AP Chemistry **Problem Sets: Atomic Structure and Light.** Unit 4 Prob. Set #1

Problem Set 1: Properties of EM Radiation and Light

1

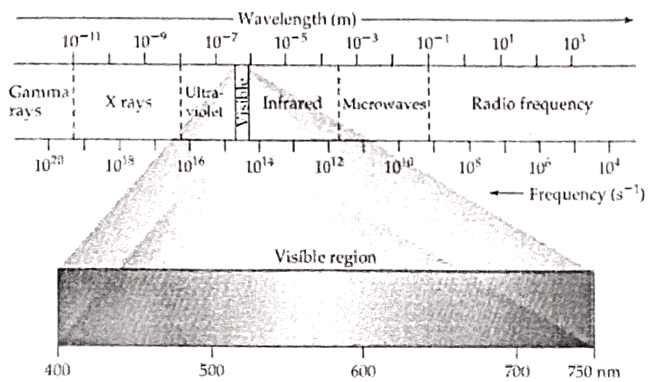
19. What type of relationship (direct or inverse) exists between wavelength, frequency, and photon energy?

2

6.13 Arrange the following kinds of electromagnetic radiation in order of increasing wavelength: infrared, green light, red light, radio waves, X-rays, ultraviolet light.

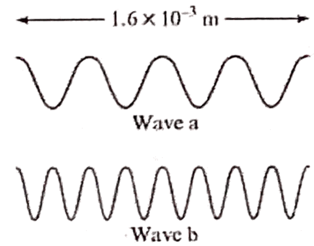
3

6.17 An argon ion laser emits light at 532 nm. What is the frequency of this radiation? Using Figure 6.4, predict the color associated with this wavelength.



4

45. Consider the following waves representing electromagnetic radiation:



Which wave has the longer wavelength? Calculate the wavelength. Which wave has the higher frequency and larger photon energy? Calculate these values. Which wave has the greater velocity? What type of electromagnetic radiation does each wave represent?

5

40. An FM radio station broadcasts at 99.5 MHz. Calculate the wavelength of the corresponding radio waves.

6

6.23 (a) Calculate and compare the energy of a photon of wavelength 3.3 μm with that of wavelength 0.154 nm. (b) Use Figure 6.4 to identify the region of the electromagnetic spectrum to which each belongs.

7

41. Microwave radiation has a wavelength on the order of 1.0 cm. Calculate the frequency and the energy of a single photon of this radiation. Calculate the energy of an Avogadro's number of photons (called an *einstein*) of this radiation.

8

39. The laser in an audio CD player uses light with a wavelength of 7.80×10^2 nm. Calculate the frequency of this light.

9

42. A photon of ultraviolet (UV) light possesses enough energy to mutate a strand of human DNA. What is the energy of a single UV photon and a mole of UV photons having a wavelength of 25 nm?

10

48. X rays have wavelengths on the order of 1×10^{-10} m. Calculate the energy of 1.0×10^{-10} m X rays in units of kilojoules per mole of X rays. AM radio waves have wavelengths on the order of 1×10^4 m. Calculate the energy of 1.0×10^4 m radio waves in units of kilojoules per mole of radio waves. Consider that the bond energy of a carbon–carbon single bond found in organic compounds is 347 kJ/mol. Would X rays and/or radio waves be able to disrupt organic compounds by breaking carbon–carbon single bonds?

Light Calculations

Determine the missing quantities and research the sources and uses of each given type of light below.

WAVE: $c = \lambda v$ where c = the speed of light in vacuum = 3.0×10^8 m/s

PARTICLE: $E = hv$ where h = Planck's constant = 6.626×10^{-34} Js

WAVE			PARTICLE		
Frequency	Wavelength	TYPE/COLOR	Photon Energy	Source	Use
5.66×10^{14} Hz					
	3.0×10^{-15} m				
			6.71×10^{-26} J		
9.0×10^{15} Hz					
	7.6 mm				
			2.92×10^{-19} J		
2.45 GHz					
	290 nm				
			8.22×10^{-14} J		

Challenge Problem

The energy from radiation can be used to cause the rupture of chemical bonds. A minimum energy of 941 kJ/mol is required to break the nitrogen-nitrogen bond in N_2. What is the longest wavelength of radiation that possesses the necessary energy to break the bond? What type of radiation is this?