Solutions S11 exam

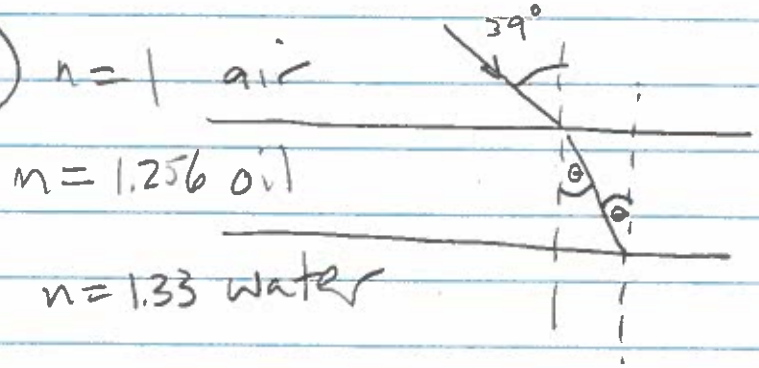
1) Star radiates equally into all directions. Therefore power of star is

$$P_0 = (\text{Intensity})(\text{Area}) = \left(\frac{540\,W}{m^2}\right)\left(4\pi(10^{12})^2\right)$$

$$\text{Area} = 4\pi r^2$$

$$= 6.78 \times 10^{27}\,W$$

2)



air-oil: $1 \cdot \sin 39^\circ = 1.256 \sin\theta$

$$\theta = \sin^{-1}\left(\frac{\sin 39^\circ}{1.256}\right) = 30.1^\circ$$

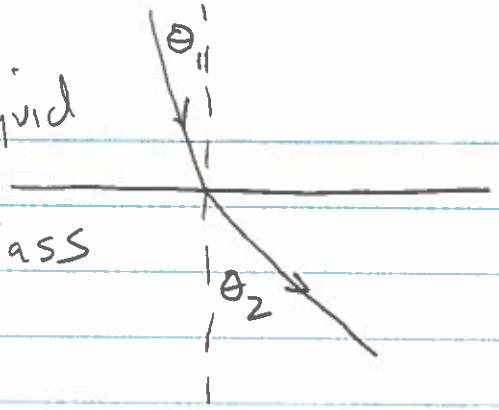
Note incident angle on water is the same as refracted angle in oil by geometry.

3) wavelength of light in quartz does not depend on angle of incident ray.

$$\lambda_{Quartz} = \frac{\lambda_{vac}}{n_{Quartz}} = \frac{640\,nm}{1.56} = 410\,nm$$

4) $n_1 = 1.70$ liquid

$n_2 = 1.52$ glass

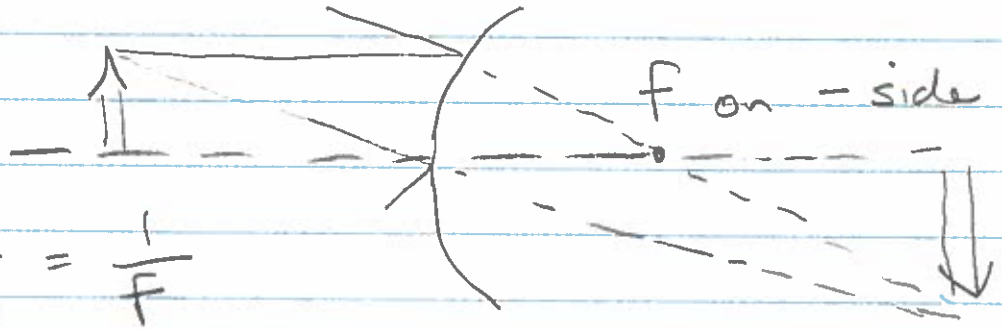


$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

Total internal reflection $\Rightarrow \theta_2 = 90^\circ$

$$\theta_c = \sin^{-1}\frac{n_2}{n_1} = 63.4^\circ$$

5)

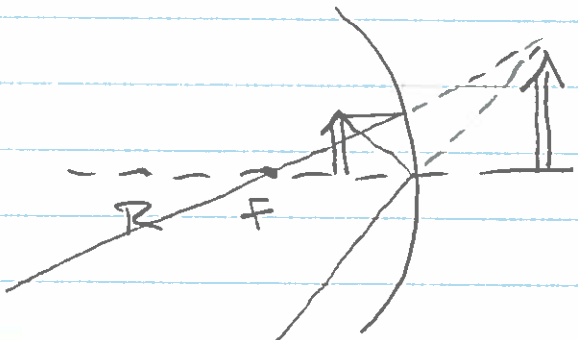


$M = -q/p$; $\frac{1}{p} + \frac{1}{q} = \frac{1}{F}$

$\frac{1}{24} + \frac{1}{q} = \frac{1}{f}$; $M = \frac{1}{3} = \frac{-q}{24} \Rightarrow q = -8$

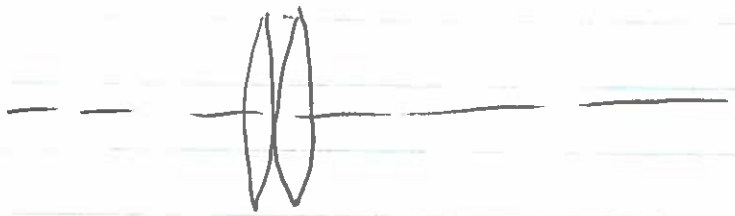
$\frac{1}{F} = -\frac{1}{8} + \frac{1}{24} = \frac{-1}{12} \Rightarrow f = -12\,cm$

6)



virtual, upright, magnification > 1 !

7)



As discussed in class,

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{50} + \frac{1}{60}$$

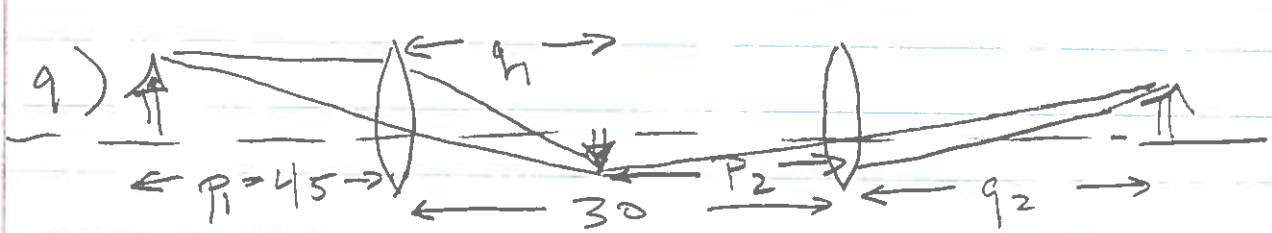
$$= \frac{60+50}{3000} = \frac{11}{300}$$

$$f = \frac{300}{11} = 27.3 \text{ cm}$$

8) $p = 80 \quad q = 40$

$$\frac{1}{F} = \frac{1}{80} + \frac{1}{40} \Rightarrow F = \frac{80}{3} = 26.7\text{cm}$$

9)



$$\frac{1}{q_1} = \frac{1}{f_1} - \frac{1}{p_1} = \frac{1}{10} - \frac{1}{45} = \frac{7}{90} \Rightarrow q_1 = 12.86\text{cm}$$

Image of 1 is object for 2

$$p_2 = 30 - 12.86 = 17.14 \text{ cm}$$

$$\frac{1}{q_2} = \frac{-1}{p_2} + \frac{1}{f_2} = \frac{-1}{17.14} + \frac{1}{10} = -0.42$$

$$\boxed{q_2 = 24 \text{ cm}}$$

10) $h_i = 10\text{ cm}$ $h_o = 5\text{cm}$

$\Rightarrow M = 2 = -q/p$ $p = 15\text{ cm}$

$q = -2p = -30$

$\frac{1}{15} + \frac{1}{q} = \frac{1}{f}$

$\frac{1}{f} = \frac{1}{15} - \frac{1}{30} = \frac{1}{30} \Rightarrow f = 30$

$f = R/2 \Rightarrow \boxed{R = 60}$

$q < 0 \Rightarrow$ image is virtual

$f > 0 \Rightarrow$ mirror is concave