***Chemistry***

**6: Electronic Structure and Periodic Properties of Elements**

**6.1: Electromagnetic Energy**

1. The light produced by a red neon sign is due to the emission of light by excited neon atoms. Qualitatively describe the spectrum produced by passing light from a neon lamp through a prism.

Solution

The spectrum consists of colored lines, at least one of which (probably the brightest) is red.

3. FM–95, an FM radio station, broadcasts at a frequency of 9.51  107 s–1 (95.1 MHz). What is the wavelength of these radio waves in meters?

Solution



5. Light with a wavelength of 614.5 nm looks orange. What is the energy, in joules, per photon of this orange light? What is the energy in eV (1 eV = 1.602  10−19 J)?

Solution

*c* = *λν*



7. A photon of light produced by a surgical laser has an energy of 3.027  10–19 J. Calculate the frequency and wavelength of the photon. What is the total energy in 1 mole of photons? What is the color of the emitted light?

Solution

*E* = *hν*



Energy mol–1 = 3.027  10–19 J  6.022  1023 mol–1 = 1.823  105 J mol–1; red.

9. The emission spectrum of cesium contains two lines whose frequencies are (a) 3.45  1014 Hz and (b) 6.53  1014 Hz. What are the wavelengths and energies per photon of the two lines? What color are the lines?

Solution

From *c = λν*

(a) 

*E* = *hν* = 6.626  10–34 J ~~s~~  3.45  1014~~s~~~~–1~~ = 2.29  10–19 J

(b) 

*E* = *hν* = 6.626  10–34 J ~~s~~  6.53  1014~~s~~~~–1~~ = 4.33  10–19 J

The color of (a) is red; (b) is blue.

11. One of the radiographic devices used in a dentist’s office emits an X-ray of wavelength 2.090  10–11 m. What is the energy, in joules, and frequency of this X-ray?

Solution

*E* = *hν* = 6.626  10–34 J ~~s~~  1.434  1019~~s~~~~–1~~ = 9.502  10–15 J; *c* = *λν*, 

13. RGB color television and computer displays use cathode ray tubes that produce colors by mixing red, green, and blue light. If we look at the screen with a magnifying glass, we can see individual dots turn on and off as the colors change. Using a spectrum of visible light, determine the approximate wavelength of each of these colors. What is the frequency and energy of a photon of each of these colors?

Solution

See Figure 6.13. Red: 660 nm; 4.54  1014 Hz; 3.01  10−19 J. Green: 520 nm; 5.77  1014 Hz; 3.82  10−19 J. Blue: 440 nm; 6.81  1014 Hz; 4.51  10−19 J. Somewhat different numbers are also possible.

15. What is the threshold frequency for sodium metal if a photon with frequency 6.66  1014 s–1 ejects a photon with 7.74  10–20 J kinetic energy? Will the photoelectric effect be observed if sodium is exposed to orange light?

Solution

*E*photon = *hν* = (6.626  10–34 J s)  (6.66  1014 s–1) = 4.41  10–19 J

*E*photon = *E*kinetic + *E*threshold,.which means that 4.41  10–19 J = 7.74  10–20 J + *E*threshold, thus *E*threshold = 3.64  10–19 J, which corresponds to a threshold frequency of 5.49  1014 s–1. Orange light is roughly 620 nm or 4.84  1014 s–1, which is less than the threshold, so no electrons will be ejected.

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