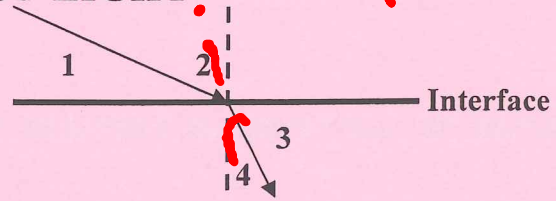


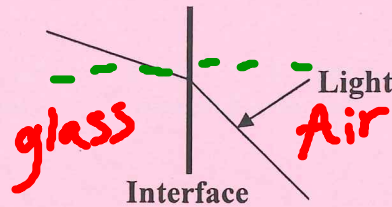
Name: \_\_\_\_\_  
Due: Feb. 8

## THE BENDING OF LIGHT

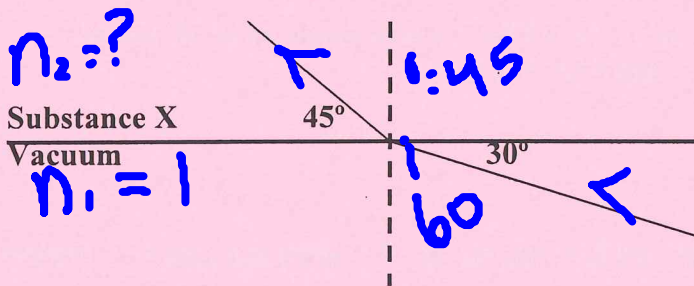
1. In the diagram at right, which is the angle of incidence? The angle of refraction?



2. The diagram at right shows the path of light traveling from air into glass. On which side is the glass?



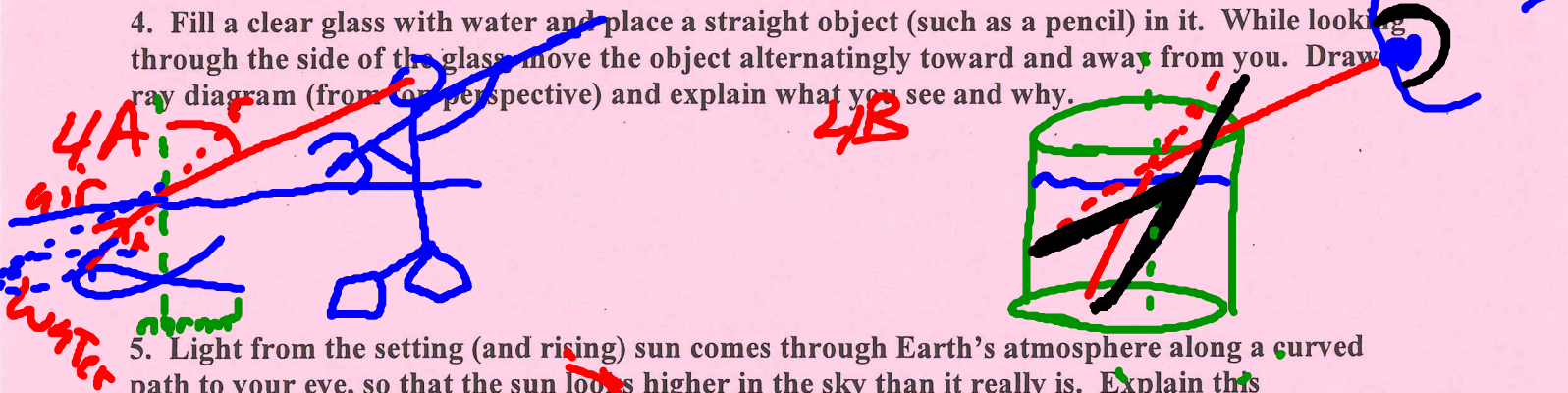
3. Calculate the index of refraction for substance X below.



$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$n_2 = \frac{\sin 60}{\sin 45} = 1.225$$

4. Fill a clear glass with water and place a straight object (such as a pencil) in it. While looking through the side of the glass, move the object alternately toward and away from you. Draw ray diagram (from top perspective) and explain what you see and why.



5. Light from the setting (and rising) sun comes through Earth's atmosphere along a curved path to your eye, so that the sun looks higher in the sky than it really is. Explain this phenomenon and illustrate with a diagram.



6. Explain nearsightedness and farsightedness. Which type of lens corrects these deficiencies?

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7. A ray of light passes from water into benzene. If the angle of incidence is  $40^\circ$ , what is the angle of refraction?

8. Calculate the speed of light in water at  $20^\circ\text{C}$ .

$$n = \frac{c}{v} \quad \text{so} \quad v = \frac{c}{n} = \frac{3 \times 10^8 \text{ m/s}}{\frac{4}{3}} = 2.25 \times 10^8 \text{ m/s}$$

9. A beam of light traveling in air passes into a slab of transparent material. If the angle of incidence is  $40^\circ$  and the angle of refraction is  $25^\circ$ , determine what the material is.

10. A light beam passes from air to a layer of ice on a lake with an angle of incidence of  $25^\circ$ .

a. Calculate the angle of refraction of light inside the ice.

$$\sin r = \frac{n_i \sin \theta_i}{n_r} = \frac{1 \sin 25^\circ}{1.309} = .3229$$

b. The light then passes out of the ice and into the water; calculate the angle of refraction for the light passing into water.

$$r = \sin^{-1}(.3229) = 18.8^\circ$$

$$\sin r = \frac{n_i \sin \theta_i}{n_r} = \frac{(1.309)(\sin 18.8^\circ)}{1.333} = .317$$

$$r = \sin^{-1}(.317) = 18.4^\circ$$

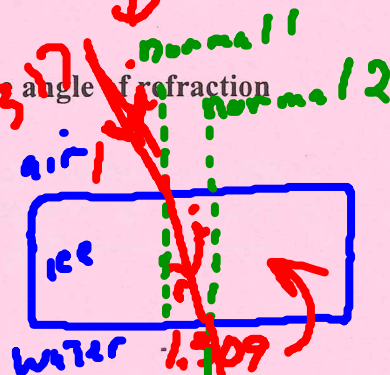


TABLE 35.1 Index of Refraction for Various Substances Measured with Light of Vacuum Wavelength  $\lambda_0 = 589 \text{ nm}$

Substance	Index of Refraction	Substance	Index of Refraction
Solids at $20^\circ\text{C}$		Liquids at $20^\circ\text{C}$	
Diamond (C)	2.419	Benzene	1.501
* Fluorite ( $\text{CaF}_2$ )	1.434	Carbon disulfide	1.628
Fused quartz ( $\text{SiO}_2$ )	1.458	Carbon tetrachloride	1.461
Glass, crown	1.52	Ethyl alcohol	1.361
Glass, flint (heavy)	1.66	Glycerine	1.473
Ice ( $\text{H}_2\text{O}$ )	1.309	Water	1.333
Polystyrene	1.49		
Sodium chloride ( $\text{NaCl}$ )	1.544		
Zircon	1.923		
Gases at $0^\circ\text{C}$ , 1 atm		Gases at $0^\circ\text{C}$ , 1 atm	
Glass: Light flint	1.575	Air	1.000293
Very heavy flint	1.89	Carbon dioxide	1.00045
Zinc crown	1.545		
Extra dense crown	1.625		
Albite	1.489		
Anorthite	1.575		
Lucite	1.50	Acrylic	1.48-1.52
Quartz	1.55	Fused silica	1.46
Amber	1.546	Calcite	1.66
Plexiglass	1.51	PVC	1.54
Nylon	1.53	Sapphire	1.76
Polypropylene	1.49		