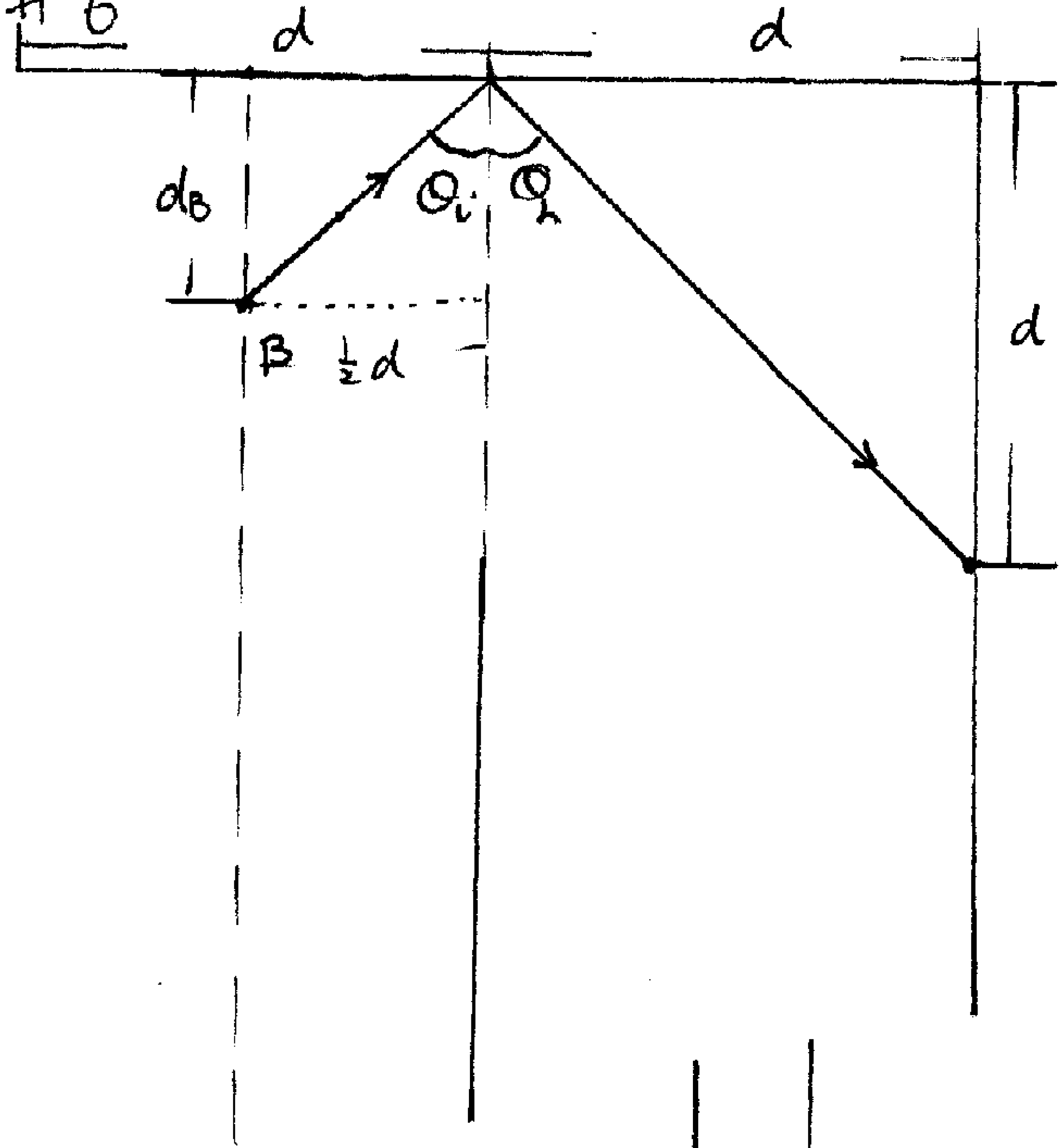
Ch 35 6, 10, 14, 15, 18, 20, 21, 24, 25, 29, 30, 33, 34, 36, 37

#6



Law of reflection : $\theta_i = \theta_r$

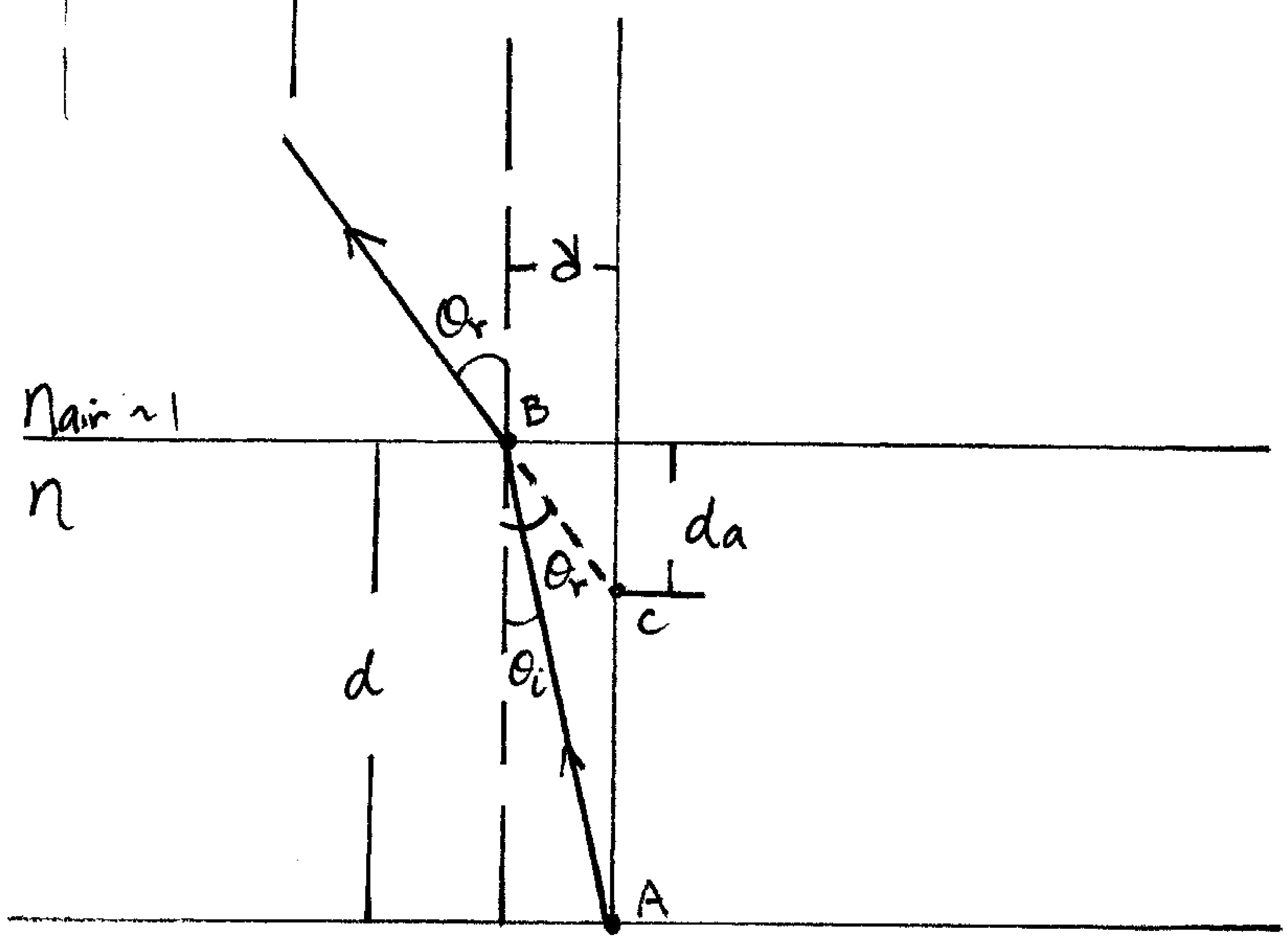
$\theta_r = \tan^{-1}\frac{d}{d} = 45°$

$\therefore \theta_i = 45° = \tan\frac{\frac{1}{2}d}{d_B}$

$\therefore d_B = \frac{1}{2}d = \frac{1}{2}\cdot 3m = \underline{1.5m}$

(You should see the burglar directly before you see her in the mirror.)

#15



$\overline{AB}\sin\theta_i = \overline{BC}\sin\theta_r = \delta$

$d\tan\theta_i = d_a\tan\theta_r$

$\therefore d_a = d\,\frac{\tan\theta_i}{\tan\theta_r} \sim d\,\frac{\theta_i}{\theta_r}$ — ①

Also,

$n\sin\theta_i = n_{air}\sin\theta_r$

$n\sin\theta_i = \sin\theta_r$

$n\theta_i = \theta_r \Rightarrow \frac{\theta_i}{\theta_r} = \frac{1}{n}$ — ②

① ← ②

$$\underline{\underline{d_a = d\,\frac{\theta_i}{\theta_r} = \frac{d}{n}}}$$

10.

	Type	f	r	i	p	m	Real or Virtual?	Invert or upright?
a	Concave	20	**40**	**-20**	+10	**+2**	**V**	**upright**
b	**flat**	**infinity**	**2Xinfinity**	**-10**	+10	+1.0	V	**upright**
c	**concave**	+20	**40**	**60**	+30	**+2**	**Real**	**invert**
d	**concave**	**+20**	**40**	**+30**	+60	-0.5	**real**	**invert**
e	**convex**	**-20**	-40	-10	**+20**	**+0.5**	**V**	**upright**
f	**convex**	20	**-40**	**-18**	**+180**	+0.10	**V**	**upright**
g	Convex	**-20**	40	4.0	**+5**	**+0.8**	**V**	**upright**
H	**concave**	**+8**	**+16**	**+12**	+24	0.50	**real**	Invert

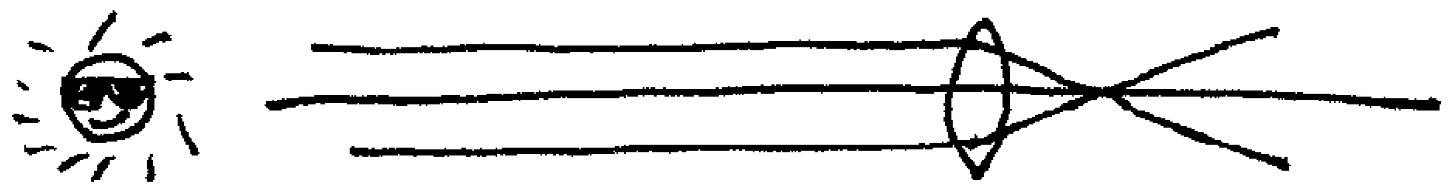
14.

	n_1	n_2	p	i	r	invert or upright?
a	1.0	1.5	+10	**-18**	+30	**upright**
b	1.0	1.5	+10	-13	**-32.5**	**upright**
c	1.0	1.5	**71**	+600	+30	**invert**
d	1.0	**0**	+20	-20	-20	**upright**
e	1.5	1.0	+10	-6.0	**30**	**upright**
f	1.5	1.0	**10**	-7.5	-30	**upright**
g	1.5	1.0	+70	**-26**	+30	**upright**
h	1.5	**-0.035**	+100	+600	-30	**invert**

24.

	type	f	r_1	r_2	i	p	n	m	Real or virtual	Upright or invert
a	C	10			**+20**	+20		**-1.0**	**real**	**invert**
b	**C**	+10			**-10**	+5.0		**+2.0**	**virtual**	**upright**
c	**C**	10			**-10**	+5.0		>1.0	**virtual**	**upright**
d	**D**	10			**-3.3**	+5.0		<1.0	**virtual**	**upright**
e	**C**	**30**	+30	-30	**-15**	+10	1.5	**+1.5**	**virtual**	**upright**
f	**D**	**-30**	-30	+30	**-7.5**	+10	1.5	**+0.75**	**virtual**	**upright**
g	**D**	**-120**	-30	-60	**-9.2**	+10	1.5	**+0.92**	**virtual**	**upright**
h	**D**	**-10**			**-5.0**	+10		0.5	**virtual**	upright
i	**C**	**+3.3**			**+5.0**	+10		-0.5	**real**	**invert**

18 $$|m| = \frac{h'}{h}$$



Because the object is so far away, the image appears at the focal pt $\Rightarrow i = f$

$$\therefore h' = h|m|$$
$$= h\left|\frac{i}{p}\right|$$
$$= h\left|\frac{f}{p}\right| \quad \text{(in this case)}$$
$$= 2\times\underbrace{(2.96\times10^{8}\,m)}_{R_\odot}\left|\frac{0.2\,m}{1.5\times10^{11}\,m}\right|$$
$$= \underline{\underline{1.856\ mm}}$$

20

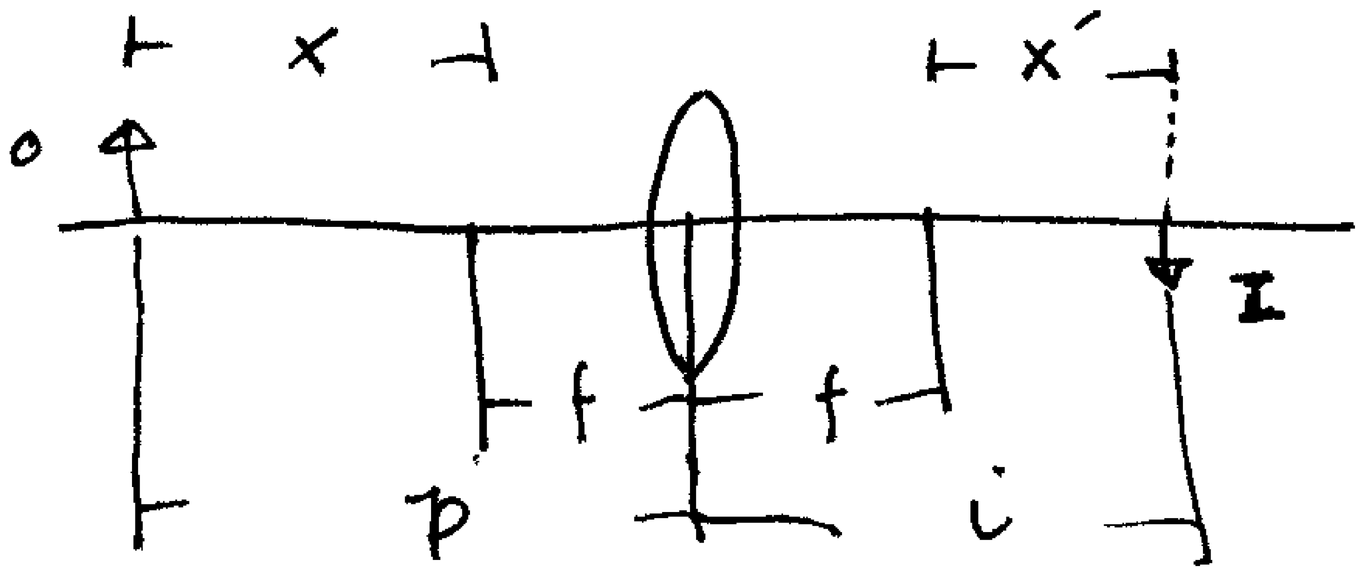
(a) $$\frac{1}{p}+\frac{1}{i} = \frac{1}{f} = (n-1)\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$$

$$\frac{1}{f} = (1.5-1)\left(\frac{1}{0.2}-\frac{1}{\infty}\right)$$
$$= 0.5\left(\frac{1}{0.2}\right)$$
$$= \frac{5}{2} = 2.5$$
$$f = \frac{10}{2.5} = 0.4\,m = \underline{\underline{40\,cm}}$$

(b) $$\frac{1}{0.4}+\frac{1}{i} = \frac{1}{0.4}$$

$$\underline{\underline{i = \infty}}$$

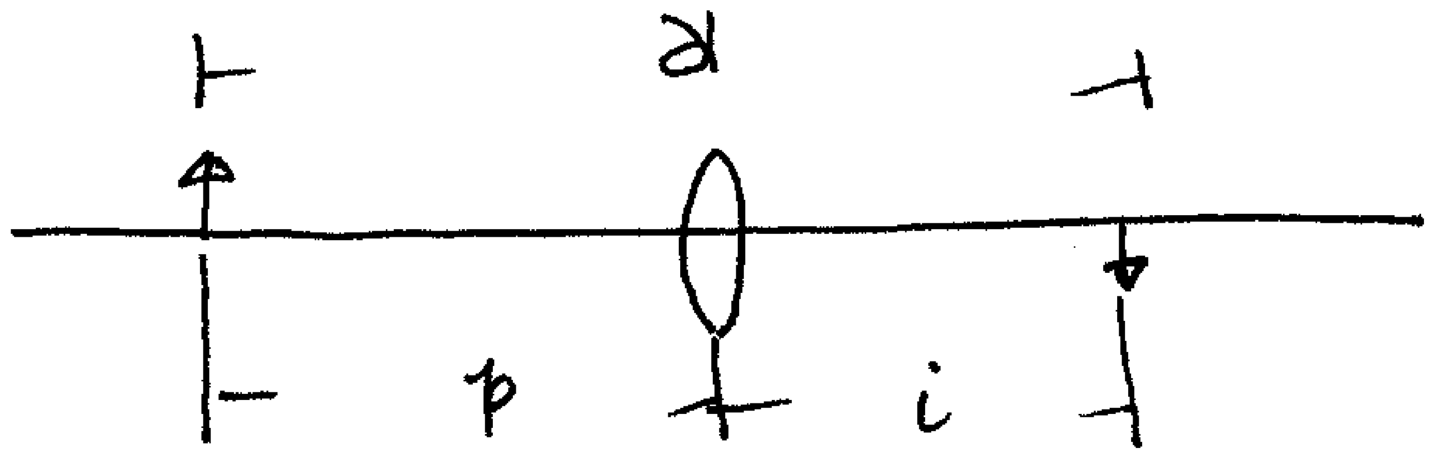
21



$$p = x+f$$
$$i = x'+f$$
$$\frac{1}{p}+\frac{1}{i} = \frac{1}{f}$$
$$\frac{1}{x+f}+\frac{1}{x'+f} = \frac{1}{f}$$
$$\frac{(x'+f)+(x+f)}{(x+f)(x'+f)} = \frac{1}{f}$$

$$\to f(x'+f+x+f) = (x+f)(x'+f)$$
$$fx'+f^2+xf+f^2 = xx'+xf+fx'+f^2$$
$$\underline{\underline{f^2 = xx'}}$$

25.



$$d = p + i \Rightarrow i = d - p$$

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

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

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

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

Solve for d (the total dist.)

$$df = p(d-p)$$

$$df - dp = -p^2$$

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

$$\therefore \quad d = \frac{-p^2}{(f-p)} \qquad \text{———} \quad (1)$$

d as a fcn. of p. If we can show the smallest $d = 4f$, then the proof is done.

to minimize d:

$$\frac{dd}{dp} = \frac{-2p}{(f-p)} - \frac{p^2}{(f-p)^2} = \frac{-2p(f-p) - p^2}{(f-p)^2} = \frac{-2pf + 2p^2 - p^2}{(f-p)^2}$$

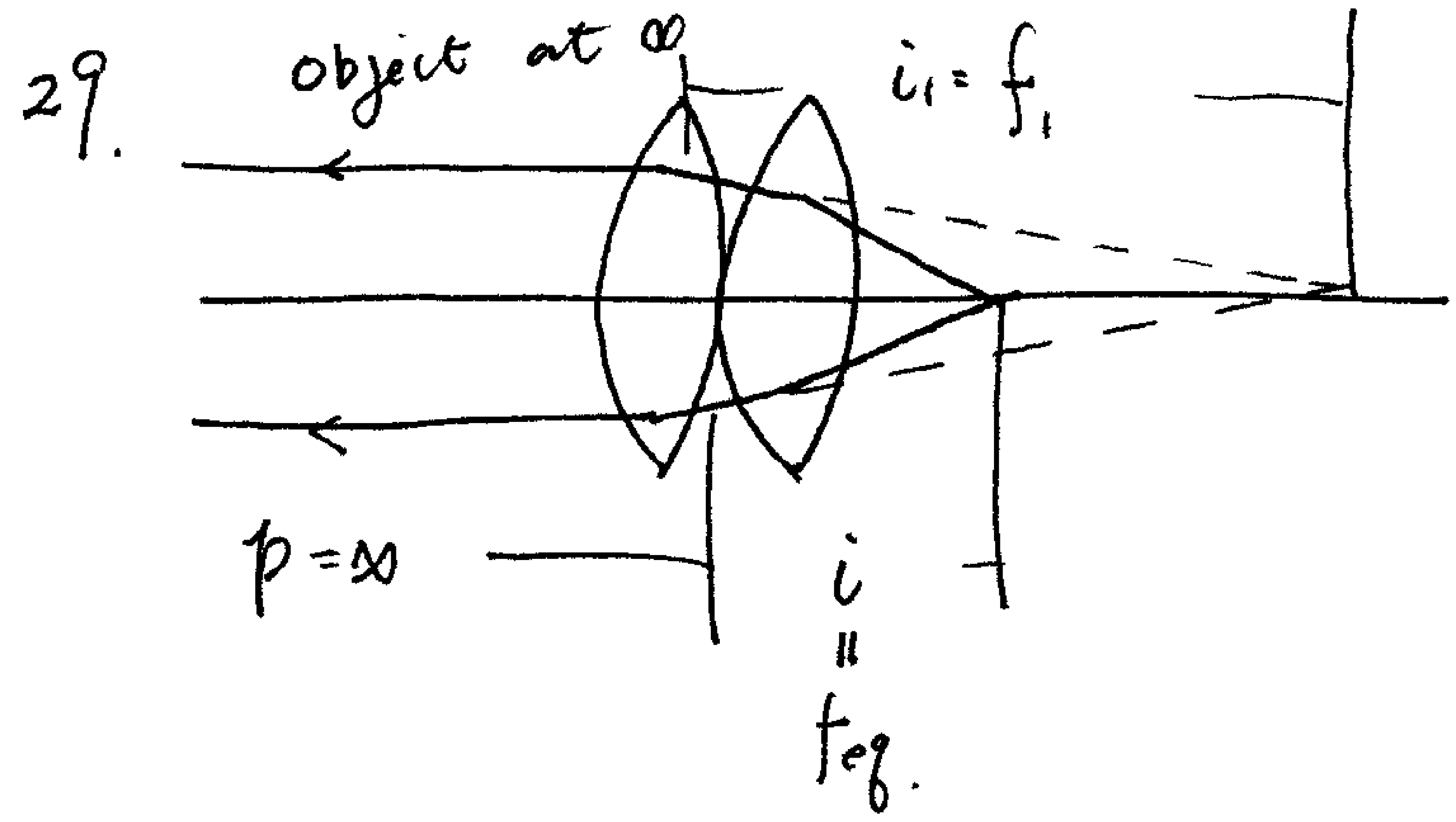
$$= \frac{-2pf + p^2}{(f-p)^2} = \frac{p(-2f+p)}{(f-p)^2} = 0$$

$\therefore \quad p = 0$ or $2f$. (0 is not possible)

Eqn. (1). at $p = 2f$

$$d = \frac{-(2f)^2}{(p-2f)} = \underline{\underline{4f}}$$

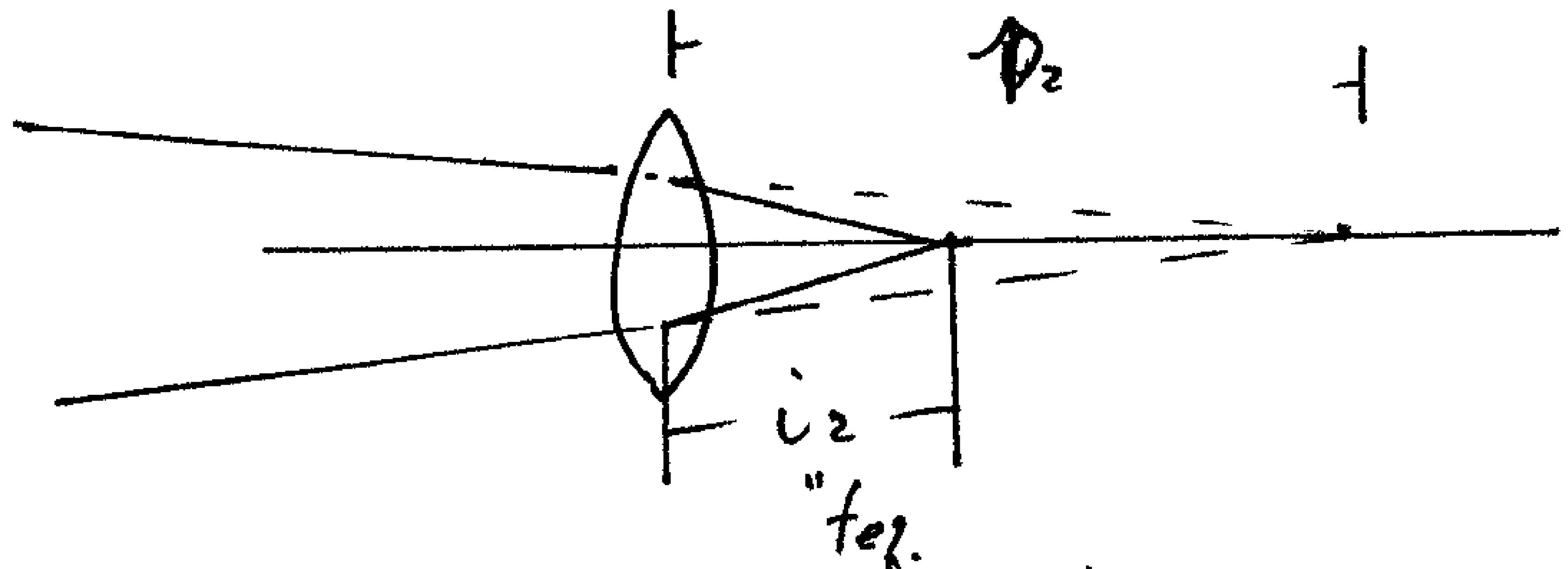
29.



1st lens.

$$\cancel{\frac{1}{p_1}}^{\,0} + \frac{1}{i_1} = \frac{1}{f_1} \qquad \therefore\ i_1 = f_1$$

2nd lens



Notice that for the second lens. the image created by the first lens is p_2

$\therefore\ i_1 = f_1 = p_2$

$$\frac{1}{p_2} + \frac{1}{i_2} = \frac{1}{f_2}$$

$$-\frac{1}{f_1} + \frac{1}{f_{eq}} = \frac{1}{f_2}$$

Because the image forms on the same side of the object (the image created by the 1st lens)

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$= \frac{f_1 + f_2}{f_1 f_2}$$

$$\therefore\ f_{eq} = \frac{f_1 f_2}{f_1 + f_2}$$

30 (a) convex

(b) $m = \frac{i}{p} = 0.5$ & $p + i = 40cm$

$i = 0.5p$

$\therefore p + 0.5p = 40cm$

$1.5p = 40cm$

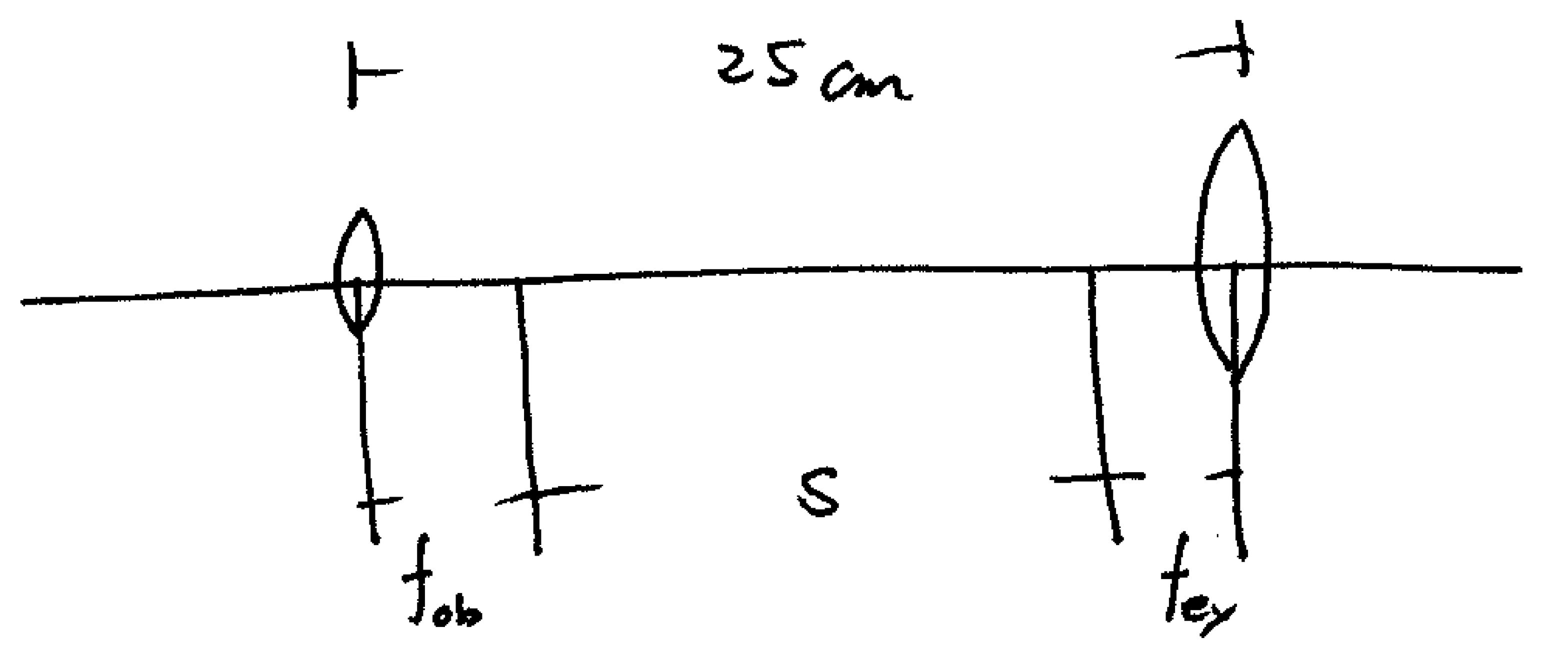
$p = 26.\dot{6}cm$ $(i = 13.\dot{3}cm)$

(c) $\frac{1}{i} + \frac{1}{p} = \frac{1}{f}$

$\frac{1}{13.\dot{3}} + \frac{1}{26.\dot{6}} = \frac{1}{f}$

$\therefore f = 8.\dot{8}cm$

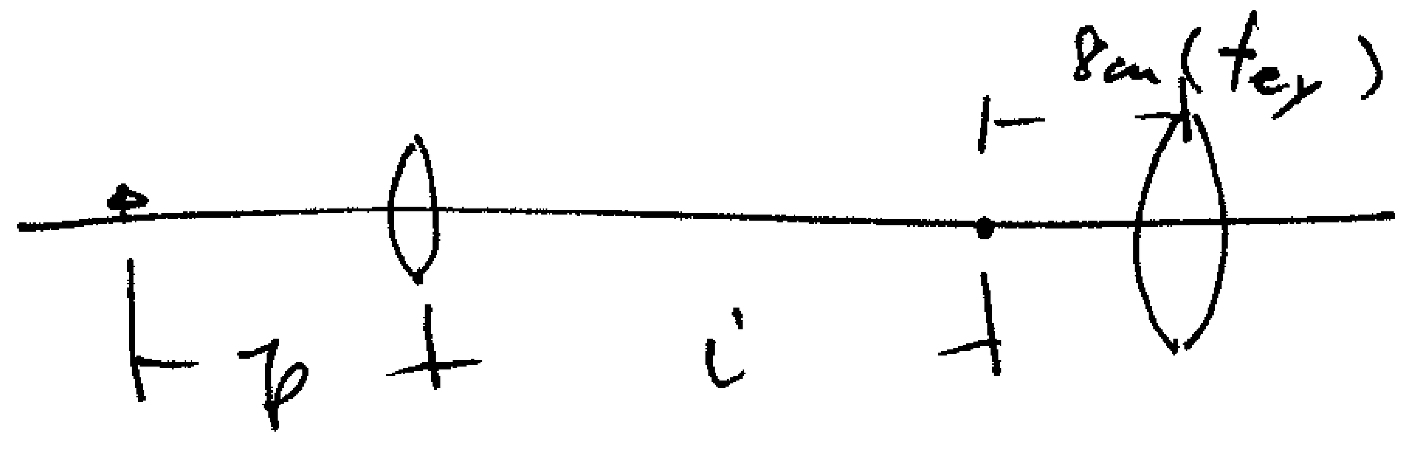
33



(a) $S = 25cm - f_{ob} - f_{ey}$

$= 25cm - 4cm - 8cm = 13cm$

(b)



$i = 25cm - 8cm = 17cm$

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

$\frac{1}{p} + \frac{1}{17} = \frac{1}{4}$

$\frac{1}{p} = \frac{1}{4} - \frac{1}{17} = 0.19117647$

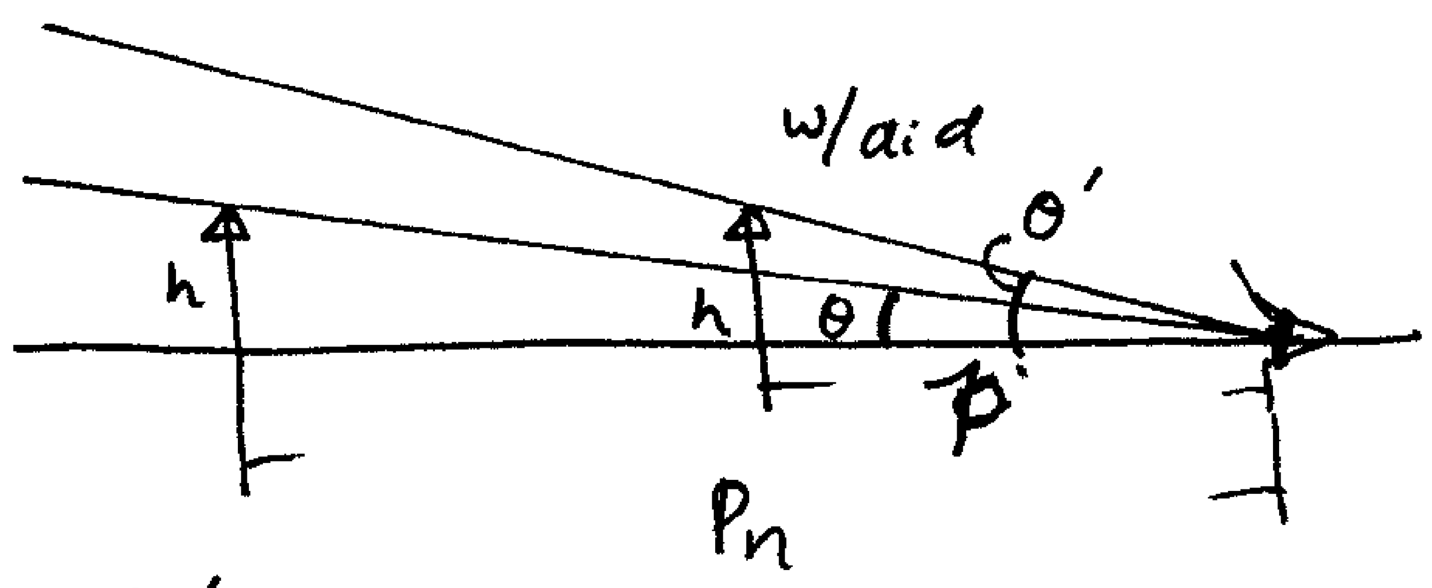
$p = 5.23cm$

(c) $m = -\frac{i}{p} = -\frac{17}{5.23} = \underline{\underline{-3.25}}$

(d) $m_\theta = \frac{25\text{ cm (for average?)}}{f_{ey}} = \underline{\underline{3.125}}$

(e) $M = m\, m_\theta = \underline{\underline{-10.15625}}$

34



(a) w/o. aid

$$m_\theta = \frac{\theta'}{\theta} = \frac{\tan^{-1}\frac{h}{p}}{\tan^{-1}\frac{h}{p_n}} = \frac{\frac{h}{p}}{\frac{h}{p_n}} = \frac{p_n}{p} \quad \text{——} \ (1)$$

Also

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

another negative because both p & i are on the same side

$$\frac{1}{p} = \frac{1}{f} - \frac{1}{i} = \frac{1}{f} + \frac{1}{p_n}$$

$$= \frac{p_n + f}{f p_n} \quad \text{——} \ (2)$$

(1) ← (2)

$$m_\theta = p_n \cdot \left(\frac{p_n + f}{f p_n}\right) = \underline{\underline{\frac{p_n + f}{f}}}$$

(b) since $i = \infty$

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

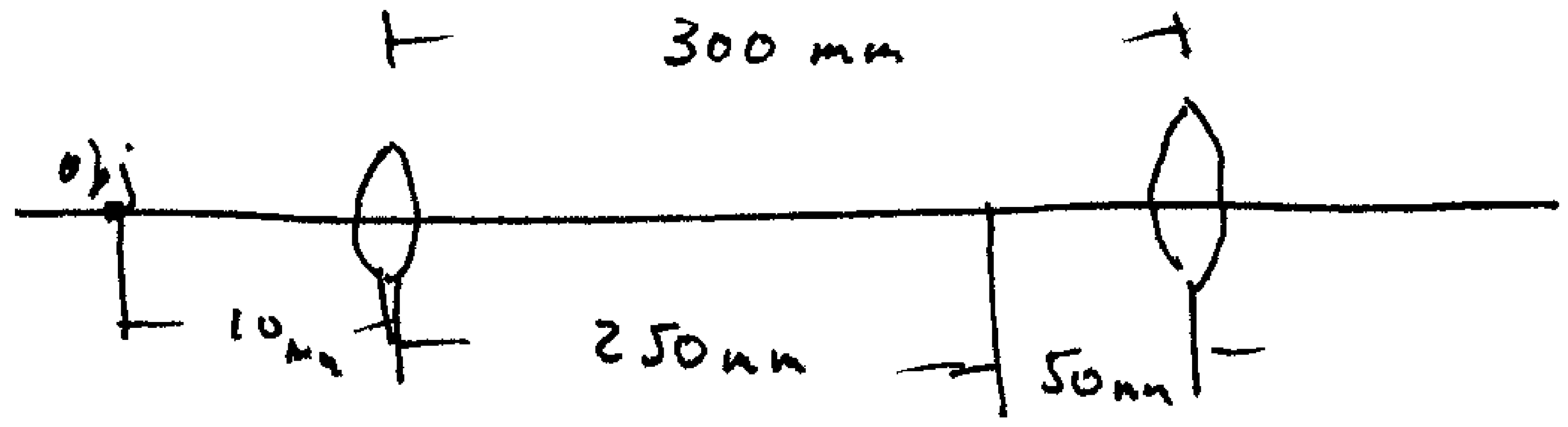
Eqn 1.

$$m_\theta = \frac{p_n}{p} = \underline{\underline{\frac{p_n}{f}}}$$

(c) If $p_n = 25\text{cm}$,

(a) $m_\theta = \frac{25+10}{10} = \underline{\underline{3.5}}$ (b) $m_\theta = \frac{25}{10} = \underline{\underline{2.5}}$

36



$$f_{ey} = 50\text{mm}$$

$$\frac{1}{p_{ob}} + \frac{1}{i_{ob}} = \frac{1}{f_{ob}}$$

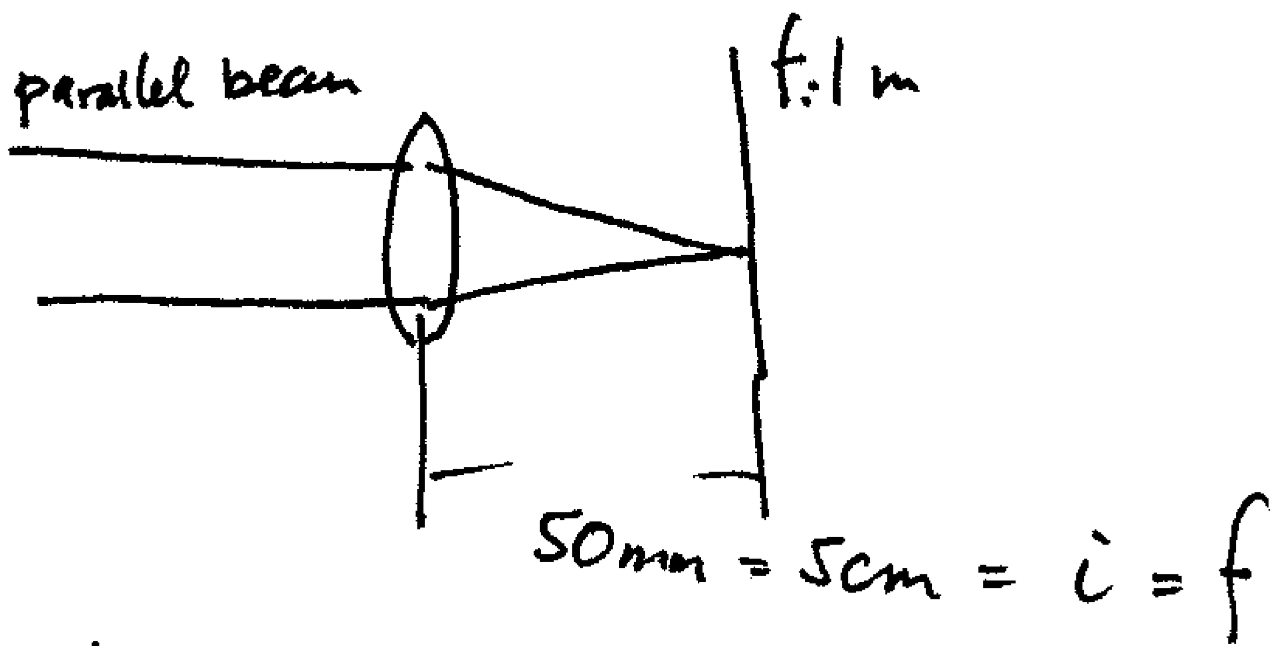
$$\frac{1}{10} + \frac{1}{250} = \frac{1}{f_{ob}} \Rightarrow f_{ob} = 9.615384615\text{mm}$$

$$M = m m_\theta = -\frac{S}{f_{ob}} \frac{25\text{cm}}{f_{ey}}$$

$$S = 300 - 9.615.. - 50 = 240.3840134\text{ mm}$$

$$\therefore M = -\frac{240.3840134\text{ mm}}{9.61538461\text{ mm}} \cdot \frac{250\text{ mm}}{50\text{ mm}} = \underline{\underline{-125}}$$

37



(a)

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

$$\frac{1}{100} + \frac{1}{i} = \frac{1}{5} \Rightarrow i = \underline{\underline{5.263157895\text{ cm}}}$$

(b) The diff. $= \underline{\underline{0.263157895\text{ cm}}}$