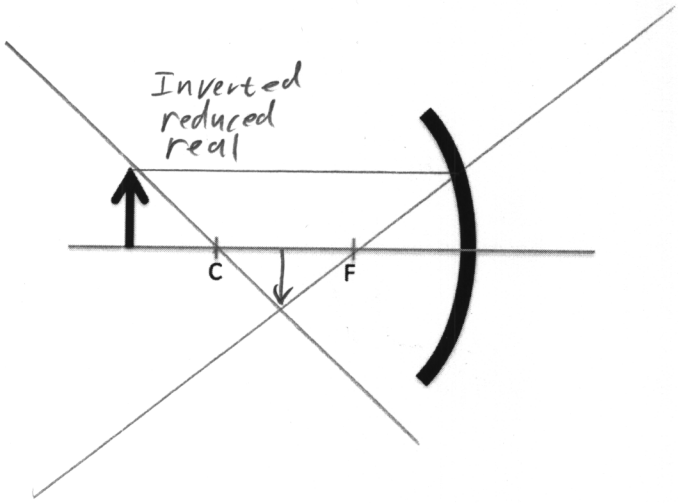
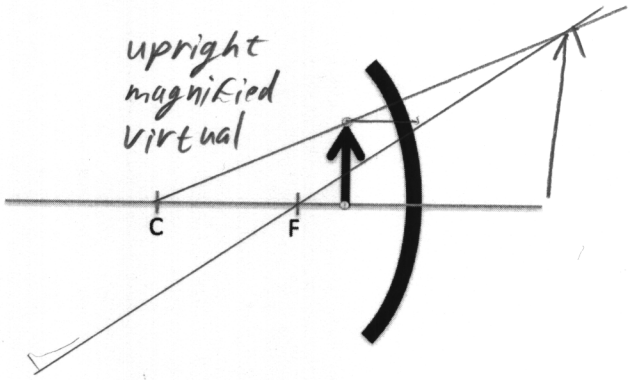
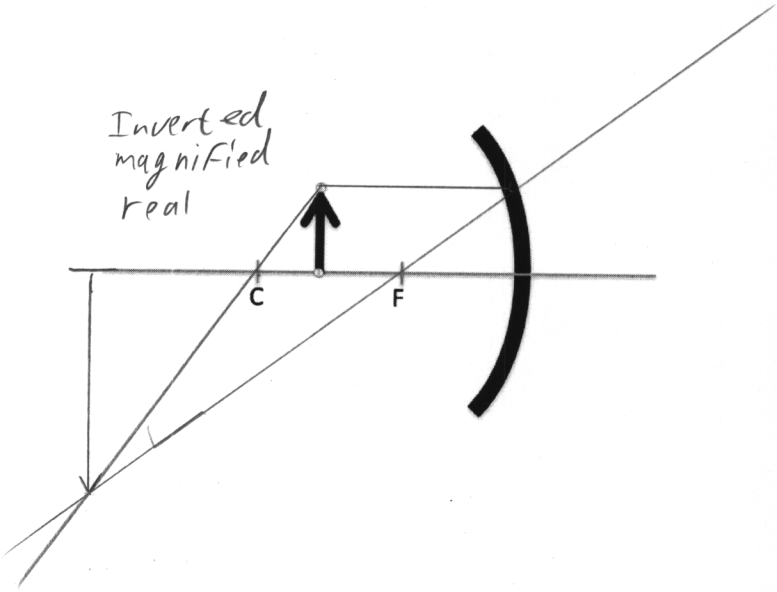
Optics – Set 2
Name: _____

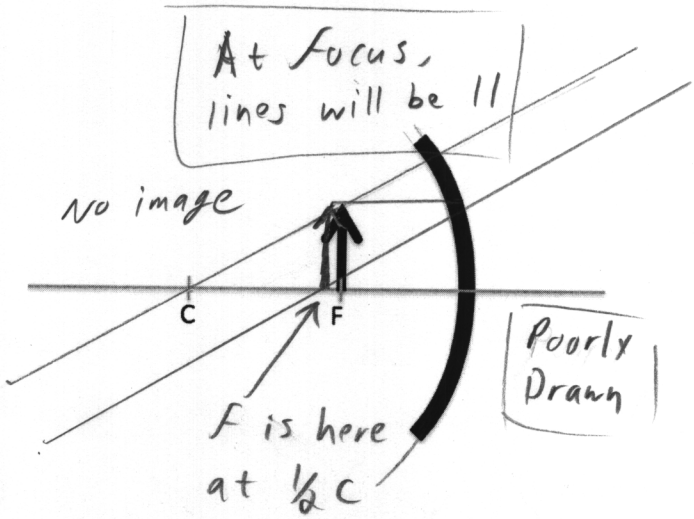
Problems Solved __/ 7

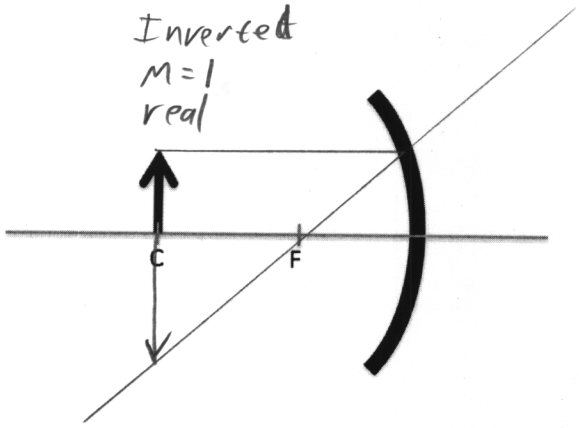
Construct a ray diagram for each mirror system. Is the image upright/inverted, magnified/reduced, real/virtual?

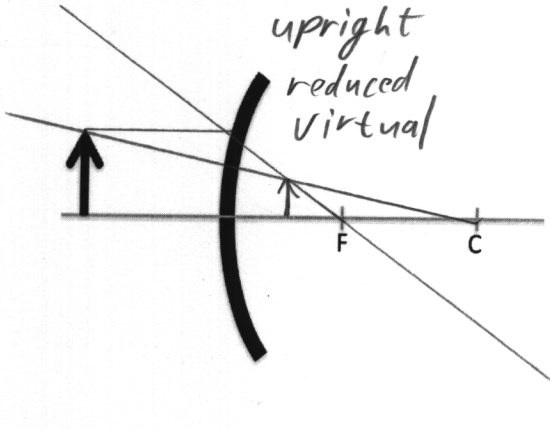




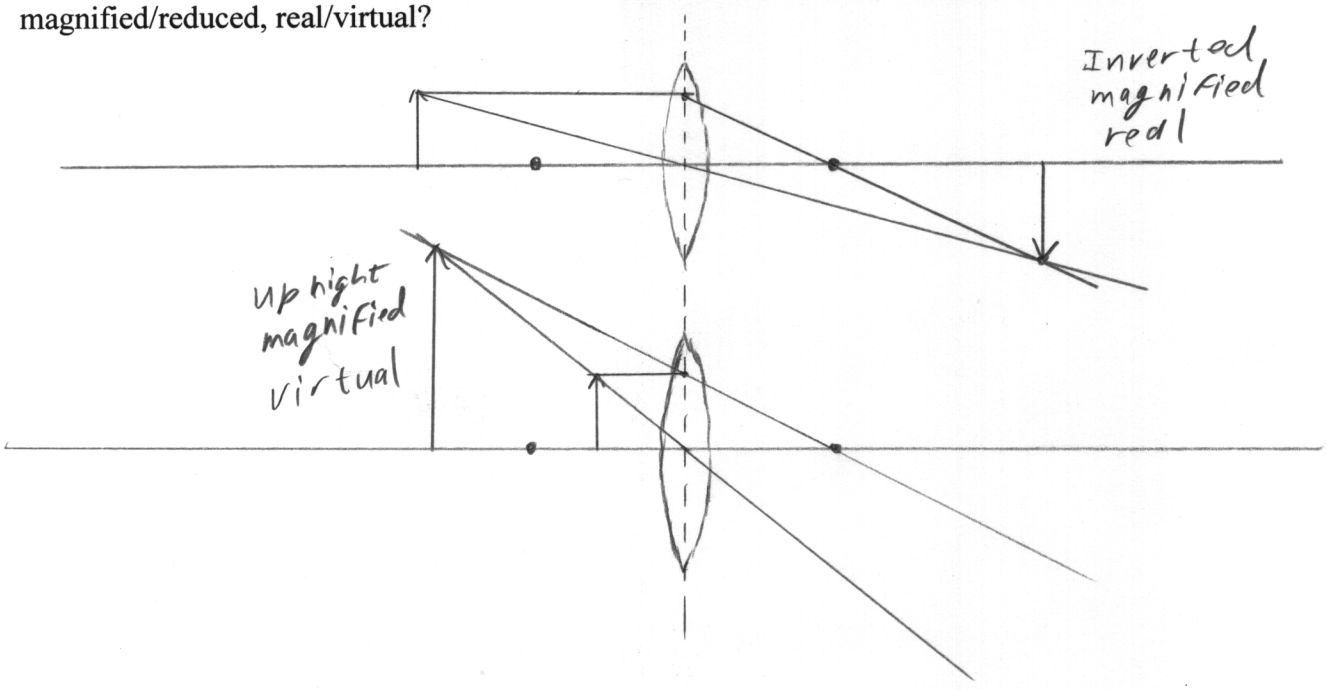




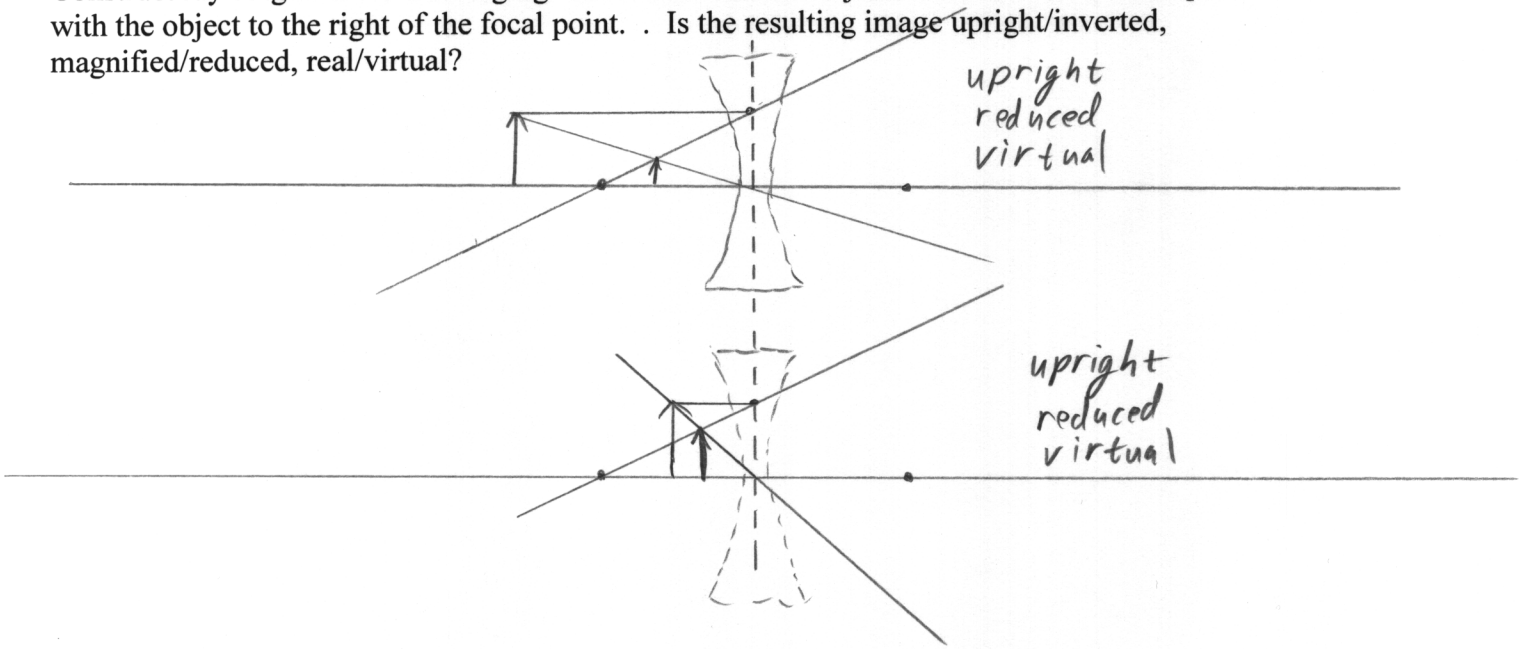




Construct ray diagrams for a converging lens. One with the object to the left of the focal point and one with the object to the right of the focal point. Is the resulting image upright/inverted, magnified/reduced, real/virtual?

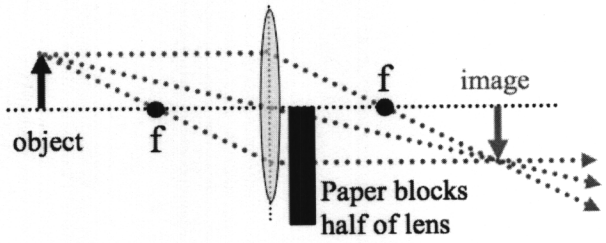


Construct ray diagrams for a diverging lens. One with the object to the left of the focal point and one with the object to the right of the focal point. . Is the resulting image upright/inverted, magnified/reduced, real/virtual?



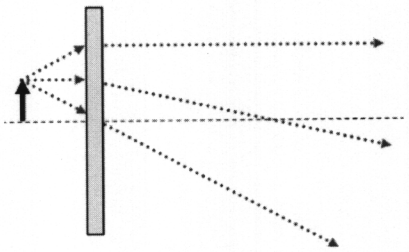
i. If half a lens is blocked with a piece of paper, as shown. What happens to the image as compared to the original image (without blocking the lens)?

a) It disappears.
b) Only half of it is still seen
c) It looks the same, but gets *slightly* dimmer.
d) It gets fuzzy.
e) It depends on what part of the lens is blocked.



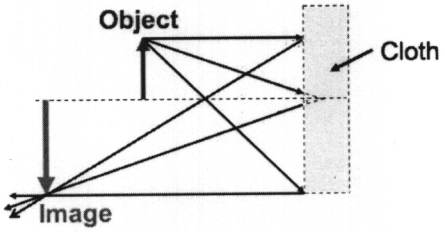
ii. For the figure below, determine the lens and type of image.

a) Convex (converging) lens, real image
b) Convex (converging) lens, virtual image
c) Concave (diverging) lens, real image
d) Concave (diverging) lens, virtual image



iii. A mirror is behind a cloth and cannot be seen. Determine its type, whether the image is real or virtual, and the sign of the magnification M.

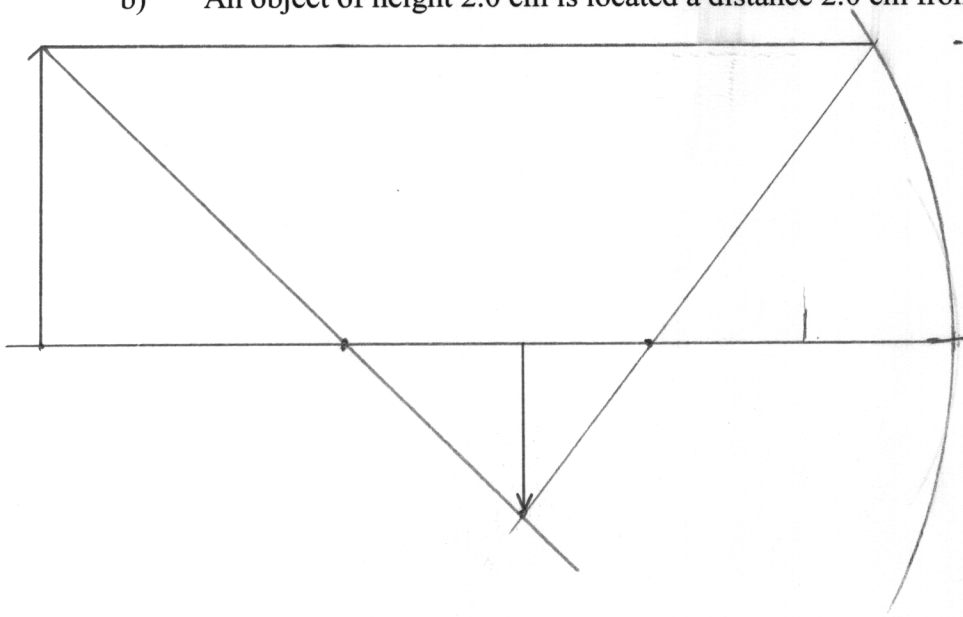
a) Concave mirror, real image, M is positive
b) Concave mirror, real image, M is negative
c) Concave mirror, virtual image, M is positive
d) Concave mirror, virtual image, M is negative
e) Convex mirror, virtual image, M is positive
f) Convex mirror, virtual image, M is negative



Assume that a certain concave spherical mirror has a focal length of 4.0 cm. Find the location of the image and the magnification both graphically (ray diagrams) and analytically (equations) for the following cases. For each case state whether the image is real/virtual and upright/inverted.

a) An object of height 4.0 cm is located a distance 12.0 cm from the mirror.

b) An object of height 2.0 cm is located a distance 2.0 cm from the mirror.



$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$

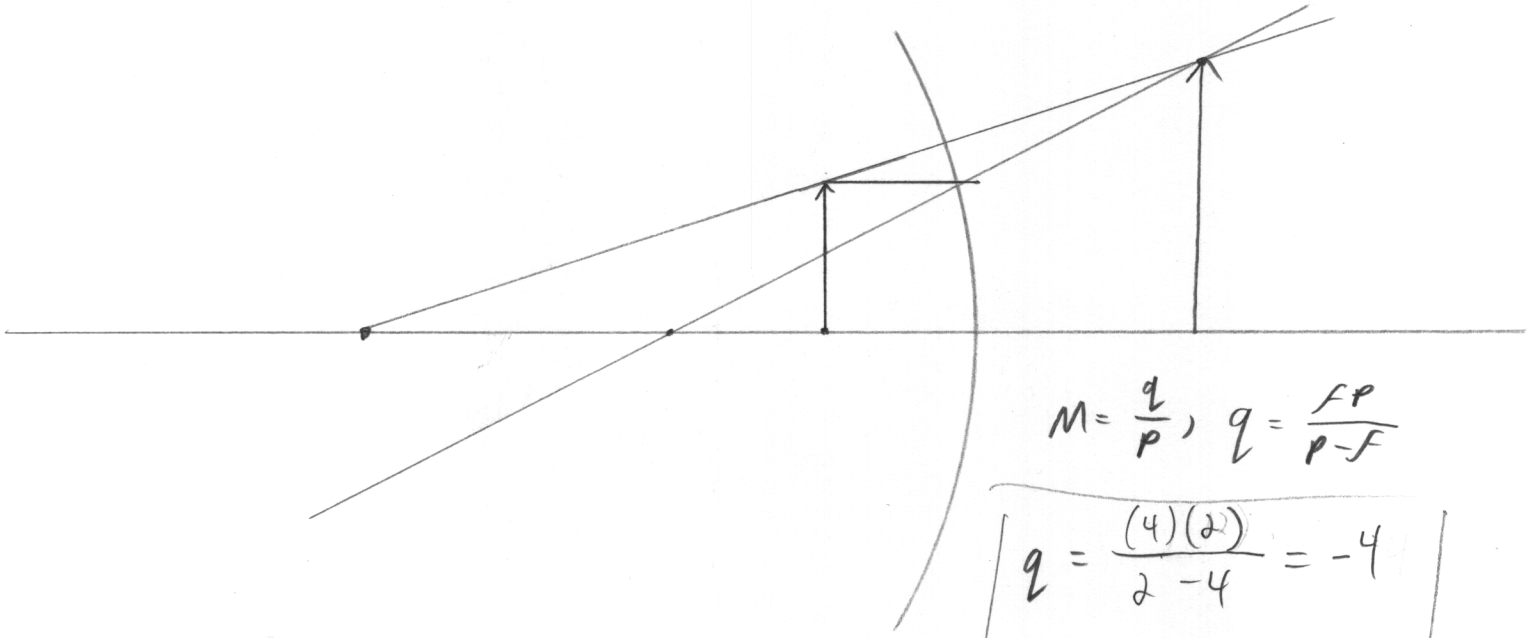
$\Rightarrow q=\frac{fp}{p-f}$

All quantities are positive

$M=-\frac{q}{p}$

$q=\frac{(4.0)(12)}{12-4}=6.0\,cm$

$M=-\frac{1}{2}$



$M=\frac{q}{p}, \quad q=\frac{fp}{p-f}$

$q=\frac{(4)(2)}{2-4}=-4$

$M=2$

How far from a page should you hold a lens with 32 cm focal length in order to see the print magnified 1.6 times?

Given
$f = 32$ cm
$M = 1.6$

Want
p

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}, \quad M = \frac{q}{p} \Rightarrow q = pM$$

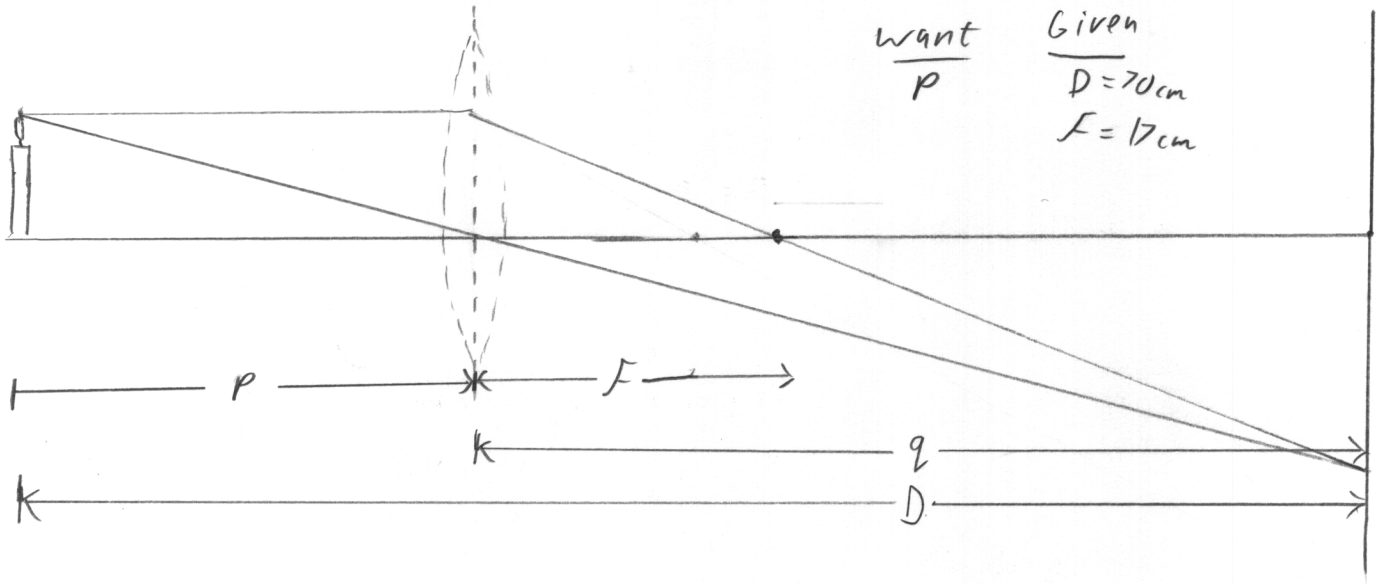
$$\Rightarrow \frac{1}{p} + \frac{1}{pM} = \frac{1}{f} \Rightarrow \frac{1}{p}\left(1 + \frac{1}{M}\right) = \frac{1}{f}$$

$$\Rightarrow \frac{1}{p}\left(\frac{M+1}{M}\right) = \frac{1}{f} \Rightarrow p\left(\frac{M}{M+1}\right) = f$$

$$\Rightarrow \boxed{p = f\left(\frac{M+1}{M}\right)}$$

$$\Rightarrow p = 32\text{ cm}\left(\frac{2.6}{1.6}\right) = \boxed{52\text{ cm}}$$

A candle and a screen are 70 cm apart. Find two points between candle and screen where you could put a convex lens with 17 cm focal length to give a sharp image of the candle on the screen.



$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, $q = D - p$

$$\frac{1}{p} + \frac{1}{(D-p)} = \frac{1}{f} \Rightarrow \frac{D - p + p}{p(D-p)} = \frac{1}{f}$$

$$\Rightarrow fD = p(D-p) \Rightarrow 0 = -fD + pD - p^2$$

$$\Rightarrow p^2 - pD + fD = 0 \quad \text{Quadratic}$$

$$p = \frac{1}{2}\left[D \pm \left[D^2 - 4fD\right]^{1/2}\right]$$

$$p = 41\text{ cm},\ 29\text{ cm}$$

An object 10cm tall is placed at the zero mark of a meter stick. A spherical mirror located at some point on the meter stick creates an image of the object that is upright, 4.0cm tall, and located at the 42cm mark of the meter stick.

a) Is the mirror convex or concave?
b) Where is the mirror?
c) What is the mirror's focal length?

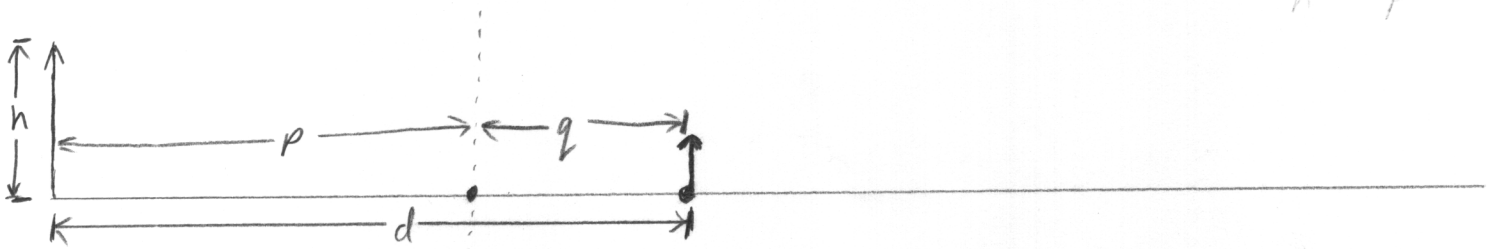
Given

$h = 10_{cm}$

$d = 42\,cm$

$h' = 4.0\,cm$

$M = \frac{h'}{h} = -\frac{q}{p}$



$M = -\frac{q}{p}$, But M is positive, so q must be negative.
Thus on the back side of the mirror.

In general, $M = -\frac{q}{p}$, $d = p - q$, and $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$

* Let's find p first given M

$q = -pM \Rightarrow d = p + pM \Rightarrow \boxed{p = \frac{d}{1+M}}$

$\Rightarrow \boxed{p = \frac{42}{1 + 4/10} = \boxed{30_{cm}}}$

Then, $q = p - d \Rightarrow q = 30 - 42 = \boxed{-12\,cm}$

continued ↓

Optics Set 2, P7 continued.

Then: $\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \Rightarrow f = \frac{qp}{q+p} =$

$$\Rightarrow \boxed{f = \frac{(-12)(30)}{(-12)+(30)} = -20\,cm}$$

So, mirror is <u>convex</u> located at 30cm with a focal length of -20cm