Name: _____

Period: _____

Lens/Mirror Equation and Magnification

6.6

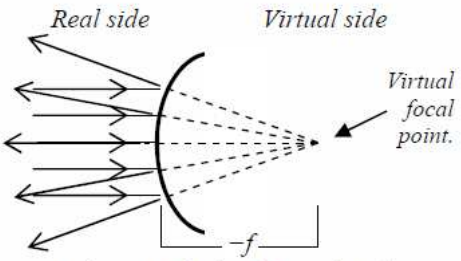
Real or Virtual

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

Focal Length – f

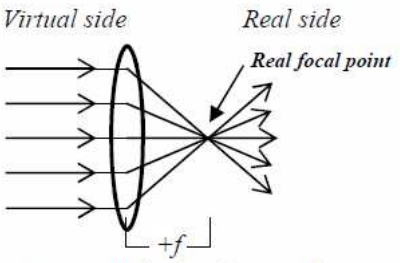
f is the focal length: the distance from the mirror or lens and the focal point.

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 –.

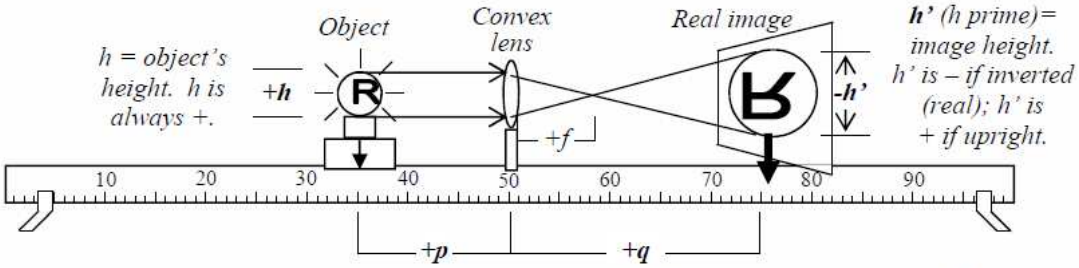
The right side of a lens is real, because light REALLY refracts thru lens.



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.



p *= object distance. p is always +.*

q *= image distance. q is + if on the real side of the device OR if the image is inverted (real).*

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 –).

NOTE: You can use cm or m, but not both!

Lens and Mirror Equation

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

Object distance (in cm or m) — p

Image distance (in cm or m) — q

Focal length (in cm or m) — f

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 = _____

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

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

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

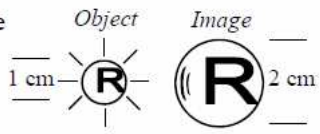
$$.083 = \frac{1}{f}$$

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

And + means on the right side of a lens.

Magnification

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



Obviously the magnification here is 2, because the image is twice as big. It is +2 because the image is upright and virtual.

Magnification

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

Magnification (no units) — M

Image height (in cm or m) — h'

Image distance (in cm or m) — q

Object height (in cm or m) — h

Object distance (in cm or m) — p

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' = _____

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

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

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

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

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

When is f negative?

When is q negative?

When is p negative?

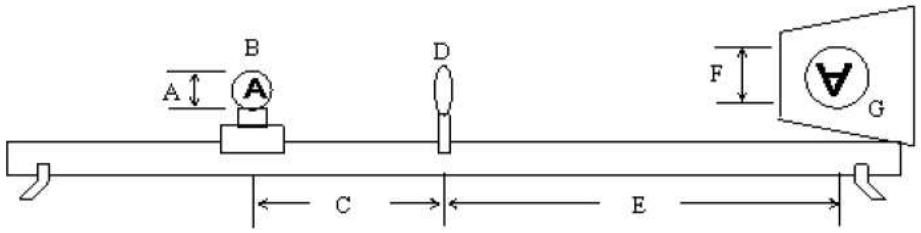
When is h' negative?

When is h 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 –.

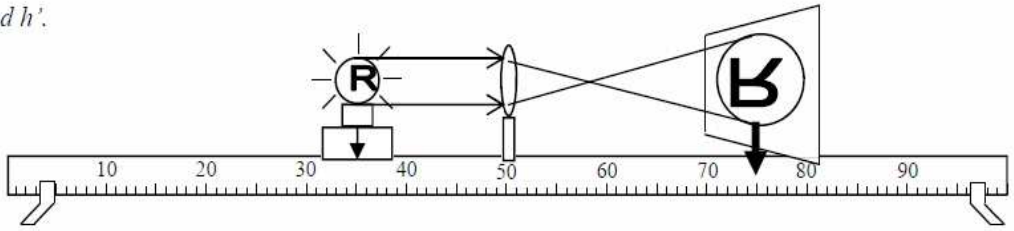
Is the image real or virtual? Why?

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?