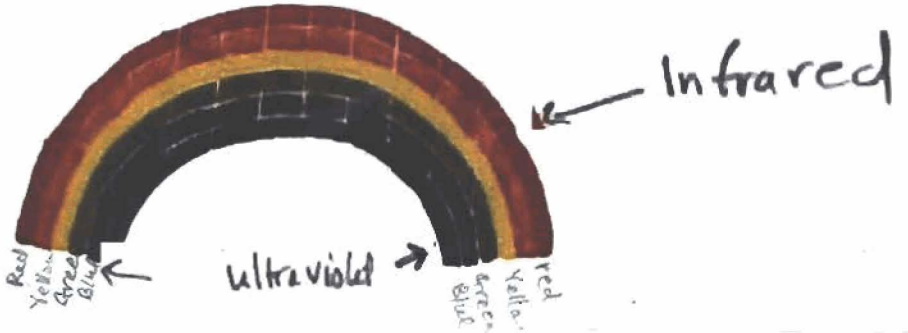
Physics 100 HW 9 (Due 3/16/07) Name S. Olsen

1. According to Maxwell, what do radio waves, visible light and x-rays have in common? How do they differ?

- They all are waves of oscillating $\vec{E}$ & $\vec{B}$ fields
- They all travel in empty space at the same speed: $c = 3\times10^8 m/s$
- They have different wavelengths & frequencies

2. Sketch a rainbow, preferably in color, otherwise indicate which colors are where. On what edges of the rainbow would the infrared- and ultraviolet-light be?



3. Blue light has a wavelength in air of $450 \times 10^{-9} m$ ($= 450 nanometers$), what is its frequency?

$$f\lambda = c \Rightarrow f = \frac{c}{\lambda} = \frac{3\times10^8 m/s}{450\times10^{-9} m} = 6.7\times10^{14} Hz$$

4. Atoms have diameters of about $10^{-10} m$ ($= 0.1 nanometers$). Why can't we use a visible light microscope with super-duper magnification to see what they look like?

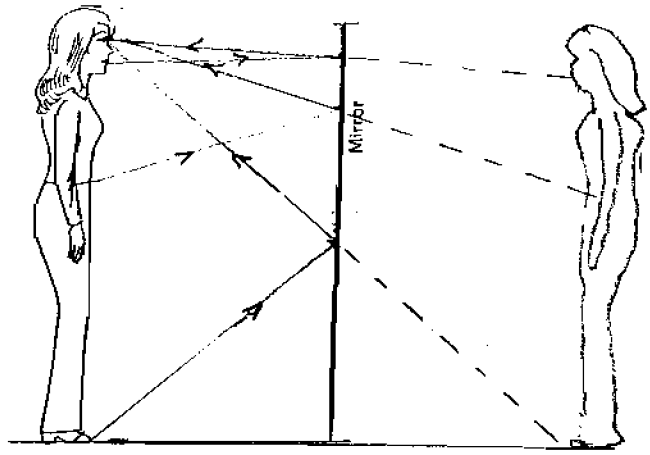
Because the dimensions of atoms are much smaller than the wave lengths of visible light.

5. Doctors use ultrasound, sound waves with frequencies of a few million hertz, to follow the development of fetuses in their mother's womb. What is the minimum size of fetal features that doctors would be able to distinguish using ultrasound waves with a frequency $f = 2 \times 10^6$ Hz? (The speed of sound in human tissue is $1500 m/s$.)

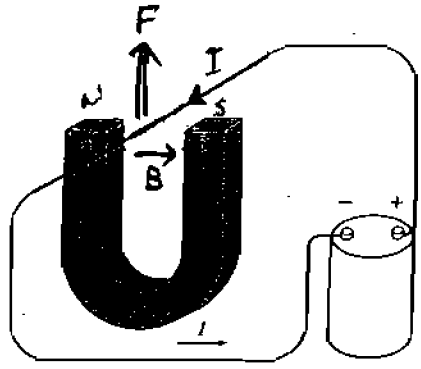
minimum size $\approx$ wavelength

$$\lambda = \frac{v}{f} = \frac{1.5\times10^3 m/s}{2\times10^6 Hz} = 0.75\times10^{-3} m = 0.75 mm$$

6. The figure at the right indicates a woman looking at herself in a mirror. Sketch how the light rays from her feet, waist, and face get to her eyes. Does she need a full-length mirror to see her whole body?



7. The wire in the figure at the right carries an electric current between the poles of a horseshoe magnet as shown. Indicate with an arrow the direction of the magnetic force on the wire.



8. Light is shined through a narrow slit as shown in the figure below. The dimension of the slit is comparable to the light's wavelength. Sketch what the light intensity pattern on the screen looks like.

9. Sketch the intensity pattern for the case where the light is shined through two slits as shown below. The dimension of the slits and their separation distance are comparable to the light's wavelength.