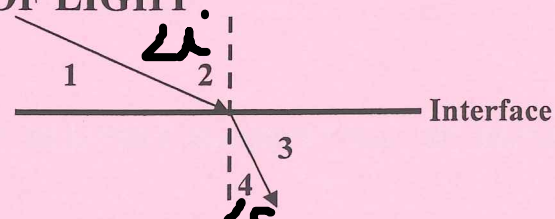
Name: _____
Due: _____

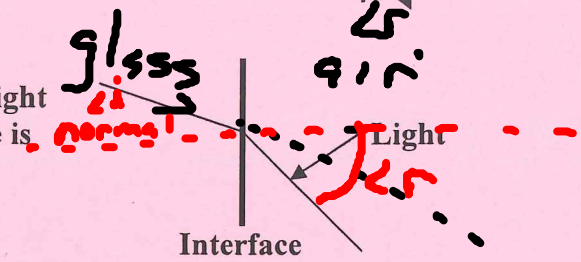
THE BENDING OF LIGHT

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

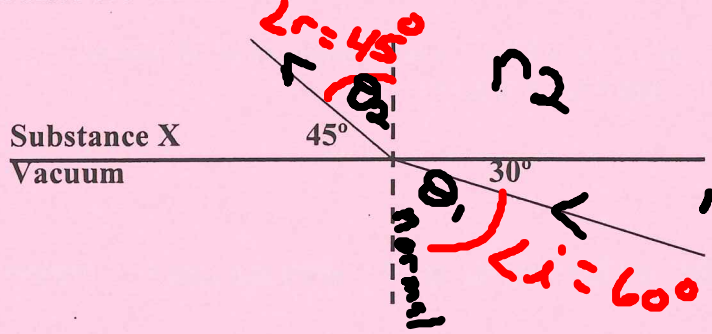


2. The diagram at right shows the path of light traveling from air into glass. On which side is the glass?

Left side



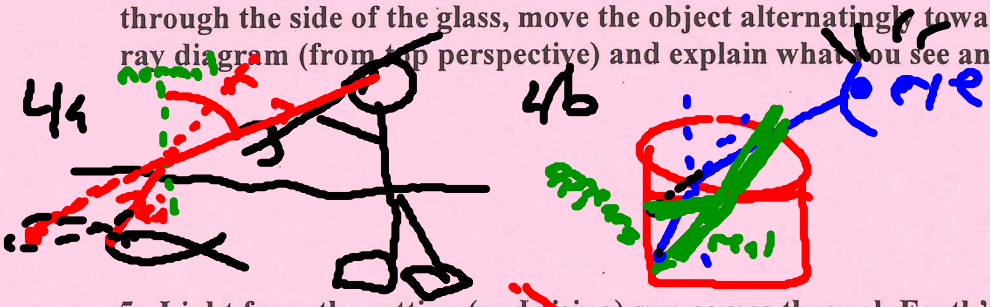
3. Calculate the index of refraction for substance X below.



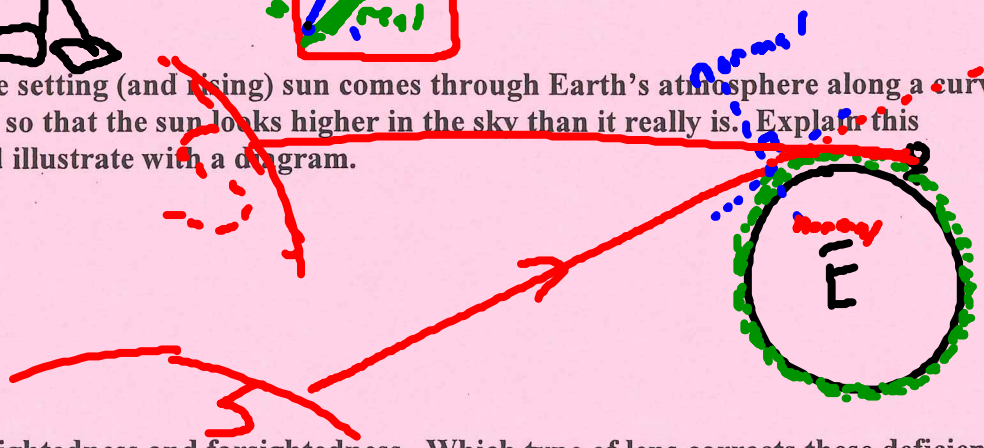
$$\frac{n_1}{n_2} = \frac{\sin\theta_r}{\sin i}$$

$$n_2 = \frac{(n_1)\sin i}{\sin r} = \frac{\sin 60°}{\sin 45°} = \frac{\frac{\sqrt{3}}{2}}{\frac{\sqrt{2}}{2}} = \frac{\sqrt{3}}{2}\cdot\frac{2}{\sqrt{2}} = \frac{\sqrt{6}}{2} = 1.224$$

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 alternatingly toward and away from you. Draw a 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?

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

8. Calculate the speed of light in water at 20° C.

$n_s = \frac{c}{V_s}$ so $V_s = \frac{c}{n_s} = \frac{3\times10^8 \text{ m/s}}{\frac{4}{3}}$ $2.25\times10^8 \frac{m}{s}$

9. A beam of light traveling in air passes into a slab of transparent material. If the angle of incidence is 40° and the angle of refraction is 25°, 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°.

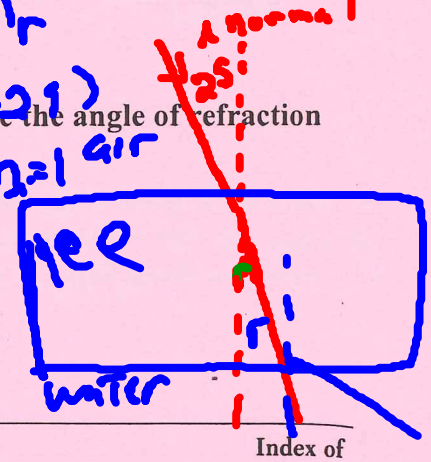
a. Calculate the angle of refraction of light inside the ice.

$\frac{n_i}{n_r} = \frac{\sin\theta_r}{\sin\theta_i}$ so $\sin\theta_r = \frac{n_i \sin\theta_i}{n_r} = \frac{(1)\sin 25°}{1.309}$

$\sin\theta_r = .3229$

$\theta_r = \sin^{-1}(.3229)$

$\theta_r = 18.8°$ $n=1$ air



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

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

Substance	Index of Refraction	Substance	Index of Refraction
Solids at 20°C		Liquids at 20°C	
Diamond (C)	2.419	Benzene	1.501
Fluorite (CaF_2)	1.434	Carbon disulfide	1.628
Fused quartz (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 (H_2O)	1.309	Water	1.333
Polystyrene	1.49	Gases at 0°C, 1 atm	
Sodium chloride (NaCl)	1.544	Air	1.000293
Zircon	1.923	Carbon dioxide	1.00045

Glass:	Light flint	1.575	Lucite	1.50	Acrylic	1.48-1.52
	Very heavy flint	1.89	Quartz	1.55	Fused silica	1.46
	Zinc crown	1.545	Amber	1.546	Calcite	1.66
	Extra dense crown	1.625	Plexiglass	1.51	PVC	1.54
	Albite	1.489	Nylon	1.53	Sapphire	1.76
	Anorthite	1.575	Polypropylene	1.49		

vacuum $n=1$