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## Review of Previous Lesson

- State as many Vocabulary words and Learning Objectives that you remember from the last lesson as you can.
- Now complete the content learning objectives.
- Remember to grade yourself from 0 – 3.

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# Law of Reflection & Mirrors

Light

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## Learning Objectives

| Content: | Start | End |
|---|---|---|
| Define the normal. | | |
| Produce ray diagrams for plane mirrors and curved mirrors (concave and convex). | | |
| Define focal length, focal point, principle axis, and image. | | |
| Determine whether an image will be magnified or inverted based on the location of the object. | | |

The distinctions between real and virtual images will not be covered on the common.

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## Language Learning Objectives

| Content: | Start | End |
|---|---|---|
| Define verbally and in writing. | | |
| Draw diagrams. | | |
| Determine. | | |

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## What is the relationship between the angle of incidence and the angle of reflection?

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What is the relationship between the angle of incidence and the angle of reflection?

- Independent Variable:
  - angle of incidence
- Dependent Variable:
  - angle of reflection
- Control Variables:
  - light ray, shape of mirror, environmental conditions

| angle of incidence (°) | angle of reflection (°) |
|---|---|
| | |
| | |
| | |
| | |
| | |

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## Ray Diagrams - Mirrors

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(Bozeman Science)

https://www.youtube.com/watch?v=WNkB8IY-ko4

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## The Anatomy of a Curved Mirror

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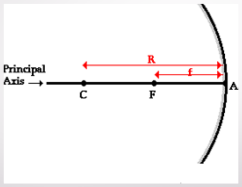
R = The distance from the vertex to the centre of curvature is known as the radius of curvature. The radius of curvature is the radius of the sphere from which the mirror was cut.

F = the distance from the mirror to the focal point is known as the focal length. Since the focal point is the midpoint of the line segment adjoining the vertex and the centre of curvature, the focal length would be one-half the radius of curvature.

If a concave mirror were thought of as being a slice of a sphere, then there would be a line passing through the centre of the sphere and attaching to the mirror in the exact centre of the mirror. This line is known as the principal axis.




A = The point on the mirror's surface where the principal axis meets the mirror is known as the vertex.

C = The point in the centre of the sphere from which the mirror was sliced is known as the centre of curvature.

F = Midway between the vertex and the centre of curvature is a point known as the focal point.

http://www.physicsclassroom.com/class/refln/Lesson-3/The-Anatomy-of-a-Curved-Mirror

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## Derivation of the mirror equation

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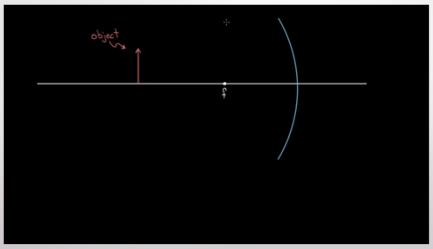
(Khan Academy)

https://www.youtube.com/watch?v=OIkD1viOMWk

Recommended

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## Mirror Equation

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

- f = focal length

## Magnification Equation

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

- M = magnification
- $h_i$ = image height
- $h_o$ = object height

$d_o$ = object distance
$d_i$ = image distance

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## Mirror equation example problems

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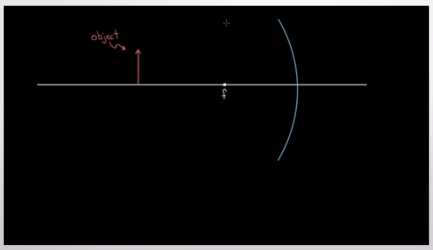
(Khan Academy)

https://www.youtube.com/watch?v=4VfDXitHaH8

Recommended

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## Mirror Equation Vs Ray Diagrams

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- The mirror equation is actually only an approximation as the mirror equation angles (see derivation) relates to a straight line through the mirror.
  - However, an actual concave or convex mirror is curved.
- There are a few "cheats" to get a ray diagram to come up with the same information as the mirror equation.

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"Cheats" to get a ray diagram to come up with the same information as the mirror equation

1. Focus in on the "middle" part of the mirror and "pretend" it is almost a straight line.
2. If you can draw your own mirror make it curve very gently so that the "middle" part of the mirror is as straight as possible.
3. Reduce the scale and use squared paper to help make the ray diagram as accurate as possible.
4. If you are not given an object or image size, use a small object or image so that the rays only hit "middle" part of the mirror.

Note: the more curve a mirror has, the more a ray diagram will differ from the mirror equation.

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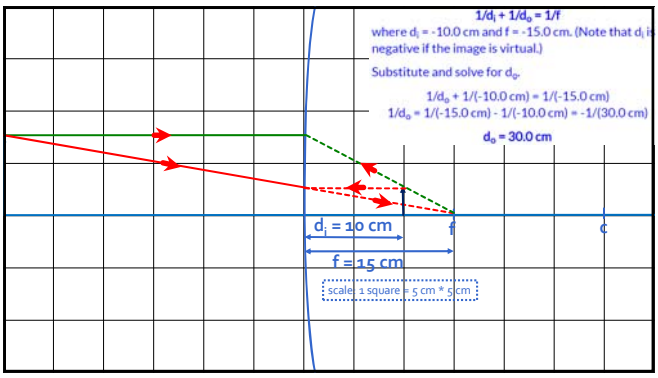


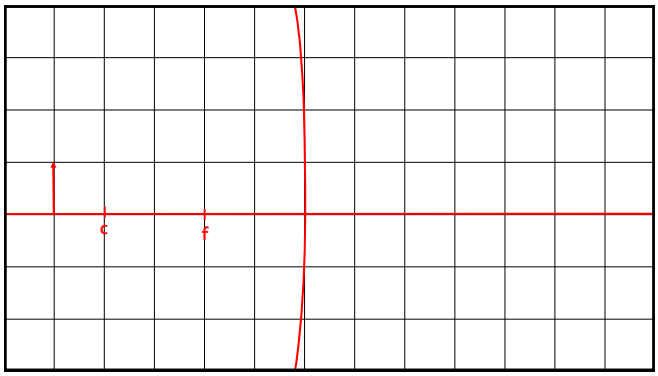


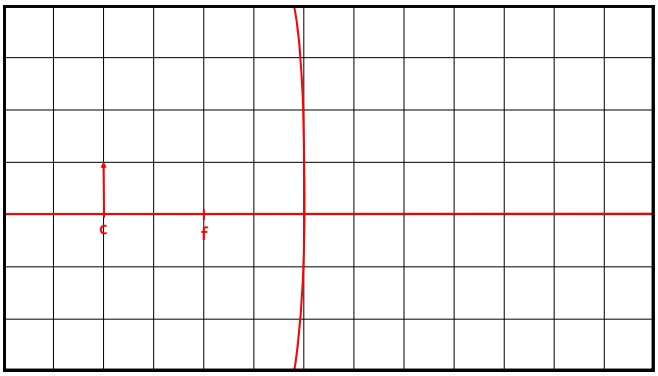


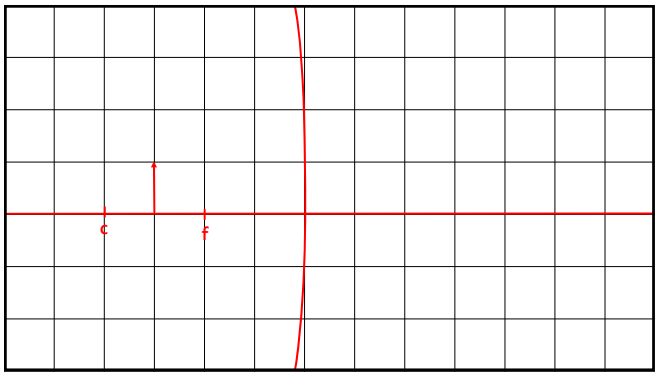


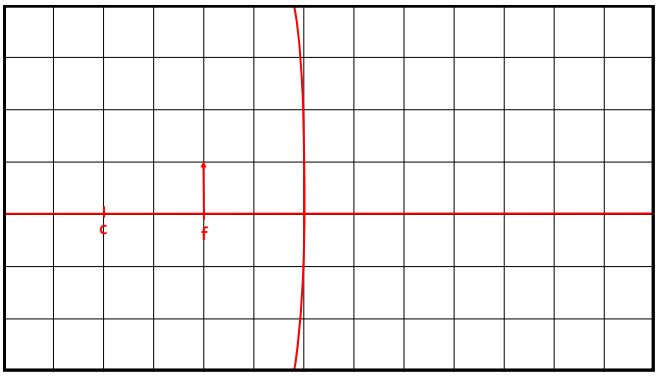

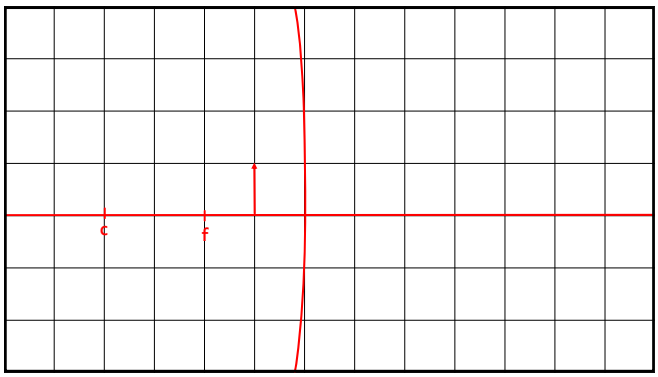


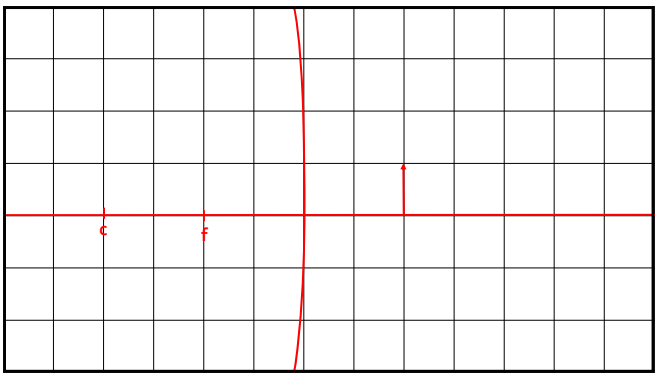


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## Sim Bucket Simulation

- https://simbucket.com/lensesandmirrors/

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## LOST

- Describes an image:
  - **L**ocation *(relative to focal point f or centre of curvature c)*
  - **O**rientation *(upright or inverted)*
  - **S**ize *(relative - larger or smaller than object)*
  - **T**ype *(real or virtual)*

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https://simbucket.com/lensesandmirrors/ *f = focal point, C = centre of curvature*

| Mirror Type | Object Location | L | O | S | T |
|---|---|---|---|---|---|
| Concave | > C | | | | |
| | C | | | | |
| | C -> f | | | | |
| | f | | | | |
| | f -> mirror | | | | |
| Convex | anywhere | | | | |

What can you say about all virtual images?
Can Convex mirrors produce a magnified image?
When can a concave mirror produce a magnified image?

**L**ocation *(relative to focal point f or centre of curvature C)*
**O**rientation *(upright or inverted)*
**S**ize *(relative - larger or smaller than object – reduced/magnified/same size)*
**T**ype *(real or virtual)*

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https://simbucket.com/lensesandmirrors/ *f = focal point, C = centre of curvature*

| Mirror Type | Object Location | L | O | S | T |
|---|---|---|---|---|---|
| Concave | > C | C -> f | upright | reduced | real |
| | C | C | inverted | same size | real |
| | C -> f | > C | inverted | magnified | real |
| | f | no image / blurry (parallel lines) | | | |
| | f -> mirror | opposite side of mirror | upright | magnified | virtual |
| Convex | anywhere | opposite side of mirror | upright | reduced | virtual |

All virtual images are upright!
A convex mirror cannot produce an image that is larger than the object!
A concave mirror produces an image larger than the object only when the object is between the mirror and twice the focal length (C).

Draw ray diagrams for each of the situations above.

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