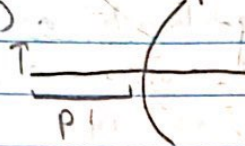


# Physics IC Chapter 24 HW

34.10)



$$R = 40 \text{ cm}, h_o = 5 \text{ cm}$$

$$p = 70 \text{ cm}$$

$$a) \frac{1}{p} + \frac{1}{q} = \frac{2}{R}$$

$$\frac{1}{70} + \frac{1}{q} = \frac{2}{40}$$

$$\frac{1}{q} = -0.06 \text{ cm}^{-1}$$

$$|q| = 15.55 \text{ cm}$$

$$b) M = -\frac{q}{p}$$

$$M = \frac{h_i}{h_o}$$

$$h_i = -\frac{q}{p} h_o$$

$$h_i = 1.11 \text{ cm}$$

$$c) m = + \rightarrow \text{upright}$$

$$d) \text{ opp. to emerging rays}$$

$$\text{Virtual}$$

34.23)



$$R = 14 \text{ cm}, n_i = 1.333$$

$$p = 14 \text{ cm}, n_o = 1$$

$$a) \frac{n_i}{p} + \frac{n_o}{q} = \frac{n_i - n_o}{R}$$

$$\frac{1.333}{14} + \frac{1}{q} = \frac{0.333}{14}$$

$$\frac{1}{q} = -\frac{1}{14}$$

$$q = -14 \text{ cm}$$

$$b) M = -\frac{n_i q}{n_o p}$$

$$M = 1.33$$

$$c) R = 14 \text{ cm}, n_i = 1, n_o = 1.33$$

$$\frac{n_o}{f} = \frac{n_i - n_o}{R}$$

$$\frac{1.33}{f} = \frac{0.33}{14}$$

$$f = 56.4 \text{ cm}$$

$$\text{no}$$

34.28)  $h_o = 4 \text{ mm}$

$$m = 0.208 \text{ cm}^{-2}$$

$$\frac{h_i}{h_o} \text{ vs. } p$$

$$\frac{h_i}{h_o} = -\frac{q}{p} \rightarrow y = mx + b$$

$$\frac{1}{h_i} = -\frac{p}{f h_o}$$

$$m = -\frac{1}{f h_o}$$

$$q = -12.02 \text{ cm}$$

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

$$\frac{h_i}{h_o} = \frac{q}{p-f}$$

$$\frac{p-f}{f h_o} = \frac{h_i}{h_o}$$

$$\frac{1}{h_i} = -\frac{p}{f h_o} + \frac{1}{h_o}$$

$$m = -\frac{1}{f h_o}$$

$$|f| = 12.02 \text{ cm}$$

34.38)  $n = 1.55, f = 18.5 \text{ cm}, R_1 = R_2$

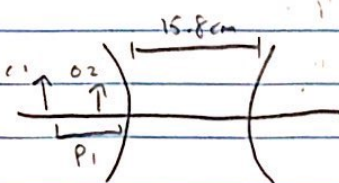
$$\frac{1}{f} = \frac{n-1}{R_1} \left( \frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\frac{1}{f} = (n-1) \left( \frac{2}{R} \right)$$

$$R = (n-1)(f)(2)$$

$$R = 20.35 \text{ cm}$$

34.45)



$$h_{o1} = 1.8 \text{ mm}, p_1 = 35 \text{ cm}, f = 21 \text{ cm}$$

$$a) \frac{1}{p_1} + \frac{1}{q_1} = \frac{1}{f}$$

$$\frac{1}{35} + \frac{1}{q_1} = \frac{1}{21}$$

$$q_1 = -13.13 \text{ cm}$$

$$p_2 = 13.13 + 15.8 = 28.93 \text{ cm}$$

$$\frac{1}{28.93} + \frac{1}{q_2} = \frac{1}{21}$$

$$q_2 = 76.65 \text{ cm}$$

$$|l| = 92.44 \text{ cm}$$



b)  $q = + \rightarrow \boxed{r = -1}$

c)  $M = -\frac{2}{P}$

$M_1 = -\frac{2}{P_1}$

$h_{o2} = -\frac{2}{P_1} h_{o1}$

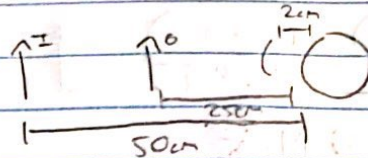
$M_2 = -\frac{2}{P_2}$

$h_{i2} = -\frac{2}{P_2} \left( -\frac{2}{P_1} \right) h_{o1}$

$|h_{i2}| = 1.8 \text{ mm}$

d)  $\boxed{\text{inverted, } h_{i2} < 0}$

34.55)



a)  $p = 23 \text{ cm}, q_1 = -48 \text{ cm}$

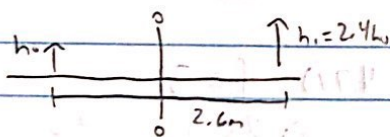
$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$

$\boxed{f = 44.16 \text{ cm}}$

b)  $D = \frac{1}{f}$

$\boxed{D = 2.26 \text{ diopters}}$

34.48)



a)  $R_0, |M| > 1 \rightarrow \boxed{\text{inverted}}$

b)  $M = 2.4$

$-2.4 = -\frac{q}{p}$

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

$p + q = 2.6 \text{ m}$

$2.4p = q$

$3.4p = 2.6 \text{ m}$

$p = 0.76 \text{ m}$

$q = 1.84 \text{ m}$

$\boxed{f = 0.54 \text{ m}}$

c)  $\boxed{\text{converging}}$

34.51)  $f_1 = 12 \text{ cm}, f_2 = -12 \text{ cm}$

a)  $p = \infty$

$q = f = 12 \text{ cm}$

b)  $4 - 12 \text{ cm} = -8 \text{ cm}$

c)  $p_2 = -8 \text{ cm}, f_2 = -12 \text{ cm}$

$\frac{1}{p_2} + \frac{1}{q_2} = \frac{1}{f_2}$

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

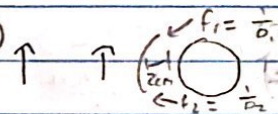
d)  $\boxed{12 \text{ cm}}$

e)  $8 \text{ cm} - 12 \text{ cm} = -4 \text{ cm}$

$p_2 = -4 \text{ cm}, f_2 = -12 \text{ cm}$

$\boxed{q_2 = 6 \text{ cm}}$

34.57)



$D_1 = -0.5 \text{ diopters}, D_2 = 2 \text{ diopters}$

a)  $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$

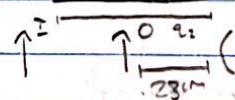
$\frac{1}{p_1} + \frac{1}{q_1} = D_1$

$\frac{1}{\infty} + \frac{1}{q_1} = D_1$

$q_1 = -2 \text{ m}$

$S_{FP} = -260 \text{ cm} + -0.02 \text{ m}$

$\boxed{S_{FP} = -202 \text{ cm}}$

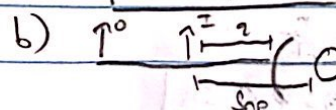


$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$

$\frac{1}{0.23} + \frac{1}{q_2} = 2$

$q_2 = -42.6 \text{ cm}$

$\boxed{S_{FP} = -44.62 \text{ cm}}$



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

$\frac{1}{p} + \frac{1}{-42.6 \text{ cm}} = -0.5$

$\boxed{p = 0.541 \text{ m}}$



34.67)  $\uparrow$  IVAM  $\left( \frac{1}{2} \right)$

a)  $M = \frac{h_i}{h_o}$

$-\frac{h_i}{h_o} = -\frac{2}{p}$

$p = 0.095m$

b)  $\frac{1}{p} + \frac{1}{2} = \frac{2}{R}$

$R = 0.187m$

34.70)  $n_0 = 1.5$ ,  $t_0 = 4.4cm$

$n_H = 1.3$ ,  $t_H = 5.7cm$

$\frac{n_0 t_0}{p} + \frac{n_H t_H}{2} = \frac{n_0 t_0 - n_H t_H}{R} \rightarrow R = \infty$

$\frac{1.5}{5.7cm} + \frac{1.3}{2} = 0$

$q = 6.43cm$

$p = 4.4 + 6.43 = 10.83cm$

$\frac{1.5}{10.83cm} + \frac{1}{2} = 0$

$q = -7.22cm$

$|s| = 7.22cm$

34.71)  $R = -18cm$ ,  $p = 7m$ ,  $h_o = 1.5m$

$\frac{2}{R} = \frac{1}{f}$

$f = 9cm \rightarrow p > f$

$\uparrow$   $\left( \frac{1}{2} \right)$

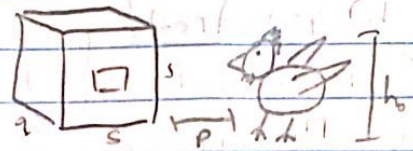
$\frac{1}{p} + \frac{1}{2} = \frac{1}{f}$

$q = 0.09m$

$-\frac{q}{p} = \frac{h_i}{h_o}$

$|h_i| = 0.015m$

34.75)



$s = 24cm$ ,  $q = 21.5cm$

a)  $h_o = 15cm$ ,  $p = 2m$

$M = -\frac{2}{p} = \frac{h_i}{h_o}$

$|h_i| = 1.61cm$

b)  $M = -\frac{2}{p}$

$M = -0.11$

34.77)  $f = 38cm$

a)  $R$  is larger,  $R > 0$

Converging

b)  $M = -2$

$\frac{f}{p-f} = -2$

$-f = -2(p-f)$

$-f = -2p + 2f$

$-2p = -3f$

$p = 57cm$

c)  $UI$ , large,  $R > 0$

Converging

d)  $M = 2$

$\frac{f}{p-f} = 2$

$-f = 2p - 2f$

$f = 2p$

$p = 19cm$



34.80)  $h_o = 6.5 \text{ mm}$ ,  $p = 8 \text{ cm}$ ,  $q = 3 \text{ cm}$

a)  $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$   
 $f = -4.8 \text{ cm}$

b)  $f < 0 \rightarrow$  diverging

c)  $M = \frac{-q}{p} = \frac{h_i}{h_o}$

$h_i = -\frac{q}{p} h_o$

$h_i = 2.44 \text{ mm}$

d) opp. eng. light

virtual

34.81)  $h_o = 3.25 \text{ mm}$ ,  $p = 16 \text{ cm}$ ,  $q = -22 \text{ cm}$

a)  $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$

$f = 58.67 \text{ cm}$

b)  $f > 0 \rightarrow$  converging

c)  $h_i = \frac{-q}{p} h_o$

$h_i = 4.47 \text{ mm}$

d) virtual

34.82)  $p = 22 \text{ cm}$

a)  $f = 3 \text{ cm}$

$q = 22 - p$

$\frac{1}{p} + \frac{1}{22-p} = \frac{1}{f}$

$22 - p + p = \frac{1}{f} (p)(22 - p)$

$22 = \frac{1}{f} (22p - p^2)$

$p^2 - 22p + 66 = 0$

$p = \frac{22 \pm \sqrt{220}}{2}$

$p = 18.42 \text{ cm}, 3.58 \text{ cm}$

b)  $p_1 = 18.42 \text{ cm}, q_1 = 3.58 \text{ cm}$

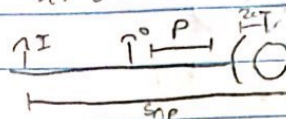
$p_2 = 3.58 \text{ cm}, q_2 = 18.42 \text{ cm}$

$M = \frac{-q}{p}$

$M_1 = -0.19, M_2 = -5.15$

34.87)  $S_{np} = 85 \text{ cm}$

a)  $D = 2.5 \text{ diopters}$



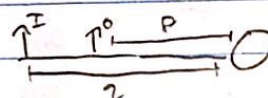
$q = 83 \text{ cm}$

$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} = D$

$\frac{1}{p} + \frac{1}{83} = 2.5$

$p = 27 \text{ cm}$

b)  $q = -85 \text{ cm}$



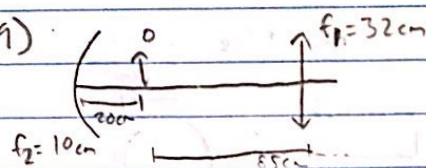
$q = -85 \text{ cm}$

$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} = D$

$\frac{1}{p} + \frac{1}{-85} = 2.5 \text{ di}$

$p = 0.272 \text{ m}$

34.89)



a)  $p_1 = 85 \text{ cm}, f_1 = 32 \text{ cm}$

$\frac{1}{p_1} + \frac{1}{q_1} = \frac{1}{f_1}$

$q_1 = 51.32$

b)  $q > 0 \rightarrow$  real

c)  $M < 0 \rightarrow$  inverted

d)  $p_2 = 20 \text{ cm}, f_2 = 10 \text{ cm}$

$\frac{1}{p_2} + \frac{1}{q_2} = \frac{1}{f_2}$

$q_2 = 20 \text{ cm}$

$p_3 = 85 \text{ cm}, f_1 = 32 \text{ cm}$

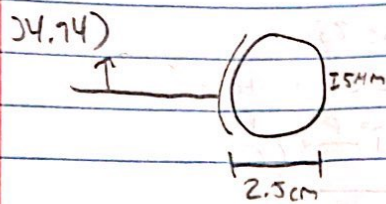
$\frac{1}{p_3} + \frac{1}{q_3} = \frac{1}{f_1}$

$q_3 = 51.32 \text{ cm}$

e)  $q > 0 \rightarrow$  real

f) upright





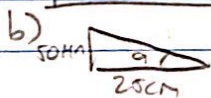
c)  $S_{np} = 25 \text{ cm} = p$

$q = 2.5 \text{ cm}$

$M = \frac{h_i}{h_o} = \frac{-2}{p}$

$h_i = 54 \text{ mm}$

$h_o = 504 \text{ mm}$



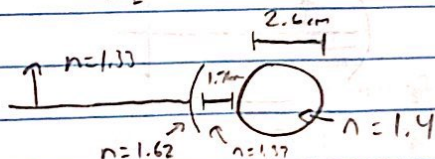
$\tan \alpha = \frac{504 \text{ mm}}{25 \text{ cm}}$

$\alpha = 0.688 \text{ mins}$

34.107)  $n_e = 1.40$

$d_e = 2.6 \text{ cm}$

$n_i = 1.62$



$\frac{n_i}{p} + \frac{n_e}{q} = \frac{n_e}{f} = \frac{n_e - n_i}{f}$

$\frac{1.33}{p} + \frac{1.4}{2.6} = \frac{0.07}{R}, R = 1.3 \text{ cm}$

$p = -2.74$

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

$q = 2.74 + 2 = 4.74 \text{ cm}$

$0 + \frac{1}{4.74} = \frac{1}{f}$

$f = 4.74 \text{ cm in water}$

$f = f'' \left[ \frac{n_e - n_i}{n_i(n_e - 1)} \right]$

$f = 1.67 \text{ cm}$