Name: _____

Skill Sheet 18.1 The Speed of Light

The speed of light is a fundamental quantity in physics. Light is an electromagnetic wave. Waves are characterized by their frequency and wavelength. In this skill sheet you will work with the formula that relates the speed of light to the frequency and wavelength of light.

1. Speed, frequency, and wavelength of light

The speed of light is related to frequency f and wavelength λ by the formula below. Frequency is given in hertz (Hz), or cycles per second, and wavelength is given in meters. The speed of light in a vacuum is 3×10^8 m/sec.

$$c = f\lambda$$

The different colors of light that we see correspond to different frequencies. The frequency of red light is higher than the frequency of blue light. Their speed is, however, the same and equal to c, the speed of light. Therefore, the wavelength of red light is higher than the wavelength of blue light. When we know the frequency of light, the wavelength is given by:

$$\lambda = \frac{c}{f}$$

When we know the wavelength of light, the frequency is given by:

$$f = \frac{c}{\lambda}$$

2. Problems

Answer the following problems and show your work.

1. Yellow light has a longer wavelength than green light. Which color of light has the higher frequency?

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2. Green light has a lower frequency than blue light. Which color of light has a longer wavelength?

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3. Calculate the wavelength of violet light with a frequency of 750×10^{12} Hz.

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4. Calculate the frequency of yellow light with a wavelength of 580×10^{-9} m.

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5. Calculate the wavelength of red light with a frequency of 460×10^{12} Hz.

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6. Calculate the frequency of green light with a wavelength of 530×10^{-9} m.

7. One light beam has wavelength, λ_1, and frequency, f_1. Another light beam has wavelength, λ_2, and frequency, f_2. Write a proportion that shows how the ratio of the wavelengths of these two light beams is related to the ratio of their frequencies.

8. The waves used by a microwave oven to cook food have a frequency of 2.45 gigahertz (2.45×10^9 Hz). Calculate the wavelength of this type of wave.

9. A radio station has a frequency of 90.9 megahertz (9.09×10^7 Hz). What is the wavelength of the radio waves the station emits from its radio tower?

10. An x-ray has a wavelength of 5 nanometers (5.0×10^{-9} m). What is the frequency of x-rays?

11. The ultraviolet rays that cause sunburn are called UV-B rays. They have a wavelength of approximately 300 nanometers (3.0×10^{-7} m). What is the frequency of a UV-B ray?

12. Infrared waves from the sun are what make our skin feel warm on a sunny day. If an infrared wave has a frequency of 3.0×10^{12} Hz, what is its wavelength?

13. Electromagnetic waves with the highest amount of energy are called gamma rays. Gamma rays have wavelengths of less than 10-trillionths of a meter (1.0×10^{-11} m).
    a. Determine the frequency that corresponds with this wavelength.

    b. Is this the minimum or maximum frequency of a gamma ray?

14. Use the information from this sheet to order the following types of waves from lowest to highest frequency: visible light, gamma rays, x-rays, infrared waves, ultraviolet rays, microwaves, and radio waves.

15. Use the information from this sheet to order the following types of waves from shortest to longest wavelength: visible light, gamma rays, x-rays, infrared waves, ultraviolet rays, microwaves, and radio waves.