TD3 - Modèles de dispositifs optiques

QCM.

1b, 2b, 3b, 4a, 5a, 6b, 7b, 8b et c.

Exercices

Ex 1 :

1) $f'_1 = 17\,mm$

2) $\frac{1}{\overline{OA'}} - \frac{1}{\overline{OA}_{PP}} = \frac{1}{f'_2}$ $\overline{OA}' = 17\,mm$ $\overline{OA} = -25\,cm$ $\Rightarrow$ $f'_2 = 15{,}9\,mm$

3) $\Delta = V_1 - V_2 = \frac{1}{f'_1} - \frac{1}{f'_2} = \frac{1}{\overline{OA}_{PP}} = -4\,m^{-1}$

4) $\Delta = -1\,m^{-1} = \frac{1}{\overline{OA}_{PP}} \Rightarrow \overline{OA}_{PP} = -1\,m$

Ex 2

1) PP $\Leftrightarrow$ $f'_{min} = \frac{\overline{OA}' \times \overline{OA}_{PP}}{\overline{OA}_{PP} - \overline{OA}'} = 13{,}19\,mm$

PR $\Leftrightarrow$ $f'_{max} = \frac{\overline{OA}' \times \overline{OA}_{PR}}{\overline{OA}_{PR} - \overline{OA}'} = 15{,}01\,mm$

2) bonne vision de loin $\Leftrightarrow$ $f'_{eq} = 15{,}2\,mm$

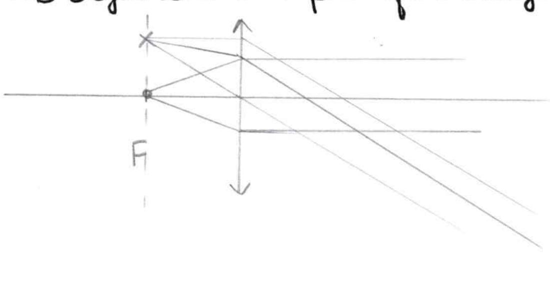
doublet accolé : $\frac{1}{f'_{eq}} = \frac{1}{f'_{max}} + \frac{1}{f'_c} \rightarrow f'_c = -1{,}2\,m$

3) $\frac{1}{\overline{OA}'} - \frac{1}{\overline{OA}_{PP_c}} = \frac{1}{f'_{min}} + \frac{1}{f'_c} \rightarrow \overline{OA}_{PP_c} = -13{,}3\,cm$

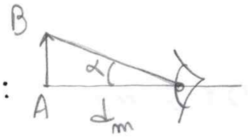
Ex 3

1) image virtuelle (situé avant la face d'entrée de la lentille)

2) à l'∞ $\rightarrow$ objet dans le plan focal objet

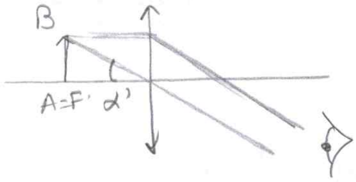


3) sans :



$\tan\alpha \simeq \alpha = \frac{AB}{d_m}$

avec :



$\tan\alpha' \simeq \alpha' = \frac{AB}{f'}$

$G = \frac{\alpha'}{\alpha} = \frac{d_m}{f'}$

4) AN : $G = d_m \times V = 10 \times 0,25 = 2,5$

5) $\alpha_{min} \simeq 3 \times 10^{-4}$ rad $AB_{min} \simeq \alpha_{min} \times d_m = 7,5 \times 10^{-5}$ m

6) avec la loupe : $AB_{min} = f'\alpha'_{min} = f'\alpha'_{min} = 3 \times 10^{-5}$ m on peut observer + de détails grâce à la loupe.

$\alpha' \geq 3 \times 10^{-4}$ rad

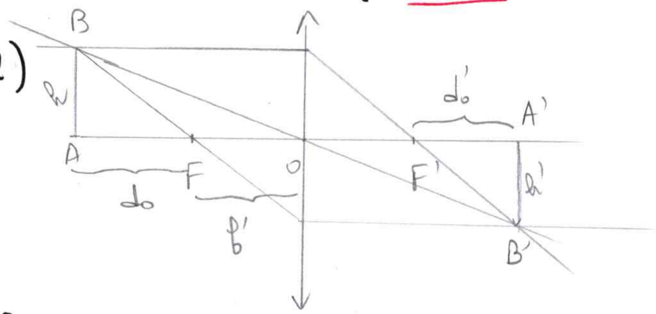
Ex 4

1) objet réel ⇒ image réelle : lentille CV $f' > 0$

↓

objet avant F

2)

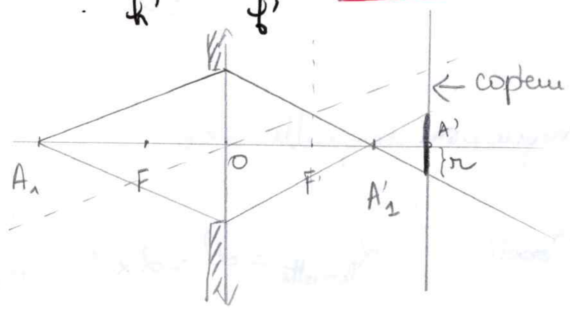


3) théorème de Thalès ⇒ $\frac{h'}{h} = \frac{d'_o}{f'}$

$d'_o = f'\frac{h'}{h} = 8,75$ mm

4) de même : $\frac{h}{h'} = \frac{d_o}{f'} = 0,29$ m

5)



6) $\frac{r}{R} = \frac{A'_1A'}{OA'_1} = \frac{d'_o - \overline{F'A'_1}}{f' + \overline{F'A'_1}}$ Newton ⇒ $\underbrace{\overline{FA_1}}_{=-d} \cdot \overline{F'A'_1} = -f'^2 \to \overline{F'A'_1} = \frac{f'^2}{d}$

$r = R\,\frac{d'_o - f'^2/d}{f' + f'^2/d}$

7) objet à l'∞ $\Rightarrow d \to \infty$ $\quad r = R\dfrac{d'_0}{f'} = \dfrac{d'_0}{2N} = 0{,}43\ \text{mm} > 0{,}05\ \text{mm}$

image floue

8) cas limite $r = 0{,}05$ mm

$$r = R\,\frac{d'_0 d - f'^2}{f'd + f'^2} \qquad r(f'd + f'^2) = Rd'_0 d - f'^2 R$$

$$d = \frac{f'^2(r+R)}{Rd'_0 - rf'} = 0{,}33\ \text{m}$$

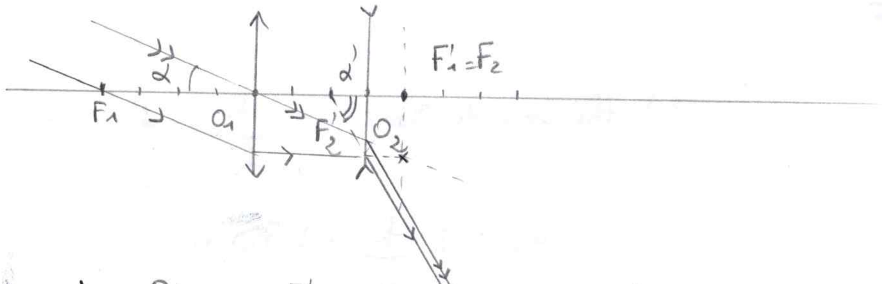
Ex 5

1) L_1 : CV $f'_1 = 20$ cm
L_2 : DV $f'_2 = -5$ cm

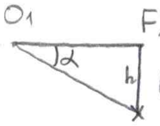
2) Un système afocal donne d'1 objet à l'∞, une image à l'∞. L'oeil emmétrope peut donc observer sans accommoder.

3) $O_1O_2 = f'_1 + f'_2 = 15$ cm

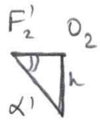
4)



5) $G = \dfrac{\alpha'}{\alpha}$



$\tan\alpha = \dfrac{h}{f'_1} \simeq \alpha$



$\tan\alpha' = \dfrac{h}{|f'_2|} \simeq \alpha'$

$G = \dfrac{-f'_1}{f'_2}$ car $G > 0$ ici

$f'_2 < 0$

6) $G = 4$

7) car $G > 0$ contrairement à la lunette astronomique pour laquelle $G < 0$.

8) . $\alpha_{cirque} = \dfrac{96}{384\times10^3} = 2{,}5\times10^{-4}$ rad $< \alpha_{min}$ (3×10^{-4} rad)

non

$\alpha_{lunette} = \alpha' = \alpha \times G > \alpha_{min}$

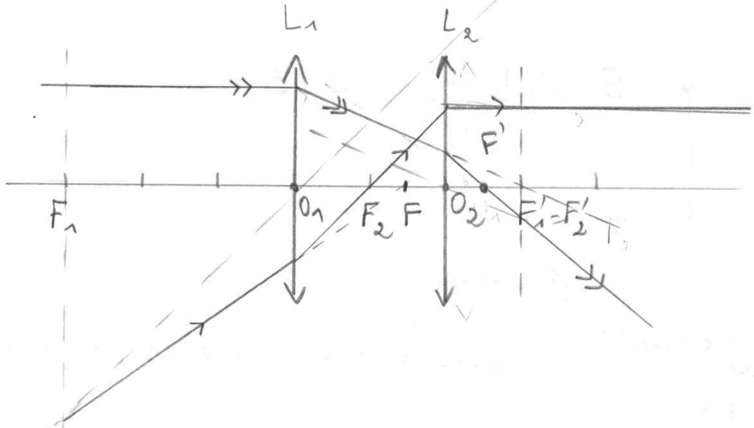
→ oui

. $\alpha_{cirque} = \dfrac{240}{384\times10^3} = 6{,}25\times10^{-4}$ rad $> \alpha_{min}$

oui et forcément aussi vu au travers de la lunette.

Ex 6

1)



2) $F \xrightarrow{L_1} A_1 \xrightarrow{L_2} A'_\infty$

$A_1 = F_2$

$\underbrace{\overline{F_1F}\cdot\overline{F_1'A_1}}_{\overline{F_1'F_2} = -2a \text{ (graphiquement)}} = -f_1'^2 = -9a^2 \Rightarrow \overline{F_1F} = \frac{9}{2}a$

ou $\overline{F_1'O_1}+\overline{O_1O_2}+\overline{O_2F_2} = -3a+2a-a = -2a$

$A_\infty \xrightarrow{L_1} A_1 \xrightarrow{L_2} F$

$A_1 = F_1'$

$\underbrace{\overline{F_2A_1}}_{\overline{F_2F_1'} = 2a \text{ (graphiquement)}}\cdot\overline{F_2'F} = -f_2'^2 = -a^2 \Rightarrow \overline{F_2'F} = -\frac{a}{2}$

ou $\overline{F_2O_2}+\overline{O_2O_1}+\overline{O_1F_1'} = a-2a+3a = 2a$

Ex 7

1) $\Delta = \overline{F_1'O_1}+\overline{O_1O_2}+\overline{O_2F_2} = -f_1' + D_0 - f_2' = 100\text{ mm}$

2) $A \xrightarrow{L_1} F_2 \xrightarrow{L_2} A'_\infty$

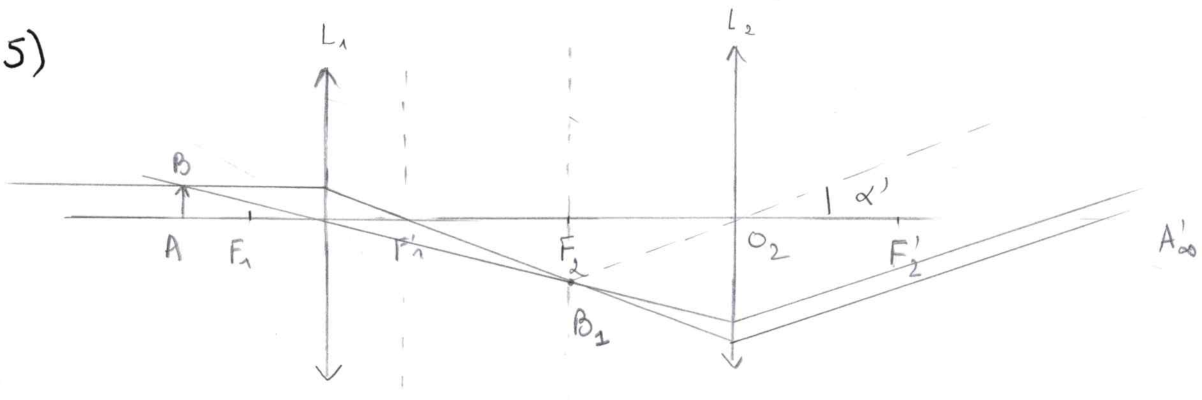
$L_1 : \underbrace{\overline{F_1A}}_{f_1'-d}\cdot\underbrace{\overline{F_1'F_2}}_{\Delta} = -f_1'^2$

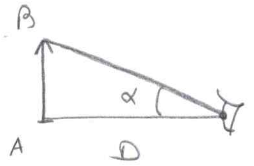
$f_1' - d = -\frac{f_1'^2}{\Delta}$ $\quad d = f_1'\left(1+\frac{f_1'}{\Delta}\right) = 5{,}25\text{mm}$

3) $\gamma_1 = -\frac{\overline{F_1'F_2}}{f_1'} = -\frac{\Delta}{f_1'} = -20$

4) L'oeil emmétrope n'accommode pas.

5)



6) 

$\tan\alpha \simeq \alpha = \frac{AB}{D}$

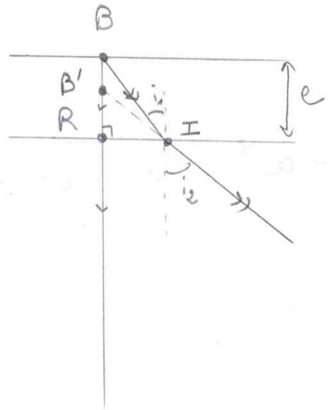
$\tan\alpha' \simeq \alpha' = \frac{F_2B_1}{f'_2} = \frac{|\gamma_1|\,AB}{f'_2}$

$G = |\gamma_1| \frac{D}{f'_2} = 333$

7) $\mathcal{E} = 0{,}08\,mm$ $\quad u(\mathcal{E}) = \frac{1\text{ graduat}^{\circ}}{\sqrt{6}}$ (double lecture) $\Rightarrow u(\mathcal{E}) = 5\,\mu m$

0,01 mm

$\mathcal{E} = 80 \pm 5\,\mu m$

8) 

$e = RB = \frac{RI}{\tan i_1} \simeq \frac{RI}{\sin i_1}$

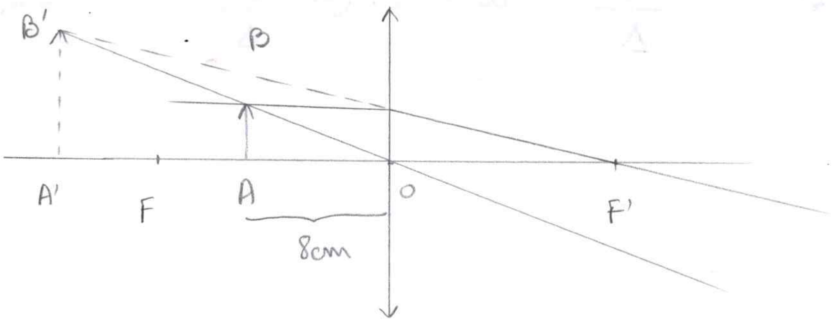
$RB' = \frac{RI}{\tan i_2} \simeq \frac{RI}{\sin i_2}$

$RB' = \frac{e \sin i_1}{\sin i_2}$ or $n \sin i_1 = \sin i_2$

$RB' = \frac{e}{n}$ or $RB' = \mathcal{E}$ $\Rightarrow \mathcal{E} = \frac{e}{n}$

$e = \mathcal{E}n = 120\,\mu m$ $(\pm 8\,\mu m)$

Ex 8



$\frac{A'B'}{AB} = \frac{OA'}{OA} = 1{,}5$

$\Rightarrow OA' = 1{,}5 \times 8 = 12\,cm$

$f' = \left(\frac{1}{OA'} - \frac{1}{OA}\right)^{-1} = 24\,cm$