Standards: SP4a Develop and use mathematical models to explain mechanical and electromagnetic waves as a propagating disturbance that transfers energy.

Rubric for Modeling: 30 Pts (23 + 7)

(1) Modeling the transverse wave (23 Pts): Reference line – 2 Pts; Wave is symmetrical: 3 Pts: Crest marked and labelled: 2 Pts; Trough marked and labelled: 2 Pts; Wavelength marked and labelled: 2 Pts: Frequency marked and labeled: 3 Pts; Amplitude is marked either in a crest or a trough clearly and labelled: 2 Pts; the word, "Time" is written for the Reference line: 2 Pts; y axis is marked as Amplitude: 2 Pts. Mounting is neat and tidy: 3 Pts

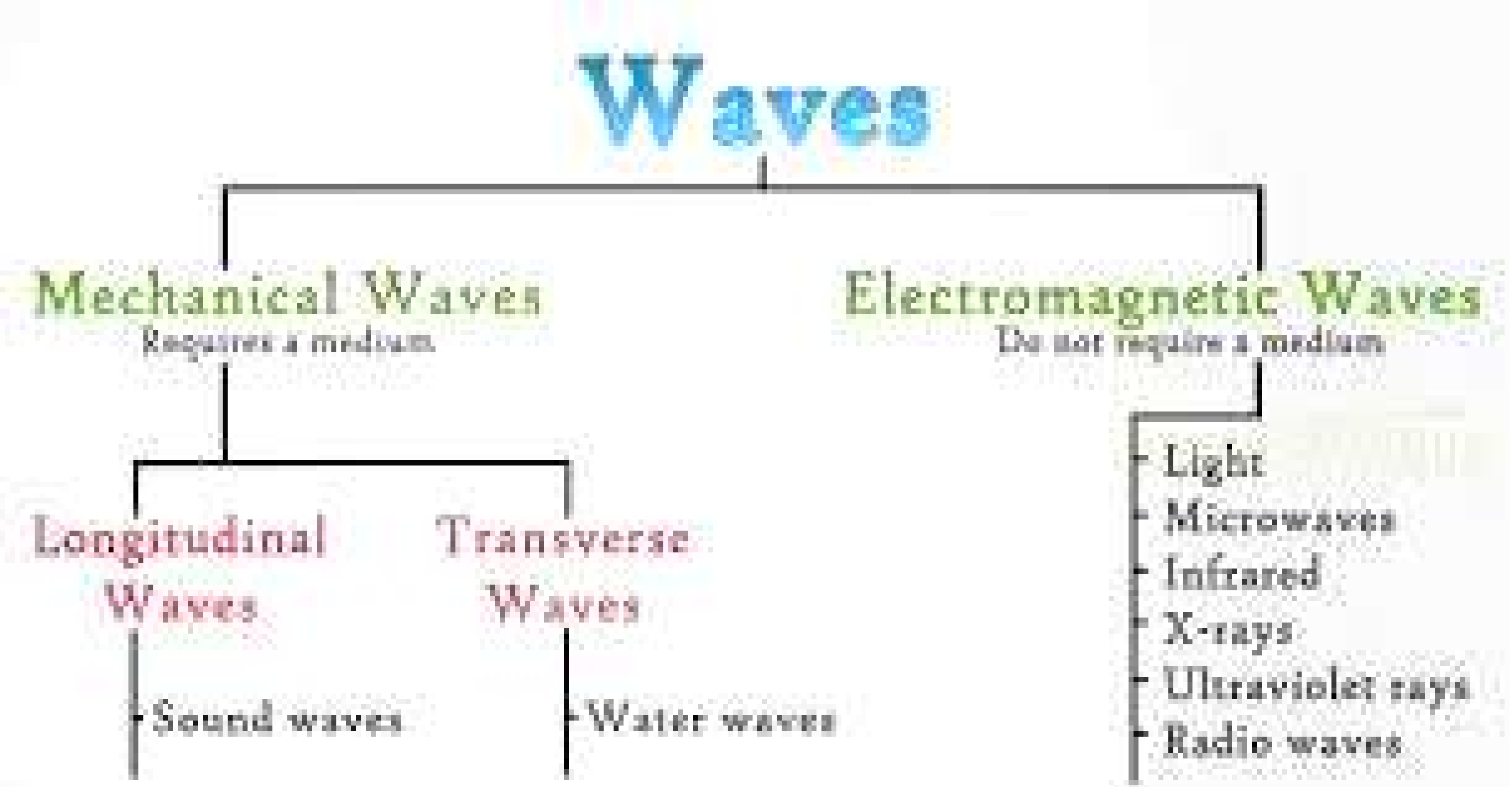
(2) Modeling of longitudinal wave (7 Pts): The pipe cleaner is coiled neatly and mounted neatly to show compression and rarefaction (3 Pts). Compression and Rarefaction are marked and labelled (1 Pt each = 2 Pts). Wavelength is shown separately as a diagram: 2 Pts.

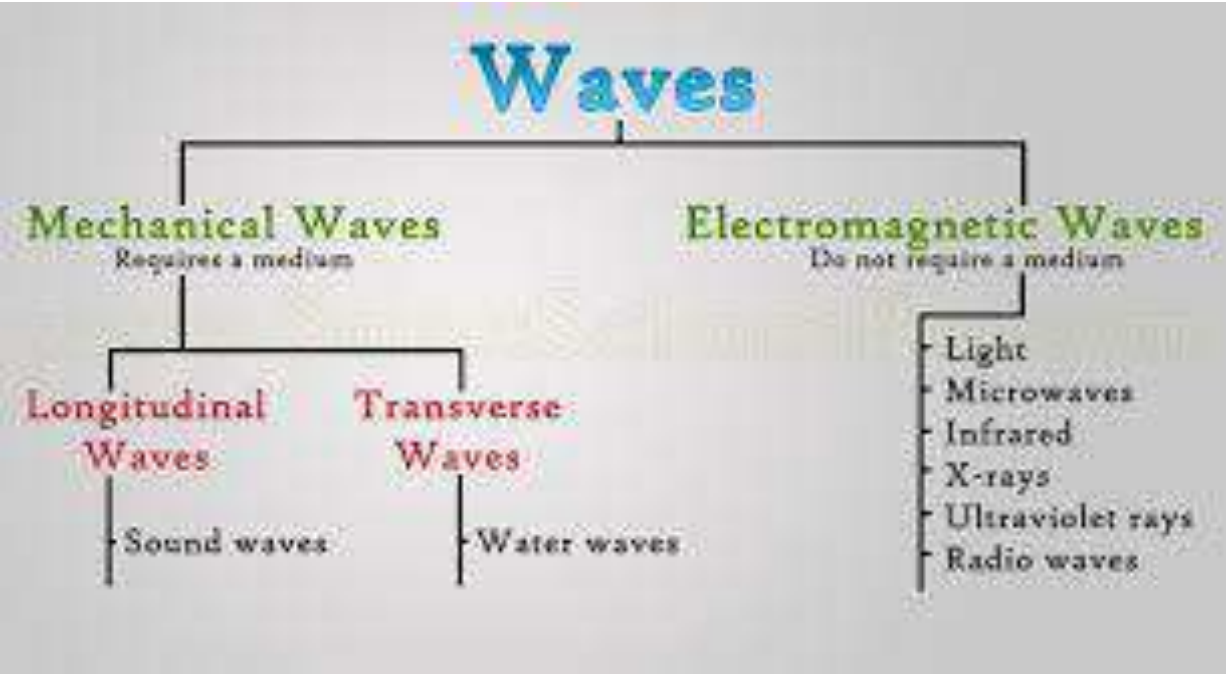
Rubric for Short Answer Questions on Type of wave, Frequency and Period: 10 Pts

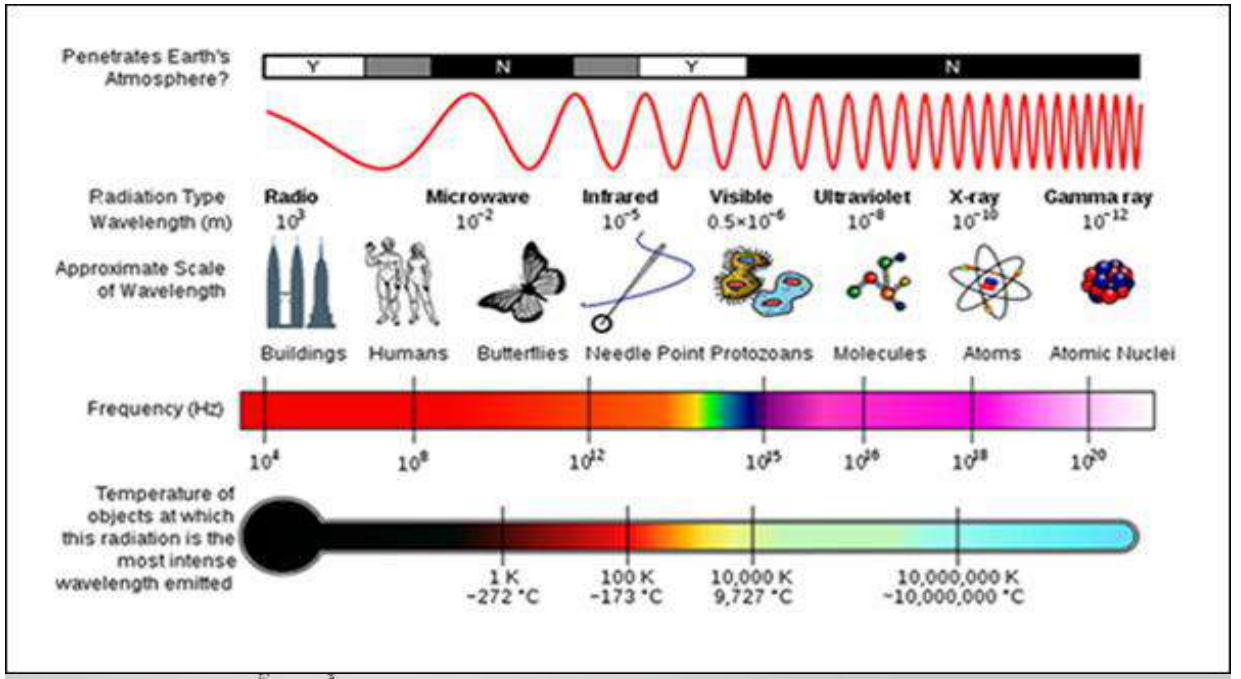
Rubric for Math Problem Solving (10 Pt for each Problem): 6 x 10 = 60 Pts

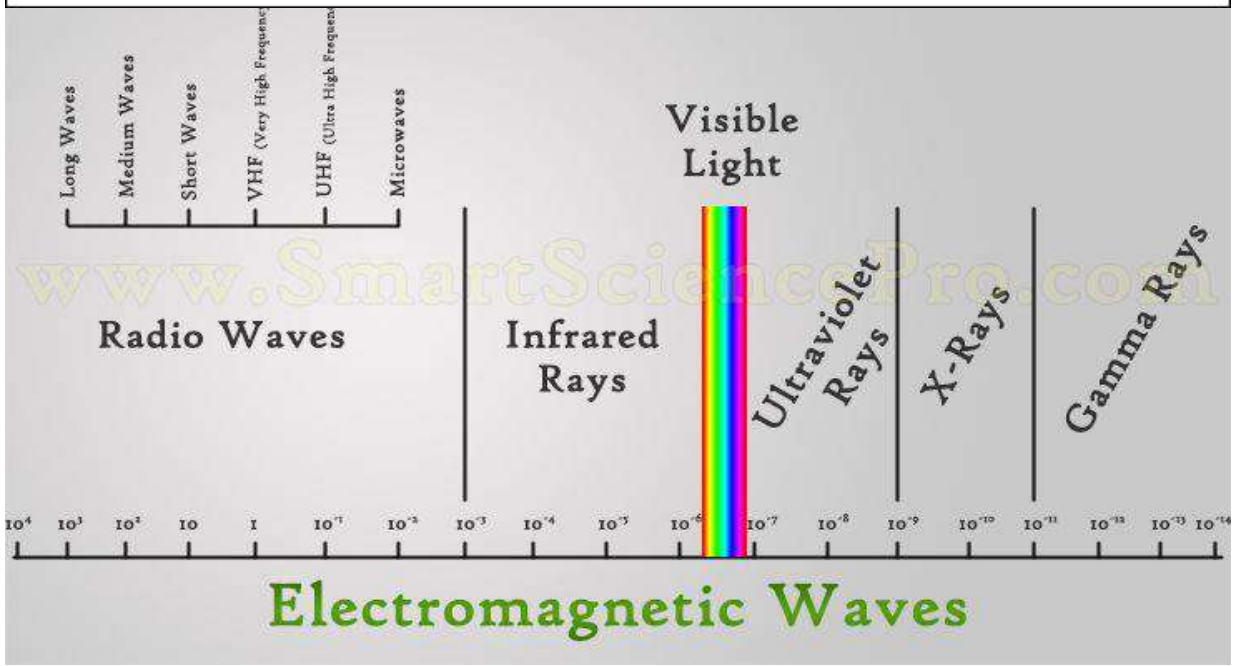
1. Correct original equation is written: 1 Pt
2. Isolation of Variable is done as shown: 1 Pt
3. The complete work is shown including all intermediary steps: 4 Pt
4. Metric conversions are done: 2 Pts
5. Unit is provided and worked out for all the solutions: 1.5 Pts
6. Answer is separately written out along with the unit in a box: 0.5 Pt

Total Points: 100


Waves
Mechanical Waves
Requires a medium
Electromagnetic Waves
Do not require a medium
Longitudinal Waves
Transverse Waves
Sound waves
Water waves
Light
Microwaves
Infrared
X-rays
Ultraviolet rays
Radio waves




**Standards**

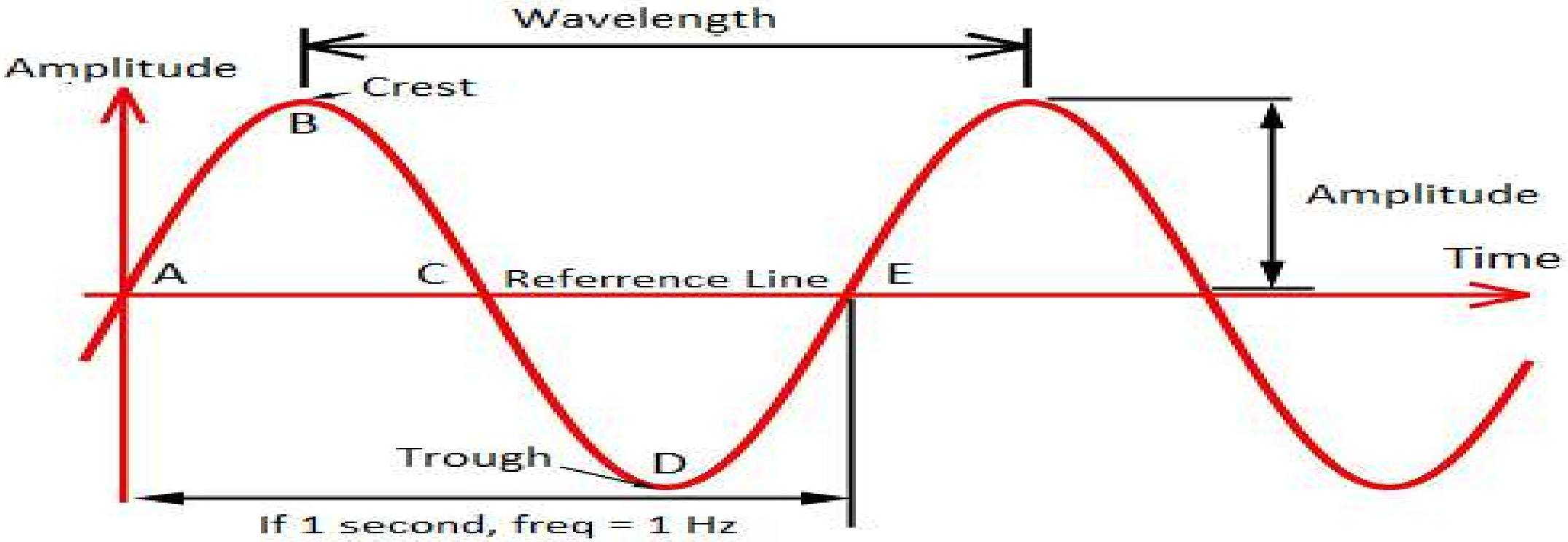
SP4a Develop and use mathematical models to explain mechanical and electromagnetic waves as a propagating disturbance that transfers energy.

SP4b Develop and use models to describe and calculate characteristics related to the interference and diffraction of waves (single and double slits).

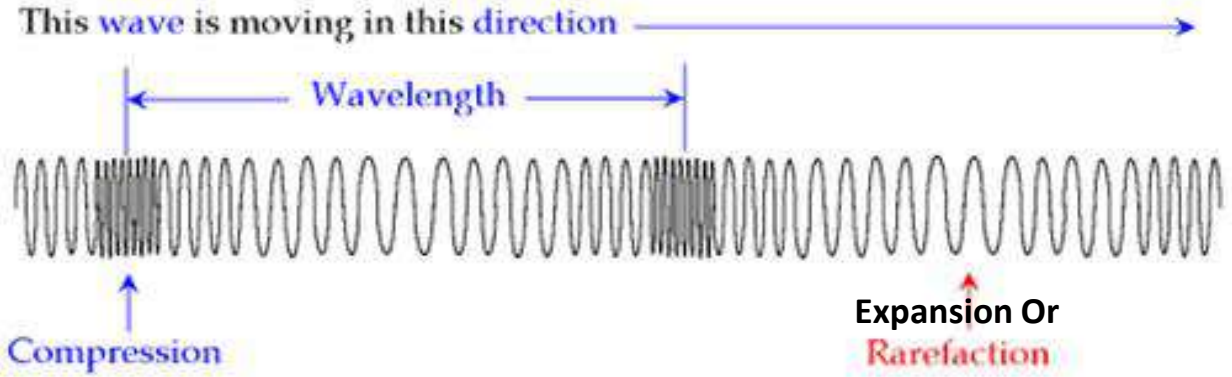
SP4c Construct an argument that analyzes the production and characteristics of sounds waves.

SP4d Plan and carry out investigations to characterize the properties and behavior of electromagnetic waves.

## Transverse Wave



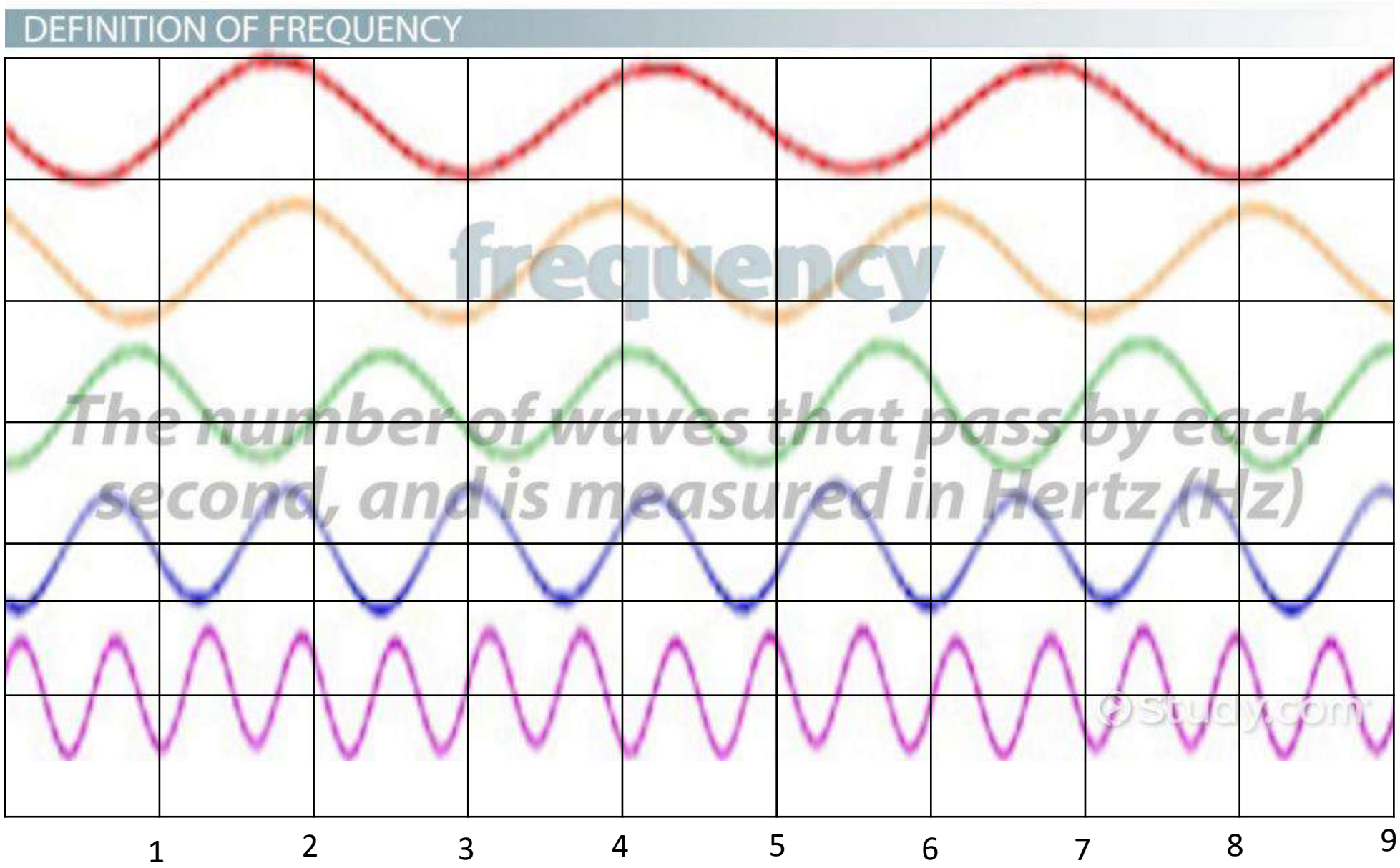

## Longitudinal Wave



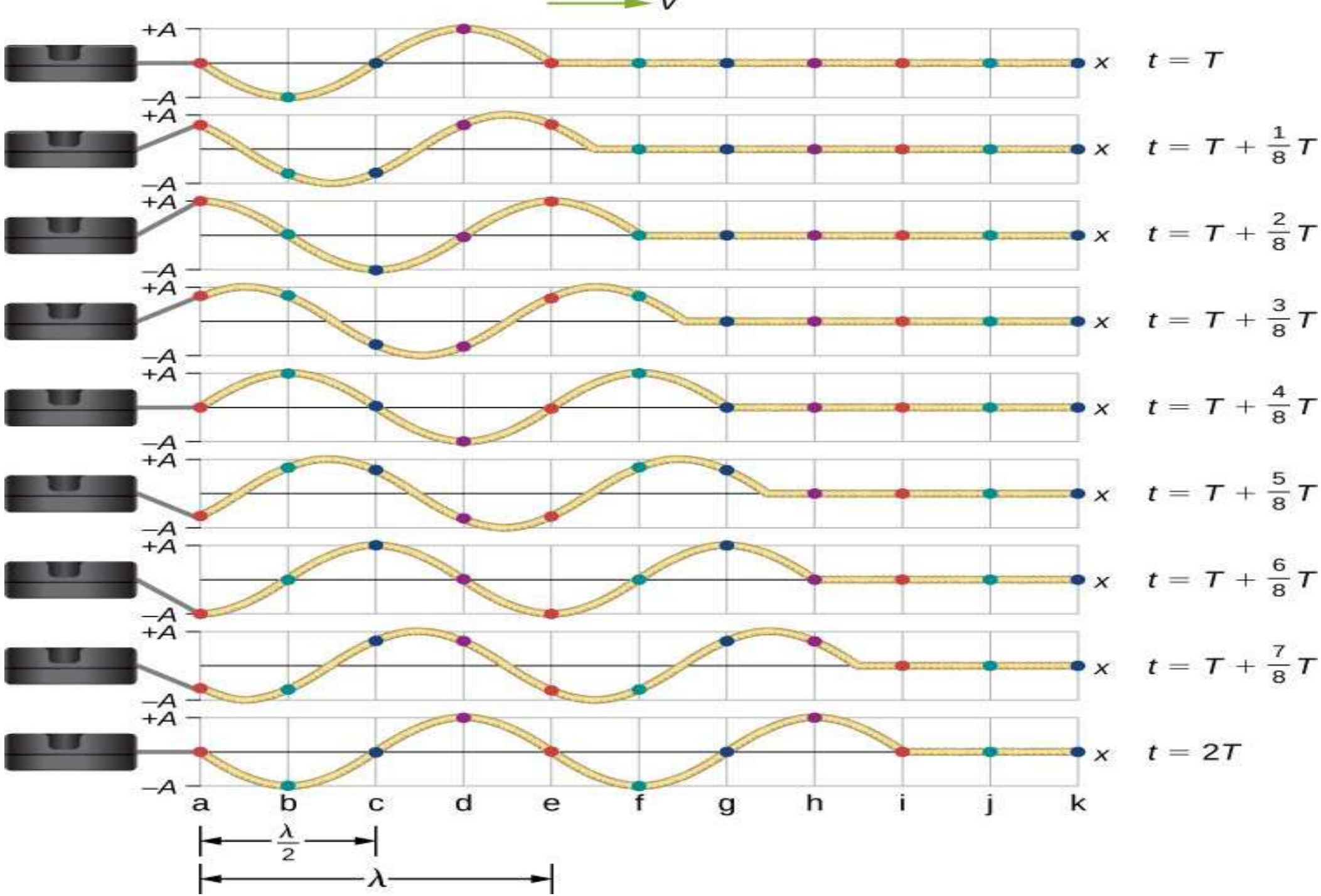
Consult the following resources for the parts and characteristics of waves

http://www.studyphysics.ca/newnotes/20/unit03_mechanical waves/chp141516_waves/lesson44.htm

http://zonalandeducation.com/mstm/physics/waves/partsOfAWave/waveParts.htm




Count the number of waves in 3 seconds and then calculate the frequency of each wave (number of waves in one second)




Waves with different periods

# Bell-Ringer: Use your notes

**Frequency & Period Problems**

A young girl is on a swing that completes 20.0 cycles in 25 seconds. What are its frequency and period?

A clock clicks 88 times in 22 seconds. Calculate the frequency and period of the clock.

The time interval between flashes on a stroboscope is 1/80 second. What is the frequency of the light flashes.

4. A spring vibrates 24, 000 times in 1.00 minutes. What are the frequency and period. [Hint: frequency is cycles per **second**.]

# Wave Speed

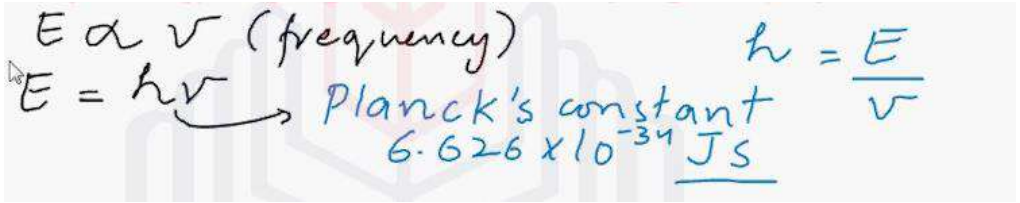
- We can use what we know to determine how fast a wave is moving.
- What is the formula for velocity?
  - velocity = distance / time
- What distance do we know about a wave
  - wavelength
- and what time do we know
  - period

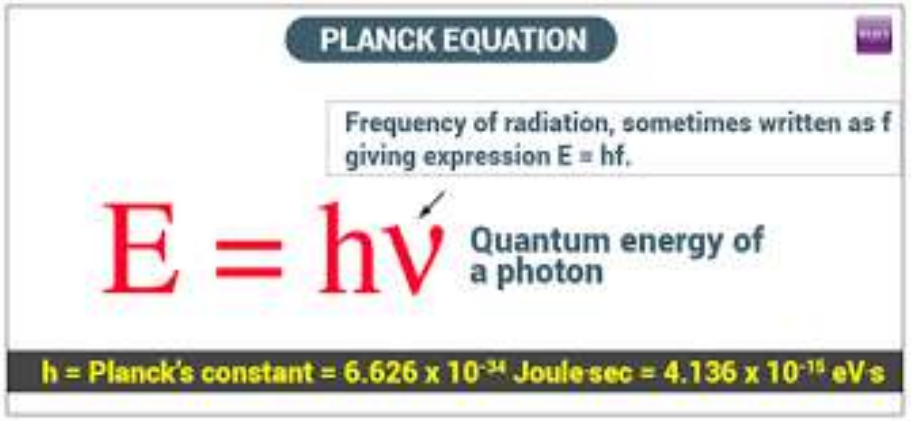
so if we plug these in we get
velocity = length of pulse / time for pulse to move pass a fixed point
$v = \lambda / T$
we will use the symbol $\lambda$ to represent wavelength

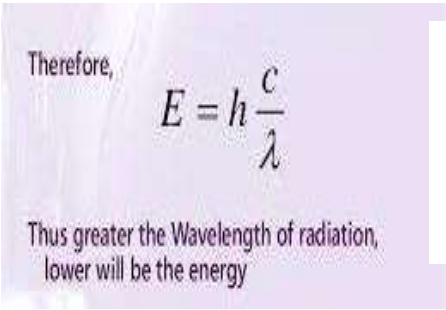
**$v = \lambda / T$**
**but what does T equal**
**$T = 1 / f$**
**so we can also write**
**$v = f \lambda$**
**velocity = frequency * wavelength**
**This is known as the wave equation.**

Here, we are substituting velocity by the velocity (speed) of light, c.
Speed of light is a constant value of $2.998 \times 10^8$ m/s
This is generally taken as $3.000 \times 10^8$ m/s

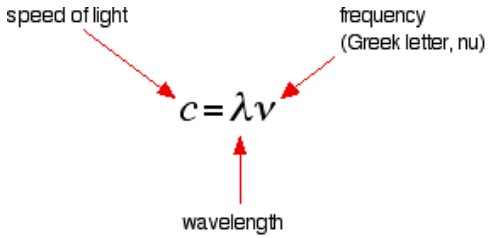
**Planck's quantum theory**. According to **Planck's quantum theory**, energy is absorbed or released in small pockets called Quanta. One packet of energy n is known as **quantum**. The energy of the radiation absorbed or emitted is directly proportional to the frequency of the radiation.




$c = \lambda \cdot \nu$
c = speed of light ($2.997925 \times 10^8$ m/s)
$\lambda$ = wavelength (m)
$\nu$ = frequency ($s^{-1}$)




## Guided Practice

What is the frequency of violet light with wavelength 400 nm?

$$c = \lambda\nu$$

$$\nu = \frac{c}{\lambda} \qquad c = 2.998 \times 10^{8}\ ms^{-1}$$
$$\lambda = 400\ nm = 400 \times 10^{-9}\ m$$

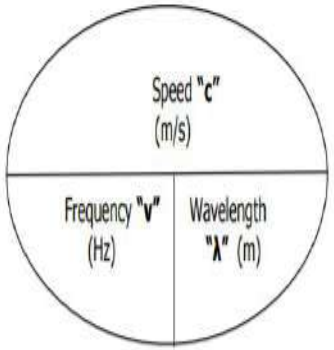
$$= \frac{2.998 \times 10^{8}\ ms^{-1}}{400 \times 10^{-9}\ m}$$

$$= 7.50 \times 10^{14}\ Hz$$

**Equation:** Speed of all Electromagnetic Spectrum Waves (c) = $3.0 \times 10^{8}$ m/s

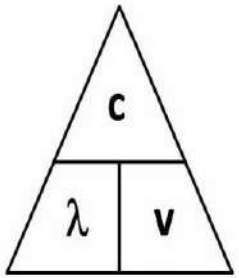
$c\ (m/s) = \nu \times \lambda$

$\nu\ (Hz) = c \div \lambda$ $\qquad$ $\lambda\ (m) = c \div \nu$




## Collaborative Practice

***The wavelength of green light is 522 nm, what is the frequency of this radiation?***




## Independent Practice

Calculations of 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)

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

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

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 $6.9 \times 10^{-13}$ m wave?
3. What is the wavelength of a 2.99 Hz wave?
4. What is the wavelength of a $1.28 \times 10^{17}$ Hz wave?
5. What is the frequency of a $7.43 \times 10^{-5}$ m wave?
6. What is the frequency of a 2,600 cm wave?
7. What is the wavelength of a $4.34 \times 10^{15}$ /s wave?
10. What is the wavelength of 109.6 MHz wave?

11. What is the energy of a $7.66 \times 10^{14}$ Hz wave?
12. What is the frequency of a wave carrying $8.35 \times 10^{-18}$ J of energy?
13. What is the frequency of a $1.78 \times 10^{-15}$ J wave?
14. What is the energy of a $3.12 \times 10^{18}$ $s^{-1}$ wave?
15. What is the frequency of a $1.31 \times 10^{-22}$ J wave? What is its wavelength?
16. What is the wavelength of a $7.65 \times 10^{-17}$ J wave?
17. What is the energy of a 9,330 cm wave?
18. What is the wavelength of a $1.528 \times 10^{-13}$ J wave?