Name: KEY Date: _____ Period: _____

ELECTROMAGNETIC RADIATION
WAVELENGTH AND FREQUENCY CALCULATIONS

Complete the following calculations using the relationship among wavelength, frequency, and the speed of light.

1. Determine the frequency of light with a wavelength of 675nm.

$\lambda = 675 \times 10^{-9}\ m$ $\quad c = 3 \times 10^{8}\ m/s$ $\quad \nu = ?$

$c = \lambda \times \nu$ $\quad \frac{c}{\lambda} = \frac{\lambda \times \nu}{\lambda}$ $\quad \nu = \frac{c}{\lambda}$

$\nu = \frac{3.0 \times 10^{8}\ m/s}{675 \times 10^{-9}\ m} = 4.44 \times 10^{14}\ Hz$

2. Determine the frequency of light with a wavelength of 4.50×10^{-7}m.

$\nu = ?$ $\quad \lambda = 4.5 \times 10^{-7}\ m$ $\quad c = 3 \times 10^{8}\ m/s$

$\nu = \frac{c}{\lambda}$ $\quad \nu = \frac{3.0 \times 10^{8}\ m/s}{4.5 \times 10^{-7}\ m} = 6.67 \times 10^{14}\ Hz$

3. What is the wavelength of an X ray that has a frequency of 7.8×10^{17} Hz?

$\lambda = ?$ $\quad \nu = 7.8 \times 10^{17}\ Hz$ $\quad c = 3.0 \times 10^{8}\ m/s$

$c = \lambda \times \nu$ $\quad \frac{c}{\nu} = \frac{\lambda \times \nu}{\nu}$ $\quad \lambda = \frac{c}{\nu}$

$\lambda = \frac{3 \times 10^{8}\ m/s}{7.8 \times 10^{17}\ 1/s}$ $\quad \lambda = 3.8 \times 10^{-10}\ m$

4. Excited sodium atoms may emit radiation having a wavelength of 589 nm. $589 \times 10^{-9}\ m$

a) What is the wavelength in meters?

$\lambda = 589\ nm = 589 \times 10^{-9}\ m$ or $5.89 \times 10^{-7}\ m$

b) What is the frequency of this light?

$\lambda = 589 \times 10^{-9}\ m$ $\quad \nu = ?$ $\quad c = 3 \times 10^{8}\ m/s$

$c = \lambda \times \nu$ $\quad \frac{c}{\lambda} = \frac{\lambda \times \nu}{\lambda}$ $\quad \nu = \frac{c}{\lambda}$

$\nu = \frac{3 \times 10^{8}\ m/s}{589 \times 10^{-9}\ m} = 5.09 \times 10^{14}\ Hz$

c) What is the energy of this light?

$E = ?$ $\quad h = 6.63 \times 10^{-34}\ J \cdot s$ $\quad \nu = 5.09 \times 10^{14}\ Hz$

$E = h\nu$ $\quad E = (6.63 \times 10^{-34}\ J \cdot s)\left(5.09 \times 10^{14}\ \frac{1}{s}\right)$

$E = 3.38 \times 10^{-19}\ J$

5. A radio station has a frequency of 96.5 MHz. Find the wavelength and energy of these waves. $E = h\nu$

$\nu = 96.5\ MHz = 96.5 \times 10^{6}\ Hz$ $\quad \lambda = ?$ $\quad c = 3 \times 10^{8}\ m/s$

$c = \nu \times \lambda$ $\quad \frac{c}{\nu} = \frac{\nu \times \lambda}{\nu}$ $\quad \lambda = \frac{c}{\nu}$

$\lambda = \frac{3.0 \times 10^{8}\ m/s}{96.5 \times 10^{6}\ 1/s}$ $\quad \lambda = 3.11\ m$

$E = ?$ $\quad h = 6.63 \times 10^{-34}\ J \cdot s$ $\quad \nu = 96.5 \times 10^{6}\ Hz$

$E = (6.63 \times 10^{-34}\ J \cdot s)\left(96.5 \times 10^{6}\ \frac{1}{s}\right) = 6.40 \times 10^{-26}\ J$

6. A certain photon of electromagnetic radiation has energy of 4.65×10^{-15} J. What is the wavelength of this light in nm?

$E = 4.65 \times 10^{-15}\ J$ $\quad h = 6.63 \times 10^{-34}\ J \cdot s$ $\quad \nu = ?$ $\quad \lambda = ?$ $\quad c = 3 \times 10^{8}\ m/s$

$\frac{E}{h} = \frac{h \cdot \nu}{h}$ $\quad \nu = \frac{E}{h}$

$\nu = \frac{4.65 \times 10^{-15}\ J}{6.63 \times 10^{-34}\ J \cdot s}$ $\quad \nu = 7.01 \times 10^{18}\ 1/s$

$c = \nu \times \lambda$ $\quad \frac{c}{\nu} = \frac{\nu \times \lambda}{\nu}$ $\quad \lambda = \frac{c}{\nu}$

$\lambda = \frac{3 \times 10^{8}\ m/s}{7.01 \times 10^{18}\ 1/s} = 4.28 \times 10^{-11}\ m \Rightarrow 4.29 \times 10^{-2}\ nm$

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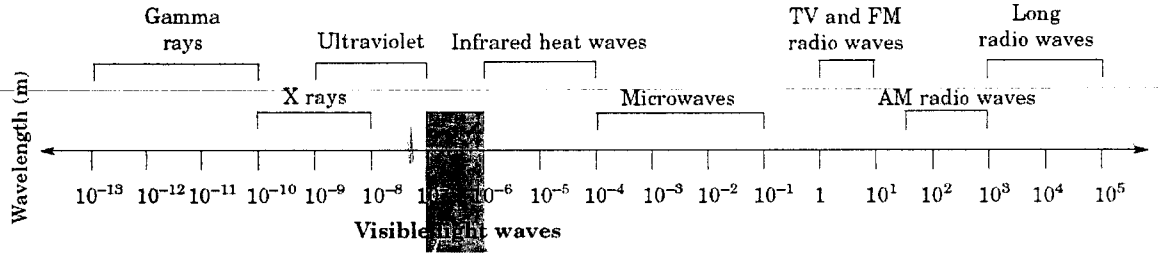

- Violet: 400-430 nm
- Indigo: 430-450 nm
- Blue: 450-500 nm
- Green: 500-570 nm
- Yellow: 570-590 nm
- Orange: 590-610 nm
- Red: 610-700 nm

72.6×10^{-9} m

10. What is the frequency of an electromagnetic wave that has a wavelength of 72.6 nm?

$\lambda = 72.6 \times 10^{-9}$ m
$c = 3.0 \times 10^{8}$ m/s
$\nu = ?$

$c = \lambda \times \nu$ $\quad \frac{c}{\lambda} = \frac{\lambda \times \nu}{\lambda}$ $\quad \nu = \frac{c}{\lambda}$ $\quad \nu = \frac{3 \times 10^{8}\ m/s}{72.6 \times 10^{-9}\ m}$

$\nu = 4.13 \times 10^{15}$ Hz

11. Using the figures above what kind of electromagnetic radiation is used in question 10?

72.6×10^{-9} m $= 7.26 \times 10^{-8}$ m $\Rightarrow$ UV

12. What is the wavelength of an electromagnetic wave that has a frequency of 6.79 X 10^{9}Hz?

$\lambda = ?$
$\nu = 6.79 \times 10^{9}$ 1/s
$c = 3 \times 10^{8}$ m/s

$c = \lambda \times \nu$ $\quad \frac{c}{\nu} = \frac{\lambda \times \nu}{\nu}$ $\quad \lambda = \frac{c}{\nu}$ $\quad \lambda = \frac{3 \times 10^{8}\ m/s}{6.79 \times 10^{9}\ 1/s}$

$\lambda = 4.42 \times 10^{-2}$ m

13. What is the wavelength of a light wave that has a frequency of 4.42 X 10^{14}Hz?

$\nu = 4.42 \times 10^{14}$ Hz
$\lambda = ?$
$c = 3 \times 10^{8}$ m/s

$\lambda = \frac{c}{\nu}$ $\quad \lambda = \frac{3 \times 10^{8}\ m/s}{4.42 \times 10^{14}\ 1/s}$

$\lambda = 6.79 \times 10^{-7}$ m

14. Using the figures above, what color is the light wave from question 13?

$\lambda = 6.79 \times 10^{-7}$ m $\quad \lambda = 679$ nm (Red)

15. A gamma ray has a wavelength of 0.039 nm. What is the frequency of the wave?

$\lambda = 0.039 \times 10^{-9}$ m
$\nu = ?$
$c = 3 \times 10^{8}$ m/s

$c = \lambda \times \nu$ $\quad \frac{c}{\lambda} = \frac{\lambda \times \nu}{\lambda}$ $\quad \nu = \frac{c}{\lambda}$ $\quad \nu = \frac{3 \times 10^{8}\ m/s}{0.039 \times 10^{-9}\ m} = 7.7 \times 10^{18}$ Hz

16. Find the energy (in J) in a quantum of light that has a frequency of 1.7 x 10^{14} Hz.

$E = ?$
$\nu = 1.7 \times 10^{14}$ Hz
$h = 6.63 \times 10^{-34}$ J.s

$E = h\nu$
$E = (6.63 \times 10^{-34}\ J.s)(1.7 \times 10^{14}\ 1/s)$
$E = 1.13 \times 10^{-19}$ J

470×10^{-9} m

17. What is the frequency of a light wave that has a wavelength of 470 nm?

$\lambda = 470 \times 10^{-9}$ m
$\nu = ?$
$c = 3.0 \times 10^{8}$ m/s

$c = \lambda \times \nu$ $\quad \frac{c}{\lambda} = \frac{\lambda \times \nu}{\lambda}$ $\quad \nu = \frac{c}{\lambda}$ $\quad \nu = \frac{3 \times 10^{8}\ m/s}{470 \times 10^{-9}\ m}$

$\nu = 6.4 \times 10^{14}$ Hz