H.W Solutions

① $n = \frac{c}{v} = \frac{3\times10^8}{2.7\times10^8} = 1.11$

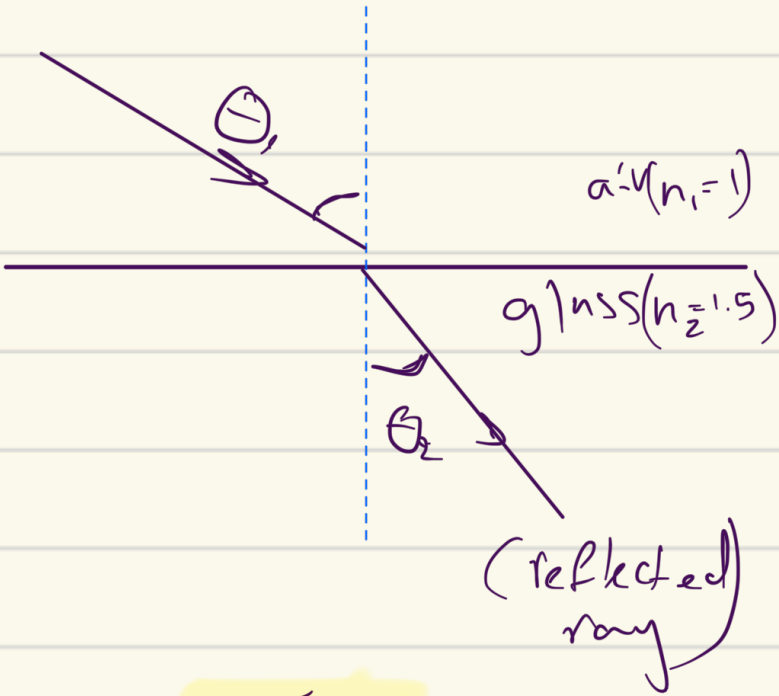
② $n = \frac{c}{v} \Rightarrow v = \frac{c}{n} = \frac{3\times10^8}{2} = 1.5\times10^8$ m/s

③ $\theta_2 = 15^\circ$

$\theta_1 = ?$

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

(Air) (Glass)



$1(\sin\theta_1) = 1.5 \sin 15^\circ$

$\sin\theta_1 = 1.5 \sin 15^\circ$

$\theta_1 = 22.84^\circ$

$n_1 < n_2$

$\theta_1 > \theta_2$

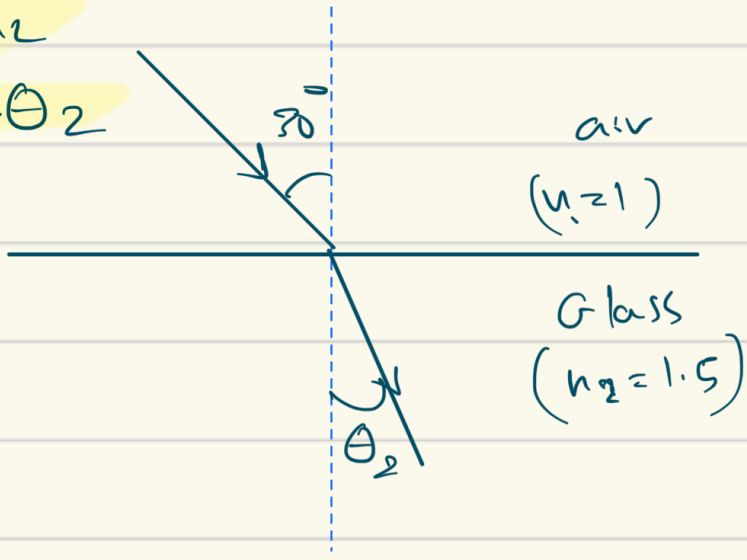
④ $n_1 \sin\theta_1 = n_2 \sin\theta_2$

$n_1 < n_2$

$\theta_1 > \theta_2$

(1) $\sin 30^\circ = 1.52 \sin\theta_2$

$\theta_2 = 19.2^\circ$



(5) convex → $f = +20$ cm

$d_o = ?$, $d_i = +40$ cm

other side → (real image)

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

$$= +\frac{1}{2 \times 20} - \frac{1}{40} = +\frac{1}{40} \text{ cm}$$

$$d_o = +40 \text{ cm}$$

(6) convex → $f = +20$ cm

$h_o = +2$ cm, $d_o = 30$ cm, $d_i = ?$

always + ↵

$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} \quad \frac{3 \times 1}{3 \times 20} - \frac{1 \times 2}{30 \times 2} = \frac{1}{60} \rightarrow d_i = +60 \text{ cm}$$

(7) convex → $f = +20$ cm

$h_o = +2$ cm, $d_o = 30$ cm, $d_i = 60$ cm (from previous question)

$m = ?$

$$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o} = -\frac{60}{30} = -2$$

if h_i is required

$$m = -2 = \frac{h_i}{h_o} \Rightarrow h_i = -4 \text{ cm}$$

→ negative → inverted

① $f \rightarrow +$ convex, $-$ concave

② $d_o \rightarrow +$ object in the same side of light, $-$ object in the opposite side of light

③ $d_i \rightarrow$ (real image) $+$ opposite side of the light; (virtual image) $-$ on the same side of the light

④ $h_i \rightarrow +$ image is upright (↑ obj ↑ image); $-$ image is inverted (↑ obj ↓ image)

⑤ $h_o \rightarrow +$ always

(8) convex ⟶ $f = +15\,cm$

$h_i = \frac{1}{3} h_o$, $d_o = ?$

$$m = \frac{h_i}{h_o} = \frac{\frac{1}{3}h_o}{h_o} = \frac{1}{3} \begin{cases} m = -\frac{d_i}{d_o} = \frac{1}{3} \\ d_o = -3 d_i \end{cases}$$

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

$$\frac{1}{15} = \frac{1}{3x d_i} + \frac{1}{-3d_i}$$

$$\frac{1}{15} = \frac{3}{3d_i} - \frac{1}{3d_i}$$

$$\frac{1}{15} = \frac{2}{3d_i} \Rightarrow 3d_i = 30$$

$$\boxed{d_i = 10\,cm}$$

$$\boxed{d_o = -30\,cm}$$

negative ⟶ the object is in the opposite side of the light ray

(9) Convex → $f = +15\,cm$

$d_o = 25\,cm$, $d_i = ?$ (real or virtual)

$+$ $-$

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

$$\frac{1}{d_i} = \frac{25}{15\times 25} - \frac{15}{15\times 25} \Rightarrow \frac{1}{d_i} = \frac{25-15}{25\times 15}$$

$d_i = 37.5\,cm \Rightarrow + \Rightarrow$ real image

(10) Virtual image → $d_i = -33.8\,cm$

$d_o = 18.5\,cm$, $f = ?$

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

$$= \frac{-1}{33.8} + \frac{1}{18.5} = \frac{33.8 - 18.5}{18.5(33.8)} = \frac{15.3}{625.3}$$

$$f = 40.87\,cm$$

(11) $f = -12.8\,cm$, $d_o = 34.5\,cm$, $d_i = ?$

↳ diverging lense → concave

$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{-1}{12.8} - \frac{1}{34.5}$$

$d_i = -9.34\,cm$ (virtual image)

Diverging → virtual

→ upright

حالة واحدة فقط

(12) $d_i = 32\ cm$, converging → curved → $f = +12\ cm$

$d_o = ?$ (real or virtual)

* converging → real (inverted)
* virtual (upright) حالتين

$$\frac{1}{d_o} = \frac{1}{f} - \frac{1}{d_i} = \frac{1}{12} - \frac{1}{32}$$

$$= \frac{32-12}{32(12)} = \frac{20}{384}$$

$$d_o = +19.2\ cm$$

* بالسؤال حكالي الصورة ← inverted ← real image

(13) $d_o = 32\ cm$, $d_i = +8\ cm$, $f = ?$

on the opposite side of the light ray (real image)

a) $$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{8} + \frac{1}{32} = \frac{8+32}{32(8)}$$

$$f = +6.4\ cm$$

↳ converging lense → convex

b) $$m = -\frac{d_i}{d_o} = -\frac{8}{32} = -0.25$$

c) f (+) ⟶ converging

The image is real ⟶ converging

(14) diverging lense → concave, $f = -32$ cm

$d_o = 20$ cm, $d_i = ?$, $m = ?$

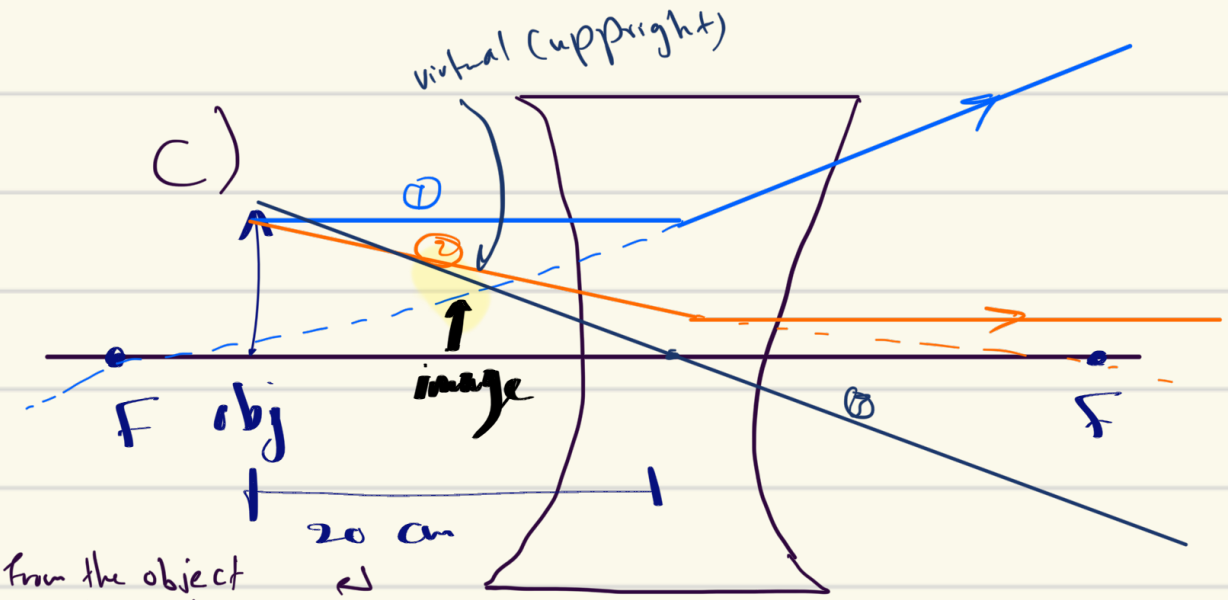
a) $\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{-1}{32} - \frac{1}{20} = \frac{-20-32}{20(32)}$

$d_i = -12.31$ cm (virtual image)

means at the same side of an image

b) $m = \frac{-d_i}{d_o} = \frac{-(-12.31)}{20} = 0.6155$

c)



→ from the F to the center of the lense (f)

(15) $n_2 < n_1$

$\theta_1 > \theta_1$

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

$1.5 \sin 45^\circ = n_2 \sin 65^\circ$

$n_2 = 1.17$