

Refraction Problems **ANSWERS**

1) Given the speed (v) of light listed below, determine the index of refraction (n) for each material. Recall that the speed of light in a vacuum = $c = 3.00 \times 10^8$ m/s. **$n = c/v$**

- a. Ruby ($v = 1.95 \times 10^8$ m/s) **1.54**
- b. Ethyl alcohol ($v = 2.20 \times 10^8$ m/s) **1.36**
- c. Sapphire ($v = 1.69 \times 10^8$ m/s) **1.78**

2) Calculate the speed of light in each of the following substances: **$n = c/v$**

- a. Diamond ($n=2.42$) **1.24×10^8 m/s**
- b. Crown glass ($n=1.52$) **1.97×10^8 m/s**
- c. Water (liquid) ($n=1.33$) **2.26×10^8 m/s**
- d. Water (ice) ($n=1.30$) **2.31×10^8 m/s**

3) If the angle of incidence (from air, $n=1.00$) is 30° , find the angle of refraction in the following substances: **snell's law**

- a. Water ($n=1.33$) **22.1°**
- b. Diamond ($n=2.42$) **11.9°**
- c. Ethyl Alcohol ($n=1.36$) **21.6°**
- d. Zircon ($n=1.90$) **15.3°**

4) If the angle of incidence (from crown glass, $n=1.52$) is 30° , find the angle of refraction in each substance listed in question #3. a) **34.8°** b) **18.3°** c) **33.9°** d) **23.6°**

5) a) Draw a ray diagram to show the path of ray of light as it passes from air ($n=1.00$) into a block of flint glass ($n=1.61$). Be sure to sketch the normal and show your measured angles and calculations using Snell's Law.

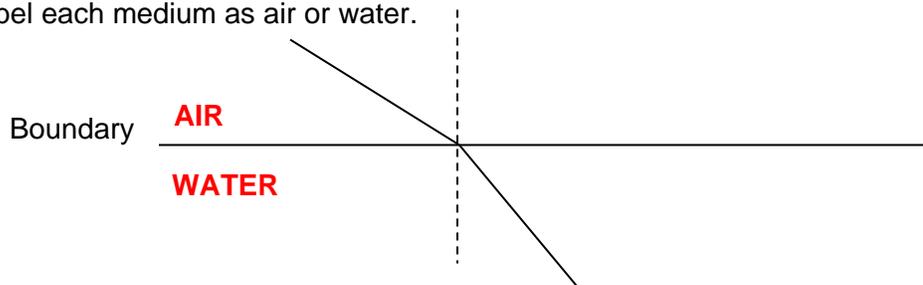


b) What would happen to the angle of refraction if the block was made of ice ($n=1.30$)?

14.5°

c) What will happen to the path of light when it passes back into the air? **20°**

6) In the diagram below, light is crossing a boundary from air ($n = 1.00$) to water ($n = 1.33$). Label each medium as air or water.

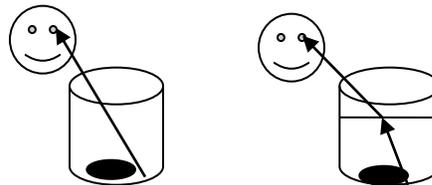


7) If the angle of refraction is 10° for the following substances find the angle of incidence:

- a. Diamond ($n=2.42$) to air ($n=1.00$) **4.1°**
- b. Air to diamond **24.7°**
- c. Air ($n=1.00$) to water ($n=1.33$) **13°**
- d. Water to diamond **18°**

8) You want to scoop a fish out of water. Where should you aim relative to the fish to capture it? Explain using a diagram.

9) In the reappearing coin demonstration, a coin in a cup can only be viewed when water is in the cup. Explain how this demonstration works using ray diagrams showing the cup without water and containing water.

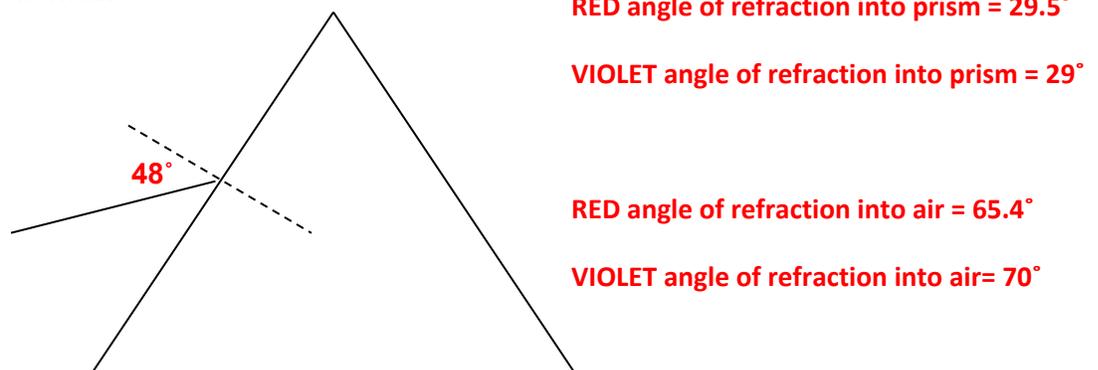


10) Dispersion is a phenomena in which the various wavelengths of visible light can be separated by a material such as glass, producing a spectrum (e.g. in a rainbow). This is caused by the fact that different colours of light travel at slightly different speeds in various materials. For example, the refractive index for red light in crown glass is 1.51, while the refractive index for violet light is 1.53.

a) Which colour of light travels at a slower speed in glass?

$V_{\text{RED}} = 1.99 \times 10^8 \text{ m/s}$ **$V_{\text{VIOLET}} = 1.96 \times 10^8 \text{ m/s}$**

b) A prism is a device which uses dispersion to create a visible spectrum pattern (ROYGBIV). If the prism is made of crown glass, draw a ray diagram to show the path of both red and **VIOLET** light through the prism. Note that 4 calculations using Snell's Law will be required. *Be sure to always measure the incident angle relative to the normal.*



11) A diagram below shows a ray travelling from air into an object composed of 3 different media. Complete the diagram by continuing the ray until it leaves the object.

This question will be taken up in class

