Pre-Lab Questions 5

Topic: Index of Refraction

Objective: To enable the students to state and differentiate important concepts and terms so that Experiment 5 can be carried out meaningfully.

After answering these questions, the students will be able to:

1. Describe the refraction of light.
2. Define *index of refraction* and state *Snell's law of refraction*.
3. State the reason why light is refracted when it passes from one transparent medium to another.
4. Apply Snell's law when a ray passes into and out of different transparent medium with parallel faces.

## PRE-LAB QUESTIONS 5

**Answer the following questions and submit your group answers to the instructor.**

1. What is *refraction* of light?

2. Define *index of refraction.*

3. Why is light refracted when it passes from one transparent medium into another transparent medium of different optical density?

4. State *Snell's law of refraction.*

5. A light beam travelling through a transparent medium of index of refraction $n_1$ passes through a thick transparent slab with parallel faces and index of refraction $n_2$ as shown in Fig. 1. Show that the emerging beam is parallel to the incident beam.

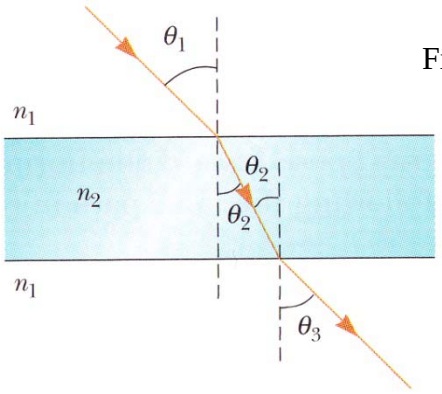


Fig. 1

Experiment 5

Topic: Index of Refraction

**Objective: To determine the index of refraction of a glass block.**

Learning Outcomes of Experiment 1

After doing the experiment, the students will be able to

1. determine the index of refraction of a given glass block.
2. calculate the uncertainty of the experimental results.
3. write a report on the experiment.
4. state the appropriate and reasonable sources of error or factors that contributed to the uncertainties in the result.

Introduction

When light passes from one transparent medium into another transparent medium of different optical density at an angle other than normal to the surface, the light is bent at the boundary. It is said to be refracted.

The relationship between the angle of incidence, $\theta_1$, angle of refraction, $\theta_2$, velocity of light in medium 1, $v_1$ and velocity of light in medium 2, $v_2$ is given as:

$$\frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1} = constant \quad \text{.....(1)}$$

The index of refraction , n, of a medium is defined as:

$n = \frac{c}{v}$ ……..(2)

*c* is the speed of light in vacuum
*v* is the speed of light in a medium

By using equation (1), (2) and the fact that $v = f\lambda$ and f does not change when light enters different medium of different optical density, Equation (1) can also be written as:

$n_1 \sin\theta_1 = n_2 \sin\theta_2$ ……(3)

Equation (3) is also known as Snell's law of refraction.
Indices of refraction for various substances area given in Table 1.

Instructions

1. Discuss with your group how you are going to determine the index of refraction of a given glass block.

2. A glass block, pins, soft board, protractor, a piece of white papers, and a ruler are available to be used in this experiment.

3. Decide how the measurements are to be carried out and the number of measurements that you need to take.

4. Tabulate your data.

5. Calculate the index of refraction of the glass block by:

   a) Direct substitution into equation (3)
   b) Computing the gradient of sin $\theta_1$ versus sin $\theta_2$.
   c) Calculate the average n from part (a) and (b).

6. Hand in your group report at the end of the lab period.

7. All groups will be scheduled to present and defend their procedures and results of certain experiments in class.

Table 1: Indices of refraction for various substances

| Substance | Index of refraction | Condition |
|---|---|---|
| Crown Glass | 1.52 | Solid at $20°C$ |
| Flint Glass | 1.66 | Solid at $20°C$ |
| Sodium Chloride | 1.54 | Solid at $20°C$ |
| Water | 1.33 | Liquid at $20°C$ |
| Air | 1.000293 | Gasses at $0°C$ |

Format of the Laboratory Report

1. *Objective* : State the objective of the experiment.
2. *Apparatus* : State the instruments used.
3. *Theory* : State the formula that you used to calculate the index of refraction of the glass block.
4. *Procedures* : Describe the steps that you take to perform the experiment.
5. *Data* : Present the data appropriately. Use correct and consistent significant figures. State the units and uncertainties of each quantity.
6. *Results* : Show the calculations of the index of refraction of the glass block.
7. *Conclusions* : Indicate what is measured, the uncertainties and the sources of uncertainties.

Post- Lab Questions

1. Using the value of n determined in your experiment, compute the speed of light in the glass block.

2. Compute the percent difference between the n from the experiment to the values of n for crown and flint glass in Table 1.

3. Describe an improvement that you think can be done in order to make the experiment easier to carry out.

References

Vuille, C., Serway, R.A., and Faughn, J.S. (2009) College Physics. 8th Ed. Brooks/Cole Cengage Learning.Belmont, CA.

Wilson, J.D. and Hernández-Hall, A.C. (2010). Physics Laboratory Experiments. 7th Edition. Brooks/Dale Cengage Learning. Boston, MA.