

Lens/Mirror Equation and Magnification

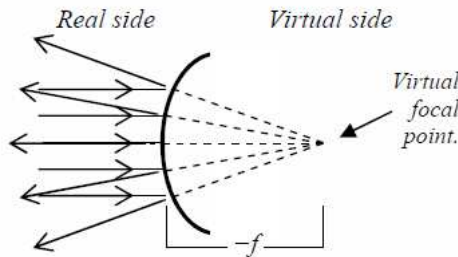
Real or Virtual

The direction light goes after hitting a mirror or lens is the real side.

Focal Length - f

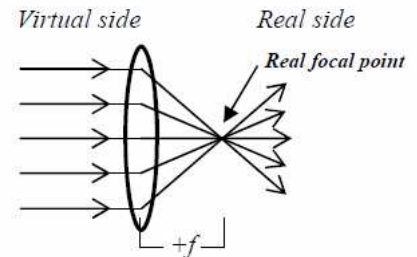
f is the focal length: the distance from the mirror or lens and the focal point.

The left side of a mirror is real, because light REALLY reflects back from a mirror.



Divergent devices have virtual focal points, so f is -.

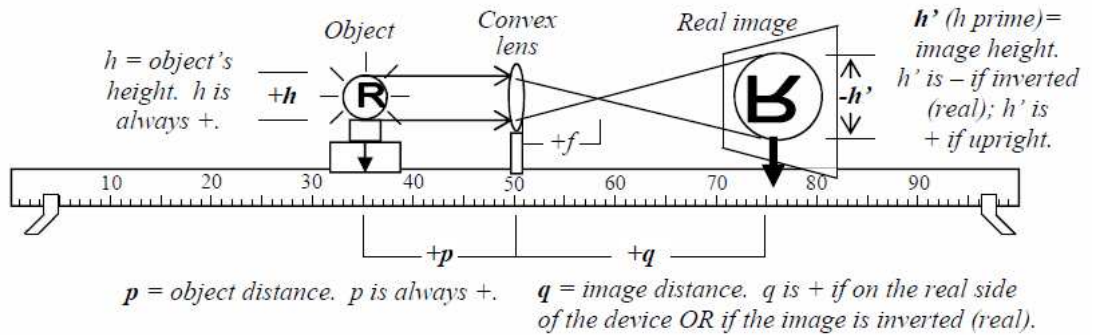
The right side of a lens is real, because light REALLY refracts thru lens.



Convergent devices have real focal points, so f is +.

Object and Image

The object is what we are looking at: the light source.
 The image is what is reflected or refracted by the device. We will always put the object on the left.



**All real images are produced on the real side of the device.
 For all real images q is + and h' is -.**

Lens/Mirror Equation

This equation lets you calculate p, q, or f knowing two of them. Use the above rules to be sure they have the correct signs (+ or -).

Lens and Mirror Equation

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

Object distance (in cm or m) Image distance (in cm or m) Focal length (in cm or m)

Example: The object is 30 cm to the left of a convex lens. The image comes into focus 20 cm to the right of the lens. Calculate the focal length.

p = 30 cm
 q = 20 cm (+ since on right side of lens)
 f = _____

$$\frac{1}{30} + \frac{1}{20} = \frac{1}{f}$$

$$.033 + .05 = \frac{1}{f}$$

$$.083 = \frac{1}{f}$$

$$f = \frac{1}{.083} = 12\text{cm}$$

NOTE: You can use cm or m, but not both!
 And + means on the right side of a lens.

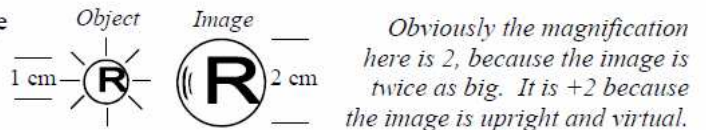
Magnification

The magnification tells you if the image is larger or smaller, virtual or real.

Magnification

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

Magnification (no units) Image height (in cm or m) Image distance (in cm or m)
 Object height (in cm or m) Object distance (in cm or m)



Example: The object is 30 cm away from a convex mirror and 2 cm tall. The image seems to be 20 cm to the right of the mirror. Calculate the height of the image.

p = 30 cm
 h = 2 cm
 q = -20 cm (- since on right side of a mirror)
 h' = _____

$$\frac{h'}{2} = -\frac{-20}{30}$$

$$\frac{h'}{2} = \frac{20}{30}$$

$$h' = \frac{40}{30} = 1.33\text{cm}$$

Obviously the magnification here is 2, because the image is twice as big. It is +2 because the image is upright and virtual.
 Since h' is +, the image is upright, which means it is virtual!

**M is + if the image is virtual, upright, and on the virtual side.
 M is - if the image is real, inverted, and on the real side.**

1. p	A. Magnification of the lens.	Which side of a lens is real? Why? Which side of a mirror is real? Why?
2. q	B. Height of the image.	
3. h	C. Distance from lens or mirror to the image.	
4. h'	D. Distance from lens or mirror to object.	
5. M	E. Height of the object.	

When is f negative?

When is h' negative?

When is q negative?

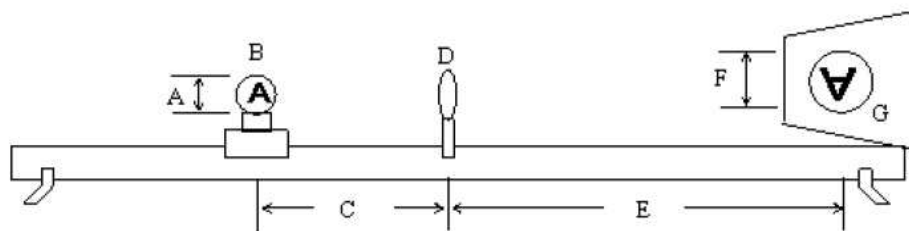
When is h negative?

When is p negative?

When is M negative?

Positive (+) or negative (-)?

- A. ____ Object distance (p).
- B. ____ Right side of a mirror.
- C. ____ Left side of a lens.
- D. ____ f for divergent devices.
- E. ____ q for a real image.
- F. ____ Left side of a mirror.
- G. ____ h .
- H. ____ Right side of a lens.
- I. ____ f for convergent devices.
- J. ____ f for a convex mirror.
- K. ____ f for a concave lens.
- L. ____ q for a virtual object.
- M. ____ h' for a real object.



Label the above diagram with p , q , h , and h' . Be sure to mark them with + or -.

Is the image real or virtual? Why?

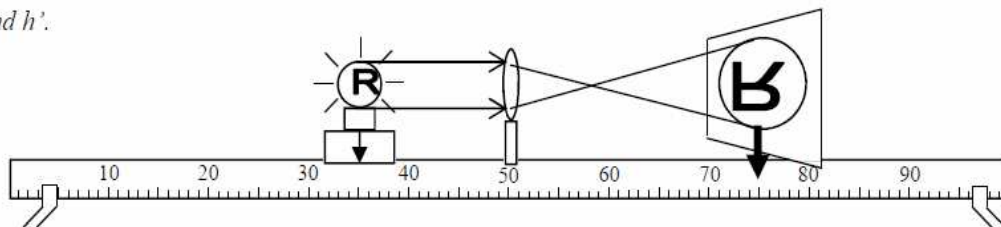
Will the magnification be a positive or negative number?

Will the magnification be greater than or less than 1?

On the diagram, label p , q , f , h , and h' .

Variables:

$p =$
 $q =$
 $f =$ _____



Calculate the focal length.

Calculate the magnification.

If the object is 1.5 cm tall, calculate h' .

The object is 12 cm from a convex lens that has a focal length of 5 cm.

Is the lens convergent or divergent?

Real or virtual focal point? Positive or negative focal length?

Find the distance to the image.

The magnification of a convex mirror is 5. The object is 3 cm tall. How tall is the image?

Is the image real or virtual?

Is the image on the left or right side of the mirror?