Optics and Waves

Lecture 13

Images
Mirrors
Y&F, Chapter 34, Geometric optics/
Ray optics
p1114-1120

Learning Objectives:
How a plane mirror form an image.

All images are formed by reflection, or refraction, or a combination of both. Light is treated as straight rays, hence "Ray optics"; or Geometric optics because everything can be solved using geometry and trigonometry.

Object: Anything from which light rays radiate: A candle, a light bulb, a star, or a person (not in complete darkness).

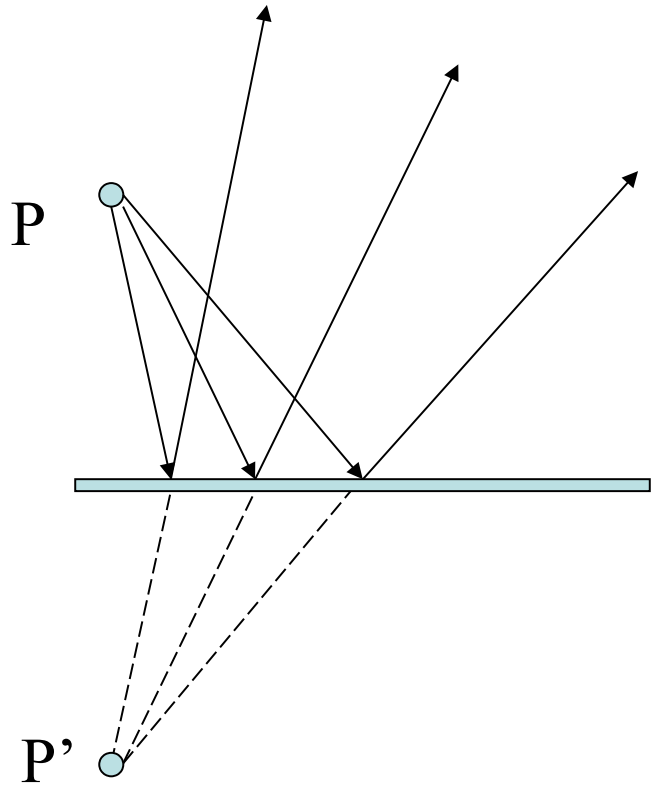
Point object: A single point.

Extended object: More than just a single point.

A star that is far away can be treated as a point object.

Mirror image of a point object

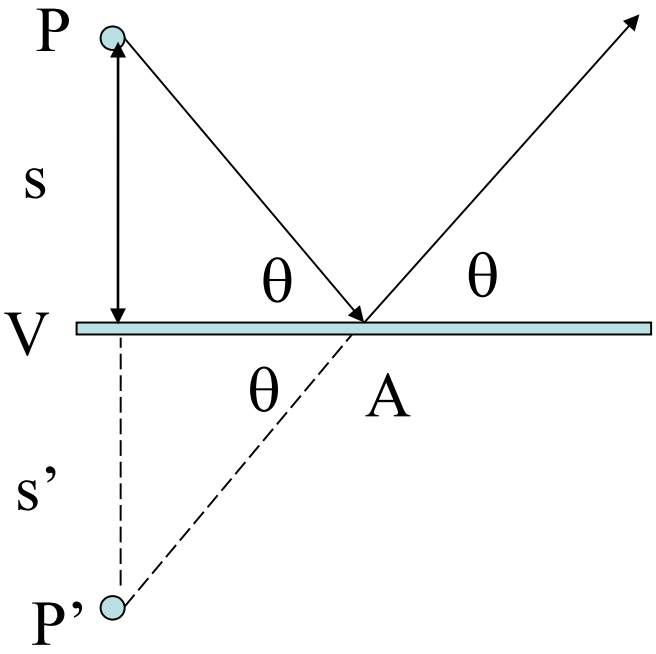
Plane Mirrors



All reflected rays appear to come from P'.

P' is the image of object P.

P' is a virtual image because there is NOT light coming from P'.

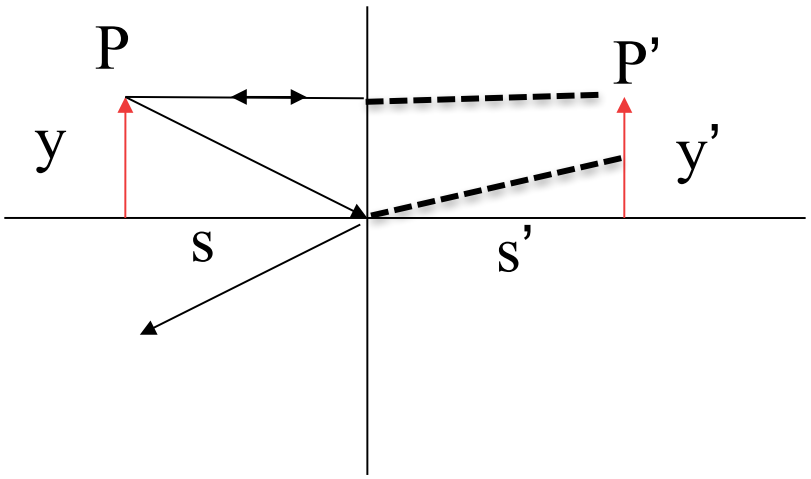


s=PV, is called the object distance.

s'=P'V, is called the image distance.

The two triangles PVA and P'VA are congruent, so *s* and *s'* have the same magnitude.

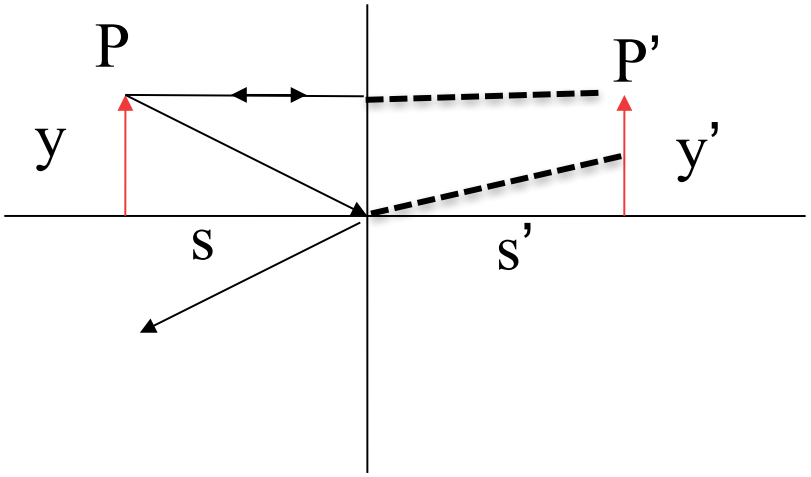
Mirror image of an extended object



ray diagram

Image formation by reflection
s, the object distance,
s' the image distance.
y, height of object
y', height of image.

Lateral magnification,
m=y'/y
m=1 for plane mirror



ray diagram

Sign Rules

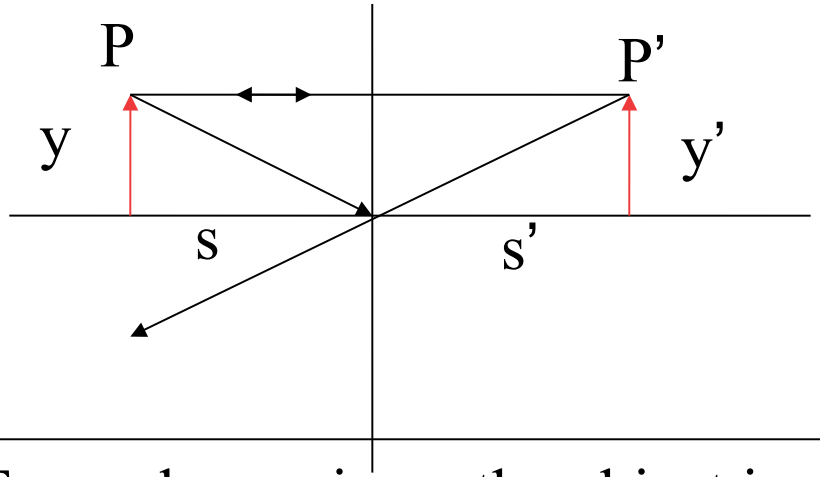
Sign Rules

1. For object distance: When the object is on the same side of the reflecting surface as the incoming light, the object distance *s* is positive; otherwise, it is negative.

2. For the image distance: When the image is on the same side of the reflecting surface as the outgoing light, the image distance *s'* is positive.

3. Radius of curvature of the mirror. When the centre of curvature C is on the same side as the outgoing light, the radius of curvature is positive.

For a mirror, the incoming and outgoing light are always on the same side. For a plane mirror, radius of curvature is infinite. Rule 3 above is useful for curved mirrors described later.



For a plane mirror, the object is on the same side of the incoming ray, so *s* is positive. The image is NOT on the same side of the outgoing ray, so *s'* is negative.

$$s = -s'$$

The image is the same height as that of the object, hence magnification is +1.

The image arrow points in the same direction as the object arrow, the image is erect/upright. If they point in opposite directions, then the image is inverted, and lateral magnification becomes negative.

Image formed by a mirror is reversed: back to front.

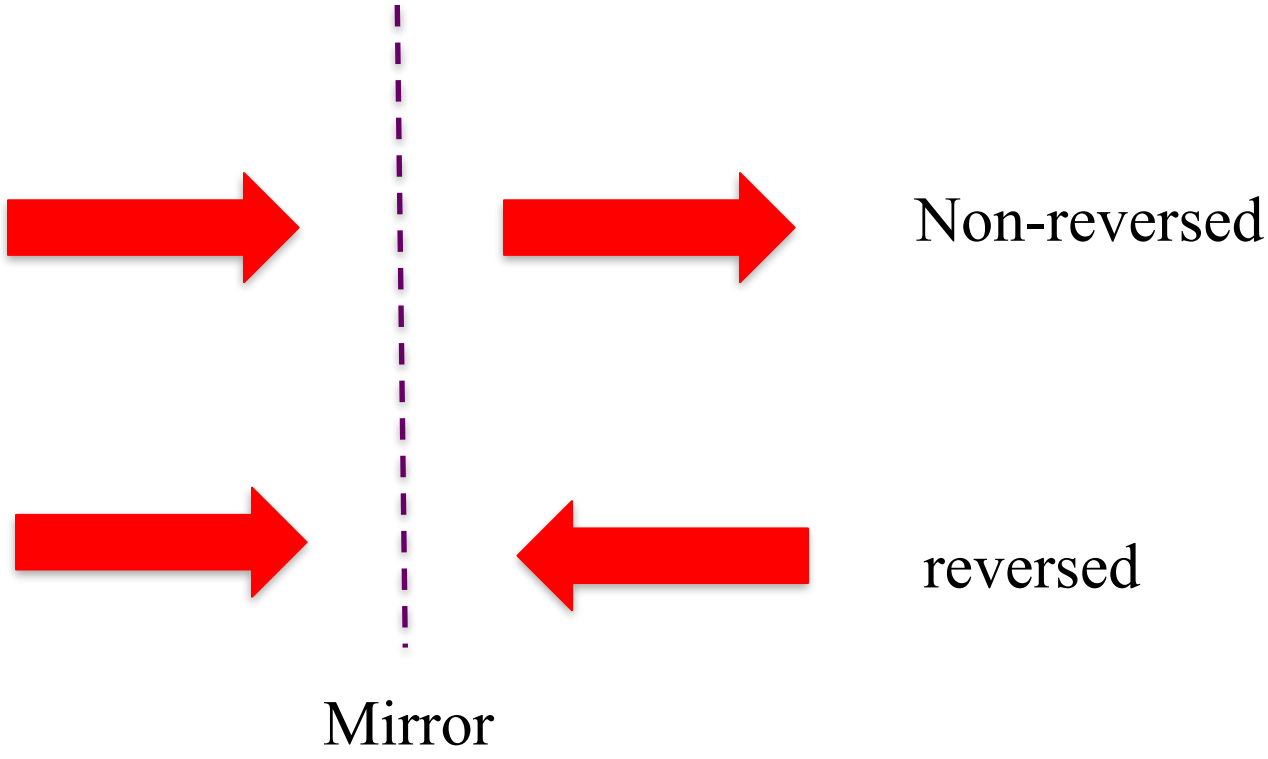


Image formed by a plane mirror is:
Virtual, erect, reversed.

Angled Mirrors

1

2

3

4

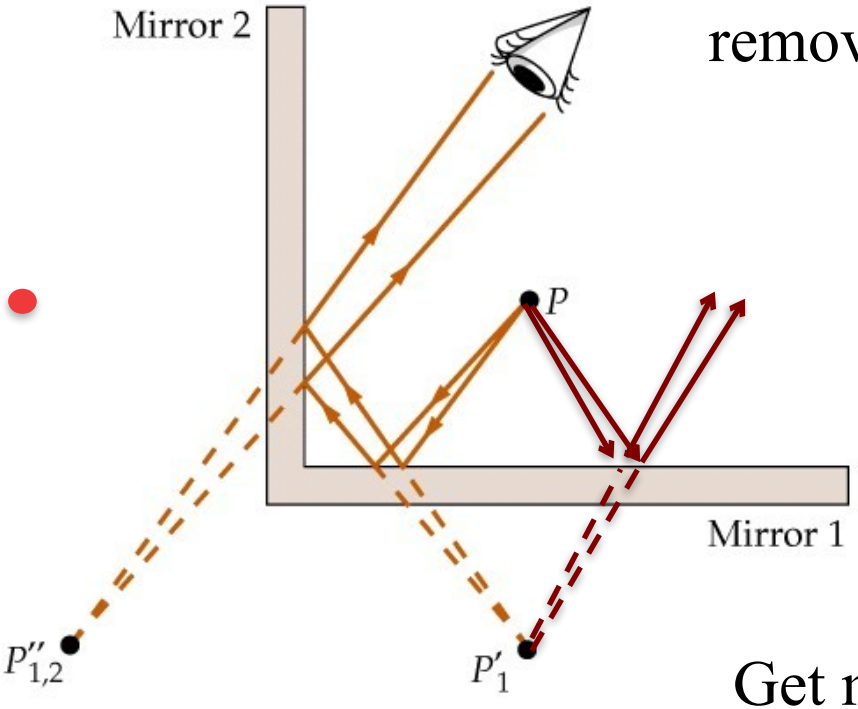
5

6

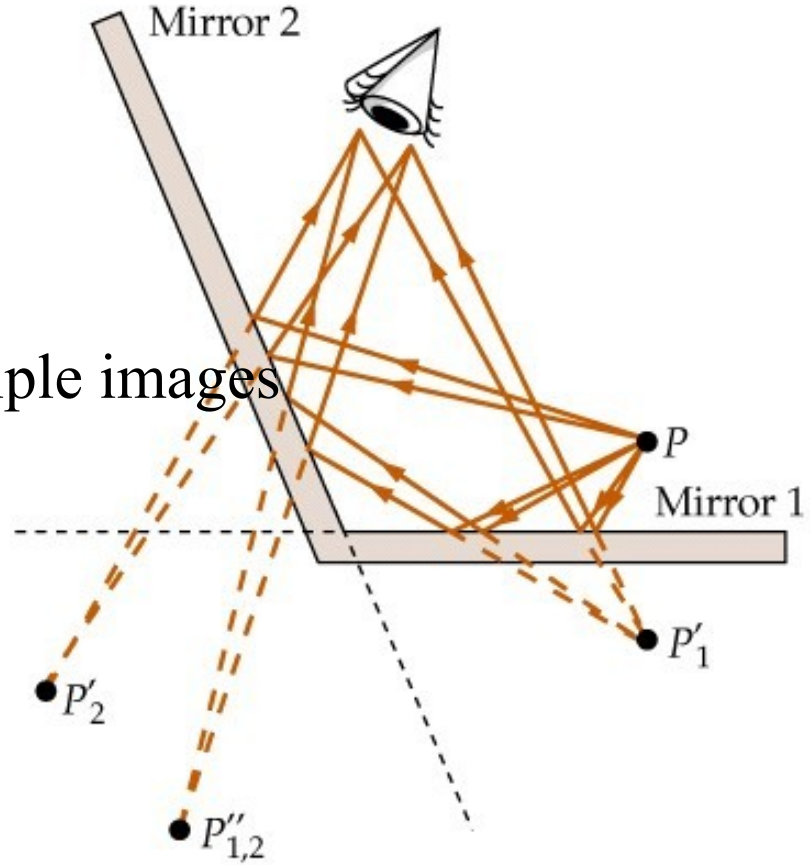
http://angelgilding.com/Multiple_Reflections.html

Angled Mirrors

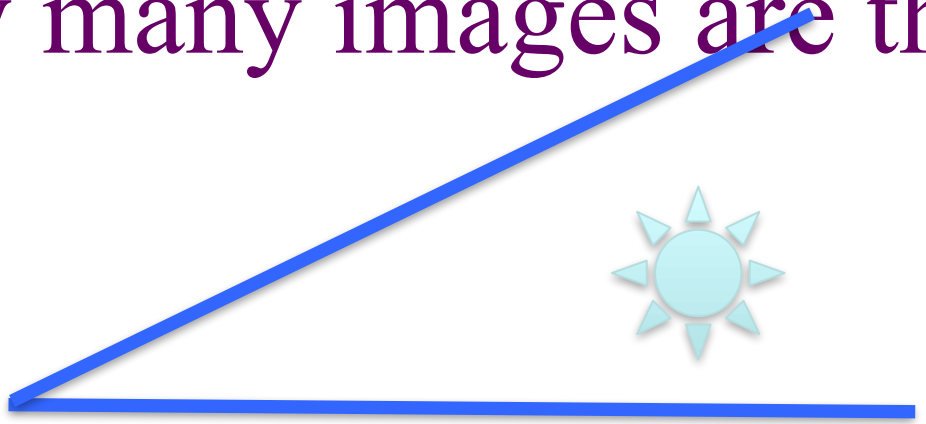
For double reflection, it is equivalent to: Placing P at the position of P' and removing Mirror 1!



Get multiple images



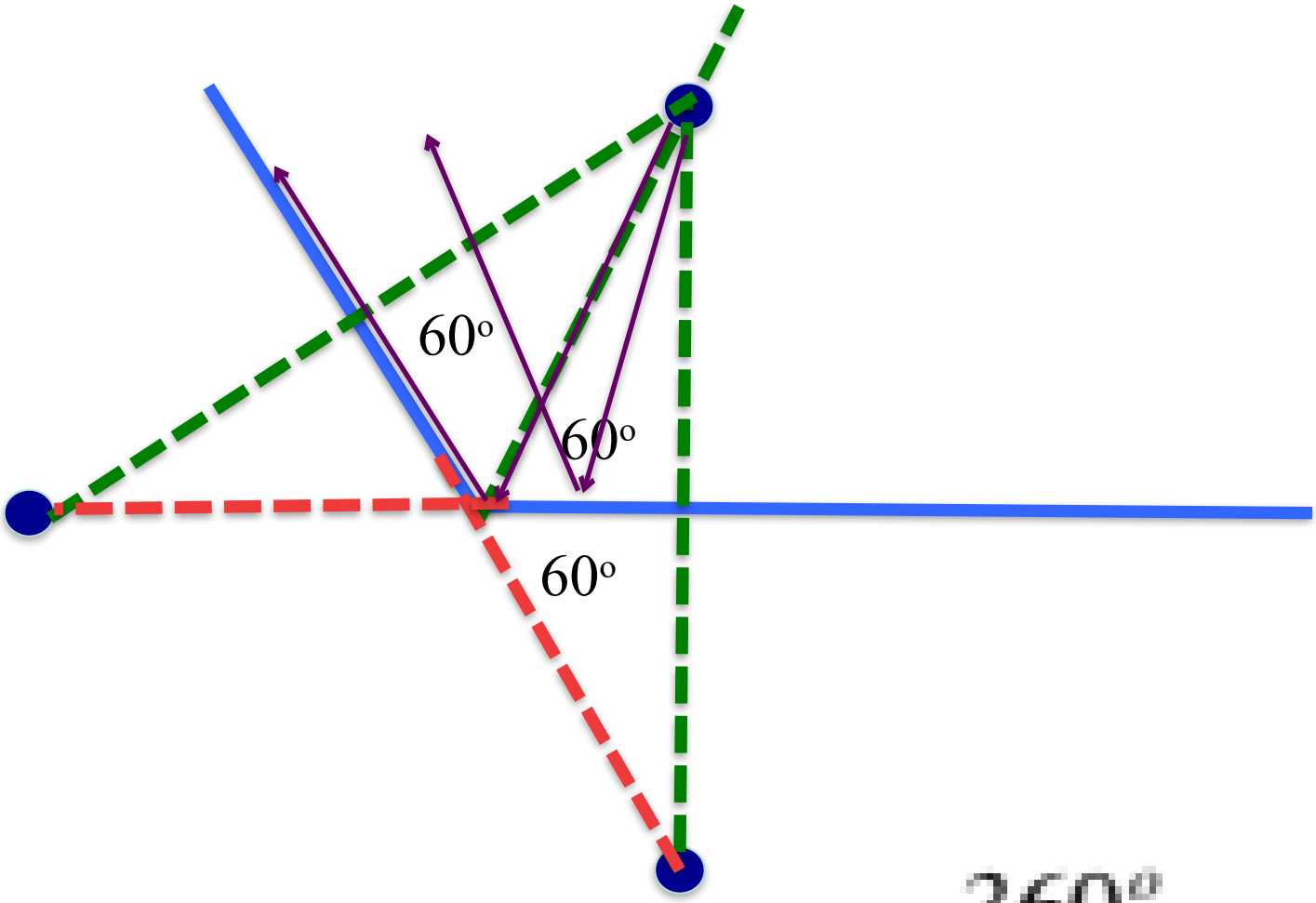
How many images are there?



How to find them?

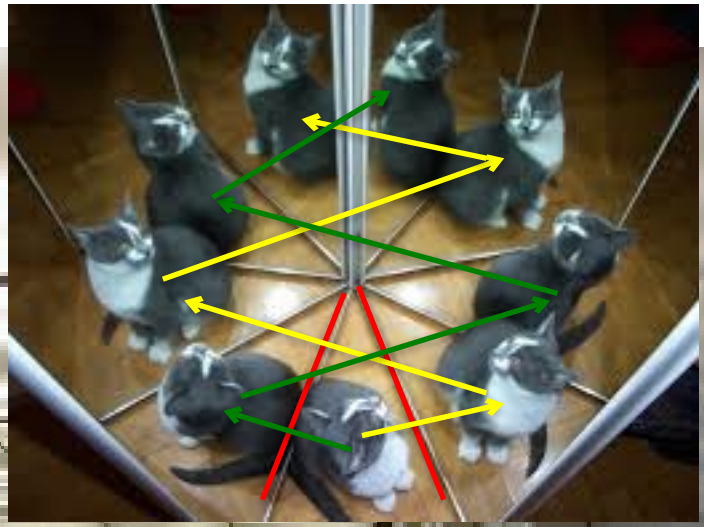
$$n = \frac{360^o}{\theta} - 1, \text{ if object falls on line}$$

bisecting the angle between the mirrors



$$n = \frac{360^o}{120^o} - 1 = 2$$

Finding multiple images
An example



http://www.youtube.com/watch?v=GKRwInEHsWc

Next Lecture:

Spherical mirrors