Optique géométrique (10 pts)

I. Miroir sphérique (3 pts)

I.1

0.5 foyer objet $\overline{SA_i} \to \infty \Rightarrow \overline{SF_o} = \frac{\overline{SC}}{2} \Rightarrow F_o$ est le milieu de SC

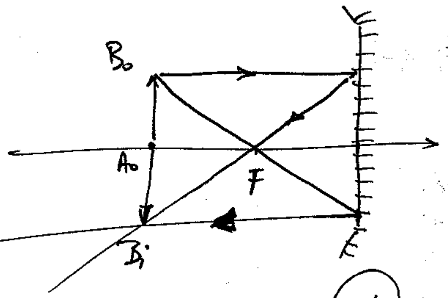
0.5 foyer image $\overline{SA_o} \to \infty \Rightarrow \overline{SF_i} = -\frac{\overline{SC}}{2} \Rightarrow F_i$ est le milieu de SC.

0.5 Rem. $\overline{SF_o} = -\overline{SF_i}$ (justifié).

I.2 $\overline{SA_i} = -\overline{SA_o} \Rightarrow \frac{-2}{\overline{SA_o}} = \frac{-2}{\overline{SC}} \Rightarrow$ A_o et A_i confondus en C.

0.5

I.3



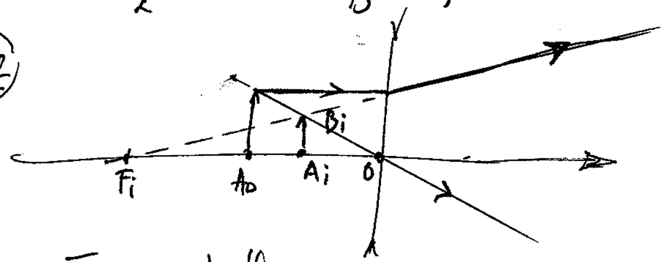
1/.

II. Lentille mince divergente (3 pts)

II.1 $\frac{1}{\overline{OA_i}} - \frac{1}{\overline{OA_o}} = \frac{1}{\overline{OF_i}} = \frac{1}{f_i}$

1 $\overline{OA_o} = -\frac{|f_i|}{2} \Rightarrow \overline{OA_i} = f_i/3 = -\frac{|f_i|}{3}$

1.0 II.2



0.5 II.3 Image virtuelle.

0.5 $G_y = \frac{\overline{OA_i}}{\overline{OA_o}} = \frac{2}{3}$ (ou par la figure)

III Association (3 pts)

0.5 **III.1** $T(\overline{OO}) = \begin{pmatrix} 1 & 0 \\ -V_L & 1 \end{pmatrix}\begin{pmatrix} 1 & e \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 \\ -V_m & 1 \end{pmatrix}\begin{pmatrix} 1 & e \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 \\ -V_L & 1 \end{pmatrix}$

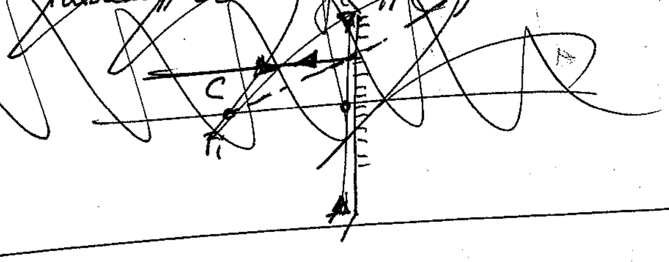
$V_L = 1/f_i$ et $V_m = -2/\overline{SC}$

1.5 **III.2** $T(\overline{OO}) = \begin{pmatrix} 1 & 0 \\ -V_m - 2V_L & 1 \end{pmatrix}$ $e = 0 \Leftrightarrow$ les 2 matrices propagation sont égales à I.

0.5 **III.3** $V = V_m + 2V_L = -\dfrac{2}{\overline{SC}} + 2/f_i$

0.5 $C = F_i \Leftrightarrow \overline{SC} = \overline{SF_i} \Leftrightarrow \underline{V = 0}$ système afocal.

~~1~~ 0.5 ~~Faisceau // Oz émerge // (Oz)~~



Optique ondulatoire

I. Onde plane monochromat. 2

0.5 I.1 $\psi(\vec{r},t) = \psi_0 \cos(\omega t - \vec{k}.\vec{r} + \varphi_0)$. ψ_0 amplitude. φ_0 phase à l'origine.

0.5 I.2 $\psi(\vec{r},t) = \psi_0 e^{i(\vec{k}.\vec{r} - \omega t + \varphi_0)} = \psi(\vec{r}) e^{-i\omega t}$.

Amplitude complexe $\psi(\vec{r}) = \psi_0 e^{i(\vec{k}.\vec{r} + \varphi_0)}$

0.5 I.3 $k = \frac{2\pi}{\lambda} = \frac{2\pi}{633.10^{-9}} = 9.93\ 10^6\ m^{-1}$.

0.5 $\nu = c/\lambda = \frac{3.10^8}{633\ 10^{-9}} = 4.74\ 10^{14}\ Hz$.

II. Fentes d'Young 12

1 II.1 $T(x,y) = 1$ si $\left(-\frac{e}{2}-\frac{a}{2} \leq x \leq -\frac{e}{2}+\frac{a}{2}\right)$ ou $\left(+\frac{e}{2}-a/2 \leq x \leq \frac{e}{2}+a/2\right)$ et $|y| \leq b/2$

0 sinon.

0.5 II.2 $\psi(u,v) = A \iint_{\text{Fentes}} T(x,y) e^{-2i\pi(ux+vy)}\, dx\, dy$

2.5 Calcul juste $= Aab\ \text{sinc}(vb)\ \text{sinc}(ua)\ \cos(\pi ue)$

$\text{sinc}(vb) = \frac{\sin \pi v b}{\pi v b}$

$\text{sinc}(ua) = \frac{\sin \pi u a}{\pi u a}$.

$u = \frac{x}{\lambda f}$, $v = \frac{y}{\lambda f}$.

0,5 II.3 $b \gg a$ et $\lambda \Rightarrow \text{sinc}(vb) \longrightarrow \delta(v)$

0.5 $I(u,v)$ II.4 $I(u,v) = |\psi(u,v)|^2 = I_0\ \text{sinc}^2(ua) \cos^2(\pi ue)\ \delta(v)$ ~~[illegible]~~

$I_0 = A^2 a^2 b^2$

III.5 $I(x) = 4I_0 \,\mathrm{sinc}^2\left(\frac{xa}{\lambda f}\right)\cos^2\left(\pi \frac{x}{\lambda f} e\right)$.

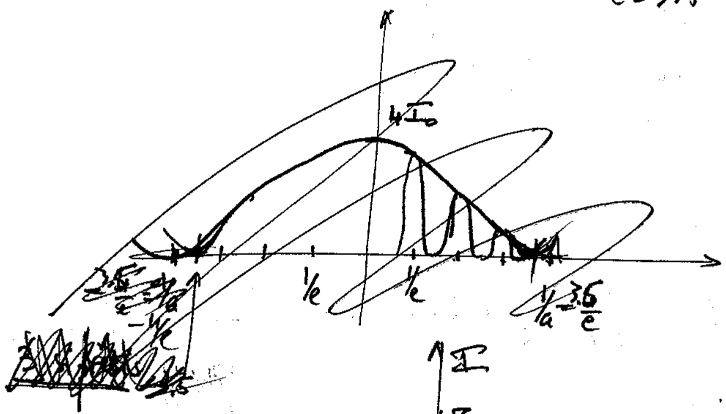
$a \ll e \Leftrightarrow \frac{1}{a} \gg \frac{1}{e}$.

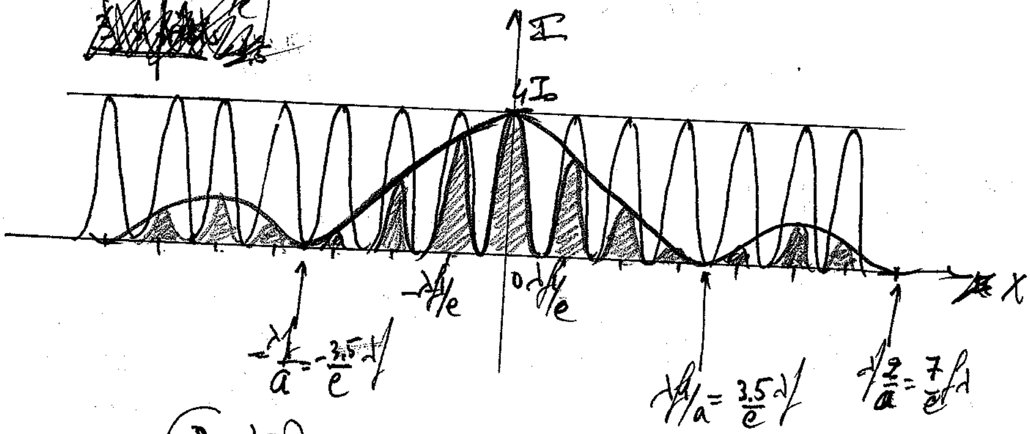
0.5 $\mathrm{sinc}^2\left(\frac{xa}{\lambda f}\right) = 0$ si $\frac{\pi x a}{\lambda f} = k\pi$ $(k \neq 0) \Leftrightarrow x = \frac{\lambda f}{a} k,\ k \neq 0$

0.5 $\cos^2\left(\frac{\pi x e}{\lambda f}\right) = 1$ si $\frac{\pi x}{\lambda f} e = k'\pi$ $(k' \in \mathbb{Z}) \Leftrightarrow x = k' \frac{\lambda f}{e}$ $k' \in \mathbb{Z}$.

$e = 3.5 \Leftrightarrow \frac{e}{3.5} = a \Leftrightarrow \frac{3.5}{e} = \frac{1}{a}$.

$\frac{7}{2e} = \frac{1}{a}$.





7 pts Maxi

0.5 III.6 $\Delta X_{\text{centre}} = \frac{2\lambda f}{e} = \frac{2\lambda f}{3.5a} \Rightarrow \Delta X_{\text{centre}} = 2.713\ \text{mm} \simeq 2.7\ \text{mm}$.

0.5 Nbre de franges brillantes dans la tache centrale = 7

(1) III.7 $4 I_0 \cos^2\frac{\phi}{2} = 2 I_0 (\cos\phi + 1)$ ou $\frac{\phi}{2} = \pi u e = \frac{\pi X}{\lambda f} e$.

$\phi = 2\pi u e$

(0.5) III.8 $\phi = 0 \Leftrightarrow x = 0$ frange centrale

0.5+0.5 $i = \Delta X = \frac{\lambda f}{e} = \frac{\lambda f}{3.5a}$ écart entre 2 franges de même nature consécutives.

0.5 $i = 1.36\,mm \simeq 1.4\,mm$

III.9 $\phi' = \frac{2\pi X e}{\lambda f} + \frac{2\pi}{\lambda} \varepsilon (n-1)$

(1)

~~Frange brillante décalée de ...~~

1ère Frange brillante pour $\phi' = 0$

$$\frac{2\pi X e}{\lambda f} = \frac{2\pi}{\lambda} \varepsilon (n-1)$$

$$\frac{te}{\varepsilon f} + 1 = n.$$

(1) $$\frac{3.5 at}{\varepsilon f} + 1 = n = 1.438 \simeq 1.44$$

(2pt) III. Réseaux (0.5) $p(\sin\theta - \sin\theta_0) = k\lambda$. $k \in \mathbb{Z}$. p pas

0.5 $\theta_0 = 0$. $k = \frac{p}{\lambda} \sin\theta \Leftrightarrow \sin\theta = \frac{k\lambda}{p} = k \times 633\,10^{-6} \times 500$
$= k \times 0.3165$.

(1) Taches
$$\left\{ \begin{array}{ll} k=0. & \sin\theta = 0 \\ k=1 & \sin\theta = 0.3165 \\ k=2 & \sin\theta = 0.633 \\ k=3 & \sin\theta = 0.949. \end{array} \right.$$

$k = 4 \Rightarrow \sin\theta > 1$ impossible