tutorial #8 [mirrors] .quiz

1) Ibn Sahl is trying to explain how light reflects in the spoon to his friend. Spoon has two sides, which we will model them with concave and convex mirrors, with radius $R = 10$ cm.
a) What is the focal lengths of the concave side and the convex side?
b) Consider you are looking at the concave side. The object is your eye which is at distance $d_o = 30$ cm from the spoon. Find where the image is and calculate the magnification. Is the image upside down? Is the image real or virtual?
c) Repeat the previous part, this time for the convex side.
d) The eye need to be at least 10 cm away from the image diverging light rays to be able to focus and make an image out of it on the retina. How close you can get to concave side of the spoon with your eye, so that you can still see a clear image of your eye? How about the convex side?

a) concave: $f = +\frac{1}{2}R = 5\,cm$, convex: $f' = -\frac{1}{2}R = -5\,cm$.

b) Concave

$d_o = 30\,cm$, $f = +5\,cm$

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \rightarrow \frac{1}{30\,cm} + \frac{1}{d_i} = \frac{1}{5\,cm} \rightarrow d_i = 6\,cm$ (real image)

$m = -\frac{d_i}{d_o} = -\frac{6\,cm}{30\,cm} = -\frac{1}{5} < 0$: upside-down

c) Convex

$d_o = 30\,cm$, $f' = -5\,cm$

$\frac{1}{d_o} + \frac{1}{d_i'} = \frac{1}{f'} \rightarrow \frac{1}{30\,cm} + \frac{1}{d_i'} = -\frac{1}{5\,cm} \rightarrow d_i' = -4.3\,cm$ (virtual image)

$m' = -\frac{d_i'}{d_o} = -\frac{-4.3\,cm}{30\,cm} = \frac{1}{7} > 0$: upright

if you get real close to concave part of the spoon, you actually see an almost 2x magnified upright image!

d) distance between the object (eye) and image for a mirror is $d_o - d_i$

Concave: $d_o - d_i = 10\,cm$ and $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{5\,cm} \rightarrow$ $\begin{cases} d_o = 3\,cm \\ d_i = -7\,cm \end{cases}$ or $\begin{cases} d_o = 17\,cm \\ d_i = 7\,cm \end{cases}$

this answer is the closest you can get to see an upside-down image less than $\frac{1}{2}$x magnified

Convex: $d_o - d_i = 10\,cm$ and $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{-5\,cm} \rightarrow$ ~~$\begin{cases} d_o = -7\,cm \\ d_i = -17\,cm \end{cases}$~~ or $\begin{cases} d_o = 7\,cm \\ d_i = -3\,cm \end{cases}$

$d_o < 0$ which can not be the case.

upright image almost $\frac{1}{2}$x magnified