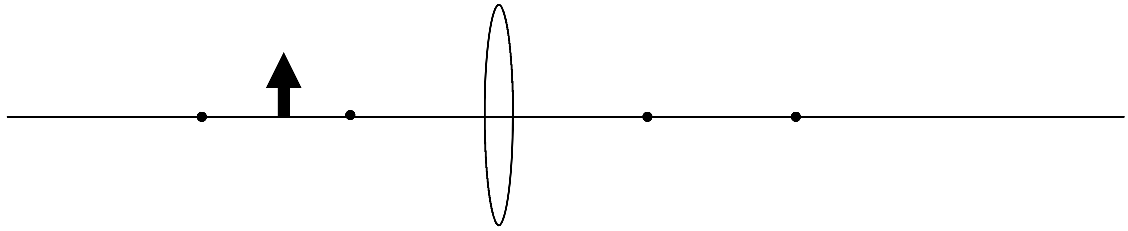
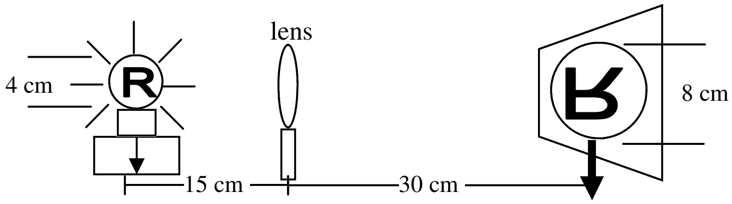
B-day: Due Mon., May 3
A-day: Due Tues., May 4

2009-10 Light 7

1. Draw the ray diagram at the right.

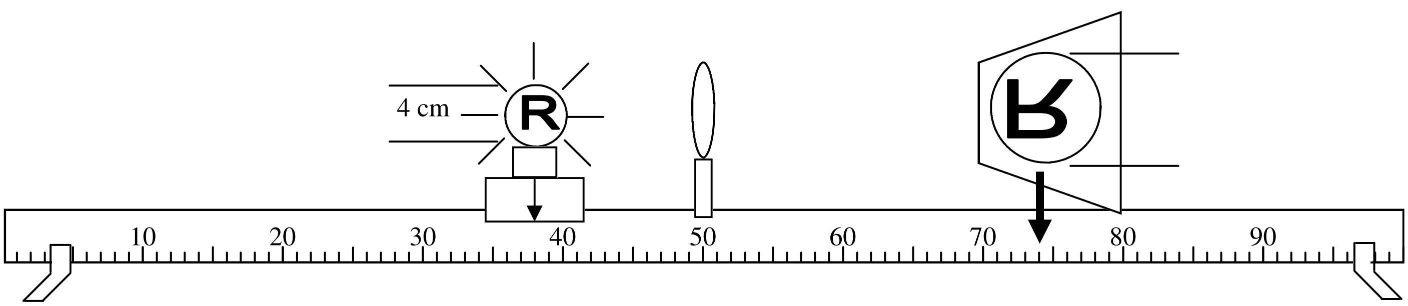


Let's now learn more about magnification (M), image distance (q), and height of the image (h'). The equation for magnification: M = −q/p = h'/h can be split up into: M = −q/p and M = h'/h. h' is negative if inverted (upside down).



2. A. h' = B. h =
   C. Calculate M =

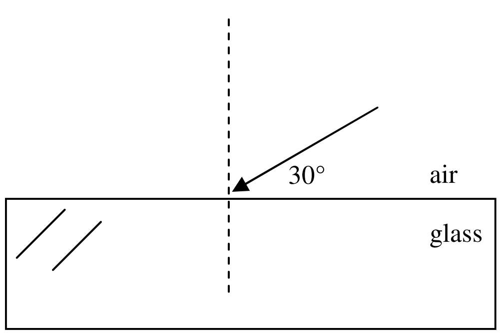
   D. Magnified, reduced, or same.
   E. Real or virtual image?
   F. p = _ G. q =
   G. Calculate f.



3. Label p, q, h, and h' on the diagram above.
   B. Is the image real or virtual?
   C. Is the image magnified or reduced?
   D. Will the value of (the number for) M be + or −?
   E. Is the image on the real or virtual side of the lens?
   F. Calculate the focal length.

   G. What is the radius of curvature for this lens?
   H. Label f and C on the diagram on both sides.
   I. Calculate the magnification.
   J. Calculate the height of the image.

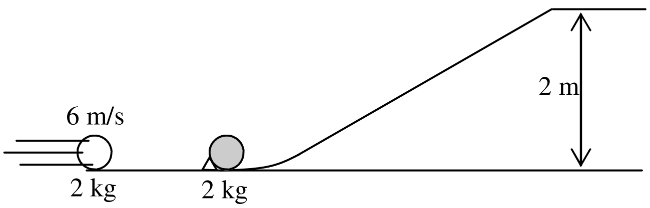
   K. To make the image bigger, which way would you move the object?



4. Use the diagram at the right to answer the following questions.
   A. Which is the first substance light is traveling in?
   B. For Snell's Law ($n_1\sin\theta_1 = n_2\sin\theta_2$), n_1 is air or glass?
   C. If all angles must be from the normal, what is θ_1?
   D. Does light speed up or slow down as it passes into the glass?
   E. What is the same for light as it passes into glass?
   F. Draw what will happen to the light in the glass AND after it passes all the way thru the glass.
   G. Find the angle of refraction after it passes into the glass.

5. Using the indexes of refraction from the "Refraction" notes, find the speed of light in ice.

6. Somehow you can change the index of refraction of substances. To make light faster, do you increase or decrease the index of refraction of a material?



7. A. On the diagram at the left, calculate the potential energy necessary to get the ball up the ramp.

   B. Calculate the energy in the moving ball.

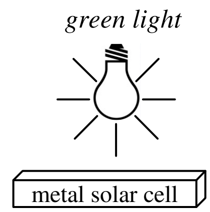
   C. Does the moving ball have enough energy to get the left ball up the ramp?

   D. If you hit the stationary ball with a second identical moving ball, would it get up the ramp?

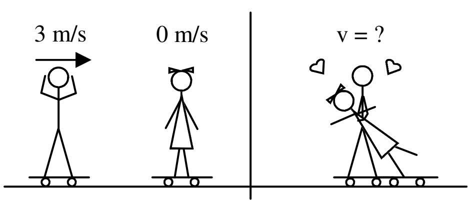
   D. What would happen if the moving ball had 50 J of energy and gave all of it to the stationary ball?

From the "Photoelectric Effect" notes:

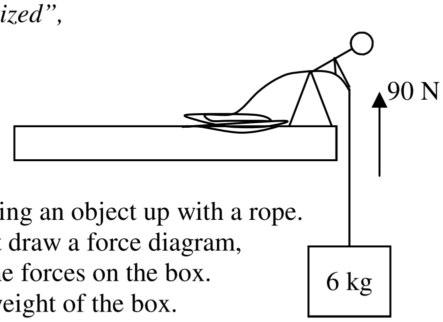
8. Which has more energy: blue or red light?
9. Which has more energy: high frequency or low frequency of light?
10. Which has more energy: long wavelength or short wavelength light?
11. A photovoltaic cell (*solar cell*) has green light shining onto it, but no electrons are being ejected (*coming off*).
    A. Would electrons start to flow if you left the light on for a long time?
    B. Would electrons be ejected if you changed to red light?
    C. Would electrons come out if you changed to blue light?



The photoelectric effect is how we know that the energy of photons are "quantized", meaning each photon has a particular amount of energy.



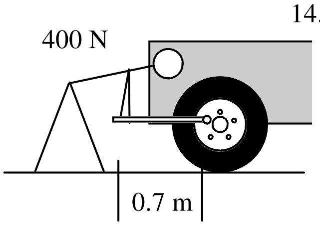
12. Remember when Slim Jim met Slim Kim? Jim is 60 kg and Kim is 40 kg. How fast are the two of them going after they meet?



13. Slim Jim is lifting an object up with a rope.
    A. On the dot draw a force diagram, labeling the forces on the box.
    B. Find the weight of the box.

    C. If Jim pulls on with 90 N, find the net force on the object.

    D. Calculate the acceleration of the box.



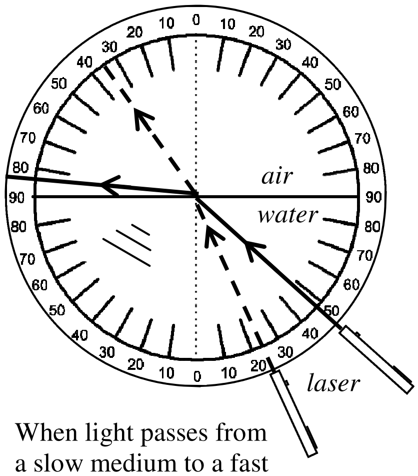
14. Slim Jim has a flat tire. He pushes on the lug wrench with 400N, 0.7 m away from the lug nut.
    A. Calculate the amount of torque he uses to remove the lug nut.

    B. Give 2 ways to increase the torque.

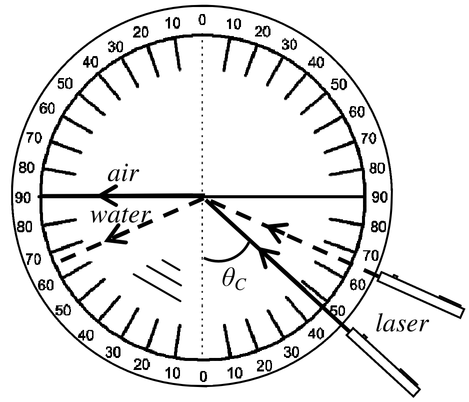
Torque

Perpendicular Force (*in N*)

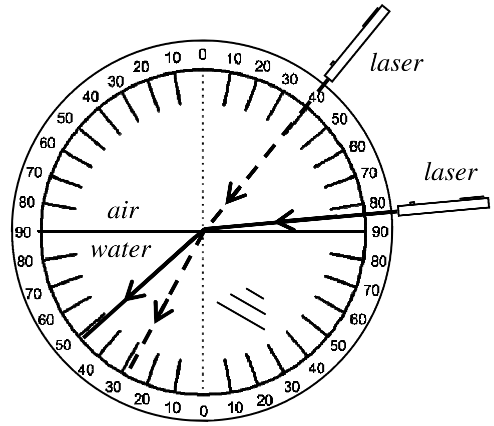
Torque (*in Nm*) → $\tau = Fd$ ← Distance from pivot to where the force is attached (*in m*)



When light passes from a slow medium to a fast medium (like water to air), the light always bends away from the normal and the angle gets bigger. Eventually the refracted light approaches 90°, the surface of the water.



At the **critical angle** (θ_C) the light refracts at 90°, parallel to the surface. Past θ_C (*example below*) he light reflects back into the slower medium. This is known as **total internal reflection**.



When passing from fast to slow mediums (like air to water) light bends toward the normal, meaning the angle in the slower medium will ALWAYS be smaller. This is why **there is no critical angle from fast to slow mediums.**

To find the critical angle (θ_C) we use Snell's Law and set θ_2 equal to 90°.

Slow *Fast*

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$
$$n_1 \sin\theta_C = n_2 \sin 90$$
$$n_1 \sin\theta_C = n_2 1$$
$$\boxed{\sin\theta_C = \frac{n_2}{n_1}}$$

Critical Angle —Past this angle light reflects back into a slower medium.

Critical Angle

$$\sin\theta_C = \frac{n_2}{n_1}$$

Index of Refraction in second medium

Index of Refraction in first medium

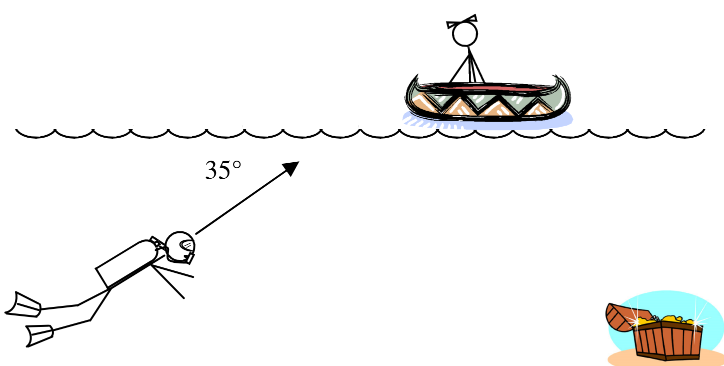
Only if $n_1 > n_2$ (slow to fast).

Example: What is the critical angle as light passes from water to air?	
$n_1 = 1.33$ *(from water)* $n_2 = 1$ *(to air)* $\theta_C = ?$	$\sin\theta_C = \frac{n_2}{n_1}$ $\sin\theta_C = \frac{1}{1.33} = 0.752$ $\theta_C = \sin^{-1}(0.752) = 48.8°$

Going a bit farther, for extra credit on the test. Read the material above and answer the following.

15. Substance 1 has an index of refraction of 1.68. Substance 2 has an index of refraction of 2.4.
    A. In which substance does light travel faster?
    B. In which case would there be a critical angle: from substance 1 OR from substance 2?

16. Calculate the critical angle from light as it passes from a diamond to water.



17. Slim Jim is also a diver. Jim finds a treasure chest and wants to signal Slim Kim in the boat above. He can see the bottom of the boat poking thru the surface of the water, but he can't see Kim.
    A. Remembering to use all angles from the normal, calculate the angle in air.

    B. What happens to the light?