

# PHYZ SPRINGBOARD: INDEX OF REFRACTION 1



## 1. Speed

When light travels through a vacuum, it propagates at  $3.0 \times 10^8$  m/s.

When light travels through glass, it propagates at  $2.0 \times 10^8$  m/s.

When light travels through gallium phosphide, it propagates at  $0.86 \times 10^8$  m/s.

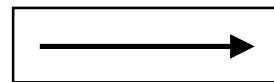
a. If the speed of light in a vacuum is  $c$  and the speed of light in a transparent material is  $v$ , write and name the ratio of the speed of light in a vacuum to the speed of light in the transparent material.

$$\frac{c}{v} = n \quad \text{The Index of Refraction}$$

b. Show calculations to determine the value of this ratio for

i. glass. 
$$\frac{3.0E+8 \text{ m/s}}{2.0E+8 \text{ m/s}} = 1.5$$

ii. gallium phosphide. 
$$\frac{3.0E+8 \text{ m/s}}{0.86E+8 \text{ m/s}} = 3.5$$



## 2. Wavelength

When light from a laser pointer travels through a vacuum, its wavelength is 670 nm.

When light from a laser pointer travels through glass, its wavelength is 447 nm.

When light from a laser pointer travels through gallium phosphide, its wavelength is 191 nm.

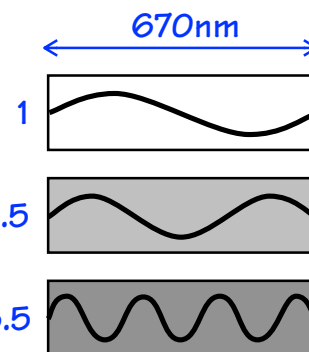
a. What is the ratio of the wavelength of light in a vacuum to the wavelength of light

i. in glass? 
$$\frac{670E-9 \text{ m}}{447E-9 \text{ m}} = 1.5$$

ii. in gallium phosphide? 
$$\frac{670E-9 \text{ m}}{191E-9 \text{ m}} = 3.5$$

b. What is the expression and name of the ratio of the wavelength of light in a vacuum ( $\lambda_1$ ) to the wavelength of light in a transparent material ( $\lambda_2$ )?

$$\frac{\lambda_1}{\lambda_2} = n \quad \text{The Index of Refraction}$$

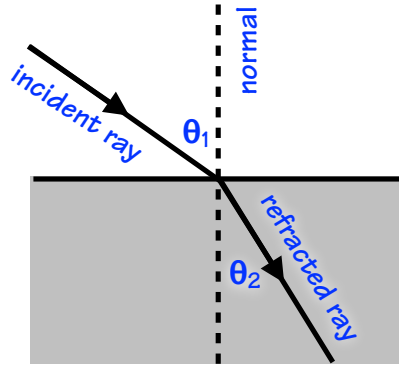


### MARGINAL QUESTIONS

1. How long are the three rectangles above?
2. How many waves are contained in each rectangle?

### 3. The Bends

The diagram to the right shows a beam of light incident from a vacuum to glass at an oblique angle.



a. Label the following:

- incident ray
- refracted ray
- normal
- angle of incidence ( $\theta_1$ )
- angle of refraction ( $\theta_2$ )

b. Not all of the light from the incident beam is refracted into the glass.

i. Which ray is missing from the diagram above?

*the reflected ray*

ii. Add it to complete the diagram.

c. For light passing from a vacuum to glass, what is the general relationship between the angle incidence and the angle of refraction?

$$\theta_1 > \theta_2$$

d. If 524 nm light had been incident from a vacuum to deucenaquarterium ( $n = 2.25$ ),

i. how fast would the light travel in the deucenaquarterium?

$$c/v = n$$
$$v = c/n = 3E+8 \text{ m/s} / 2.25$$

ii. what wavelength would the light have in the deucenaquarterium?

$$\lambda_1/\lambda_2 = n$$
$$\lambda_2 = \lambda_1/n = 524 \text{ nm} / 2.25 = 233 \text{ nm}$$