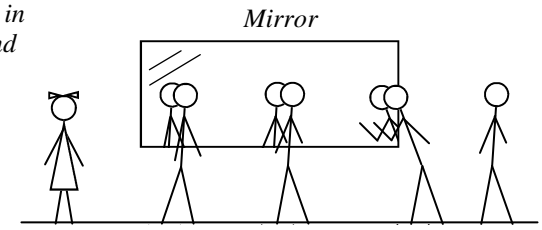
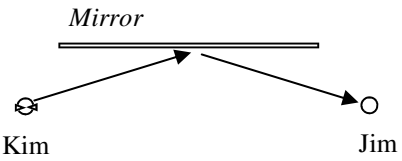
PreAP Light and Optics 6

Slim Jim is walking by a long flat mirror (plane mirror). His image is always exactly in front of his body, even when he moves beyond the mirror. When he looks around the edge of the mirror, the image of his legs are still attached to his upper body. When he is to the right of the mirror Slim Jim can't see himself, but Slim Kim can see him. The diagram at the right shows why.





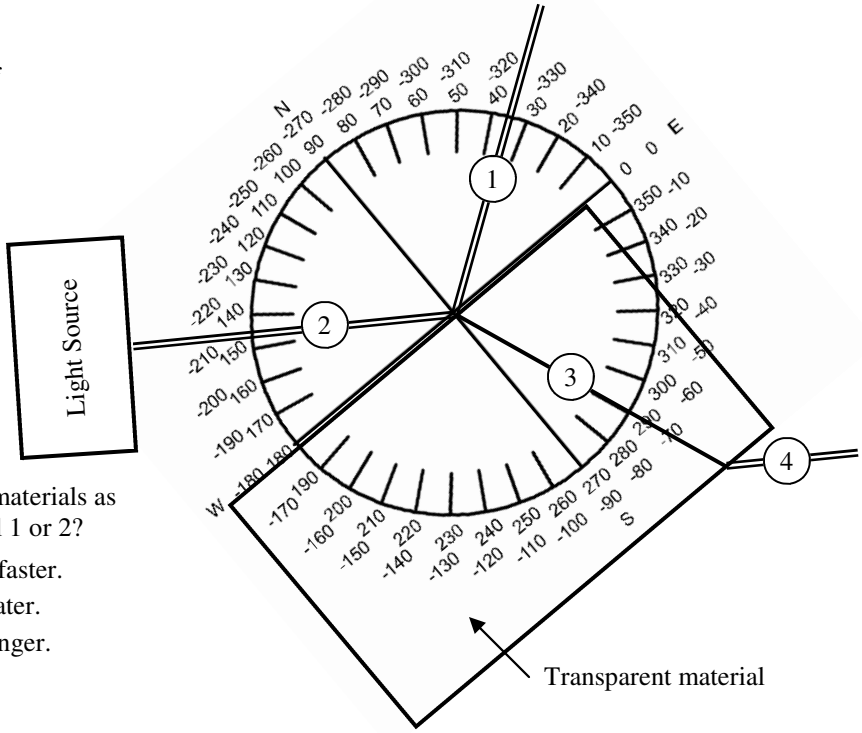
1. <u>In both diagrams</u> above show where Jim's image is when he is on the right of the mirror. For the right diagram continue the straight line from Kim thru the mirror. Make it dotted to show that it is not real when it goes into the mirror.

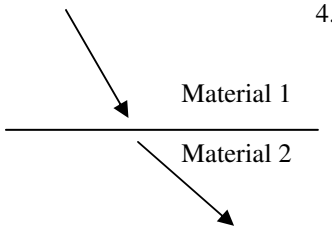
2. Think about yourself when looking in a mirror. You reach your hand close to the mirror. Where is your image's hand? Is it closer or farther from the mirror than your image's body?

3. A. Use the diagram at the right to find the index of refraction of the transparent material.

   B. Using the table of indexes of refractions, what material is this?

   C. What is the speed of light in this material?





4. Light passes between two materials as shown at the left. Material 1 or 2?
   A. ____ Speed of light is faster.
   B. ____ Frequency is greater.
   C. ____ Wavelength is longer.
   D. ____ n is smaller.

5. 480 nm light passes from air into a substance that has an index of refraction of 1.8.
   A. * Calculate the speed of light in the new substance.

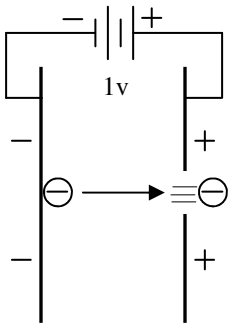
   B. Calculate the wavelength of light in the new substance.

   C. * Calculate the energy of the light in air. (*See previous HW for the equation.*)

6. Compared to the previous 480 nm photon, how much energy does a 550 nm photon have?

7. So, to increase the energy of a photon do you want to shorten or lengthen the wavelength?

Turns out that a joule is a VERY large unit of energy for photons, which are usually in the magnitude of 10^{-19} J. So scientist use a much more useful unit of energy: the electron volt (eV). Scientists use electron volts for most atomic and nuclear physics. It is defined below:



An electron repelled by a negative plate and attracted by a positive plate has potential energy. Since volts = J/C, then PE = qV. This potential energy becomes kinetic energy, so that $qV = \frac{1}{2}mv^2$.

An electron volt is defined as (≡) the energy an electron gains when accelerated thru a potential difference of 1 volt.

1eV = (charge of electron)×1 volt
= 1.6×10^{-19} C(1 J/C) = 1.6×10^{-19} J

SO: $1eV \equiv 1.6\times10^{-19}$ J

You change to or from eV you could do a conversion OR use this easy method: 8eV = 8(1.6×10^{-19} C)(1 J/C) = 12.8×10^{-19} J

8. * An electron is accelerated thru a potential difference of 12 volts. Calculate its energy in electron volts.

9. * A photon has an energy of 6.5×10^{-19} J. How many electron volts is that?

10. A photon has a frequency of 3.5×10^{15} Hz.
    A. Calculate its energy.

    B. Convert this energy to eV.

5A) 3E8/1.8 = 1.67E8 m/s
5C) E = hf = hc/λ = 6.63E-34(3E8)/480E-9 = 4.14E-19 J/photon
8) 12eV = 12(1.6E-19)(1J/C) = 1.92E-18 J
9) 6.5E-19/1.6E-19 = 4.1eV