Name:_____Class:_____ Date:_____

Light and Reflection

Problem A

ELECTROMAGNETIC WAVES

PROBLEM

How fast does light with a frequency of 5.4999×10^{14} Hz and a wavelength of 545.00 nm travel?

SOLUTION

Given: $\lambda = 5.450\ 0 \times 10^{-7}$ m $\quad f = 5.4999\ 10^{14}$ Hz

Unknown: c = ?

Choose the equation(s) or situation:

Use the wave speed equation for electromagnetic waves.

$$c = f\lambda = (5.4999\ 10^{14}\ \text{s}^{-1})\ (5.4500 \times 10^{-7}\ \text{m}) = \boxed{2.9974 \times 10^{8}\ \text{m/s}}$$

ADDITIONAL PRACTICE

1. How fast does a radio wave travel that has a frequency of 7.6270×10^{8} Hz and a wavelength of 39.296 cm? Does this radio wave travel through Earth's atmosphere or in space? Light travels in a vacuum at $2.997\ 924\ 58 \times 10^{8}$ m/s and in air at $2.997\ 09 \times 10^{8}$ m/s.
2. How fast does microwave radiation that has a frequency of $1.173\ 06 \times 10^{11}$ Hz and a wavelength of 2.555 6 mm travel? Does this microwave travel through Earth's atmosphere or in space? Light travels in a vacuum at $2.997\ 924\ 58 \times 10^{8}$ m/s and in air at $2.997\ 09 \times 10^{8}$ m/s.
3. Scientists at Lucent Bell Labs use high-resolution microscopes to make images of tiny organisms that provide a lot of information. By using 3.2 nm x-rays on human tissue, images can be made showing microtubules in the nuclei of cells. What is the frequency of these x-rays?
4. In order to see objects, the wavelength of the light must be smaller than the object. The Bohr radius of a hydrogen atom is $5.291\ 770 \times 10^{-11}$ m.
    a. What is the lowest frequency that can be used to locate a hydrogen atom?
    b. The visible part of the spectrum ranges from 400 nm to 700 nm. Why aren't individual atoms visible?

5. Your skin tans when melanin within the skin oxidizes. Your skin sunburns when it receives more ultraviolet radiation than the protection provided by the melanin. Generally, ultraviolet (UV) radiation has been divided into two classes: UVA and UVB. You are more likely to be sunburned if you are exposed to radiation in the UVB range (280 nm–320 nm) than in the UVA range (320 nm–400 nm). To what range of frequencies do these wavelength ranges correspond?
6. Suppose you must decide whether a pre-Columbian mask is genuine before buying it for a museum. It looks genuine, but to ensure its authenticity, you shine X rays of wavelength 1.67×10^{-10} m on it to see if a certain element is present. What is the frequency of this radiation?
7. Suppose you use ultraviolet light of frequency 9.5×10^{14} Hz to determine whether a mineral is fluorescent. To what wavelength does this correspond?
8. Meteorologists use Doppler radar to watch the movement of storms. If a weather station uses electromagnetic waves with a frequency of 2.85×10^{9} Hz, what is the length of the wave?
9. PCS cellular phones have antennas that use radio frequencies from 1800–2000 MHz. What range of wavelengths corresponds to these frequencies?
10. Suppose the microwaves in your microwave oven have a frequency of 2.5×10^{10} Hz.
    a. What is the wavelength of these microwaves?
    b. The holes in the door of a microwave oven have a radius of 1.2 mm. Why don't microwaves pass through these holes?
    c. Visible light has a wavelength that ranges from 400 nm to 700 nm. Would visible light be able to pass through the holes? Why or why not?