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What's Your Angle? Worksheet Answer Key

Objective: To study and understand how different liquids affect refraction of light.

Materials:

- 100-ml beakers (6)
- 20 ml water
- 20 ml ethyl alcohol
- 20 ml clear dish soap
- 20 ml corn syrup
- 20 ml vegetable oil
- one laser pointer (prefer green laser)
- one protractor
- one ruler
- a dry-erase marker or masking tape (to label beakers)

Safety Precautions: Do not look directly into the laser at any time.

Procedure:

1. Take six 100-ml beakers.
2. Label the beakers with the medium name using masking tape or dry-erase markers as described below.
   i) Beaker 1 - air (leave the beaker empty)
   ii) Beaker 2 - water
   iii) Beaker 3 - ethyl alcohol
   iv) Beaker 4 - clear dish soap
   v) Beaker 5 - vegetable oil
   vi) Beaker 6 - corn syrup
3. Add 20 ml of the labeled liquid to beakers 2 through 6.
4. Place the six beakers in the circles on the placemats.
5. Search for the densities of the known liquids online.
6. Place the laser on the placemat. Note the laser should always stay flat on the table.
7. Turn on the laser and aim it toward beaker 1 at an angle.
8. Using a protractor, measure the angle the light from the beaker makes with the normal line (horizontal line).
9. On the opposite side, ask one team member to measure the angle of the refracted light with the normal line.
10. Enter your data into the data table.
11. Repeat the procedure for the rest of the beakers, pointing the laser toward the liquid. Use the same angle of entry for each liquid.
12. Compute the index of refraction for each liquid using the angles from the data using the following formula:

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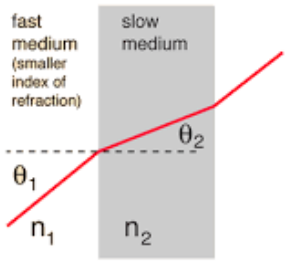
Snell's Law

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



13. Find the indices of refraction of the liquids used and enter them into the data table. Remember, because air is the first medium, the index of incidence (n1) will be 1.00.

Data:

#	Medium	Density	Angle of Entry/Incidence	Angle of Exit/Refraction	Index of Refraction	Known Index of Refraction
1	Air	0.001	40°	38°	1.04	1.00
2	Water	1.00	40°	27.5°	1.39	1.33
3	Ethyl Alcohol	0.791	40°	27.2°	1.40	1.36
4	Clear Dish Soap	1.03	40°	31.6°	1.23	1.20
5	Vegetable Oil	0.93	40°	25.0°	1.52	1.47
6	Corn Syrup	1.48	40°	24.5°	1.55	1.52

Analysis/Questions:

1. Why does the light bend when it enters a new medium?

When a light beam travels from one medium to another, its velocity decreases or increases depending on the optical density of the other medium. This phenomenon is called refraction of light.

2. How do the exit angles compare with the densities of the liquids?

When light travels from a more dense to a less dense medium, the light wave speeds up and bends away from normal. For a less dense to a more dense medium, the light wave slows down and bends toward the normal.

3. How do the experimental indices of refraction compare with the known indices of refraction?

Our results were somewhere close to the known indices of refractions. The variation of the data could be the result of several causes, such as measuring angles, slight difference of the medium etc.

Conclusion:

Write a conclusion for this activity based on your observations.

A light wave refracts when entering a different medium. If light travels from a medium with lower refractive index n_1 to another medium with a higher index n_2, it is bent toward the normal and vice versa. Mathematically, the angle of incident and that of the refracted ray are connected by the equation $n_1 * \sin \theta_1 = n_2 * \sin \theta_2$. This represents Snell's law. The medium with the highest density refracts most because it has the highest index of refraction, while low density medium shows less refraction.