \times 10^{8}\ m/s}{2.99\ \cancel{Hz}} \times \frac{1\ \cancel{Hz}}{s^{-1}} = \frac{3.00 \times 10^{8}\ m}{\cancel{s}} \times \frac{\cancel{s}}{2.99} = 1.00 \times 10^{8}\ m$$

4. What is the wavelength of a 1.28×10^{17} Hz wave?

$$\lambda = c/\nu = \frac{3.00 \times 10^{8}\ m/s}{1.28 \times 10^{17}\ Hz} = \frac{1\ Hz}{s^{-1}} \times \frac{3.00 \times 10^{8}\ m}{\cancel{s}} \times \frac{\cancel{s}}{1.28 \times 10^{17}}$$

$$= 2.34 \times 10^{-9}\ m$$

5. What is the frequency of a 7.43×10^{-5} m wave?
6. What is the frequency of a 2,600 cm wave?
7. What is the wavelength of a 4.34×10^{15} /s wave?

8. What is the frequency of a 5.6×10^{10} μm wave?

$$\nu = c/\lambda = \frac{3.00 \times 10^{8}\ m/s}{5.6 \times 10^{10}\ \mu m} = \frac{3.00 \times 10^{8}\ \cancel{m}}{s} \times \frac{1}{5.6 \times 10^{10}\ \cancel{\mu m}} \times \frac{1\ \cancel{\mu m}}{10^{-6}\ \cancel{m}} = 5.4 \times 10^{3}\ s^{-}$$

9. What is the wavelength of 109.6 MHz wave?

$$\lambda = c/\nu = \frac{3.00 \times 10^{8}\ m/s}{109.6\ MHz} = \frac{3.00 \times 10^{8}\ m}{\cancel{s}} \times \frac{1}{109.6\ \cancel{MHz}} \times \frac{1\ \cancel{MHz}}{10^{+6}\ \cancel{Hz}} \times \frac{1\ \cancel{Hz}}{\cancel{s^{-1}}} =$$

= 2.74 m

10. What is the energy of a 7.66 x 10^{14} Hz wave?

$E = h\nu = 6.626\ 2 \times 10^{-34}$ J/~~Hz~~ x 7.66×10^{14} ~~Hz~~ $= 5.07 \times 10^{-19}$ J

11. What is the frequency of a wave carrying 8.35 x 10^{-18} J of energy?

$$\nu = E / h = \frac{8.35 \times 10^{-18}\ \cancel{J}}{6.626\ 2 \times 10^{-34}\ J\text{-}s} = 1.26 \times 10^{16}\ s^{-1}$$

12. What is the energy of a 3.12 x 10^{18} s^{-1} wave?

$E = h\nu = 6.626\ 2 \times 10^{-34}$ J-~~s~~ x 3.12×10^{18} ~~s~~$^{-}$

$= 2.07 \times 10^{-15}$ J

13. What is the frequency of a 1.31 x 10^{-22} J wave? What is its wavelength?

$$\nu = E / h = \frac{1.31 \times 10^{-22}\ \cancel{J}}{6.626\ 2 \times 10^{-34}\ J\text{-}s} = 1.977\ 000\ 392 \times 10^{11}\ s^{-1} = 1.98 \times 10^{+11}\ s^{-1}$$

$$\lambda = c/\nu = \frac{3.00 \times 10^{8}\ m/s}{1.977\ 000\ 392 \times 10^{11}\ s^{-1}}$$

$$= \frac{3.00 \times 10^{8}\ m}{\cancel{s}} \times \frac{\cancel{s}}{1.977\ 000\ 392 \times 10^{11}} = 0.001\ 52\ m = 1.52 \times 10^{-3}\ m$$

14. What is the wavelength of a 7.65 x 10^{-17} J wave?

$$\nu = E / h = \frac{7.65 \times 10^{-17}\ \cancel{J}}{6.626\ 2 \times 10^{-34}\ J\text{-}s} = 1.154\ 507\ 863 \times 10^{17}\ s^{-1}$$

$$\lambda = c/\nu = \frac{3.00 \times 10^{8}\ m/s}{1.154\ 507\ 863 \times 10^{17}\ s^{-1}} =$$

$$= \frac{3.00 \times 10^{8}\ m}{\cancel{s}} \times \frac{\cancel{s}}{1.154\ 507\ 863 \times 10^{17}} = 0.001\ 52\ m = 1.52 \times 10^{-3}\ m$$

15. What is the energy of a 9,330 cm wave?

$$\nu = c/\lambda = \frac{3.00 \times 10^{8}\ m/s}{} = \frac{3.00 \times 10^{8}\ \cancel{m}}{} \times \frac{1}{} \times \frac{1\ \cancel{cm}}{} = 3.215\ 434\ 084 \times 10^{6}\ s^{-1}$$

9,330 cm s 9,330 ~~cm~~ 10^{-2} ~~m~~

$E = h\nu = 6.626\,2 \times 10^{-34}$ J-~~s~~ x $3.215\,434\,084 \times 10^{6}$ s^{-1} = 2.13×10^{-27} J

16. What is the wavelength of a 1.32×10^{-6} eV wave?

$$\nu = E / h = \frac{1.32 \times 10^{-6}\ \text{eV}}{6.626\,2 \times 10^{-34}\ \text{J-s}} \times \frac{1.602 \times 10^{-19}\ \text{J}}{1\ \text{eV}} = 3.191\,331\,38 \times 10^{+8}\ \text{s}^{-1}$$

$$\lambda = c/\nu = \frac{3.00 \times 10^{8}\ \text{m/s}}{3.191\,331\,38 \times 10^{+8}\ \text{s}^{-1}} = \frac{3.00 \times 10^{8}\ \text{m}}{\text{s}} \times \frac{1}{3.191\,331\,38 \times 10^{+8}\ \text{s}^{-1}}$$

= 0.940 m

17. What is the energy in electron-volts (eV) of a 4.22 μm wave?

$$\nu = c/\lambda = \frac{3.00 \times 10^{8}\ \text{m/s}}{4.22\ \mu\text{m}} = \frac{3.00 \times 10^{8}\ \text{m}}{\text{s}} \times \frac{1}{4.22\ \mu\text{m}} \times \frac{1\ \mu\text{m}}{10^{-6}\ \text{m}}$$

= $7.109\,004\,73 \times 10^{13}$ s^{-}

$E = h\nu = 6.626\,2 \times 10^{-34}$ J-~~s~~ x $= 7.109\,004\,73 \times 10^{13}$ s^{-} = 4.71×10^{-20} J

18. What is the wavelength of a 1.528×10^{-13} J wave?

$$\nu = E / h = \frac{1.528 \times 10^{-13}\ \text{J}}{6.626\,2 \times 10^{-34}\ \text{J-s}} = 2.305\,997\,404 \times 10^{20}\ \text{s}^{-1}$$

$$\lambda = c/\nu = \frac{3.00 \times 10^{8}\ \text{m/s}}{2.305\,997\,404 \times 10^{20}\ \text{s}^{-1}} = \frac{3.00 \times 10^{8}\ \text{m}}{\text{s}} \times \frac{1}{2.305\,997\,404 \times 10^{20}\ \text{s}^{-1}}$$

= 1.30×10^{-12} m