QUIZ5 Key

1.You place an object 34.0 cm in front of a convex mirror and the image produced is half the height of the object. What is the focal length of the mirror? State your answer with the correct sign.

$$\frac{1}{f}=\frac{1}{d_I}+\frac{1}{d_O}\Rightarrow\frac{1}{f}=\frac{1}{-\left(34\times\frac{1}{2}\right)}+\frac{1}{34}\Rightarrow f=\boxed{-34(cm)}$$

2.A convex mirror has a radius of curvature of 36.0 cm. When a 5.60 cm tall object is placed in front of the mirror, the magnification is 0.250. (a) What is the height of the image? (b) How far is the object from the mirror?

(a) $$h=5.6\times0.25=\boxed{1.4(cm)}$$

(b) $$\begin{cases}-\frac{d_I}{d_O}=m=0.25\\ \frac{1}{f}=\frac{1}{d_I}+\frac{1}{d_O}\Rightarrow-\frac{2}{36}=\frac{1}{d_I}+\frac{1}{d_O}\end{cases}\Rightarrow\begin{cases}d_I=-13.5(cm)\\ d_O=\boxed{54(cm)}\end{cases}$$

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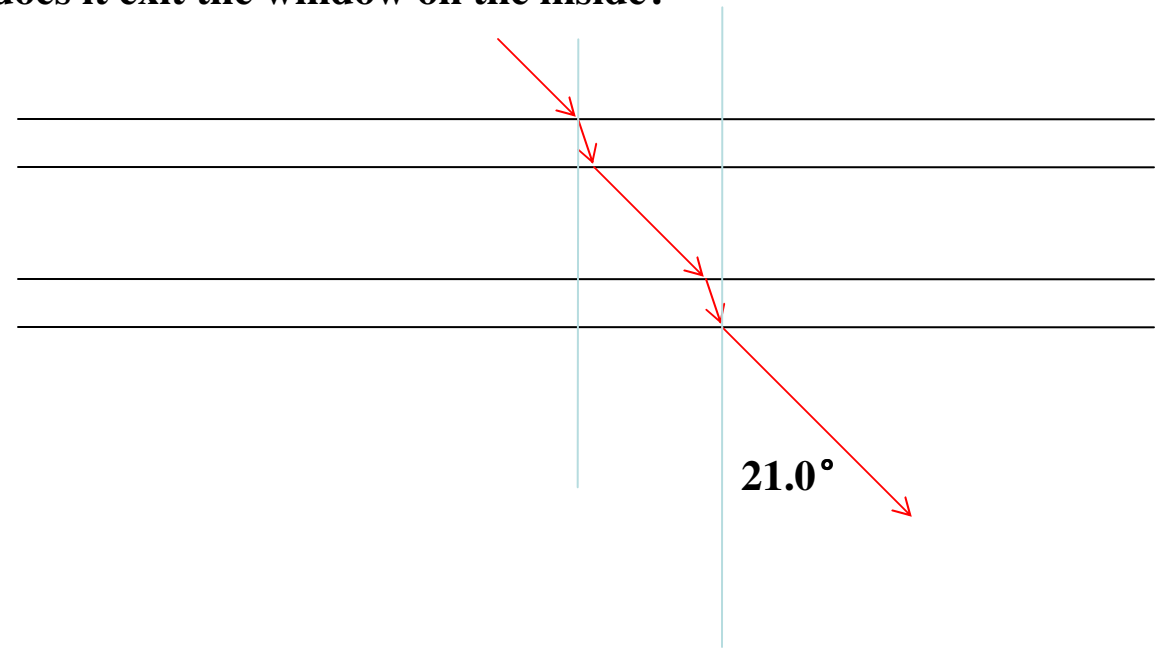
3.A double-paned window consists of two parallel panes of glass with an air gap between them. The outside pane has an index of refraction of 1.61 while the inside layer has an index of refraction of 1.51. If light enters the window from outside at 21.0° to the normal, at what angle to the normal does it exit the window on the inside?



it exit the window on the inside at 21.0° to the normal

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4.You are constructing a fiber optic cable. You wish to surround the core of the cable with a cladding material such that the critical angle to go from the core to the cladding is 73.0°. If the index of refraction of the core material is 1.61, what must the index of refraction of the cladding material be?

$$\frac{1}{\sin\left(73^\circ\right)} = \frac{1.61}{n} \Rightarrow n = \boxed{1.54}$$

5.Prove that the effective focal length *f of two thin lenses placed side to side is*

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

Where *f*1 and *f*2 are the focal lengths of the two thin lenses.

$$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{d_{I1}} + \frac{1}{d_{O1}} + \frac{1}{d_{I2}} + \frac{1}{d_{O2}} = -\frac{1}{d_{O2}} + \frac{1}{d_{O1}} + \frac{1}{d_{I2}} + \frac{1}{d_{O2}} = \frac{1}{d_{O1}} + \frac{1}{d_{I2}} = \frac{1}{f}$$

6.A lensmaker creates a lens with a material whose index of refraction is 1.43. The near surface has a radius of curvature of −12.0 cm and the far surface has a radius of curvature of +14.0 cm. What is the focal length of the lens in air and in water?

$$\frac{1}{f}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]\Rightarrow\frac{1}{f}=(1.43-1)\left[-\frac{1}{12}-\frac{1}{14}\right]\Rightarrow\boxed{f=15.03(cm)}$$

$$\frac{1}{f}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]\Rightarrow\frac{1}{f}=(1.43-1.33)\left[-\frac{1}{12}-\frac{1}{14}\right]\Rightarrow\boxed{f=64.62(cm)}$$

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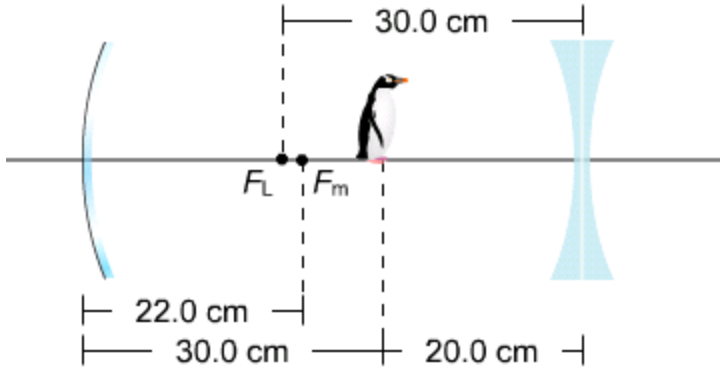
7.A diverging lens is placed 50.0 cm to the right of a concave mirror. An object is placed between the two, 30.0 cm from the mirror. The lens has a focal length of –30.0 cm and the mirror has a radius of curvature of 44.0 cm. Use only the light that leaves the object and hits the mirror first to answer the following questions. (a) Is the final image to the left or right of the mirror? (b) Is the final image real or virtual? (c) Is the final image upright or inverted compared to the original object? (d) How far is the final image from the mirror? Give the absolute value of this distance if it is negative. (e) What is the overall magnification of the system?

for the first image:

$$\frac{1}{f}=\frac{1}{d_I}+\frac{1}{d_O}\Rightarrow\frac{1}{22}=\frac{1}{d_I}+\frac{1}{30}\Rightarrow d_I=82.5(cm)$$



for the second image:

$$d_O=50-82.5=-32.5(cm)$$

$$\frac{1}{f}=\frac{1}{d_I}+\frac{1}{d_O}\Rightarrow-\frac{1}{30}=\frac{1}{d_I}-\frac{1}{32.5}\Rightarrow d_I=-390(cm)$$

overall magnification *m is*

$$m_1 = -\frac{d_I}{d_O} = -\frac{82.5}{30} = -2.75$$

$$m_2 = -\frac{d_I}{d_O} = -\frac{-390}{-32.5} = -12$$

$$m = m_1 \times m_2 = -2.75 \times (-12) = \boxed{33}$$

(a) the final image is to the left of the mirror

(b) the final image is virtual

(c) the final image is upright compared to the original object

(d) the final image is 340 cm from the mirror

(e) the overall magnification of the system is 33.