Φ2020: MANIC MONDAY #5: OPTICS

(A) In the case of the distant roadrunner, I am keeping the OBJECT DISTANCE fixed: d_o = CONST. I change the focal length of my lens to make a LARGER IMAGE, or in other words, I INCREASE MAGNIFICATION. The image distance d_i must necessarily change. Start with the magnification equation:

$$m = \pm \frac{d_i}{d_o}$$

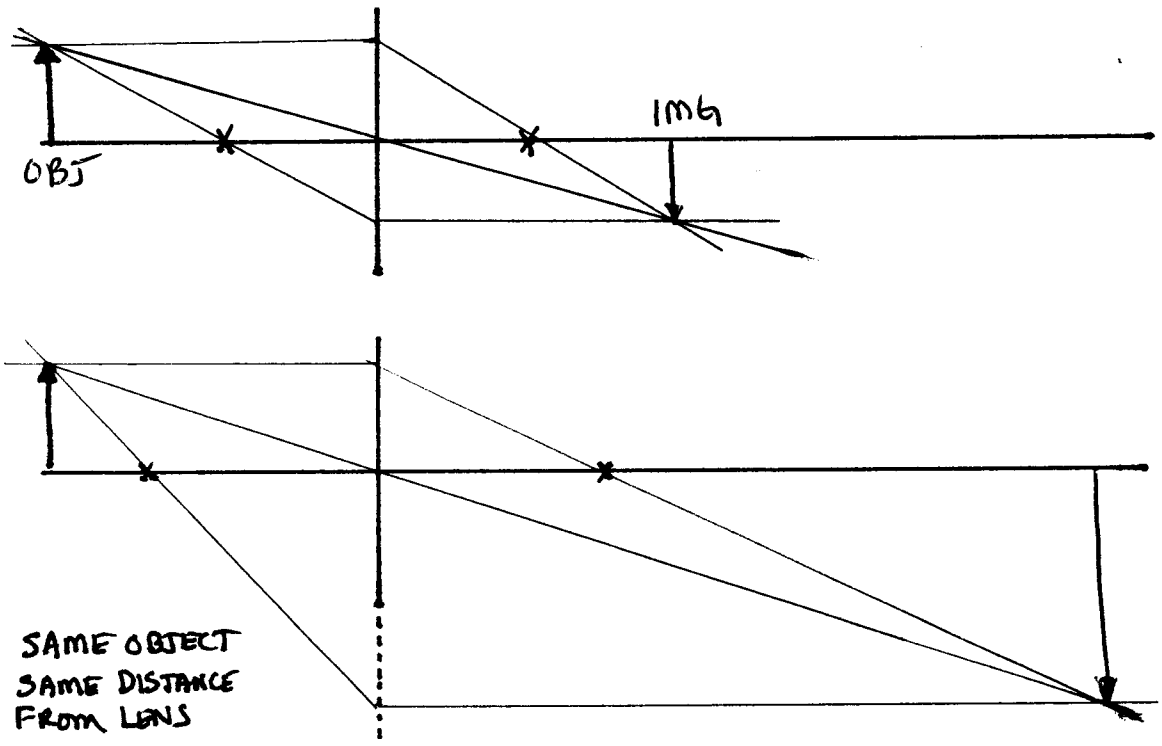
For d_o = CONST, the only way for m to increase is for d_i to INCREASE.

Now go to lensmaker equation:

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

For d_o = CONST, if d_i INCREASES, then $\frac{1}{f}$ DECREASES, implying f should <u>INCREASE</u>.

RAY TRACE: Original & f INCREASED



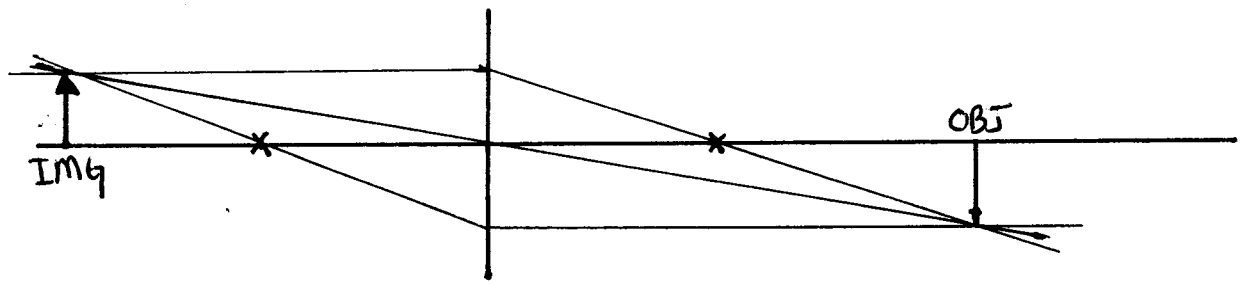
(B) For the projector, I keep the IMAGE DISTANCE fixed: d_i = CONST. I change the focal length of the lens to make a larger image, or I <u>INCREASE</u> magnification. The object distance d_o will necessarily change, though object size is fixed. Start with magnification equation:

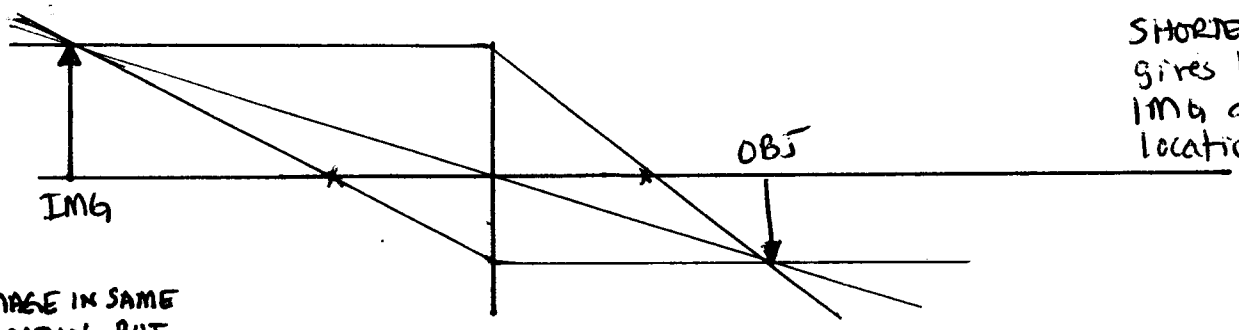
$m = \hookrightarrow \frac{d_i}{d_o}$ For d_i = CONST, to make m increase then d_o MUST DECREASE.

Now to the lensmaker equation:

$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$ For d_i = CONST, if d_o DECREASES, then $\frac{1}{f}$ INCREASES, implying f should <u>DECREASE</u>.

<u>RAY TRACE</u>: ORIGINAL & f DECREASED





SHORTER f gives larger IMG at same location.

IMAGE IN SAME LOCATION, BUT MAGNIFIED

Note in this region the rays DIVERGE. Images are located where rays cross, so I have to extend these rays backwards (----) to their crossing point.