



# *MND Physics*

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## Snell' Law of Refraction

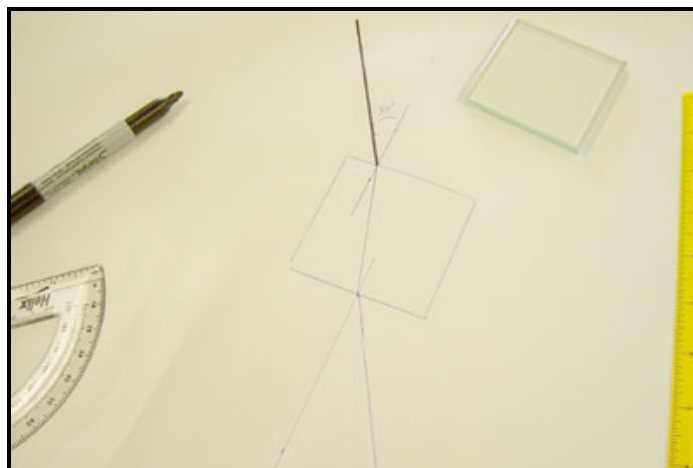
Light travels at different speeds in different media. Light bends (refracts) at the boundary as it travels from one media into another. If light enters a more optically dense media at an angle, the ray will bend towards the normal. Conversely, if light enters a less optically dense media at an angle, the ray will bend away from the normal.

The index of refraction of a substance is the ratio of the speed of light in a vacuum to its speed in the substance:

$$n_s = c / v_s$$

For any light ray traveling between media, Snell's Law can be written:

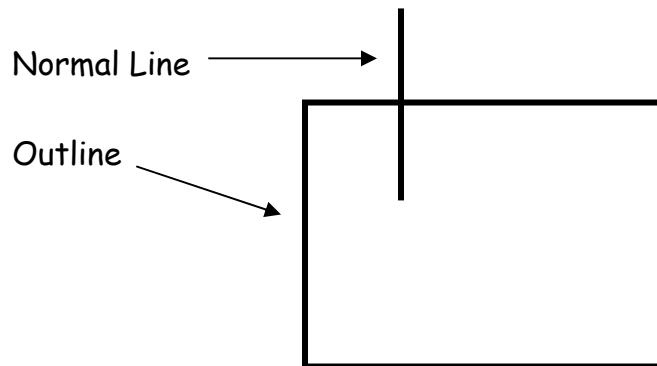
$$n \sin \theta = n \sin \theta$$



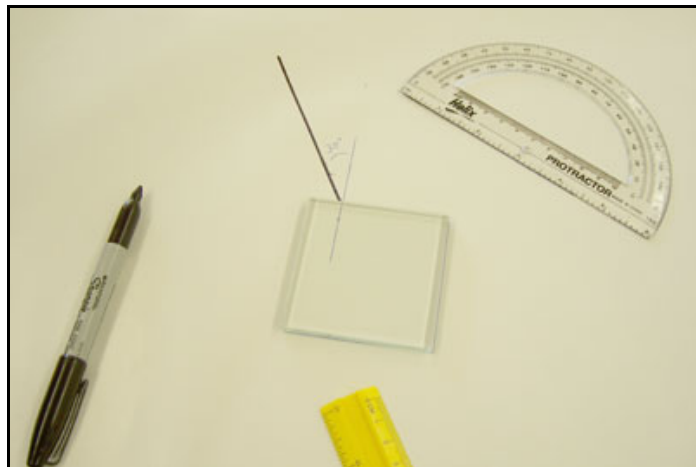
**EQUIPMENT:** Crown glass square plate, metric ruler, protractor, drawing paper, black marking pen.

**PROCEDURE: PART 1 Incident angle of 30 degrees.**

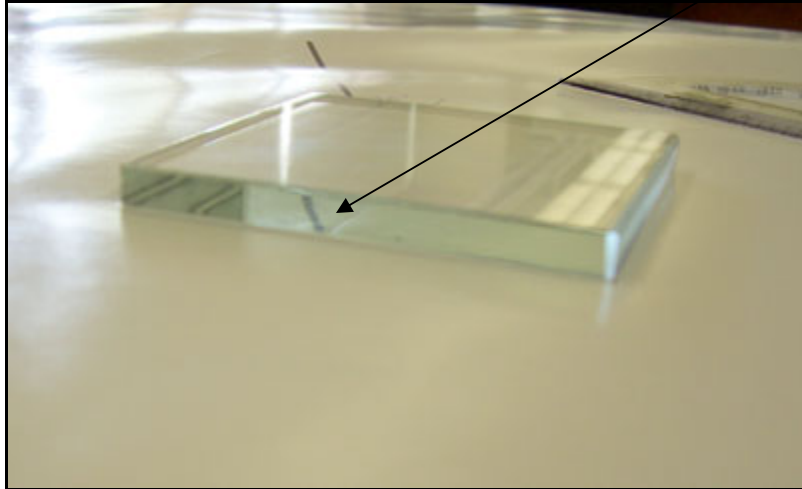
1. Place the crown glass plate in the center of a sheet of drawing paper. Use a pencil or pen to draw an outline of the plate.
2. Remove the glass plate and construct a normal line at the top left.



3. Use your ruler and protractor to draw a heavy line which forms an angle of 30 degrees with the normal as shown. Then replace the glass plate in the outline.



4. With your eyes on a level with the glass plate, sight along the edge of the plate until you locate the image of the heavy line in the edge of the glass.



5. Now, sight down the edge of the ruler so that the ruler's edge and the heavy line image in the edge of the glass line up exactly (as shown here):

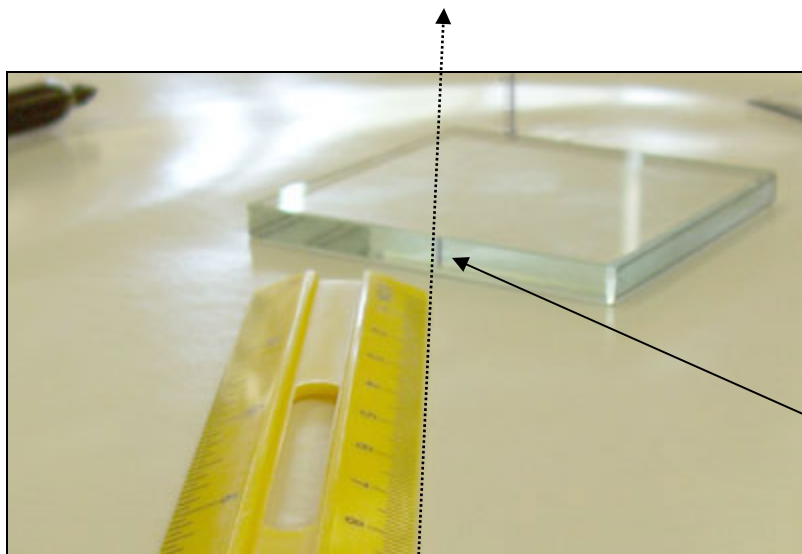
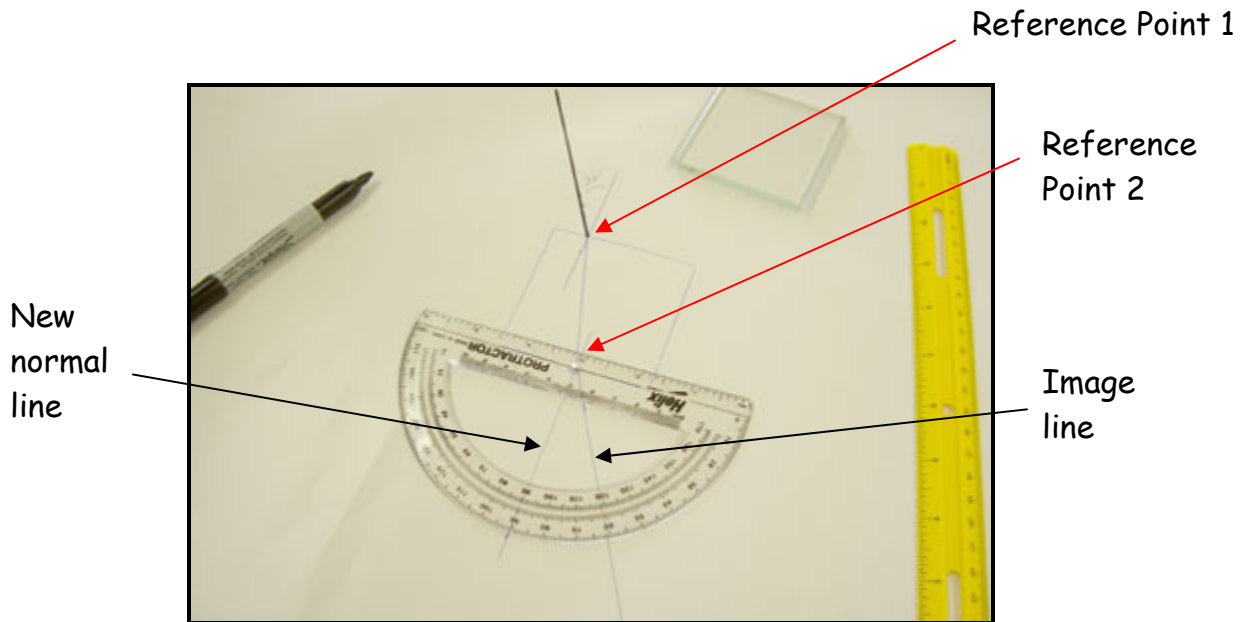


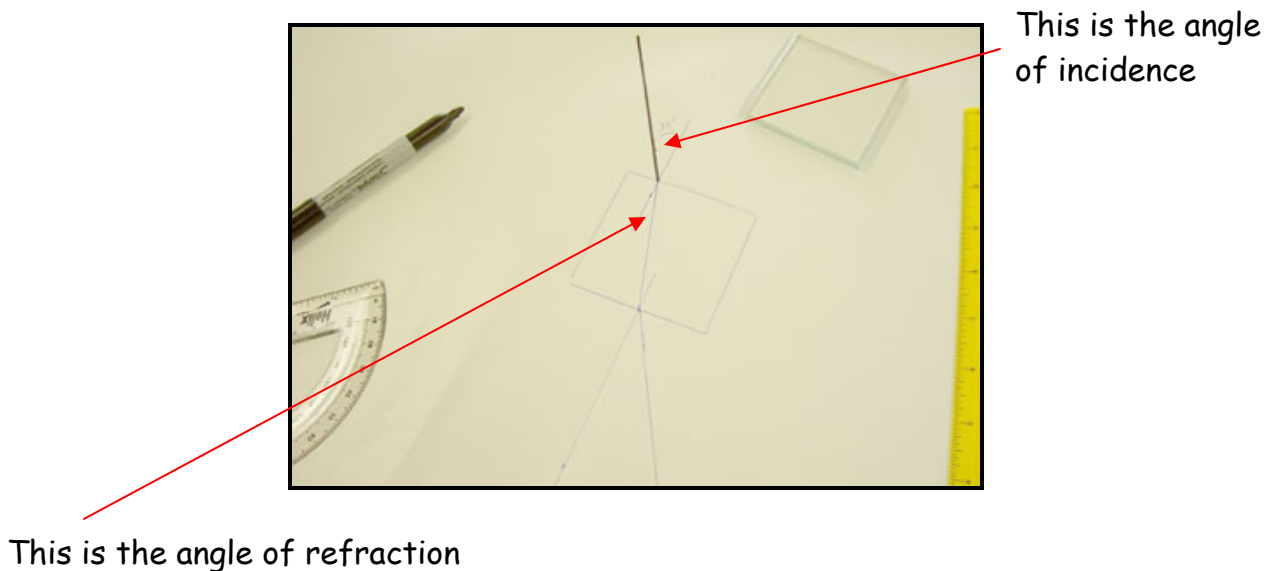
Image  
of Line  
in Glass

Line of Sight

6. While holding the ruler firmly, carefully draw a line along the ruler edge. This new line is called the Image line. Temporally remove the glass plate and extend the straight line all the way to the glass plate outline so that it just touches the outline.
7. Using your protractor, draw a second normal line where the Image line meets the glass outline (at Reference Point 2).



8. Connect Reference Point 1 and Reference Point 2 with a line. This line represents the internal path of the light ray through the glass.
9. Finally, measure the angle of refraction (inside the glass):



10. Using Snell's Law, calculate the index of refraction of crown glass.
11. Compare the result in step #10 with the accepted index of refraction from your text book.
12. Calculate the % error.

**PROCEDURE: PART 2 Incident angle of 45 degrees.**

Repeat steps 1 through 12 above using a 45 degree angle as the angle of incidence. You can use empty available space on the same drawing paper for this trial.

**ANALYSIS:**

Discuss all sources of error.

**QUESTIONS:**

- 1) Will light be refracted more while passing from air into water or while passing from water into glass? Justify your answer with calculations.
- 2) You are spear fishing and standing knee-high in a clear stream. You notice a fish swim up to your feet, about a meter in front of you. To spear this fish, will you have to aim exactly at the fish's image, somewhere between your feet and the fish image, or somewhere out beyond the image of the fish? Explain using a drawing.