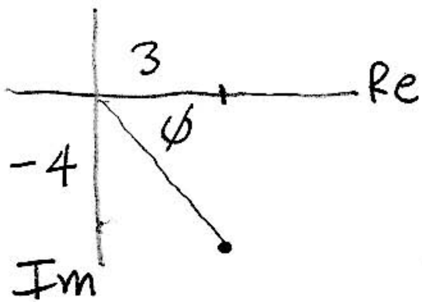
1

$$Z = \frac{1}{i\omega C} + R \qquad \omega = 2\pi f = 2\pi \cdot 10^6\ \text{Hz}$$

$$\frac{1}{\omega C} = \frac{1}{2\pi \cdot 10^6 \cdot \frac{1}{8\pi} \cdot 10^{-6}} = 4\ \Omega$$

(a) $|Z| = \sqrt{\left(\frac{1}{\omega C}\right)^2 + R^2} = \sqrt{4^2 + 3^2} = \boxed{5\ \Omega = |Z|}$

(b) $Z = R + \frac{1}{i\omega C} = (3 - 4i)\ \Omega$



$$\tan\phi = \frac{-4}{3} = -1.333$$

$$\boxed{\phi = -0.927\ \text{Rad} = -53.1^\circ}$$

$\boxed{2}$ (a) $\text{curl } \vec{E} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ E_0 \sin(ky-\omega t) & 0 & 0 \end{vmatrix}$

$$= \hat{x}\cdot 0 - \hat{y}\cdot 0 + \hat{z}\cdot\left(-\frac{\partial}{\partial y} E_0 \sin(ky-\omega t)\right)$$

$$= \hat{z}\cdot\left(-kE_0\cos(ky-\omega t)\right)$$

$$\boxed{\text{curl } \vec{E} = -kE_0\cos(ky-\omega t)\ \hat{z}}$$

(b) $\text{curl } \vec{B} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 0 & 0 & \alpha \sin(ky-\omega t) \end{vmatrix}$

$$= \hat{x}\,\alpha k \cos(ky-\omega t)$$

$$\boxed{\text{curl } \vec{B} = k\alpha\cos(ky-\omega t)\ \hat{x}}$$

(c) Maxwell's Equations (vacuum)

$\text{curl } \vec{E} = -\frac{1}{c}\frac{\partial \vec{B}}{\partial t}$ $\qquad\qquad$ $\text{curl } \vec{B} = \frac{1}{c}\frac{\partial \vec{E}}{\partial t}$

$$-kE_0\cos\cancel{(ky-\omega t)}\ \cancel{\hat{z}} = -\frac{1}{c}\frac{\partial}{\partial t}(\alpha\sin(ky-\omega t))\hat{z}$$

$$= -\frac{\alpha}{c}(-\omega)\cos(ky-\omega t)$$

$$kE_0 = -\frac{\omega}{c}\alpha \qquad\qquad k\alpha\cancel{\cos(ky-\omega t)}\ \cancel{\hat{x}} = \frac{1}{c}\frac{\partial}{\partial t}E_0\sin(ky-\omega t)\ \cancel{\hat{x}}$$

$$= -\frac{\omega}{c}E_0\cos(ky-\omega t)$$

$$kE_0 = -\frac{\omega}{c}\cdot\left(-\frac{\omega}{ck}\right)\cancel{E_0} \qquad\qquad \boxed{\alpha = -\frac{\omega}{ck}E_0}$$

$$\boxed{k = \frac{\omega}{c}}$$

Then $$\frac{\omega}{c} E_0 = -\frac{\omega}{c} \alpha$$

$$\boxed{\alpha = -E_0}$$

(d) $$\boxed{k = \frac{\omega}{c} = \frac{3 \cdot 10^{8}\ 1/s}{3 \cdot 10^{10}\ cm/s} = 10^{-2}\ 1/cm}$$

$$\boxed{\alpha = -0.1 \text{ Gauss}}$$

3 Two Steps

#1

$$-\frac{1}{l}+\frac{1}{l'}=\frac{1}{f_1}$$

$$\frac{1}{l'}=\frac{1}{f_1}+\frac{1}{l}=-\frac{1}{10}-\frac{1}{15}$$

$$=\frac{-3-2}{30}=-\frac{5}{30}=-\frac{1}{6}$$

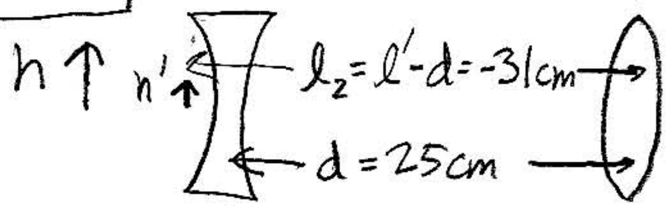
$$\underline{\underline{l'=-6\text{ cm}}}$$

From triangles

$$-\frac{h'}{l'}=\frac{-h}{l}\Rightarrow h'=\frac{l'}{l}\cdot h=\frac{-6}{-15}\cdot 1=\frac{2}{5}=0.4\text{ cm}$$

#2

$f_1=-10cm$ $\qquad$ $f_2=10cm$

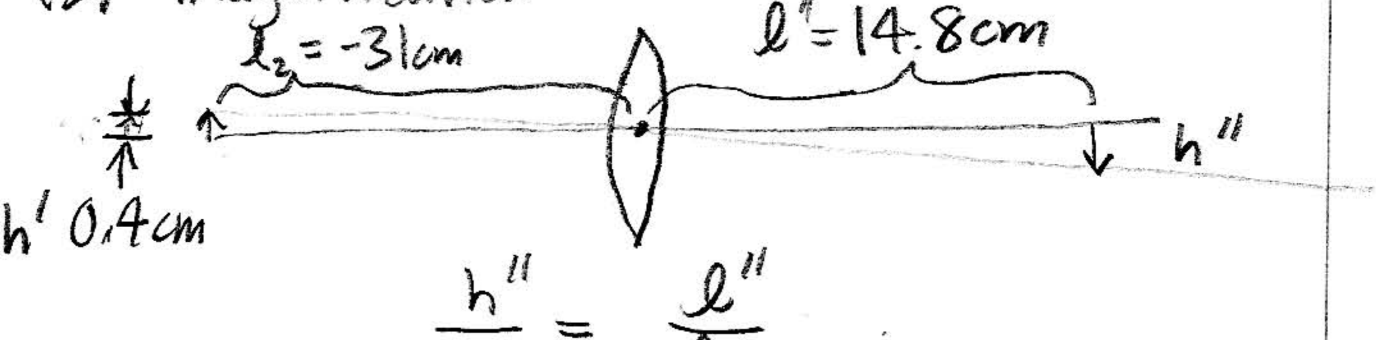


$$-\frac{1}{l_2}+\frac{1}{l''}=\frac{1}{f_2}$$

$$\frac{1}{l''}=\frac{1}{10}+\frac{1}{-31cm}=0.0677\,\frac{1}{cm}$$

(a) $\boxed{l''=14.8\text{ cm}\approx 15cm}$

(b) Magnification



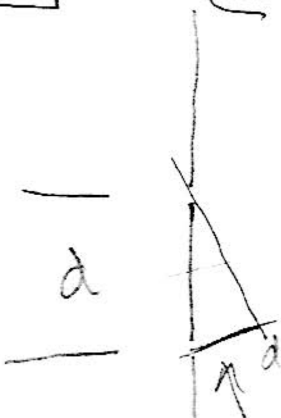
$$\frac{h''}{h}=\frac{l''}{l_2}$$

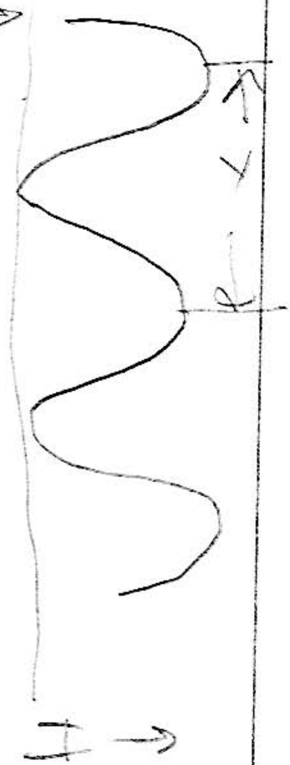
$$h''=\left(\frac{l''}{l_2}\right)\cdot h'=\frac{14.8}{-31}\cdot 0.4=-0.19\text{ cm}$$

$$\boxed{m=\frac{h''}{h}=-\frac{0.19}{1}=-0.19}$$

$\boxed{4}$

$\leftarrow L = 10 \text{ meters} \rightarrow$





want $\frac{2\pi}{\lambda} d\sin\theta = 2\pi$

$\Leftrightarrow \theta = \frac{\lambda}{d}$

$$y = \theta L = \frac{\lambda L}{d}$$

$$= \frac{600 \cdot 10^{-9} \cdot 10}{(30) \cdot 10^{-6}} \text{ m}$$

$$= 20 \cdot 10^{-3} \cdot 10 \text{ m}$$

$$\boxed{y = 0.2 \text{ m} = 20 \text{ cm}}$$