Physics 123 Homework Solutions

Week #1 Unit O Geometric Optics

O4.1

$$\frac{1}{d_{o1}}+\frac{1}{d_{i1}}=\frac{1}{f_1}\rightarrow\frac{1}{d_{i1}}=\frac{1}{f_1}-\frac{1}{d_{o1}}=\frac{1}{50cm}-\frac{1}{70cm}=0.0057cm^{-1}\rightarrow d_{i1}=175cm$$

Thus, $d_{o2}=-75cm$ (it is 175cm from lens 1, and lenses 1 and 2 are separated by 100cm.)

Therefore this is a virtual object.

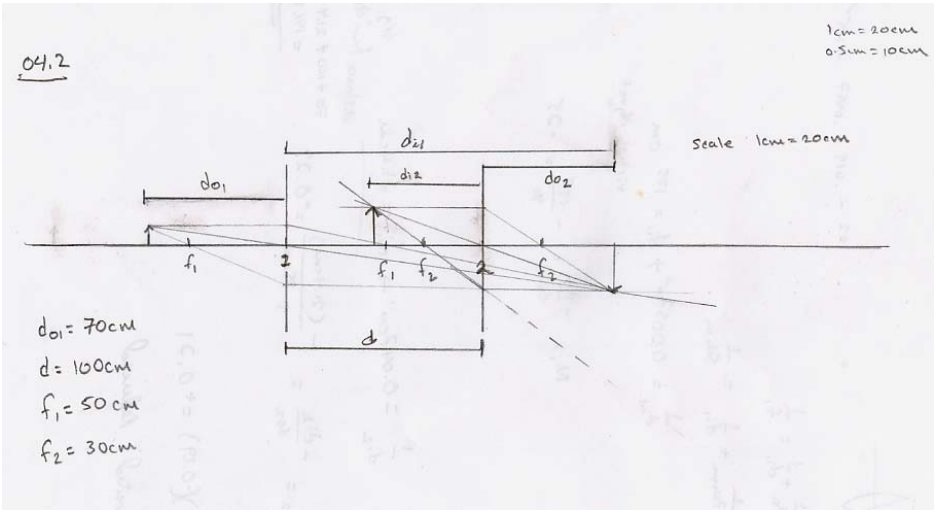
$$\frac{1}{d_{o2}}+\frac{1}{d_{i2}}=\frac{1}{f_2}\rightarrow\frac{1}{d_{i2}}=\frac{1}{f_2}-\frac{1}{d_{o2}}=\frac{1}{30cm}-\frac{1}{-75cm}=0.047cm^{-1}\rightarrow d_{i2}=21.4cm.$$

This image is a virtual image since it is located on the same side of the lens as the object.

$$M_{total}=M_1M_2=\left(-\frac{d_{i1}}{d_{o1}}\right)\left(-\frac{d_{i2}}{d_{o2}}\right)=\left(-\frac{175}{70}\right)\left(-\frac{21.4}{-75}\right)=-0.71$$

Thus the final image is virtual, inverted wrt original object and reduced in size. It is located at 70cm + 100cm + 21.4cm = 191.4 cm to the right of the original object.

O4.2



NOTE: This drawing does not correspond to the mathematics given above. I'll fix the drawing or mathematics in the morning.

O4.9

$$\frac{1}{d_{o1}}+\frac{1}{d_{i1}}=\frac{1}{f_1}\rightarrow\frac{1}{d_{i1}}=\frac{1}{f_1}-\frac{1}{d_{o1}}=\frac{1}{25cm}-\frac{1}{40cm}=0.015cm^{-1}\rightarrow d_{i1}=66.7cm$$

Thus, $d_{o2}=d-d_{i1}=100cm-66.7cm=33.3cm$(to the left of lens 2.)

Therefore this is a real object.

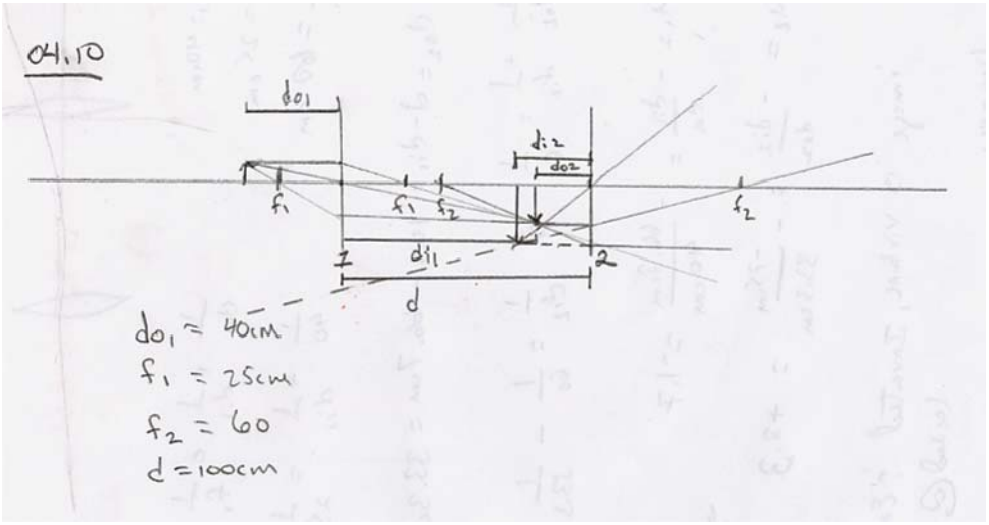
$$\frac{1}{d_{o2}}+\frac{1}{d_{i2}}=\frac{1}{f_2}\rightarrow\frac{1}{d_{i2}}=\frac{1}{f_2}-\frac{1}{d_{o2}}=\frac{1}{-15cm}-\frac{1}{33.3cm}=-0.097cm^{-1}\rightarrow d_{i2}=-10.3cm.$$

This image is a virtual image since it is located on the same side of the lens as the object.

$$M_{total}=M_1M_2=\left(-\frac{d_{i1}}{d_{o1}}\right)\left(-\frac{d_{i2}}{d_{o2}}\right)=\left(-\frac{66.7}{40}\right)\left(-\frac{-10.3}{33.3}\right)=-0.53$$

Thus the final image is virtual, inverted wrt original object and reduced in size. It is located at $40\text{cm}+(100\text{cm}-10.3\text{cm})=129.7$ cm to the right of the original object.

O4.10



O4.15

$$\frac{1}{d_{o1}}+\frac{1}{d_{i1}}=\frac{1}{f_D}\rightarrow\frac{1}{d_{i1}}=\frac{1}{f_D}-\frac{1}{d_{o1}}=\frac{1}{-25cm}-\frac{1}{100cm}=-0.14cm^{-1}\rightarrow d_{i1}=-7.1cm$$

Thus, this is a virtual image and, $d_{o2}=d+d_{i1}=20cm+7.1cm=27.7cm$(to the left of lens 2.)

$$\frac{1}{d_{o2}}+\frac{1}{d_{i2}}=\frac{1}{f_C}\rightarrow\frac{1}{d_{i2}}=\frac{1}{f_C}-\frac{1}{d_{o2}}=\frac{1}{25cm}-\frac{1}{27.1cm}=-0.003cm^{-1}\rightarrow d_{i2}=337.5cm.$$

This image is a real image since it is located on the opposite side of the lens as the object.

$$M_{total}=M_1M_2=\left(-\frac{d_{i1}}{d_{o1}}\right)\left(-\frac{d_{i2}}{d_{o2}}\right)=\left(-\frac{-7.1}{10}\right)\left(-\frac{337.5}{27.1}\right)=-12.5$$

Thus the final image is real, inverted wrt original object and enlarged in size. It is located at $337.5\text{cm}+20cm+10\text{cm}=367.5\text{ cm}$ to the right of the original object.

O4.16