Phys 141 HW 2 Solutions

1) before the screen and object are moved

$$M_{T,} = \frac{y_i}{y_o} = \frac{-s_i}{s_o} = -2 \Rightarrow s_i = 2s_o$$

and

$$\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f} \Rightarrow \frac{1}{s_o} + \frac{1}{2s_o} = \frac{1}{f}$$

$$\Rightarrow f = \frac{1}{\frac{2}{2s_o} + \frac{1}{2s_o}} = \frac{2s_o}{3}$$

after the screen and object are moved

$$M_{T'} = \frac{y_i'}{y_o'} = -\frac{(s_i + 7s)}{(s_o + d)} = -3$$

$$\Rightarrow s_i' = 3s_o'$$

also $\Rightarrow s_i + 7s = 3s_o + 3d$

and,

$$\frac{1}{f} = \frac{1}{s_o'} + \frac{1}{s_i'} = \frac{1}{s_o + d} + \frac{1}{s_i + 7s}$$

$\Rightarrow f =$

and

$$\frac{1}{f} = \frac{1}{S_o'} + \frac{1}{S_i'} = \frac{1}{S_o'} + \frac{1}{3S_o'}$$

$$\Rightarrow \quad f = \frac{3S_o'}{4} = \frac{3(S_o + d)}{4}$$

we get

$$\frac{3(S_o+d)}{4} = \frac{2S_o}{3} \quad \Rightarrow \quad S_o = -9d$$

also from M_T,

$$S_i + 7S = 3S_o + d \quad \Rightarrow 2S_o + 7S = 3S_o + 3d$$

$$\Rightarrow 2(-9d) + 7S = 3(-9d) + 3d$$

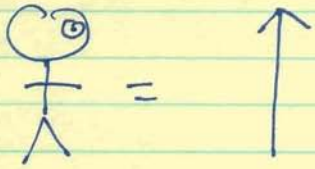
$$\Rightarrow \boxed{d = -\frac{7S}{6} \text{ cm}}$$

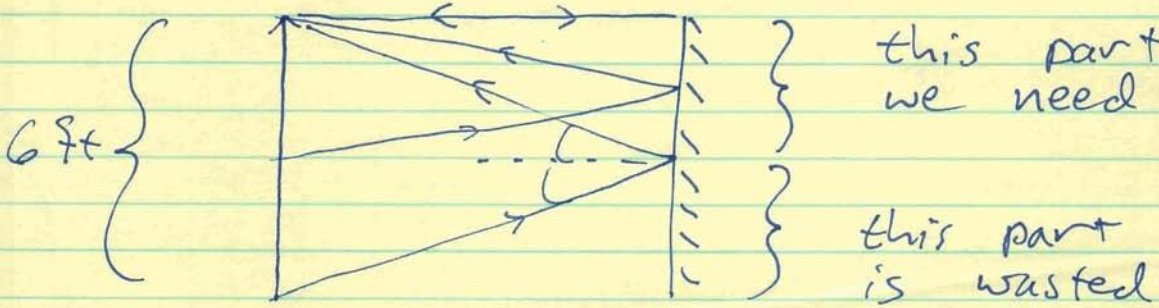
$$S_o = -9\left(\frac{-7S}{6}\right) = \frac{3}{2}7S$$

$$S_i = 2S_o = 3 \times 7S$$

$$\Rightarrow \quad f = \frac{1}{\frac{2}{3\times 7S} + \frac{1}{3\times 7S}} = \frac{3\times 7S}{3} = 7S \text{ cm}$$

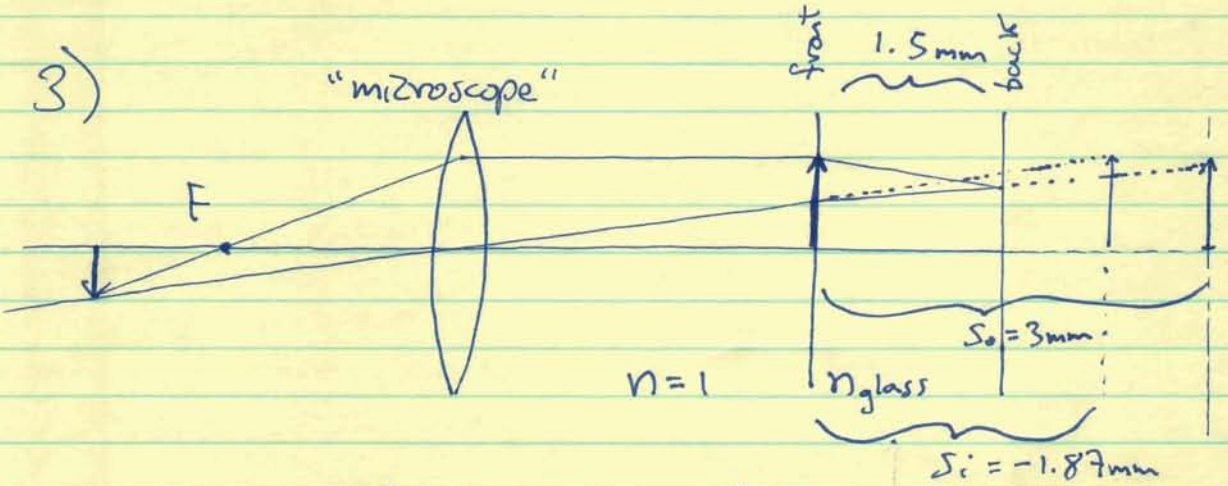
2)





the mirror should be 3 ft high and 3 ft off of the floor

3)



the first image of the scratch is just from the front surface of the glass

the second image is formed from the reflection of the scratch off of the back of the glass plate, which is refracted at the front surface

for a spherical refracting surface (here with $R = \infty$)

$$\frac{n_1}{s_o} + \frac{n_2}{s_i} = \frac{n_2 - n_1}{R}$$ see p. 153

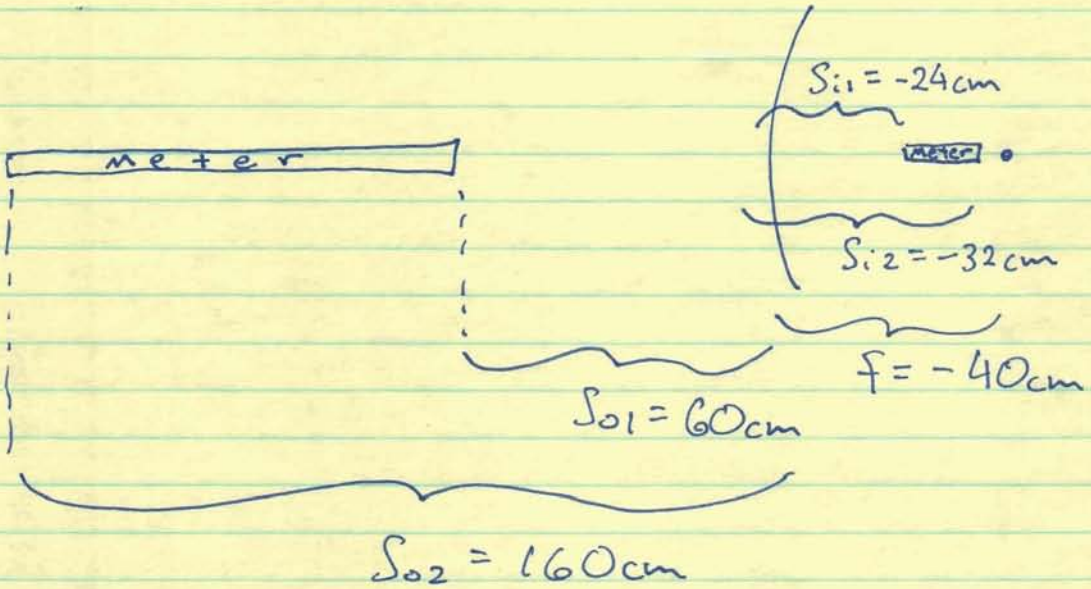
$n_1 = n_{glass}$ $n_2 = 1$

the object appears $2t$ behind the refracting surface of the plate (where $t = 1.5mm$, the thickness)

the image we know is formed 1.87mm behind the surface. That's where the object for the microscope is located

$$\frac{n_{glass}}{2 \times 1.5mm} + \frac{1}{-1.87mm} = 0 \quad \Rightarrow \quad n = 1.604$$

4) $\frac{1}{S_o} + \frac{1}{S_i} = \frac{1}{f}$ where f is negative for convex mirrors



for S_{i1}

$$\frac{1}{60\text{cm}} + \frac{1}{S_{i1}} = \frac{1}{-40} \Rightarrow S_{i1} = -24\text{cm}$$

for S_{i2}

$$\frac{1}{160\text{cm}} + \frac{1}{S_{i2}} = \frac{1}{-40} \Rightarrow S_{i2} = -32\text{cm}$$

so the image of the meter stick appears $32 - 24 = 8$ cm long!

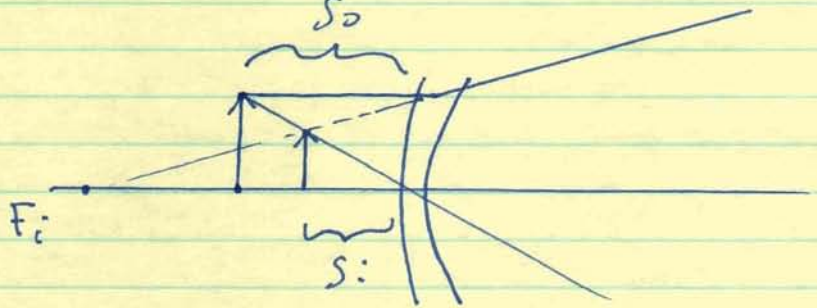
5) $R_1 = 20\,cm \qquad R_2 = 10\,cm \qquad n = 1.5$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = 0.5\left(\frac{1}{20} - \frac{1}{10}\right)$$

$$= \frac{-1}{40}$$

$$\frac{1}{f} = \frac{1}{S_o} + \frac{1}{S_i} \qquad S_o = 20$$

$$S_i = \frac{-1}{\frac{1}{20} + \frac{1}{40}} = -\frac{40}{3} \simeq -13.3\,cm$$


s_o
F_i
s_i