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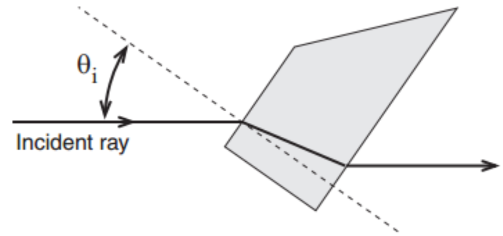
LAB 11. RAY OPTICS: SNELL'S LAW

AP PHYSICS II



Driving Question | Objective

If light has different speeds in different mediums, how will that affect the paths in which light travels from one medium to another?

Materials and Equipment

- Acrylic Block
- Light Source
- Protractor
- White Paper
- Ruler

Procedure

1. Place the light source in ray-box mode on a sheet of white paper. Turn the wheel to select a single ray.
2. Place the trapezoid on the paper in the square on the handout. Trace the outline of the trapezoid with a pencil.
3. Position it so the ray passes through the parallel surfaces, as shown in the figure above.
4. As the ray is shining through the trapezoid, trace the path of the incident and transmitted ray. Indicate the incoming and outgoing rays with arrows in the appropriate directions. Carefully mark where the rays enter and leave the trapezoid.
5. Remove the trapezoid and draw a line on the paper connecting the points where the rays entered and left the trapezoid. This line represents the ray inside the trapezoid.
6. Choose either the point where the ray enters the trapezoid of the point where the ray leaves the trapezoid. At this point, draw the normal to the surface.
7. Measure the angle of incidence and the angle of refraction with a protractor. Both of these angles should be measured from the normal. Record the angles in the first row of Table 1.
8. After you complete the analysis on the back of this page, use your equation to calculate the index of refraction, assuming the index of refraction of air is 1.0.

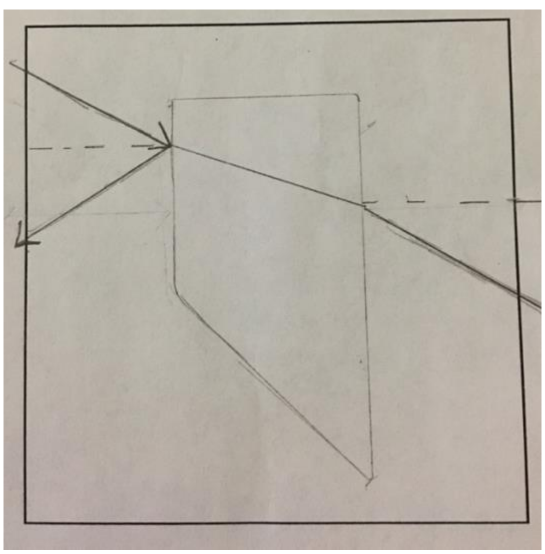


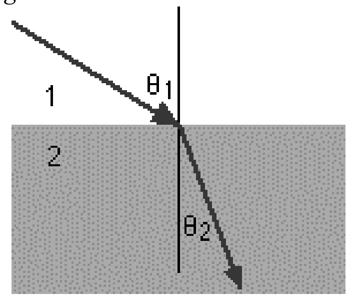
Table 1

Angle of Incidence	Angle of Refraction	Calculated Index of Refraction
25°	19°	1.298

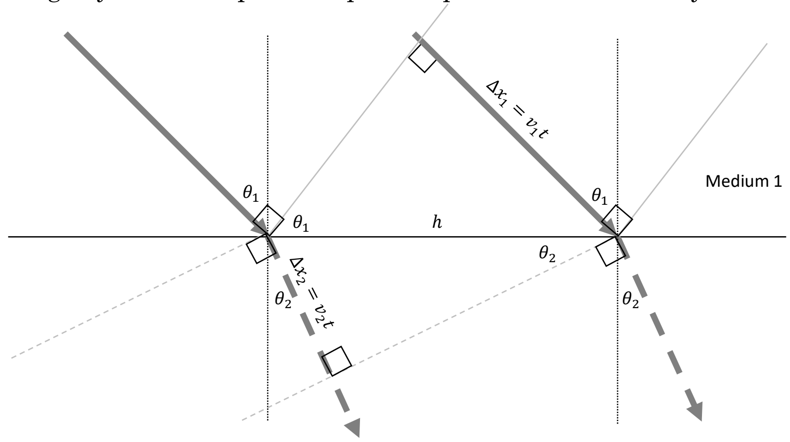
Analysis

❷ 1. Let's create a relationship between the indices of refraction and the angles of incidence and refraction.

a) Let's begin by looking at a basic sample of a refracted ray.



b) Now let's look at a slightly more complex sample of 2 parallel refracted rays. Certain right angles have been identified.



c) Defining a few variables, we have:

a. $\boldsymbol{\theta_1}$**:** The angle of incidence. There are some other geometrically equivalent angles labeled above.

b. $\boldsymbol{\theta_2}$**:** The angle of refraction. There are some other geometrically equivalent angles labeled above.

c. $\boldsymbol{\Delta x_1 = v_1 t}$**:** The distance the incident light travels in a time t.

d. $\boldsymbol{\Delta x_2 = v_2 t}$**:** The distance the refracted light travels in *the same time* t.

e. $\boldsymbol{h}$**:** an arbitrary distance between the 2 incident rays when they change mediums.

d) Using the variables above, can you express h in terms of $\boldsymbol{v_1 t}$ and $\boldsymbol{\theta_1}$? $h = \frac{v_1 t}{\sin\theta_1}$

e) Using the variables above, can you express h in terms of $\boldsymbol{v_2 t}$ and $\boldsymbol{\theta_2}$? $h = \frac{v_2 t}{\sin\theta_2}$

f) Set these h's equal to each other and provide an equation which only contains the variables $v_1 t,\ v_2 t,\ \theta_1,$ & θ_2. Do any variables cancel out? Check your answer with Mr. Hart. t

g) Now lets define an **<u>index of refraction</u>** of a material, n, to be the ratio of the speed of light in a vacuum, c, to the speed of light in that material, v: $\boldsymbol{n = \frac{c}{v}}$

a. Thus $n_1 = \frac{c}{v_1}$, and $n_2 = \frac{c}{v_2}$.

h) Find an algebraic method to incorporate the indices of refraction, n_1 & n_2 into your equation from f).

$$\boldsymbol{n_1 sin\theta_1 = n_2 sin\theta_2}$$

This equation is called ***<u>Snell's Law</u>***

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