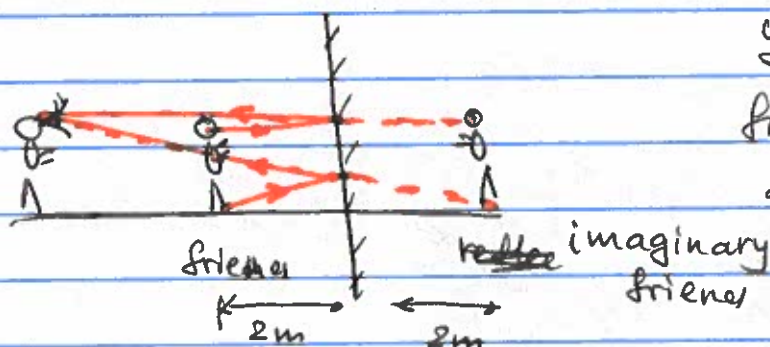


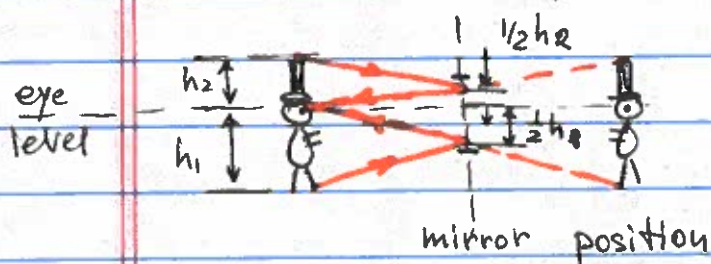
Homework #1 - solutions

A1: Flat mirror creates virtual images with magnification 1



You will see your friend's reflection 2m behind the mirror, 6m from you

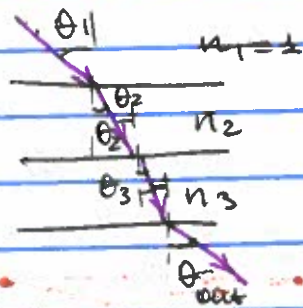
A2. You need to make sure that the ~~beam~~^{ray} originated from your toes and top of your head make it into your eyes (I'll add a top hat to make it more visual)



$$\text{Min mirror size} = \frac{1}{2}h_1 + \frac{1}{2}h_2 = \frac{1}{2} \text{ your height}$$

The bottom of the mirror should be at $\frac{1}{2}h_1$ - half way b/w your toes and your eyes. Then the top will be half way b/w your eyes and the top of your head/hat

A3 At each surface we will apply Snell's law
 $\frac{1}{\sqrt{2}} = n_1 \sin \theta_1 = n_2 \sin \theta_2 = n_3 \sin \theta_3$
 $\dots = n_1 \sin \theta_{out}$
 (same as the first)

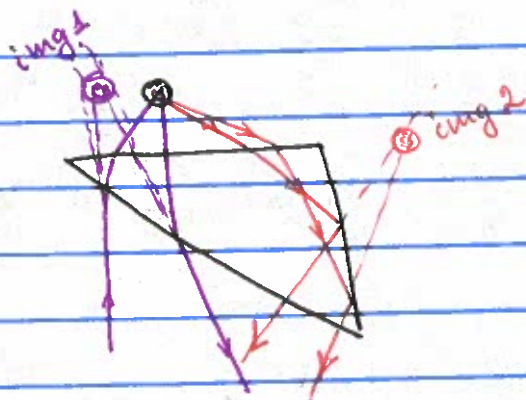


Thus, the final angle will be the same as input, 45°

~~However, depending on refractive~~
 That also means it will not be possible to create conditions for total internal reflection, since in each layer $n \sin \theta = 1/\sqrt{2}$, ~~and never~~ so for any $n \geq 1$ there is a real transmission angle.

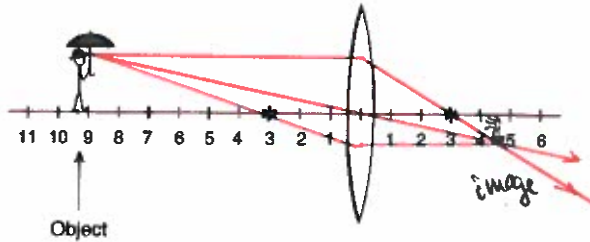
A4

If you look carefully, you can see the bottom of a triangular glass shape the girls are standing behind. One image is transmitted through the prism, and the other is formed by total internal reflection



A6. In the following images the focal points are marked *, and the distance is marked in cm. Use the principle rays to find the position of the image graphically, and then qualitatively describe the image in each case (using a ruler or something capable producing straight lines will make your life easier).

(a)



$$\boxed{d_o = 9}$$

$$\boxed{f = 3}$$

$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{d_o - f}{d_o \cdot f}$$

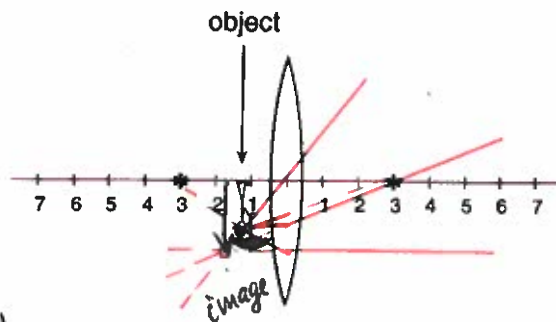
$$d_i = \frac{d_o \cdot f}{(d_o - f)}$$

$$d_i = \frac{9 \cdot 3}{6} = 4.5 \quad \text{real}$$

$$m = -\frac{d_i}{d_o} = -\frac{4.5}{9} = -\frac{1}{2}$$

inverted, magnified, shrunk

(b)



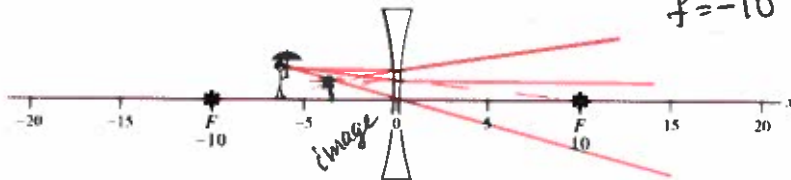
$$d_o = 1$$

$$f = 3$$

$$d_i = \frac{1 \cdot 3}{-2} = -1.5 \quad \text{virtual}$$

$$m = -\frac{-1.5}{1} = 1.5 \quad \text{erect, magnified}$$

(c)



$$d_o = 6$$

$$f = -10$$

$$d_i = \frac{6 \cdot (-10)}{16} = -3.75 \quad \text{Virtual}$$

$$m = -\frac{d_i}{d_o} = \frac{3.75}{6} = 0.625$$

erect, shrunk

A7. Use the lens formula to verify your results for each case. Calculate the image position and magnification, point out how these numbers (hopefully) confirm your conclusion from A6.

A8. Let's get artsy! Below I show a photograph (next page) from the underwater photography website: <https://www.uwphotographyguide.com>, and a (rather lame) its artistic description.

The viewpoint is from beneath the surface of a clear swimming pool, looking upward through the water. The surface forms a bright, undulating boundary, producing a network of moving highlights across the water. The upside-down musician reflection is visible on top, though its appearance is distorted by ripples that stretch and bend its outlines. Most of the frame is filled with clear blue water. Sunlight enters the pool, creating bright patches and intricate caustic patterns that shift across the bottom. Small air bubbles and suspended particles catch the light, adding fine points of brightness throughout the water column. Every object seen through the water appears slightly displaced and warped, with contours bending near the surface and becoming sharper deeper in the pool.

Attempt to explain as many listed features as you can using knowledge received in the last two weeks.

A5 a) The calculations for the angles of ~~reflex~~ refraction are done correctly $\sin \theta_t = \frac{1}{n_{\text{glass}}} \sin \theta_{\text{inc}}$, but the refracted beam is shown ^{tilted} in the wrong direction

A8. There are many things to point out, a few

- The musician upside down reflection due to ~~total~~ internal reflection off the surface of water

- Waves on the water change reflection angle locally, distorting the image.

- Sun light refracts going through the top of the water, and ripples create lensing effect that looks like wiggly lines on the bottom

- light bubbles reflect sunlight into the camera, ^(scatter) creating bright spots