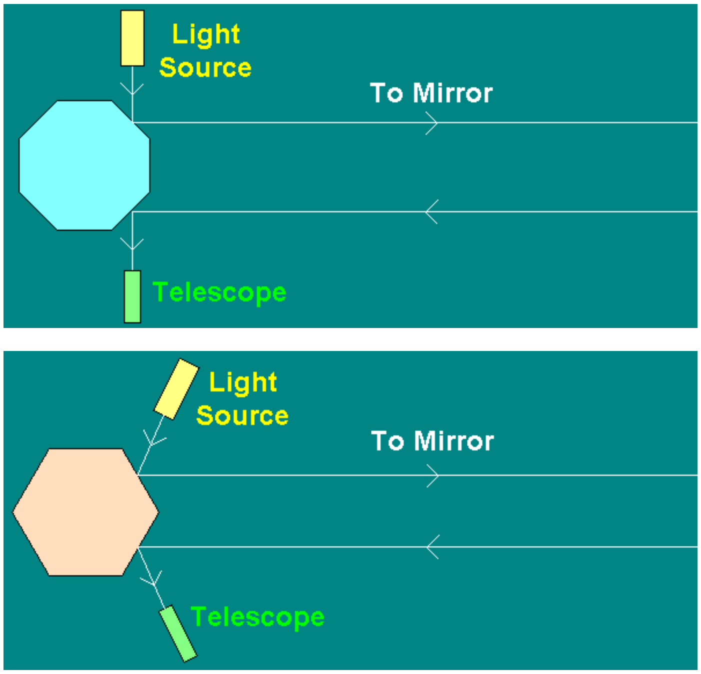
The Fall Break is Almost Here and You Deserve a Break with these Shorter Problems.

HW M1. Measuring the Speed of Light. The speed of light was measured accurately by Michelson around 1880 at the ***US Naval Academy***. He used a rotating octagonal mirror. The light traveled from the mirror to a distant mirror on a mountain 22 miles away and back during the time frame of 1/8 rotation of the mirror.



For this question, consider the 22 miles for the Michelson case to be 21 miles (close enough among friends). Suppose we replace the octagonal mirror with a hexagonal mirror (6 sides). Note how we need to adjust the angles of the light source and telescope in order to make the hexagonal mirror work. How far should the mountain be in order to measure the speed of light with the same rotational rate of the mirror?

SOLUTION

Since the mirror is 6-sided, it will have to make a sixth of a turn instead on an 8th of a turn. This time is 8/6 = 4/3 longer than the 8-sided case. The mountain distance should then be

$$\frac{4}{3}\cdot 21 = 4\cdot 7 = 28 \text{ miles} \qquad \boxed{d = 28 \text{ miles}}$$

HW M2. EM Spectrum. a) Most commercial microwave ovens use microwaves with a frequency of 2,450 MHz, i.e., 2,450,000,000 Hz. What is the wavelength of the microwaves in centimeters to three significant figures?

SOLUTION

$$\lambda = \frac{c}{f} = \frac{3.00\cdot 10^{8} \text{ m/s}}{2.45\cdot 10^{9} \text{ 1/s}} = 1.22\cdot 10^{-1}\text{m}$$

$$\boxed{\lambda = 12.2 \text{ cm}}$$

b) Give the wavelengths in meters to three significant figures for Blue Ridge Public Radio WCQS 88.1 FM (Classical Music, News, Talk) and WISE 1310 AM (Sports).

My Dad's 1970s Kenwood AM-FM Stereo Receiver.

SOLUTION

$$\lambda(88.1\text{ MHz}) = \frac{c}{f} = \frac{3.00 \cdot 10^8 \text{ m/s}}{88.1 \cdot 10^6 \text{ 1/s}} = 3.41\text{ m}$$

$\boxed{\lambda(88.1\text{ MHz}) = 3.41\text{ m}}$ or $\boxed{\lambda(88.1\text{ MHz}) = 3.40\text{ m}}$ with $c = 2.998 \cdot 10^8 \text{ m/s}$

The latter is actually better since starting with "c" to 4 sig figs is safer.

$$\lambda(1310\text{ kHz}) = \frac{c}{f} = \frac{3.00 \cdot 10^8 \text{ m/s}}{1310 \cdot 10^3 \text{ 1/s}} = 229\text{ m}$$

$$\boxed{\lambda(1310\text{ kHz}) = 229\text{ m}}$$

HW M3. EM Spectrum 2. Give the frequency in hertz and the energy in electron volts (eV) for H-alpha, using E = hf, where h is the Planck constant. Look up any conversions for units that you might need. Give your answers to three significant figures.

SOLUTION

$$h = 6.626 \cdot 10^{-34}\text{ J} \cdot \text{s}$$

$$hc = 6.626 \cdot 10^{-34}\text{ J} \cdot \text{s} \cdot (2.998 \cdot 10^8 \ \frac{\text{m}}{\text{s}})(\frac{1\text{ eV}}{1.602 \cdot 10^{-19}\text{ J}}) = 1.240 \cdot 10^{-6} \text{ eV} \cdot \text{m}$$

$$\boxed{hc = 1240 \text{ eV} \cdot \text{nm}}$$

$$E = hf = h\frac{c}{\lambda} = \frac{hc}{\lambda} = \frac{1240 \text{ eV} \cdot \text{nm}}{656.3\text{ nm}} = 1.89\text{ eV}$$ => $\boxed{E = 1.89\text{ eV}}$