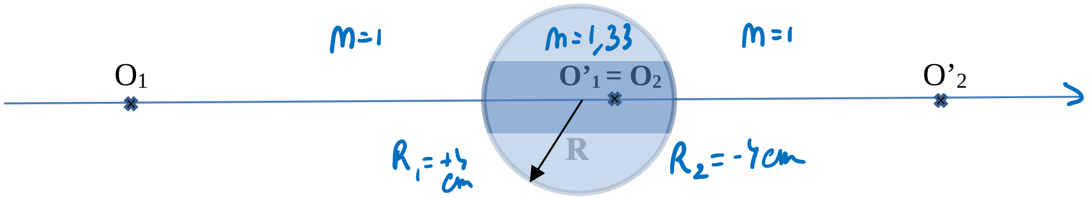
valeur indic
-60 ⟷ 1
-59 ⟷ 11
0 ⟷ 601
$(x+60)\cdot 10 + 1$

Homework 1 (06/10/2020)

Consider a sphere of refractive index 1.33 and radius R=4cm.
Any diameter can be taken as the optical axis of a system of two spherical interfaces.



Our purpose is to study this system of two separated spherical interfaces in the paraxial zone, showing that is like a 'thick' lens. We will use scripts in Matlab or Python language.

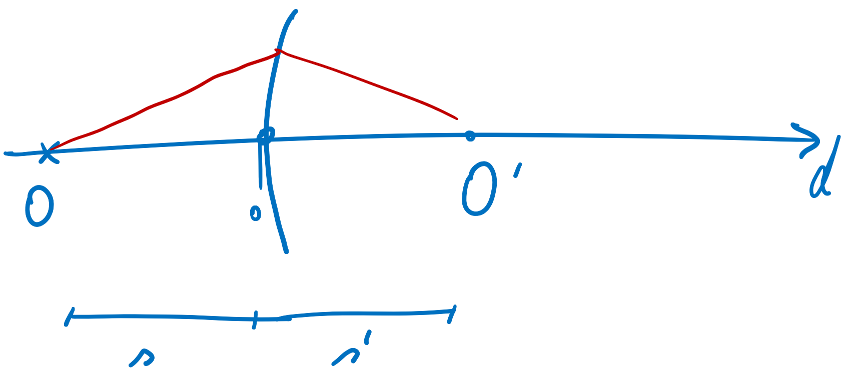
1) Define a function that, for any object distance, returns the image distance and magnification given by one spherical interface.
2) For our sphere, only for objects placed at distances -60<d<0 from the first spherical interface, plot the image distances given by this first interface. Explain the meaning of the asymptotes of the plot. Write a table with the values for d=-60, -30, -15, -10, 0 cm.
3) For our sphere, plot the final image distances given by the two spherical interfaces (measured from the second interface), for objects placed at distances -60<d<0 from the first spherical interface. Explain the meaning of the asymptotes of the plot. Write a table of the values for d=-60, -10, -5, 0 cm.
4) For our sphere, plot the final magnification given by the two spherical interfaces, for objects placed at distances -60<d<0 from the first interface. Explain the meaning of the asymptotes of the plot. Write a table with the values for d=-60, -15, -5, -2, 0 cm.

<u>Plots: only the range -60<d<0 for X; for Y, use from -60 to 60, and -10<β'<10 for magnification.</u>

Explain all your procedures in a single 'pdf' text file. The complete code of your 'scripts' has to be included inside the text file, as well as the required tables and figures.

1) $Ex_1(R, s, n, n')$

Dioptre in paraxial condition:



$$\frac{n'}{s'} = \frac{n}{s} + \frac{n'-n}{r}$$

$$\Longleftrightarrow s' = \frac{n'}{\frac{n}{s} + \frac{n'-n}{r}} = \frac{n' s R}{nR + (n'-n)s}$$

image distance

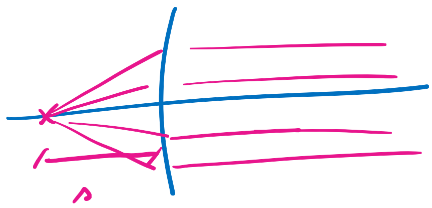
$$\beta' = \frac{n s'}{n' s}$$

pour 60cm → $s' = \frac{1,3}{\frac{1}{60} + \frac{0,3}{4}} =$

2) We see focal point in $s \simeq -12$ → Check with equation

$\underbrace{\text{focal point}}_{s' = \infty}$

$\Downarrow$



$$\underbrace{\frac{n'}{\infty}}_{0} = \frac{n}{s} + \frac{n'-n}{r}$$

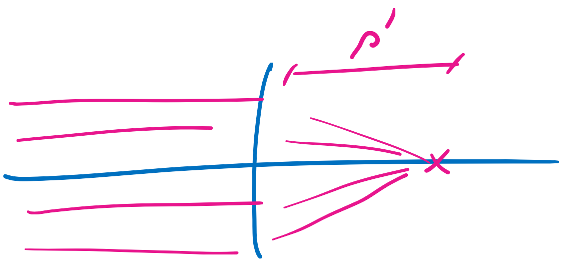
$$\to s = \frac{n}{\frac{n-n'}{r}} = \frac{nR}{n-n'} = \frac{4}{1-1{,}33} = -12{,}1212\ cm$$

OK

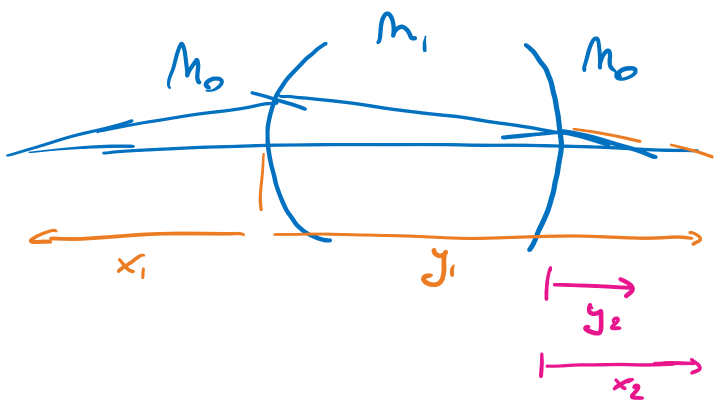
H Asymptote in $s' \simeq 16$

$$\to \frac{n'}{s'} = \underbrace{\frac{n}{\infty}}_{0} + \frac{n'-n}{r}$$

$$\Leftrightarrow s' = \frac{n'R}{n'-n} = \frac{1{,}33 \cdot 4}{0{,}33} = 16{,}1212\ cm$$



3



$$\begin{cases} \dfrac{n_1}{y_1} = \dfrac{n_0}{x_1} + \dfrac{n_1 - n_0}{R_1} \rightarrow \dfrac{n_1}{x_2 + 8} = \dfrac{n_0}{x_1} + \dfrac{n_1 - n_0}{R_1} \\[2ex] \dfrac{n_0}{y_2} = \dfrac{n_1}{x_2} + \dfrac{n_0 - n_1}{R_2} \Rightarrow x_2 = \dfrac{n_1}{-\dfrac{n_0 - n_1}{R_2} + \dfrac{n_0}{y_2}} \\[2ex] y_1 = x_2 + 8 \end{cases}$$

$$y_2(x_1) \Rightarrow \frac{n_1}{\dfrac{n_1}{-\dfrac{n_0 - n_1}{R_2} + \dfrac{n_0}{y_2}} + 8} = \frac{n_0}{x_1} + \frac{n_1 - n_0}{R_1}$$

if $x_1 \Rightarrow \infty$ (H Asympt)

$$\frac{1{,}33}{\dfrac{1{,}33}{-+0{,}33/4 + \dfrac{1}{y_2}} + 8} = \frac{0{,}33}{4}$$

$$\Leftrightarrow \underbrace{\frac{1{,}33 \cdot 4}{0{,}33} - 8}_{6{,}1212} = \frac{1{,}33}{-\dfrac{0{,}33}{4} + \dfrac{1}{y_2}}$$

$$\Leftrightarrow -\frac{0{,}33}{4} + \frac{1}{y_2} = \frac{1{,}33}{6{,}1212} = 0{,}1696$$

$$\frac{1}{y_2} = 0{,}2463$$

$$\Rightarrow y_2 = 4{,}060 \text{ [cm]}$$

if $y_2 \Rightarrow \infty$ (V. Asymptote)

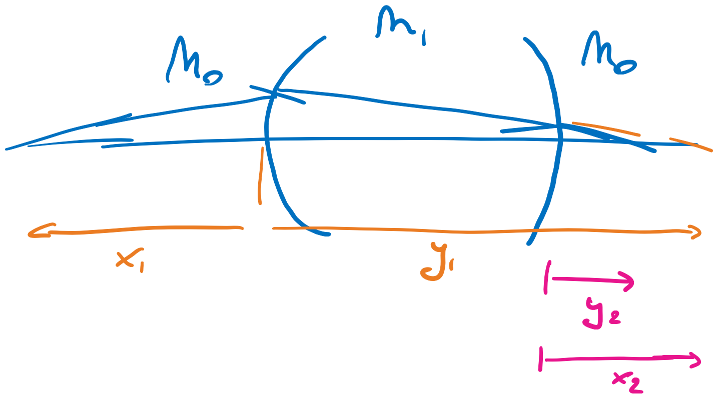
$$\frac{1{,}33}{\dfrac{1{,}33}{\underbrace{-\dfrac{0{,}33}{4}}_{-0{,}1638}} + 8} = \frac{1}{x_1} + \frac{0{,}33}{4}$$

$$\Rightarrow x_1 = -4{,}0601 \text{ [cm]}$$

(4)

$$\begin{cases} \bullet\ \dfrac{n}{y_1} = \dfrac{n_0}{x_1} + \dfrac{n_1 - n_0}{R_1} \\ \bullet\ \dfrac{n_0}{y_2} = \dfrac{n_1}{x_2} + \dfrac{n_0 - n_1}{R_2} \\ \bullet\ \beta_B = \dfrac{n_1 y_2}{n_0 x_2} \\ \bullet\ y_1 = x_2 + 8 \end{cases}$$

$\beta_B(x_1)$?



$x_2(x_1)$?

$y_2(x_1)$?

$$\frac{n_1}{\dfrac{n_1}{-\dfrac{n_0 - n_1}{R_2} + \dfrac{n_0}{y_2}} + 8} = \frac{n_0}{x_1} + \frac{n_1 - n_0}{R_1}$$

$x_1 = -\infty \Rightarrow y_1 = 16,1212$ cm

$\Downarrow$

$$x_2 = y_1 - 8 = 8,1212 \text{ cm} \longrightarrow y_2 = \frac{n_0}{\dfrac{n_1}{x_2} + \dfrac{n_0 - n_1}{R_2}} = \frac{1}{\dfrac{1,33}{8,1212} + \dfrac{0,33}{4}} = 4,0606 \text{ cm}$$

$$\beta_B = \frac{n_1 y_2}{n_0 x_2} = \frac{1,33 \cdot 4,0606}{1 \cdot 8,1212} = 0,665$$

- mail prof (n', n)
- Message WTSpp