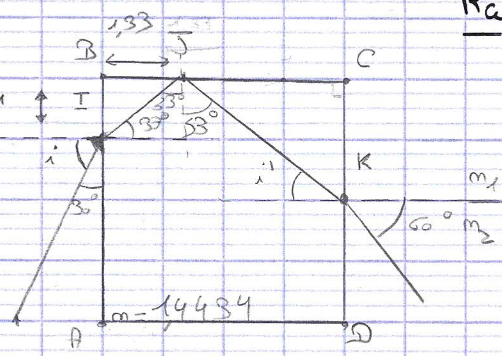
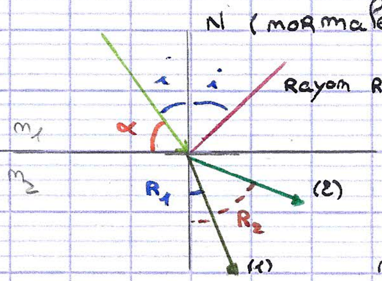
Optique géométrique

I - Réfraction, réflexion, prismes

Exercice 1



Rappels :



dioptre = interface qui sépare 2 milieux d'indice différents

$i = 60°$

$\sin i = n \sin R$

$R = \cancel{37}\,\mathit{3}9{,}9°$

$\tan R = \dfrac{IB}{BJ}$

$BJ = 1{,}33$ cm

$n \sin 53 = \sin R'$

$\sin R' = 1{,}15$

impossible ⇒ pas de réfraction

Loi de Snell :

$n_1 \sin i_1 = n_2 \sin i_2$

$n = \dfrac{c}{v} \geqslant 1$

(1) Si $\dfrac{n_2}{n_1} \geqslant 1 \Rightarrow \sin i_1 \geqslant \sin i_2$

$i_1 \geqslant i_2$

(2) Si $\dfrac{n_2}{n_1} \leqslant 1 \Rightarrow \sin i_1 \leqslant \sin i_2$

$i_2 \geqslant i_1$

$\Rightarrow \exists\ i_{lim}$ incident $/ i_2 = 90°$

⇒ Réflexion totale

Angle limite en J

on cherche j_{lim} tel que $R' = 90°$

$n \sin j_{lim} = 1$

$j_{lim} = 43{,}9°$

$R = j > j_{lim}$

⇒ réflexion totale en J

Angle d'incidence en K : i'

$i' = 90 - j = 36{,}9$

$i' < j_{lim}$ ⇒ réfraction en K

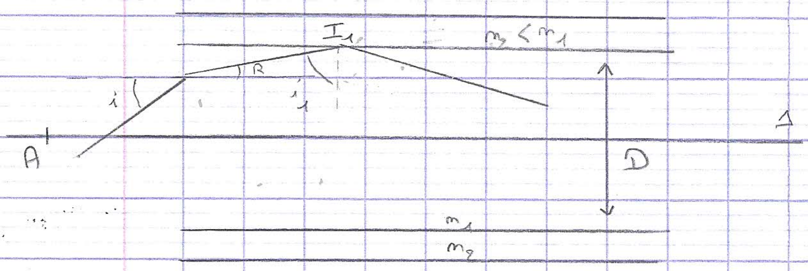
$n \sin i' = \sin R''$

$R'' = 60°$

$\tan \cancel{S} = \dfrac{JC}{KC}$

$KC = 2$ cm

Exercice 8



$n_1 > 1$ et $\sin i = n \sin r$

$\Rightarrow i > r$

1) On veut une réflexion totale en I

on cherche le i_1 limite tel que $r' = 90°$

$\Rightarrow n_1 \sin i_{1_{lim}} = n_2 \sin r'$

$= n_2 \quad (si\ r' = 90)$

$$\sin i_{1_{lim}} = \frac{n_2}{n_1}$$

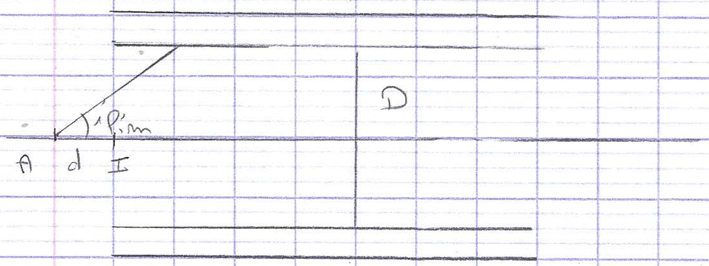
2) donc propagation guidée quand $i_1 > i_{1_{lim}}$

$r_{lim} = \frac{\pi}{2} - i_{1_{lim}}$ et $\sin i_{lim} = n_1 \sin r_{lim}$

$= n_1 \sin\left(\frac{\pi}{2} - i_{1_{lim}}\right)$

$\Rightarrow i < i_{lim}$ propagation

3) Cas optimal

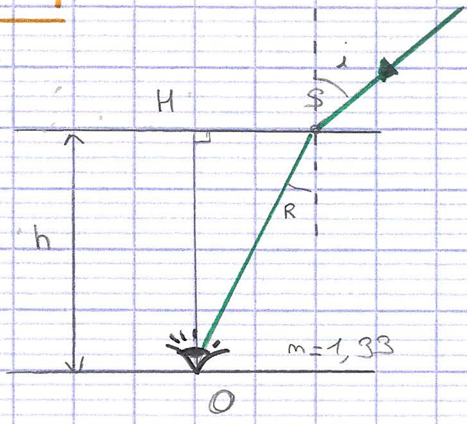


$\tan i_{lim} = \frac{D/2}{d} \Leftrightarrow 1/d = \frac{D}{2} \tan i_{lim}$

$i_{lim} = 31,3$

$d = 1,64$ mm

Exercice 4



Calcul de HS :

$i = 90°$

$\sin i = n \sin R$

$\Rightarrow 1 = n \sin R_{lim}$

$\Rightarrow R_{lim} = \arcsin \frac{1}{n}$

$= 48,8°$

$$\sin R_{lim} = \frac{HS}{OS}$$

$$\Leftrightarrow HS = OS \sin R_{lim}$$

$$= \sqrt{h^2 + HS^2} \sin R_{lim}$$

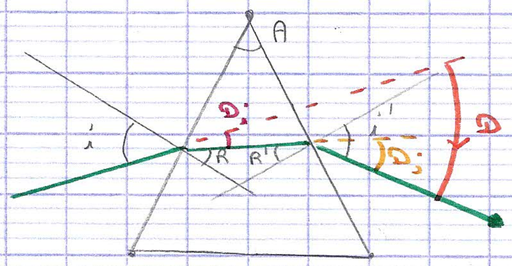
$$HS^2 = (h^2 + HS^2) \sin^2 R_{lim}$$

$$(1 - \sin^2 R_{lim}) HS^2 = h^2 \sin^2 R_{lim}$$

$$(1 - \frac{1}{n^2}) HS^2 = \frac{h^2}{n^2}$$

$$HS = \frac{h}{\sqrt{n^2 - 1}}$$

Exercice 7



(1) $\sin i = n \sin R$

(2) $n \sin R' = \sin i'$

(3) $R + R' = A$

(4) $D = D_i + D_j$

$D_i = i - R$

$D_j = i' - R'$

1) A et i sont petits devant 1 (Rad)

$i \ll 1 \rightarrow R \ll 1$ car $n \simeq 1$

$\sin i \simeq i$ (Rad)

$\Rightarrow i \simeq nR$.

Si $R \ll 1$ et $A \ll 1 \Rightarrow R' \ll 1$

$\Rightarrow nR' \simeq i'$

$D \simeq nR + nR' - A \simeq A(n-1)$

$\Leftrightarrow \frac{D}{A} + 1 = n$

2) (a) $i = 90^\circ$

• en I : $\sin 90^\circ = \sqrt{3}\,\sin R$

$R = \arcsin(1/\sqrt{3})$

$= 35,26^\circ$

• en J : $i' = \arcsin(\sqrt{3}\,.\sin(24,74)) = 46,46^\circ$

$R + R' = A$

$\Rightarrow R' = A - R$

$= 24,74^\circ$

$D = i + i' - A$

$= 76,46^\circ$

(b) On veut maintenant $i' = 90^\circ$

Principe de retour inverse de la lumière

$i = 90^\circ \Rightarrow i' = 46,66^\circ$

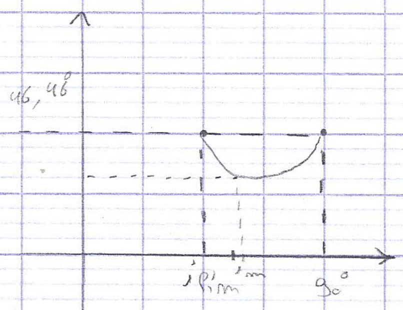
$\Rightarrow i' = 90^\circ \Rightarrow i = 46,66^\circ \Rightarrow D = 76,46^\circ$

(c) $i = 45^\circ$?

Si $i = 46,46^\circ \Rightarrow i' = 90^\circ$

Si $i \searrow \Rightarrow R \searrow$ (1) $\Rightarrow R' \nearrow$ (3) $\Rightarrow i' \nearrow$.

Si $i \leq 46,46^\circ$ il y a reflexion totale en J.



on cherche $\frac{\partial D}{\partial i} = 0$

on constate que $D = D_m$ quand IJ // base

$R = R' \Rightarrow R + R' = A$

$\Rightarrow i = i'$

$D_m = 2\,i_m - A$

$R = \frac{A}{2} = 30^\circ$

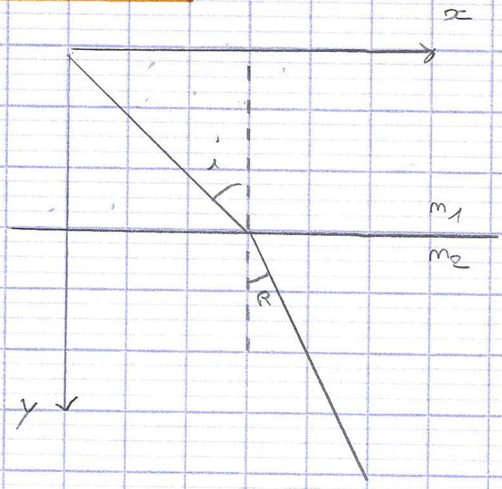
$i_m = \arcsin(\sqrt{3}\,\sin 30^\circ) = 60^\circ$

$D_m = 60^\circ$

(d) $\sin i_m = n \sin i_R = n \sin \frac{A}{2}$

$\sin\left(\frac{D_m + A}{2} = i_m\right) = n \sin \frac{A}{2}$

Exercice 6



• A ↦ I $\quad v_1 = c/n \qquad$ • I ↦ B $\quad v_2 = c/n_2$ donc

$t_{A\to I} = t_1 = d_{AI}/v_1 \qquad t_{I\to B} = t_2 = d_{IB}/v_2$

or $\quad AI^2 = d^2 + x^2 = d_{AI}$

$IB^2 = (y_B - d)^2 + (x_B - x)^2 = d_{IB}$

donc $\quad T_{A\to B} = t_1 + t_2 = \dfrac{d_{AI}}{v_1} + \dfrac{d_{IB}}{v_2} = \dfrac{n_1}{c} d_{AB} + \dfrac{n_2}{c} d_{IB}$

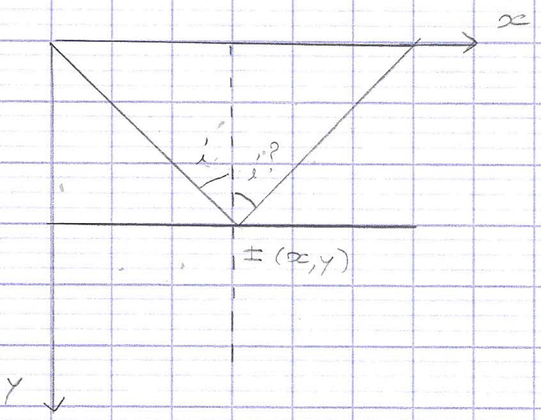
$= \dfrac{1}{c}\left[n_1 \sqrt{d^2+x^2} + n_2 \sqrt{(x_B - x)^2 + (y_B - d)^2} \right]$

Principe de Fermat $\quad \dfrac{\partial T(x)}{\partial x} = 0$:

$\dfrac{n_1}{c} \dfrac{x}{\sqrt{x^2+d^2}} - \dfrac{n_2}{c} \dfrac{x_B - x}{\sqrt{x^2+d^2}}$

$\sin i = x/d_{IA} \quad , \quad \sin R = (x_B - x)/d_{IB}$

$n_1 \sin i = n_2 \sin R$

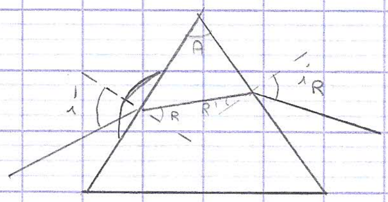


on a $\sin i = \sin i'$

donc $i = i'$

ou $i' = \pi - i'$ (faux)

Exercice 9



(1) en I : $N \sin(i) = n \sin(R_1)$

On a réfraction en I

si $\sin R < 1$ or $\sin i < 1$

$\Rightarrow \frac{N}{n} < 1$

(2) $N \sin i = n \sin R$

$R + R' = A$

$n \sin R' = \sin i'$

$N \sin i = n \sin(A - R')$

$\sin(a+b) = \sin a \cos b + \cos a \sin b$

$\cos(a+b) = \cos a \cos b - \sin a \sin b$

$\sin(A - R') = (\sin A \cos R' - \cos A \sin R')$

$\cos(R') = \sqrt{n^2 - \sin^2(i')}\ \frac{1}{n}$

$$N = \frac{1}{\sin i}\left(\sin(A)\sqrt{n^2 - \sin^2(i')} - \cos(A)\sin i'\right)$$

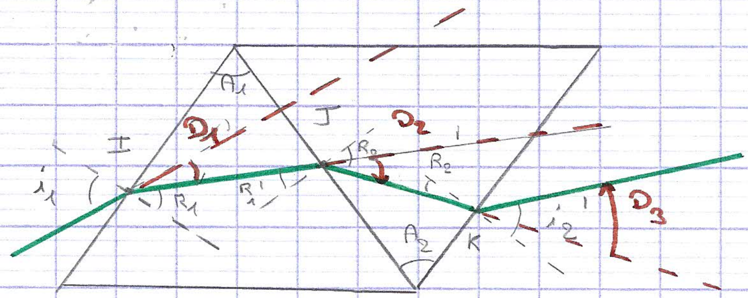
(3) Soit $i = 90°$ $\quad i_1' = 26,5°$ (avec N)

$i_2' = 42,5°$

$1 = \sin A \sqrt{n^2 - \sin^2 i_2'} \Leftrightarrow n = \left(\sin^2 42,5 + \left(\frac{1 + \cos 60 \sin 45,5}{\sin 60}\right)^2\right)^{1/2}$

$n = 1,686$, $N = 1,185$

Exercice 12



(1) En I : $\sin i_1 = n_1 \sin R_1$

$R_1 + R_1' = A_1$

En J : $n_1 \sin R_1' = n_2 \sin R_2$

$R_2 + R_2' = A_2$

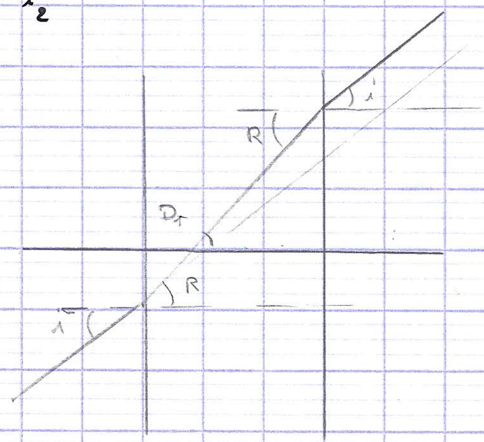
$n_2 \sin R_2' = \sin i_2'$

(2) $i_1 = n_1 R_1$

$n_1 R_1' = n_2 R_2$

$n_2 R_2' = i_2'$

(3)



$D_1 = i - R$

$D_2 = -i + R$

$D = 0$

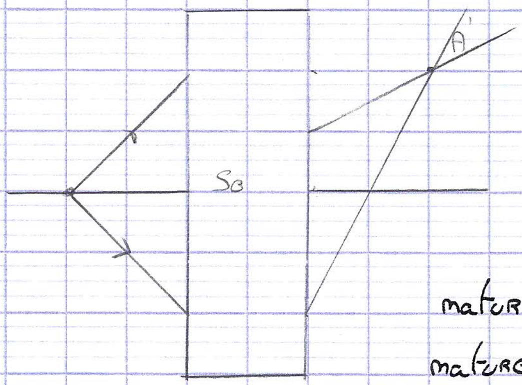
$D = D_1 + D_2 + D_3 = (i_1 - R_1) + (R_2 - R_1') - (i_2' - R_2')$

$= n_1 R_1 - R_1 + R_2 - A + R_1 - n_2 R_2' + A - R_2$

$= n_1 R_1 - A_1 - n_2 R_2' + A_2$

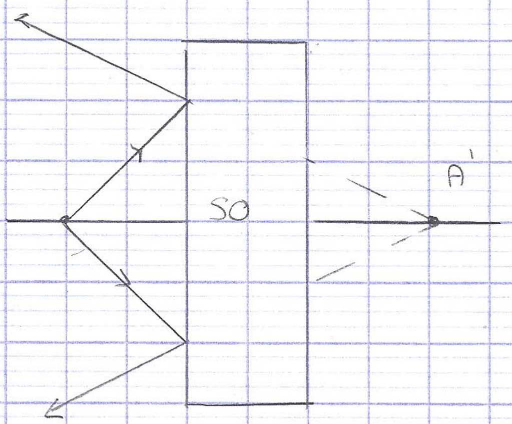
II - Miroirs plans

Rappel : construction de l'image d'un point un système optiq

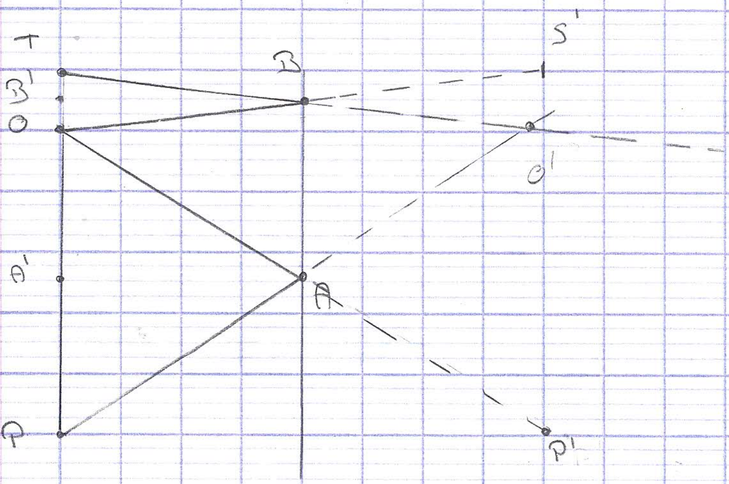


Il faut au moins 2 rayons issus de A pour avoir A'

nature de A' : réel (on peut visualiser l'objet)
nature de A : réel (lumière émis de A)



propriété du miroir :
$i = i'$
$AH = HA'$
$\overline{AH} = \overline{HA'} = -\overline{A'H}$
A, H, A' tous alignés

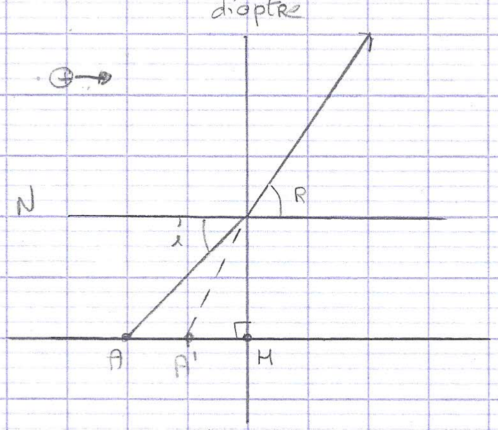


Théorème des milieux
$TP = 2AB$
$\Rightarrow AB_{min} = TP/2 = 90cm$

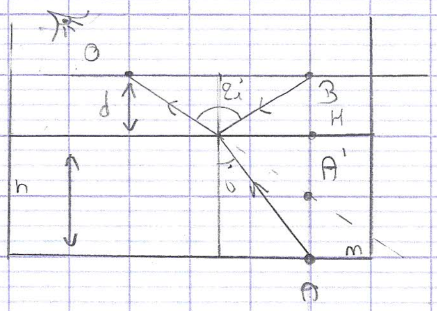
$AH = A'P = \frac{1}{2}P_0$
$= 85 cm$

Exercice 16 — Dioptres plans

Rappel :



$\frac{\overline{HA}}{n_1} = \frac{\overline{HA'}}{n_2}$ dans les condition de Gauss { petit angles / proche de la normale



~~En~~ En I : $n \sin j = \sin i$

$\tan i = \frac{OB}{2d}$

$\tan j = \frac{OB}{2h}$

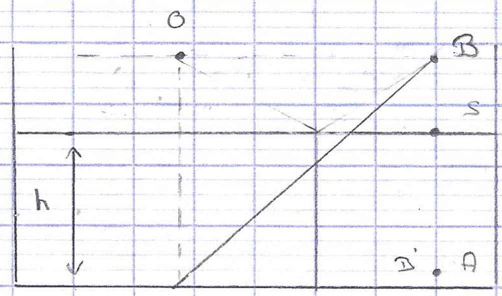
$i = 60°$
$j = 40°$ $\Rightarrow$ $n = 1,33$

① $\overrightarrow{B'A'}$ $\tan(\pi/2 - i) = \frac{A'B'}{OB/2}$

$A'B' = 17 \cdot \tan(90 - 59,5)$
$= 10 \text{ cm}$

(2) formule du dioptre : $\frac{\overline{B'A}}{n} = \overline{B'A'} = 15 \text{ cm}$ ⚠ gauss

Exercice 16

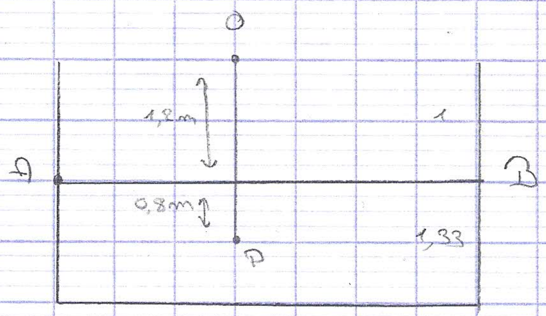


$$\frac{1}{\overline{SB}} = \frac{n}{\overline{SB'}}$$

$$\frac{1,33}{\overline{SA}} = \frac{1}{\overline{SA'}}$$

$$SA' = 15\,cm$$

Exercice 17



Exercice 20

Analyse pb :
- lentille conv $\overline{OF'} > 0$
- objet réel $\overline{OA} < 0$

$\Rightarrow \overline{OA} = -20cm$
- image virtuelle : $\overline{OA'} < 0$
- $|\gamma| = 3$

$$1 - \frac{\overline{OA}}{\overline{OA}} = 1 - \alpha$$

$$\overline{OA'} = \alpha\,\overline{OA}$$

$$-60$$

$$\frac{1}{\overline{OF'}} = \frac{1}{\overline{OA'}} - \frac{1}{\overline{OA}} \qquad \gamma = \frac{\overline{OA'}}{\overline{OA}}$$

$$\frac{-60}{OF'} = 1-\alpha$$

$$OF' = \frac{-60}{1-\alpha}$$

$$\frac{\overline{OA'}}{\overline{OF'}} = 1 - \frac{\overline{OA'}}{\overline{OA}} = 1-\gamma$$

$$\frac{1}{\overline{OA'}} = \frac{1}{\overline{OA}} + \frac{1}{\overline{OF'}}$$

si $\gamma = +3$, $\overline{OF'} = 30\,cm$ (1)

$\gamma = -3$, $\overline{OF'} = 15\,cm$ (2)

$$\Rightarrow \overline{OA'} = \frac{\overline{OF'} \times \overline{OA}}{\overline{OF'} + \overline{OA}}$$

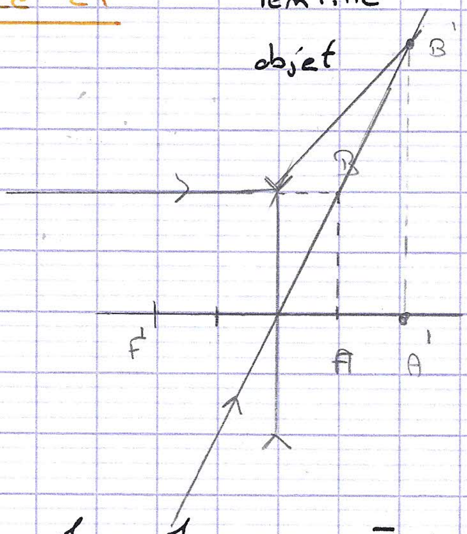
$\Rightarrow$ (1) : $\overline{OA'} = -60\,cm$ virtuelle

(2) : $\overline{OA'} = 60\,cm$ réelle

Exercice 21

Lentille divergente $\Rightarrow \overline{OF'} < 0$

objet



Lentille divergente $\Rightarrow \overline{OF'} < 0$

objet virtuel $\Rightarrow \overline{OA} > 0$

$\overline{OF'} = -15$ cm

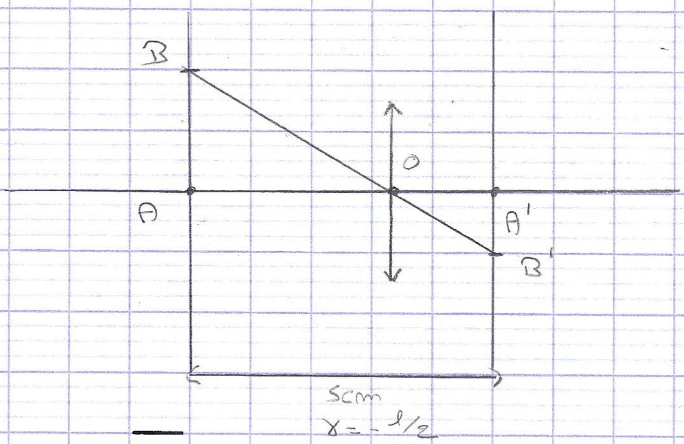
$\overline{OA} = 10$ cm

$$\frac{1}{\overline{OF'}} = \frac{1}{\overline{OA'}} - \frac{1}{\overline{OA}} \Leftrightarrow \overline{OA'} = \frac{\overline{OA}\,\overline{OF'}}{\overline{OF'} + \overline{OA}}$$

AN $\overline{OA'} = 30$ cm

$\gamma = 3$

Exercice 22



A réel

A' réel

$$\gamma = -\frac{1}{2} = \frac{\overline{A'B'}}{\overline{AB}} \Rightarrow \overline{A'B'} = \frac{1}{2}\overline{AB}$$

$$-\gamma = \frac{\overline{OA'}}{\overline{OA}} = \frac{\overline{A'B'}}{\overline{AB}} = \frac{1}{2}$$

$\overline{AA'} = 45$ cm $= -\overline{OA} + \overline{OA'}$

$\Rightarrow \overline{OA'} = 15$ cm $\Rightarrow \frac{1}{\overline{OF'}} = \frac{1}{\overline{OA'}} - \frac{1}{\overline{OA}}$

$\overline{OA} = -30$ cm

$\Rightarrow OF' = 10$ cm

Exercice 24

L_1 lentille convergente

$\overline{OF_1} = +5c$

$\overline{A_1B_1}$ sur un film photo $\Rightarrow$ A_1B_1 réelle

AB réel

$\overline{AB} = 10\ cm$

$\overline{OA} = -100\ cm$

$$\frac{1}{\overline{OF'}} = \frac{1}{\overline{OA'}} - \frac{1}{\overline{OA}} \Rightarrow \overline{OA'} = \frac{\overline{OF'} \cdot \overline{OA}}{\overline{OF'} + \overline{OA}} \simeq 5,26\ cm$$

$$\overline{A'B'} = \gamma\, \overline{AB} = -\frac{10}{19}$$

A_2B_2 virtuel (objet de L_2 divergente) $\quad \overline{O_2A_2} > 0$

$\overline{O_2A_2} = 2cm$

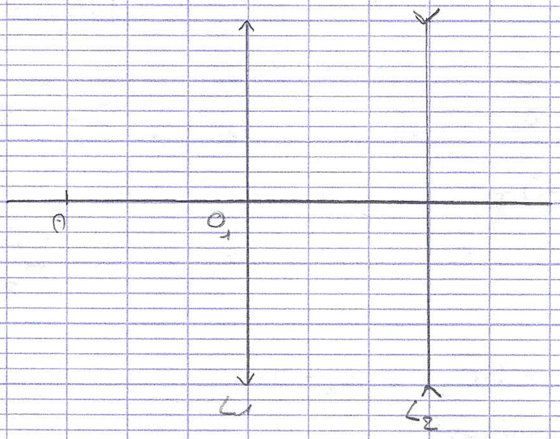
$\overline{O_2F_2'} = -4cm$

$A_2 \xrightarrow{L_2} A'$

$$\frac{1}{\overline{O_2F_2'}} = \frac{1}{\overline{O_2A'}} - \frac{1}{\overline{O_2A_2}}$$

$$\overline{O_2A'} = \frac{\overline{O_2A_2}\ \overline{O_2F_2'}}{\overline{O_2F_2'} + \overline{O_2A_2}} = 4cm$$

A' image réelle



$\overline{O_1A_1} = 5,26$

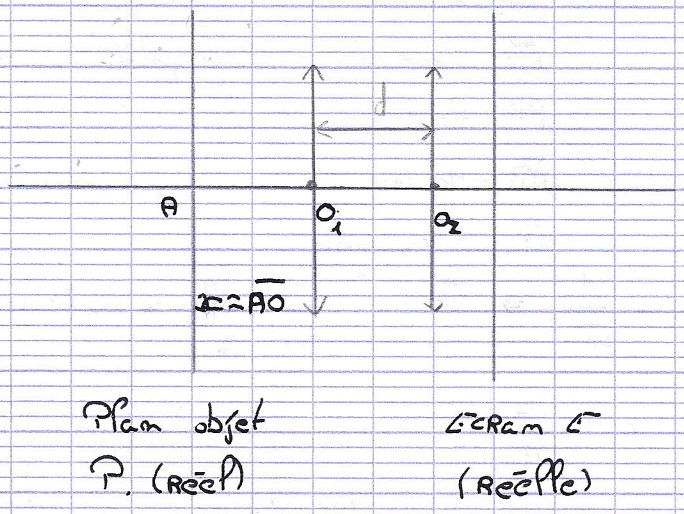
$A \xrightarrow{L_1} A_1 \xrightarrow{L_2} A'$

$\overline{O_1A_1} = 5,26\ cm$

$\overline{O_2A_1} = 2\ cm$

et $\overline{O_2A'} = 4cm$

Exercice 25



Relation de conjugaison : $\dfrac{1}{\overline{OA'}} - \dfrac{1}{\overline{OA}} = \dfrac{1}{\overline{OF'}}$

$x = \overline{AO}$

$D = \overline{AA'} \Rightarrow D = \overline{AO} + \overline{OA'} = x + \overline{OA'}$

$\overline{OA'} = D - x$

$\dfrac{1}{D-x} + \dfrac{1}{x} = \dfrac{1}{f'}$

$\dfrac{x + (D-x)}{x(D-x)} = \dfrac{1}{f'}$

$Df' = -x^2 + Dx$

$x^2 - Dx + Df' = 0$

$\Delta = D^2 - 4Df' = D(D - 4f')$

$> 0 \Rightarrow D > 4f'$

2 solutions $\Rightarrow$ 2 images

Si $\Delta = 0 \Rightarrow D = 4f'$

$x_1 = \dfrac{D - \sqrt{D(D-4f')}}{2}$

$x_2 = \dfrac{D + \sqrt{D(D-4f')}}{2}$

$d = \overline{O_1O_2} = \overline{O_1A} + \overline{AO_2} = x_2 - x_1$

$d = \sqrt{D(D-4f')}$

$\Rightarrow f' = \dfrac{D^2 - d^2}{4D}$

Exercice 26 — 2 lentilles convergentes L_1 et L_2

de foyer $f' = 3$ cm et $\overline{O_1O_2} = 2$ cm

$\overline{FA} = \overline{FO} + \overline{OA} = f' + \overline{OA}$ et $\frac{1}{OA'} - \frac{1}{OA} = \frac{1}{f'}$

$\overline{F'A'} = \overline{F'O} + \overline{OA'} = -f' + \overline{OA'}$

$\frac{OA - OA'}{OA'OA} = \frac{1}{f'}$

$f' = \frac{OA'OA}{OA - OA'}$

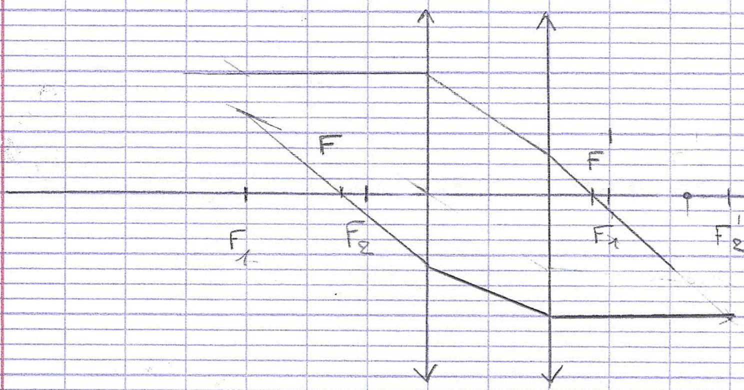
$(f' + OA)(-f' + OA')$

$-f'^2 - f'OA + f'OA' + OAOA'$

$-f'^2 + f'(OA' - OA) + OAOA'$

$-f'^2 + f'\left(\frac{OA'OA}{f'}\right) + OAOA'$

$-f'^2$



$\overline{F_1F} \times \overline{F_1'F_2} = -f_1'^2$

$\overline{F_1'F_2} = \overline{F_1'O_1} + \overline{O_1O_2} + \overline{O_2F_2'} = -f_1' + \overline{O_1O_2} - f_2'$

$= -4$ cm

$F_1F = +\frac{9}{4}$ cm $= 2,25$

$\infty \xrightarrow{L_1} F_1' \xrightarrow{L_2} F'$: $\overline{F_2F_1'} \cdot \overline{F_2'F'} = -f_2'^2$

$\overline{F_2F_1'} = \overline{F_2O_2} + \overline{O_2O_1} + \overline{O_1F_1'} = f_2' - \overline{O_1O_2} + f_1' = -\frac{9}{4} = -2,25$ cm

L'oeil et la vision

Exercice 31

- PP à 10 cm punctum proximum
- $\Delta C = 8\ \delta$ amplitude dioptrique.

Image nette si elle se forme sur la rétine

et $\dfrac{1}{\overline{OA'}} - \dfrac{1}{\overline{OA}} = \dfrac{1}{f'} = C$

on pose $K = \dfrac{1}{\overline{OA'}} = cte$

$\dfrac{1}{\overline{OA}}$ varie tout le temps $\Rightarrow f'$ s'ajuste en permanence

Pour un oeil au repos (observation à l'∞)

on pose $D_{PR} = \dfrac{1}{\overline{AO}} > 0$, $C_0 - \dfrac{1}{D_{PR}} = K$

Pour un oeil accommodant

$$C_0 + \Delta C - \frac{1}{D_{PP}} = K$$

donc au final : $C_0 - \dfrac{1}{D_{PR}} = C_0 + \Delta C - \dfrac{1}{D_{PP}}$

$$\Rightarrow \Delta C = \frac{1}{D_{PR}} - \frac{1}{D_{PR}}$$

oeil emmetrope : $D_{PR} \to \infty$ et $D_{PP} \sim 25\ cm = \dfrac{1}{4}\ m$

$\Rightarrow \Delta C = 4\ \delta$

(1) $\Delta C = \dfrac{1}{D_{PP}} - \dfrac{1}{D_{PR}} \Rightarrow \dfrac{1}{D_{PR}} = \dfrac{1}{0,1} - 8$

$\Rightarrow \dfrac{1}{D_{PR}} = 25 \Rightarrow D_{PR} = 50\,cm$

(2) Nature de la lentille pour un PR à l'∞

sans correction : $C - \dfrac{1}{D_{PR}} = K$

une correction : $C_0 + C - \dfrac{1}{D_{PR}^{c}} = K$ on veut $D_{PR}^{c} \to \infty$

$\Rightarrow C_0 + C = C_0 - \dfrac{1}{D_{PR}}$, ~~ou~~ $C = -\dfrac{1}{D_{PR}} = -2\ \delta$

$C < 0 \Rightarrow$ lentille divergente

$C = \dfrac{1}{f'_c} \Rightarrow f'_c = -50\ cm$

oeil avec PR à l'∞ et $\Delta C = 8\ \delta$ et
on cherche le PP

$$\Delta C = \frac{1}{D_{PP}^{c}} - \frac{1}{D_{PR}^{c}}$$

$\Delta C = 8\ \delta$

$\Rightarrow D_{PP}^{c} = 12,5\ cm$

et un oeil avec PR à l'∞ et $\Delta C = 8\ \delta$ et tel que

$\Delta C = \dfrac{1}{D_{PP}} - \dfrac{1}{D_{PR}} \Rightarrow D_{PP} = 12,5\ cm$

$\Rightarrow$ la correction corrige aussi le PP !

(3) Lentille correctrice

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

Rayon de l'oeil : $R = 8$ mm , indice du verre : 1,5 δ

$\Rightarrow R_2 = \overline{S_2C_2} = 8$ mm et $C = -2\ \delta$

$\Rightarrow -2 = (1,5-1)\left(\frac{1}{R_1} - \frac{1}{8.10^{-3}}\right)$

$\Rightarrow -4 + \frac{1}{8.10^{-3}} = \frac{1}{R_1}$

$R_1 = 8,265$ mm
$= \overline{S_1C_1}$

Exercice 32

PP = 1m

PR virtuel $\Rightarrow$ il accomode tout le temps

(1) Avec accomodation $C_0 + \Delta C - \frac{1}{P_{PP}} = K$

avec correction $C_0 + \Delta C + C - \frac{1}{D^c_{PP}} = K$

$C_0 + \Delta C - \frac{1}{D_{PP}} = C_0 + \Delta C + C - \frac{1}{D^c_{PP}}$

$\Rightarrow C = \frac{1}{D^c_{PP}} - \frac{1}{D_{PP}}$ $\quad$ $\delta'_c = 33$ cm

$C = \frac{1}{0,25} - 1 = 3\ \delta$

$C > 0 \Rightarrow$ lentille convergente

$\Delta C = \frac{1}{D^c_{PP}} - \frac{1}{D^c_{PR}}$ $\Rightarrow 4\ \delta = \frac{1}{\frac{1}{4}\text{m}} - \frac{1}{D^c_{PR}}$

$\Rightarrow D^c_{PR} \rightarrow \infty$ la lentille ~~converge~~ change aussi le PR.

À travers la loupe : $G_c = 12,5$ 32 µm

$\Rightarrow \varepsilon_l = \dfrac{\varepsilon}{G_L} \Rightarrow \varepsilon_l =$ $3,2 \times 10^{-5}$

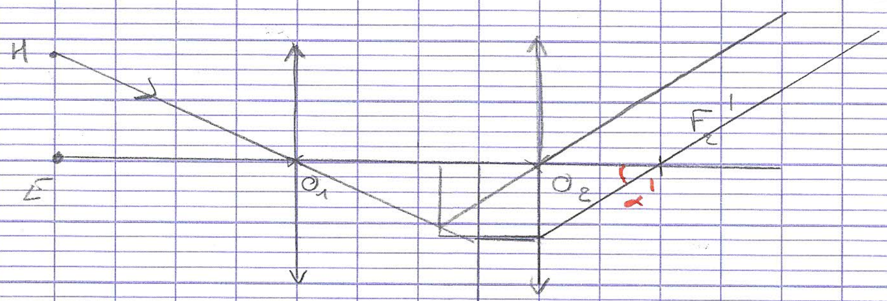
$\Rightarrow R_l = 8\ \mu m$

Exercice 39

$L_1 : f_1' = 1m$

$L_2 : C = 60\delta$

(1) distance angulaire $E, H = 20''$



Pas d'accomodation :

- image finale à l'∞
- image intermédiaire au foyer objet de L_2

$$C_2 = \frac{1}{f_2'} = 60 \Rightarrow f_2' \simeq 2cm$$

$$G = \frac{\alpha'}{\alpha} \qquad \alpha' = \frac{\overline{E_1H_1}}{\overline{O_2F_2'}}$$

$$\alpha = \frac{\overline{E_1H_1}}{\overline{O_1F_2}} \Rightarrow$$

$$G = -\frac{1}{f_2'} \times f_1' = -60$$

(2) $\alpha' = \alpha G \Rightarrow \alpha' = -60 \times 20''$

$= -20'$

(3) $\varepsilon = 1'$

$\Rightarrow$ on ne peut pas résoudre les 2 étoiles

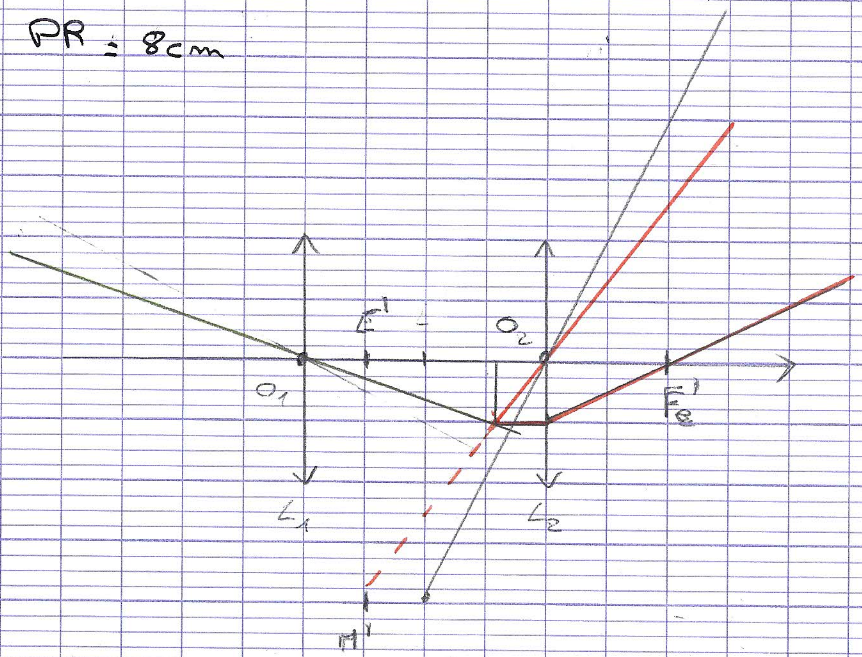
$\Rightarrow$ on voit 2 étoiles à travers la lunette

On cherche α_{min} sachant que $\varepsilon = 1'$

$$G = \frac{\varepsilon}{\alpha_{min}} \Rightarrow \alpha_{min} = \frac{\varepsilon}{G} = -\frac{1'}{60}$$

$$\alpha_{min} = -1''$$

(4) $PR = 8cm$



$$\overline{O_1O_2} = \overline{O_1F_1'} + \overline{F_1'F_2} + \overline{F_2O_2}$$
$$= f_1' + \overline{F_1'F_2} + f_2'$$

or $\overline{F_1F_2} \cdot \overline{F'F_2'} = -f_2'^2$

$$\overline{F_1F_2} = -\frac{f_2'^2}{\overline{F'F_2'}} = -\frac{(1/60)^2}{0,08} = 3,47 \cdot 10^{-3} m$$

$$\overline{O_1O_2} = 1,013 m$$

$$G = \frac{\alpha'}{\alpha} = -f_1' C_2$$

Exercice 37

$f_1' = 100$ mm objectif
$f_2' = 300$ mm occulaire

$\overline{O_1O_2} = 50$ cm
$\overline{AB} = 2{,}5$ cm
$\overline{O_1A} = -15$ cm

$$\overline{A_1B_1} = \frac{1}{\overline{OA_{11}}} - \frac{1}{\overline{O_1A}} = \frac{1}{f_1'} \Rightarrow \overline{O_1A_1} = \frac{f_1' \times \overline{O_1A}}{f_1' + \overline{O_1A}}$$
$$= 30 \text{ cm}$$

$$\overline{O_1O_2} = \overline{O_1A_1} + \overline{A_1O_2} \Rightarrow \overline{A_1O_2} = 20\text{cm}$$

$$\frac{1}{\overline{O_2A'}} - \frac{1}{\overline{O_2A_1}} = \frac{1}{f_2'} \Rightarrow \overline{O_2A'} = \frac{f_2' \, \overline{O_2A_1}}{f_2' + \overline{O_2A_1}} = -60 \text{ cm}$$

$$\gamma_1 = \frac{\overline{O_1A_1}}{\overline{OA}} = -2 \Rightarrow \overline{A_1B_1} = -5\text{cm}$$

$$\gamma_2 = \frac{\overline{O_2A'}}{\overline{O_2A}} = 3 \Rightarrow \overline{A'B'} = 3\overline{AB} - 6 \; \overline{AB} = 15 \text{ cm}$$

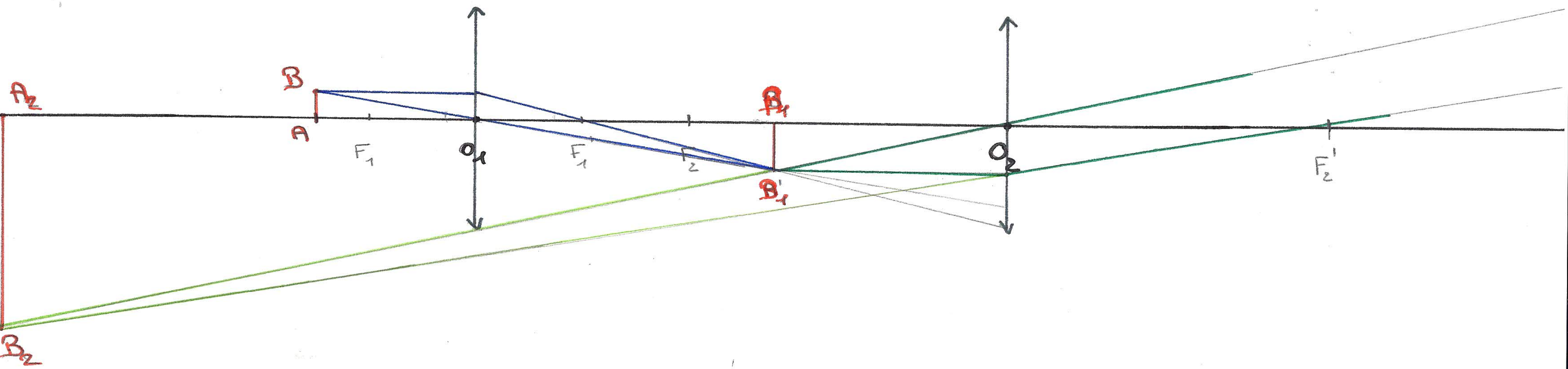
$$\overline{O_1A_1} = \overline{O_1O_2} + \overline{O_2A_1} = \overline{O_1O_2} + \overline{O_2F_2}$$

$\overline{O_1A} = 15$cm $\Rightarrow$ l'image finale A' à 90 cm de l'oeil l'image finale à l'∞ (PR) $\Rightarrow \overline{O_1A} = -20$ cm

(2) $f_1' = 5$mm $\quad \gamma_1 = 40 \quad \Delta = \overline{F_1'F_2} = 20$cm
$f_2' = 25$ m $\quad G_2 = 10 \quad \overline{AB} = 1\,\mu$m

A' à l'∞ $\Rightarrow$ A_1 en F_2 $\quad \overline{O_1A_1}$?

Figure ex 37



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