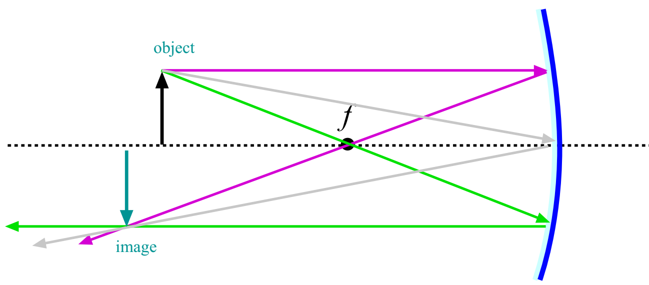
Name__________________________

Apr. 14, 2008

Quiz #3 — Spring 2008

Phys 2020 (NSCC)

1. **a)** Shown here is a diagram for an object in front of a concave mirror. (The object is farther away than the focal point.) On the diagram, draw rays and locate the image. (Hint: This case was demonstrated in class when I put a concave mirror *far* from someone's face.)



Rays have been added to the original figure. They are: Parallel $\longrightarrow$ Focal Point, Focal Point $\longrightarrow$ Parallel, and a ray which hits the center and bounces at equal angles. The image is shown.

b) Is the image real or virtual? Upright or inverted? (Explain your choices.)

It is real because light rays truly emanate from a point. It is inverted because the image is... upside-down!

2. An object of height 4.0 cm is 50.0 cm in front of a convex mirror whose radius of curvature is 60.0 cm.

Find the location of the image (be sure you specify if it is in front of the mirror or behind it). Find the height of the image, and state whether it is real or virtual, upright or inverted.

For a convex mirror the focal length is *negative* (focal point is on the far side). So from the data we have

$$|f| = R/2 = 30.0 \text{ cm} \qquad \Longrightarrow \qquad f = -30.0 \text{ cm}$$

We are given that $d_o = +50.0 \text{ cm}$ and $h_o = 4.0 \text{ cm}$. From the mirror equation,

$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{1}{(-30.0 \text{ cm})} - \frac{1}{(50.0 \text{ cm})} \qquad \Longrightarrow \qquad d_i = -18.8 \text{ cm}$$

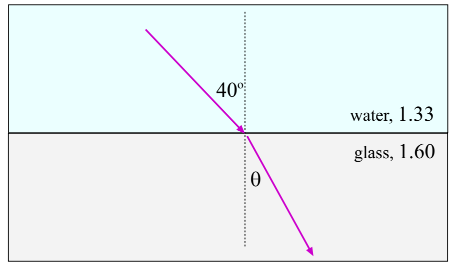
The magnification and image height are

$$m = -\frac{d_i}{d_o} = 0.375 \qquad \Longrightarrow \qquad h_i = mh_o = 1.5 \text{ cm}$$

The image is located 18.8 cm on the far side of the mirror; it is a $\boxed{\text{virtual}}$ image since d_i is negative; it is $\boxed{\text{upright}}$. The height of the image is $\boxed{1.5 \text{ cm}}$.

3. a) Light passes from water to glass; it is incident on the glass at an angle of 40.0° from the vertical. (Indices of refraction for the two materials are given in the figure.)

At what angle (from the vertical) does the refracted beam pass into the glass?



Use Snell's law; solve for the second angle:

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad \Longrightarrow \qquad (1.33)\sin 40^\circ = (1.60)\sin\theta_2$$

Solve for θ_2:

$$\sin\theta_2 = \frac{(1.33)}{(1.60)}\sin 40^\circ = 0.534 \qquad \Longrightarrow \qquad \theta_2 = 32.3^\circ$$

b) What is the speed of light in the glass material of this problem?

From the definition of the index of refraction, $n = \frac{c}{v}$, get:

$$v = \frac{c}{n} = \frac{(3.00\times 10^8\,\frac{\mathrm{m}}{\mathrm{s}})}{(1.60)} = 1.88\times 10^8\,\frac{\mathrm{m}}{\mathrm{s}}$$

You must show all your work and include the right units with your answers!

$$c = 3.00\times 10^8\,\tfrac{\mathrm{m}}{\mathrm{s}} \qquad I = I_0\cos^2\theta \qquad \lambda f = v \qquad n = \frac{c}{v}$$

$$|f| = R/2 \qquad \frac{1}{d_o}+\frac{1}{d_i}=\frac{1}{f} \qquad m = \frac{h_i}{h_o} = -\frac{d_i}{d_o} \qquad n_1\sin\theta_1 = n_2\sin\theta_2 \qquad \sin\theta_c = \frac{n_2}{n_1}$$

$$\text{Interference:}\quad \sin\theta_{\mathrm{br}} = m\frac{\lambda}{d} \qquad \text{Diffraction:}\quad \sin\theta_{\mathrm{dark}} = p\frac{\lambda}{a}$$