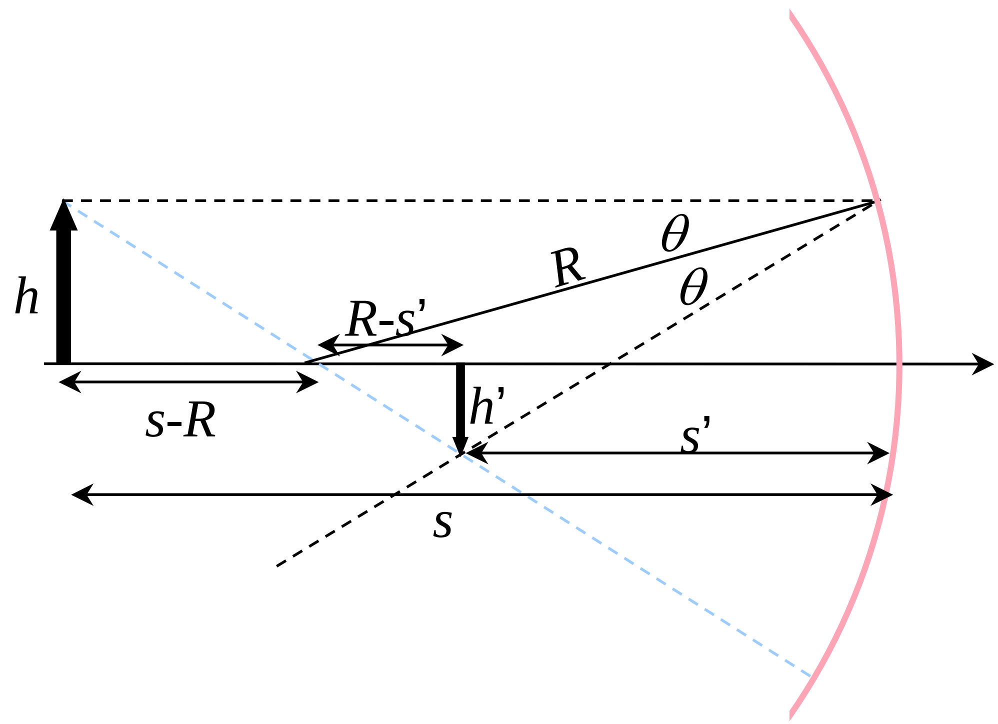
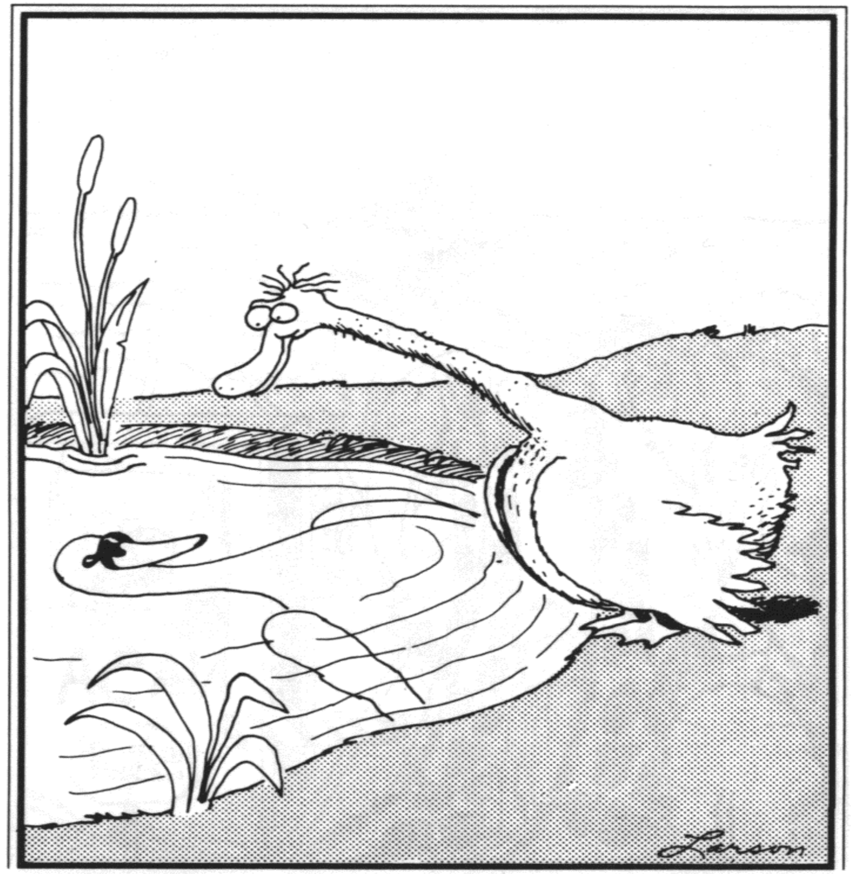
Mirrors



Reflections…



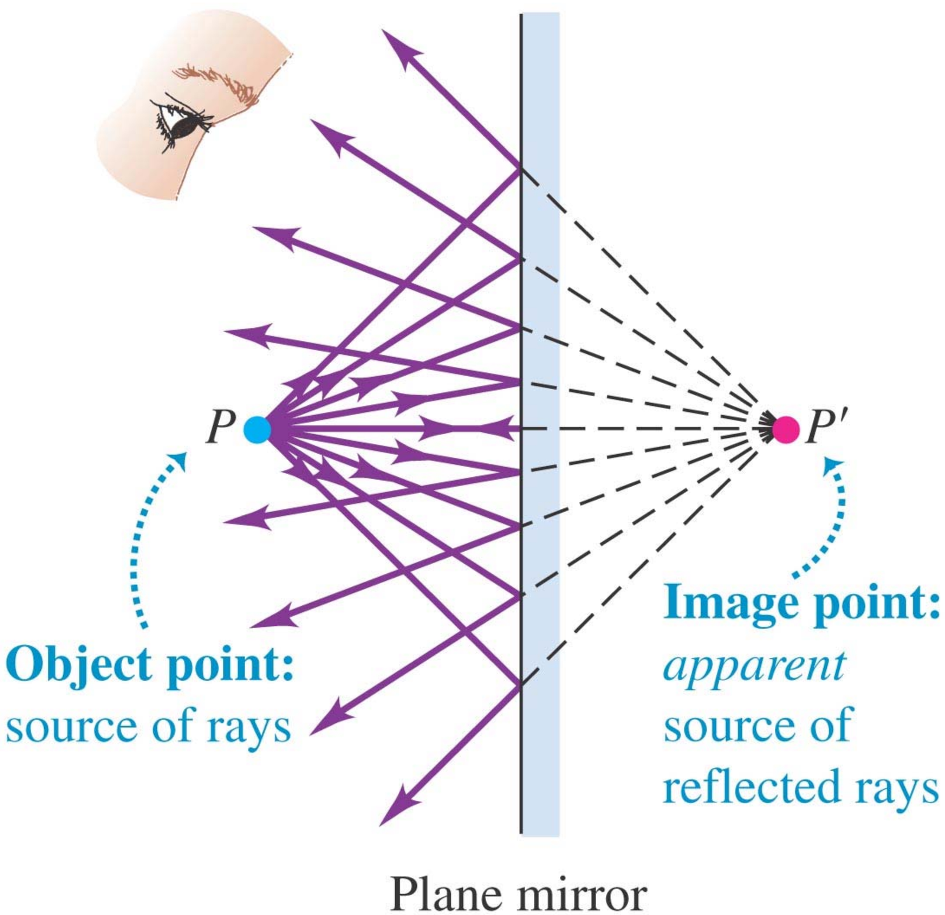
Plane Mirrors

Already know physics:

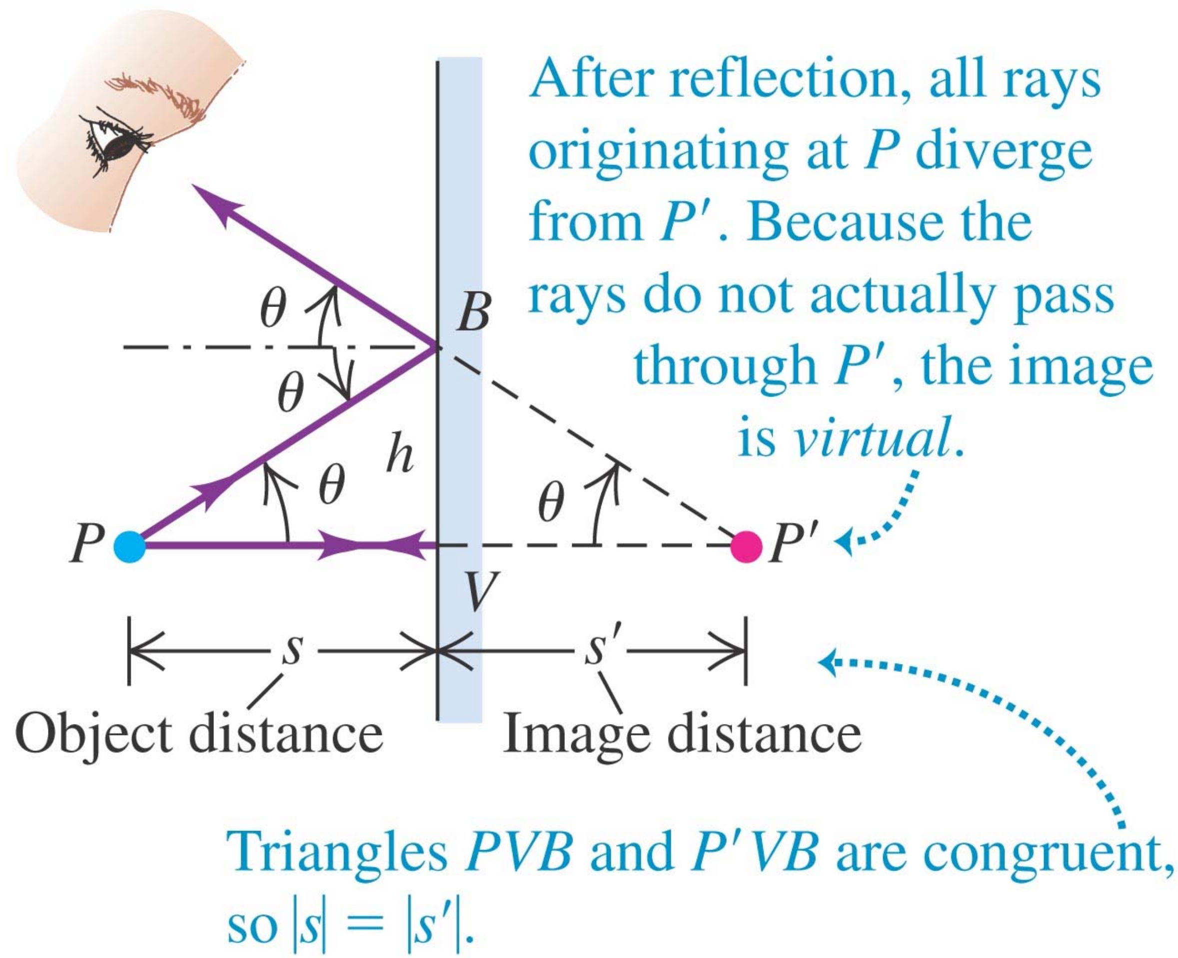
$$\boxed{\theta_R = \theta_I}$$

Source: Object – emits rays in all directions.

Eye intercepts cone of rays.



Plane Mirrors

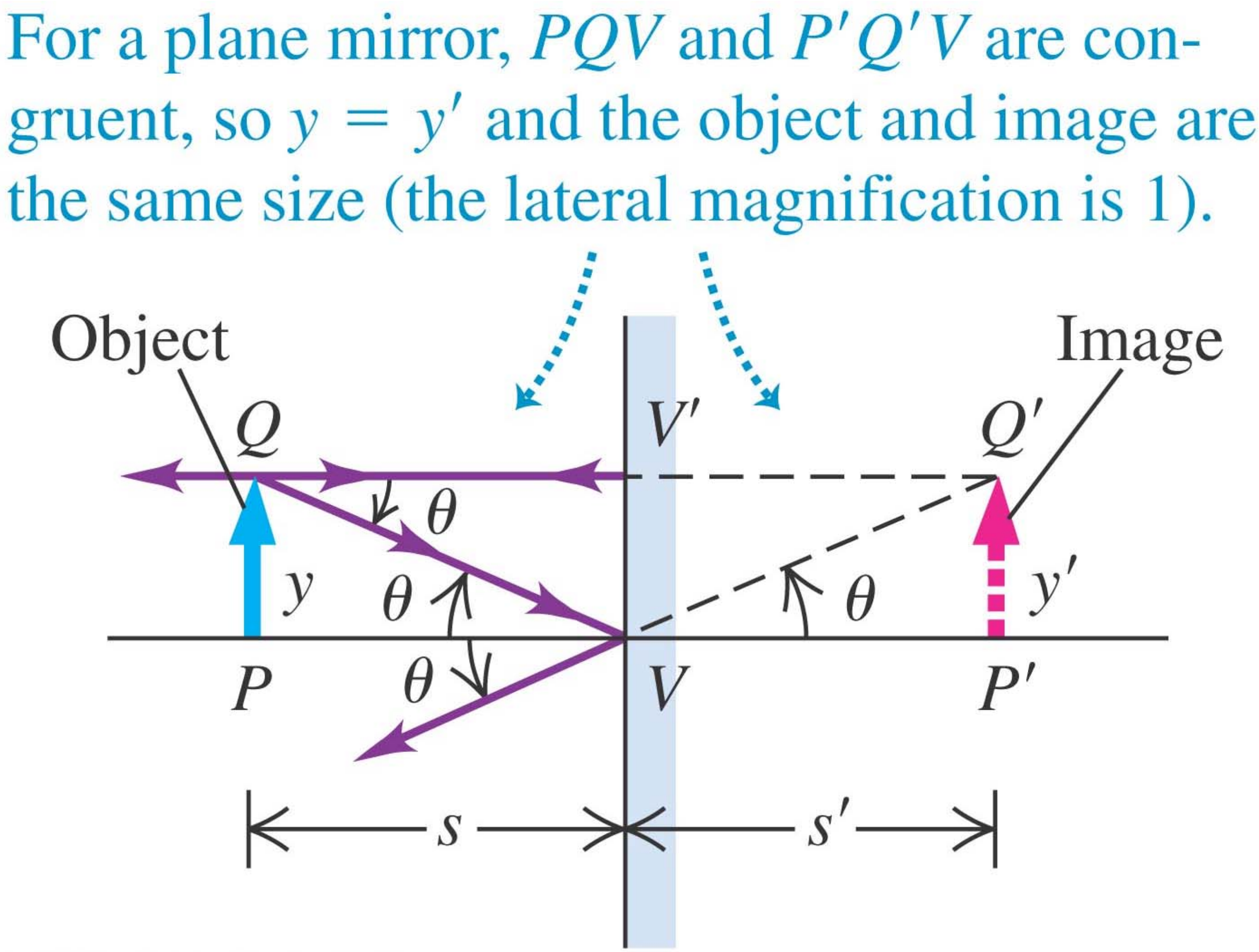


SIGN RULE convention for s and s′;

- IF object & incoming ray same side, pos. s, otherwise neg.
- IF image & outgoing ray same side, pos. s′, otherwise neg.
- IF curv. cent. & outgoing ray same side, pos.,otherwise neg.

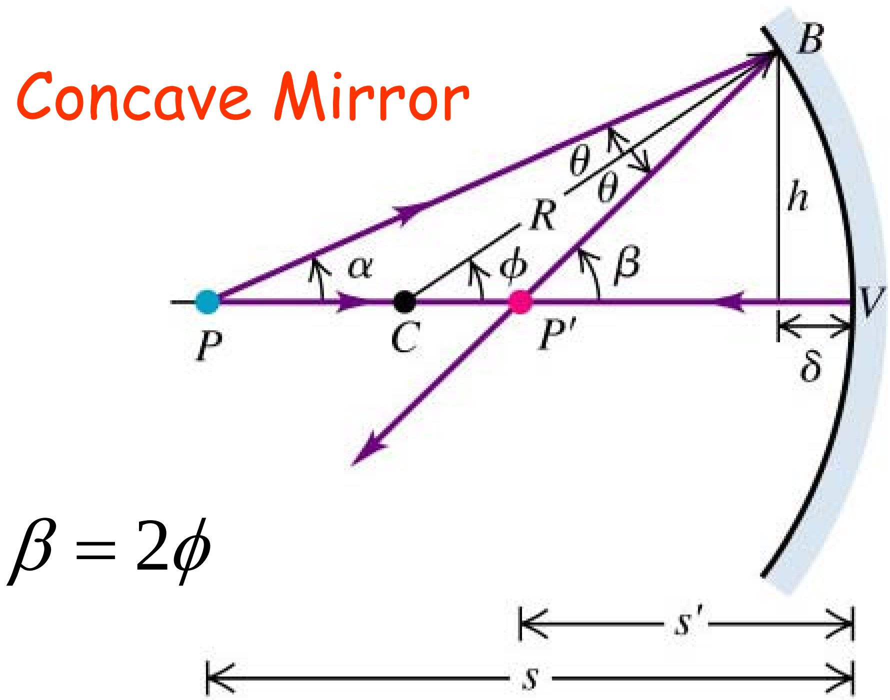
For mirror example, we have $s = -s'$

Plane Mirrors



Spherical Mirror

Point C, center of curvature.
Suppose object at P, then out
Going ray passes through P′.



$$\alpha + \theta = \phi \; ; \; \phi + \theta = \beta \;\; \Rightarrow \alpha + \beta = 2\phi$$

$$\tan\alpha = \frac{h}{s-\delta} \; ; \; \tan\beta = \frac{h}{s'-\delta} \; ; \; \tan\phi = \frac{h}{R-\delta}$$

Assume, angles small, $\delta \cong 0$,
paraxial rays, approx. parallel
to axis. Note s and s′ positive.

$$\alpha \cong \frac{h}{s} \; ; \; \beta \cong \frac{h}{s'} \; ; \; \phi \cong \frac{h}{R}$$

$$\boxed{\frac{1}{s} + \frac{1}{s'} = \frac{2}{R}}$$

Spherical Mirror

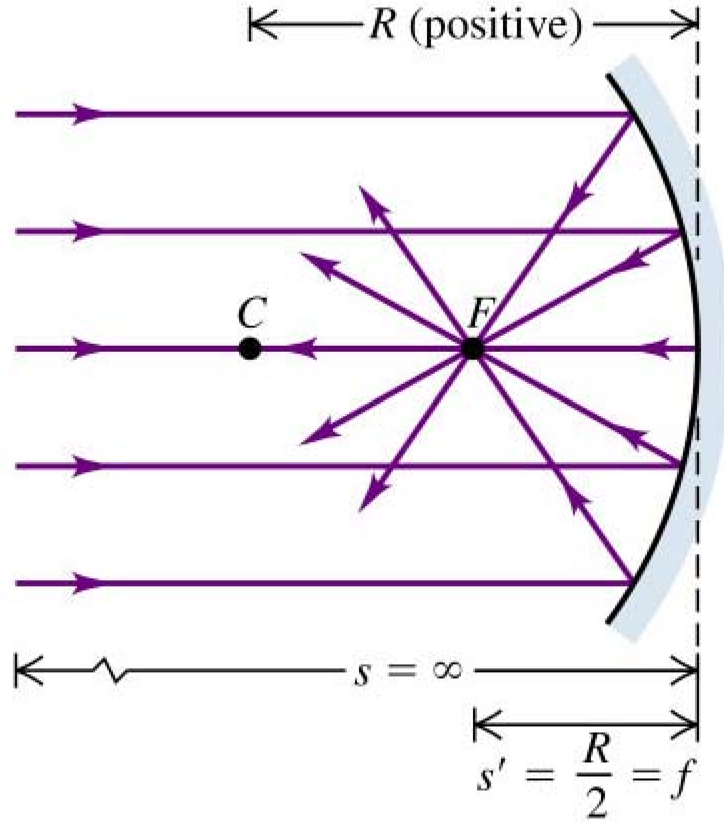
Equation $\boxed{\frac{1}{s} + \frac{1}{s'} = \frac{2}{R}}$

Infinite distance, s= ∞, s′=R/2 image appears at ½ radius of curvature.

$$\frac{1}{\infty} + \frac{1}{s'} = \frac{2}{R}$$

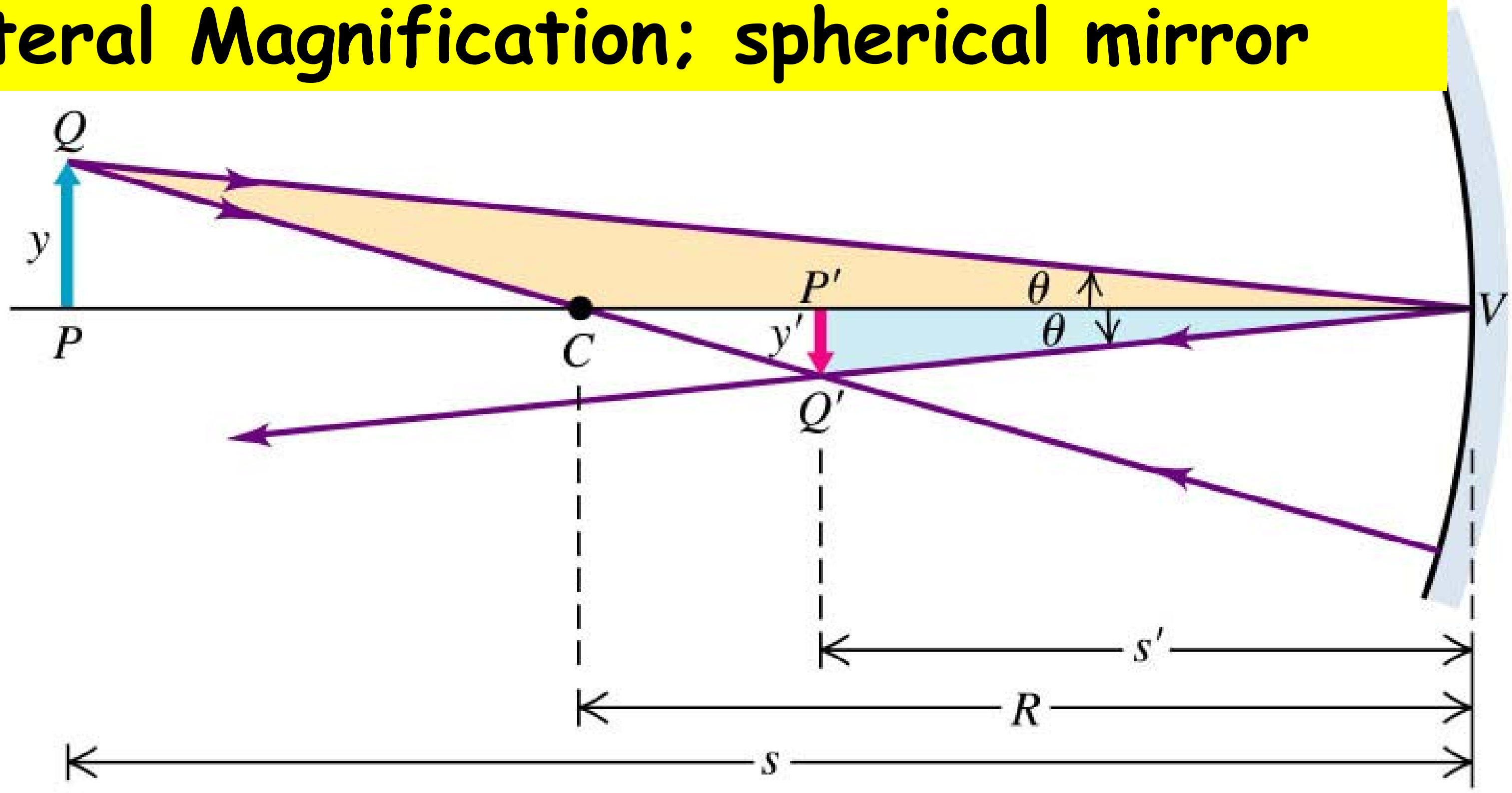
Nomenclature; focal length, f=R/2, is image length when object is at infinity.

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$



Real image – formed by converging rays. Can be viewed on screen.
Virtual image – rays do not go through. Can not be shown on screen.
Concave mirror: can have real or virtual image.

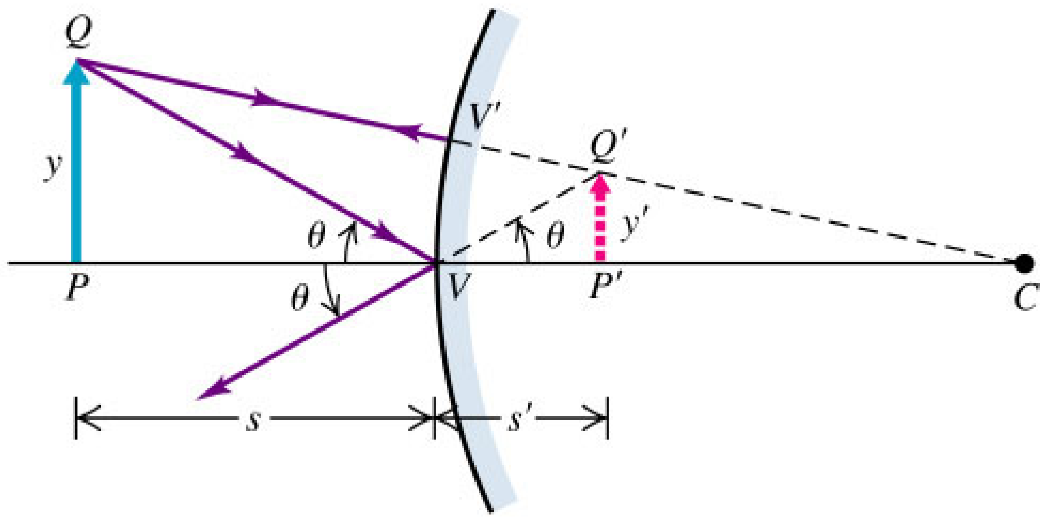
Lateral Magnification; spherical mirror



Magnification = $\dfrac{y'}{y} = -\dfrac{s'}{s}$

Remarks; note that y′=-|y′|, since the arrow is upside down and that s, s′, and y are positive. So the magnification by this definition is negative, since y′ is upside down.

Convex mirror



For a convex mirror, the radius of curvature is inside the mirror. We have another RULE, that when the curvature center C is on the same side of the outgoing ray, then the radius is positive. For the convex mirror we have NEGATIVE radius. Also from our rule for s', we observe this is negative in the above drawing. Using same recipe as we used for concave mirrors, we would find same formula:

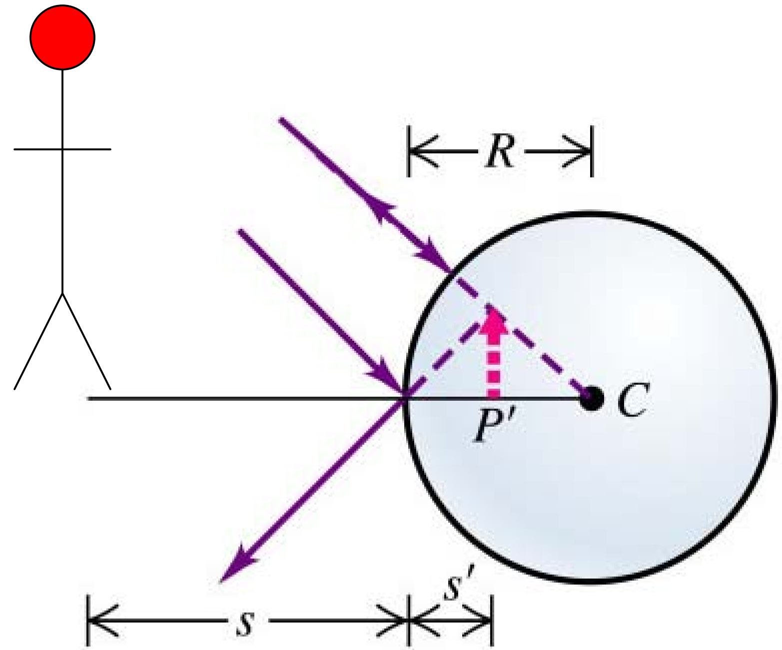
$$\boxed{\frac{1}{s} + \frac{1}{s'} = \frac{2}{R}}$$

Again, note s' and R are negative

Magnification = (this is positive) $\dfrac{y'}{y} = -\dfrac{s'}{s}$

Christmas Tree Ornament, Y&F example 34.4

Convex mirror, R & s' negative



Santa is 75cm from convex mirror of radius 3.6cm. What is image position and magnification?

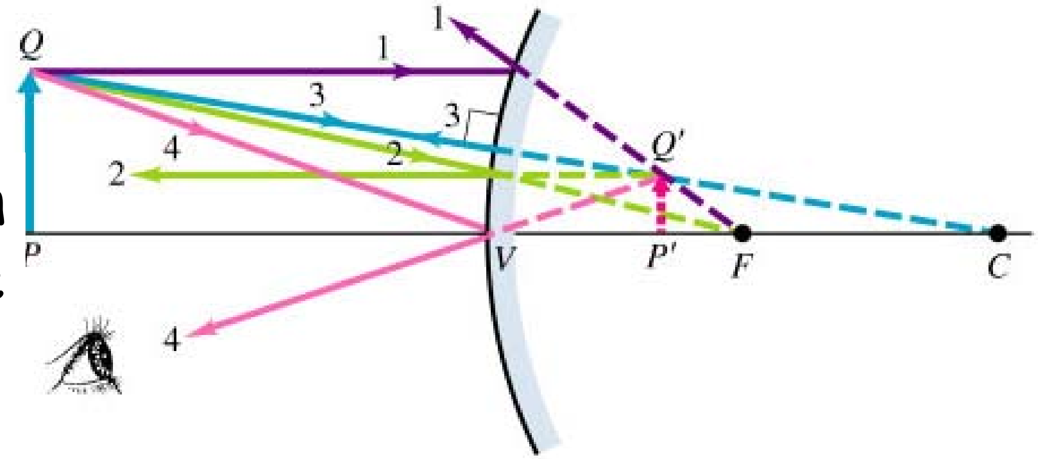
$$\frac{1}{s}+\frac{1}{s'}=\frac{2}{R}=\frac{1}{75}+\frac{1}{s'}=\frac{2}{-3.6}$$

$$s'=-1.76cm$$

$$m=-\frac{s'}{s}=-\frac{-1.76}{75}=.0234$$

Ray Tracing or Graphical techniques

Useful to help describe image.



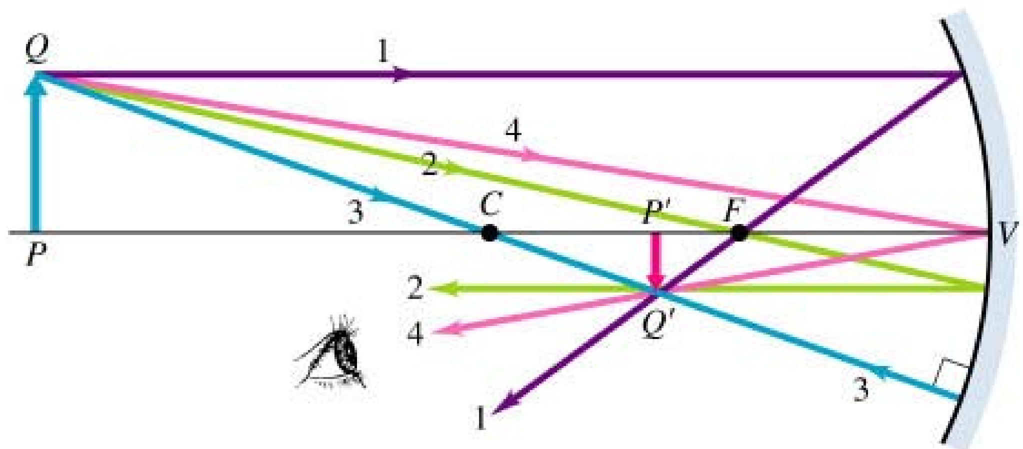
To find the image position in Practice we need to find the Intersection of at least two rays. Useful rays are

1) Focal point F, #2

2) Ray through C, #3

3) Vertex V, #4

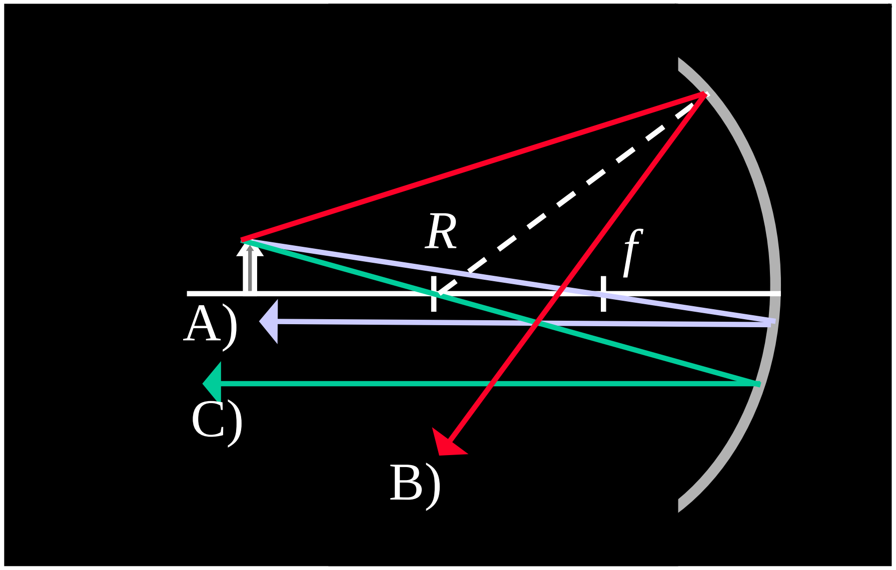
4) Parallel ray reflects through F, #1



(a)

Question 1

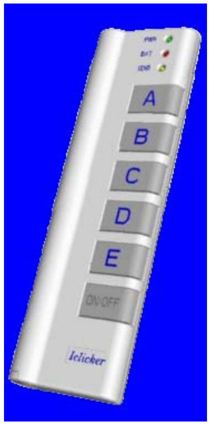
The diagram below shows three light rays reflected off of a concave mirror. Which ray is NOT correct?



A)

B)

C)



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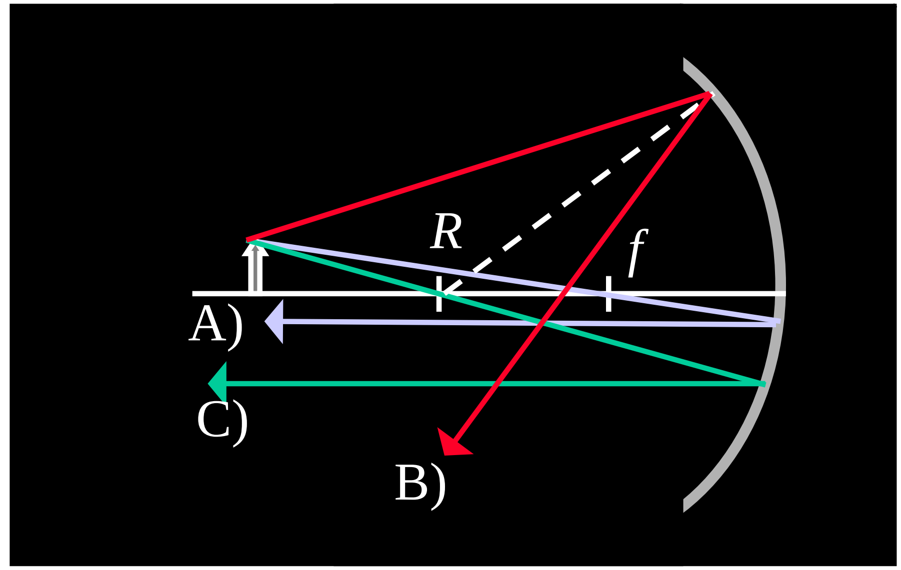
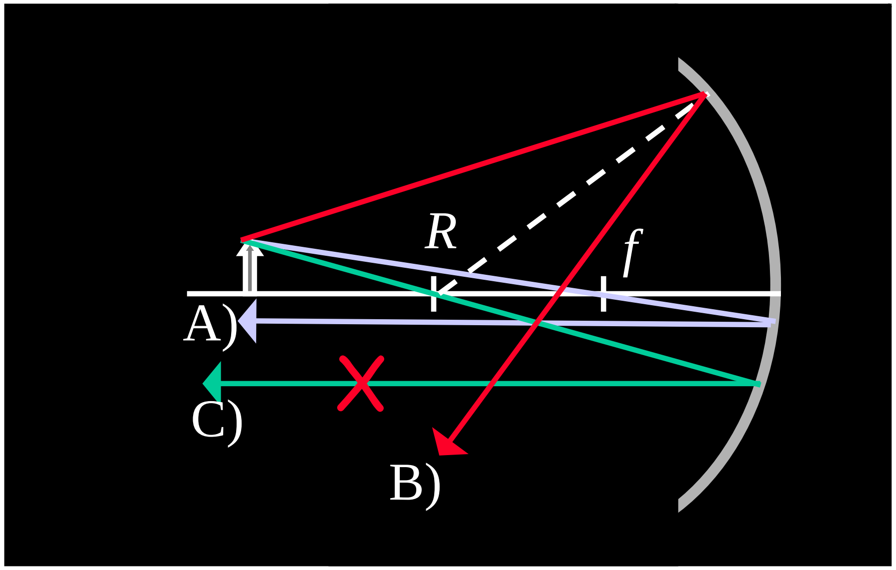


A)

B)

C)



- Ray *A* goes through focal pt and is reflected parallel to the axis.

- Ray B has angle incidence = angle reflection

- Ray *C* goes through center of sphere.
    - Therefore it has normal incidence
    - Should be reflected straight back

For next time

- Homework #12 posted → due Monday
- The home stretch: optics/optical phenomenon
- Last quiz (#6) Friday – E&M waves, refraction (1 note card)