Lenses

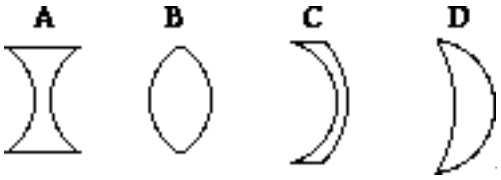
Read from **Lesson 5** of the **Refraction and Lenses** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/refrn/u14l5a.html
http://www.physicsclassroom.com/Class/refrn/u14l5b.html
http://www.physicsclassroom.com/Class/refrn/u14l5c.html

MOP Connection: Refraction and Lenses: sublevel 7

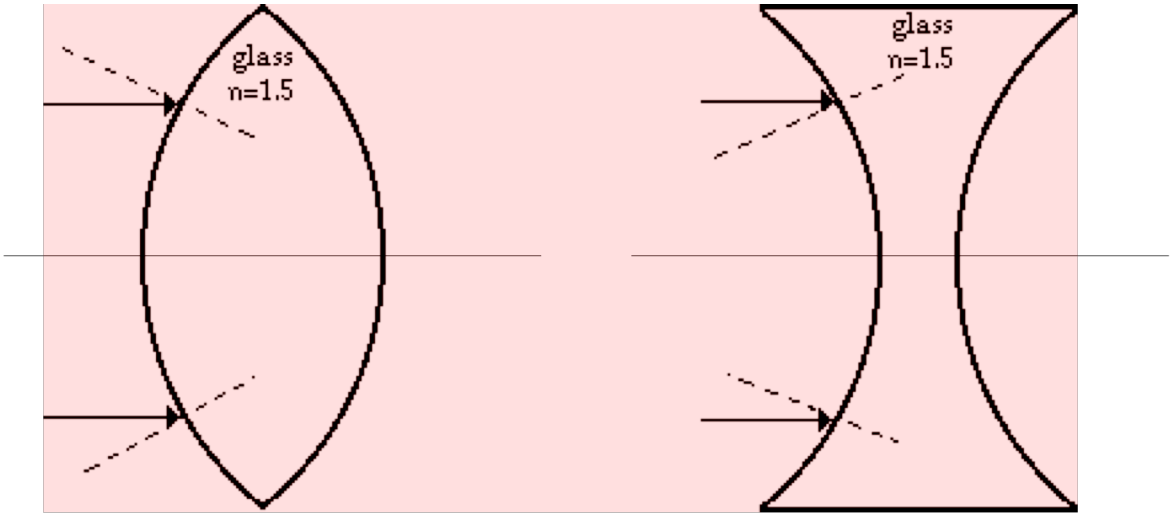
1. Converging lenses are _____ at the center and _____ at the edges.
   a. thickest, thinnest b. thinnest, thickest
2. Diverging lenses are _____ at the center and _____ at the edges.
   a. thickest, thinnest b. thinnest, thickest

Consider the diagram at the right in answering the next two questions.



3. List the letters of all the converging lenses.
4. List the letters of all the diverging lenses.

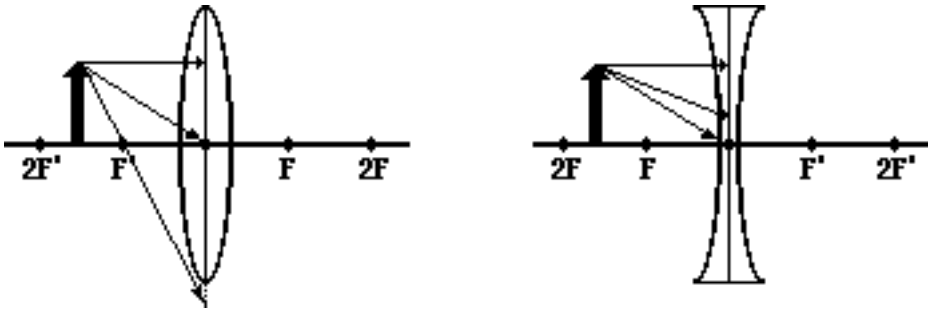
5. Use refraction principles to sketch an approximate path of light as it enters and exits the lens. Think FST and SFA. Trace the path of the rays into, through and out of the lens. Repeat the procedure for the light rays exiting the lens and trace the emerging light rays. Place arrowheads on all light rays.



6. Explain why lenses (like the one on the left above) are called "converging" lenses.

7. Converging lenses will have _____ (positive, negative) focal lengths. Diverging lenses will have _____ (positive, negative) focal lengths.

8. The diagram below shows an *arrow object* positioned in front of a converging and a diverging lens. Three incident rays are shown. Construct the corresponding refracted rays. Show arrowheads.



9. State the three *rules of refraction* for converging lenses:

#1: _____

_____

#2: _____

_____

#3: _____

_____

10. State the three *rules of refraction* for diverging lenses:

#1: _____

_____

#2: _____

_____

#3: _____

_____

11. The diagrams below depict the refraction of light through various lenses. List the diagrams that show the proper refraction of light. _____ For those which show the improper refraction of light, either correct the diagrams by showing the proper refracted rays or explain what is wrong with the refracted rays.

Diagram A

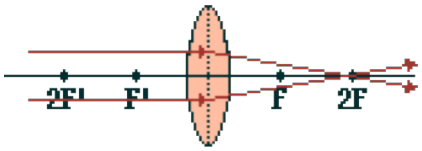


Diagram B

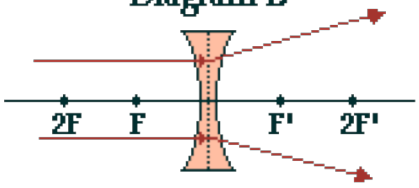


Diagram C

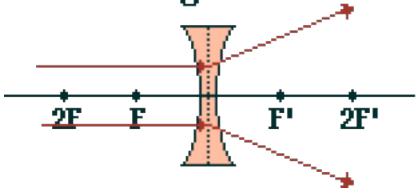
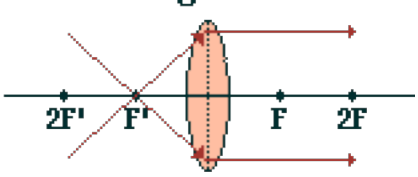


Diagram D



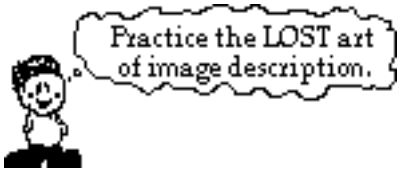
Ray Diagrams for Converging Lenses

Read from **Lesson 5** of the **Refraction and Lenses** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/refrn/u14l5da.html
http://www.physicsclassroom.com/Class/refrn/u14l5db.html

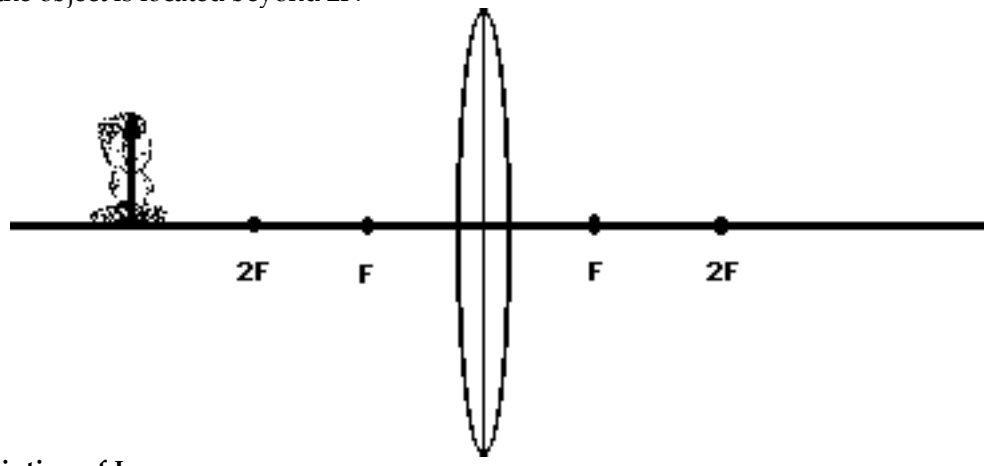
MOP Connection: Refraction and Lenses: sublevels 8 and 9

For the following lenses and corresponding object positions, construct ray diagrams. Then describe the **L**ocation of the image, **O**rientation (upright or inverted) of the image, the relative **S**ize of the image (larger or smaller than object), and the **T**ype of image (real or virtual). For **Case 4**, merely construct the ray diagram.



NOTE: 1) All light rays have arrowheads which indicate the direction of travel of the ray.
2) Always draw in the image once located (an arrow is a good representation).
3) Exactness counts. Use a straight-edge and be accurate.

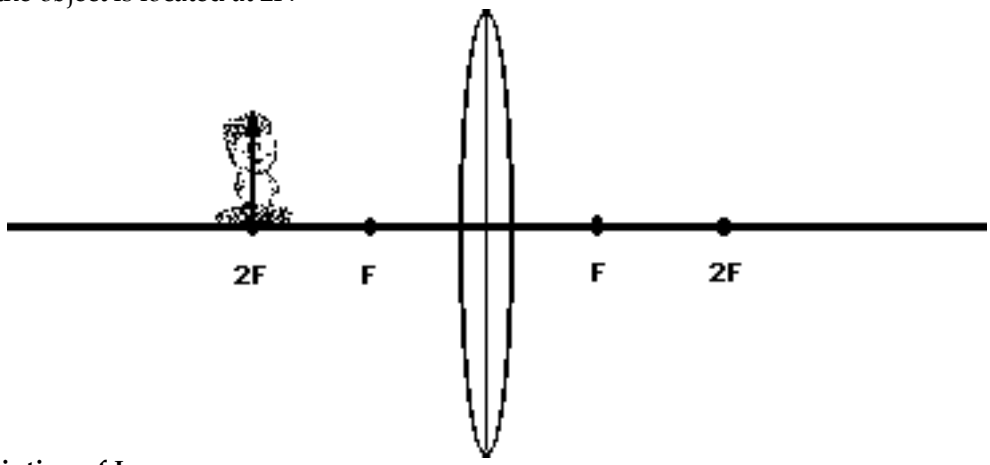
Case 1: If the object is located beyond 2F:



Description of Image:
Location: _____

O: Upright or Inverted **S:** Magnified or Reduced **T:** Real or Virtual

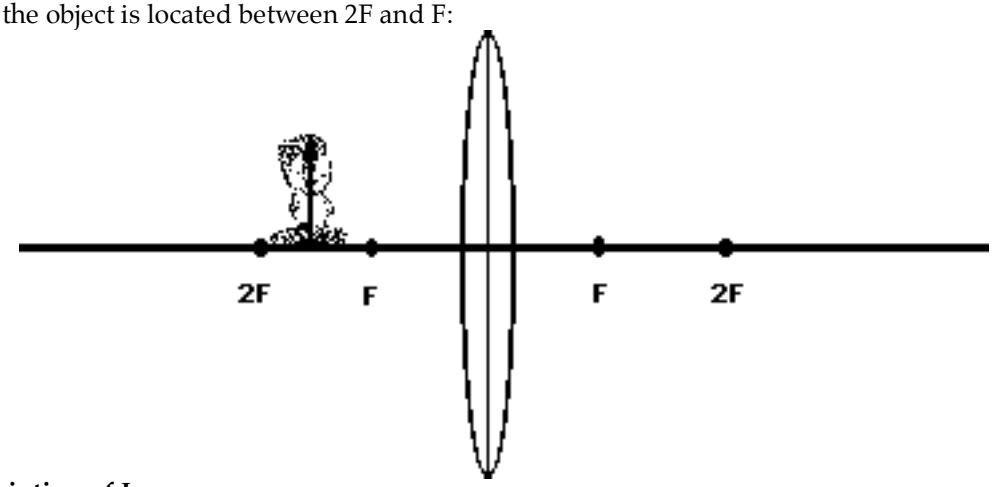
Case 2: If the object is located at 2F:



Description of Image:
Location: _____

O: Upright or Inverted **S:** Magnified or Reduced **T:** Real or Virtual

Case 3: If the object is located between 2F and F:

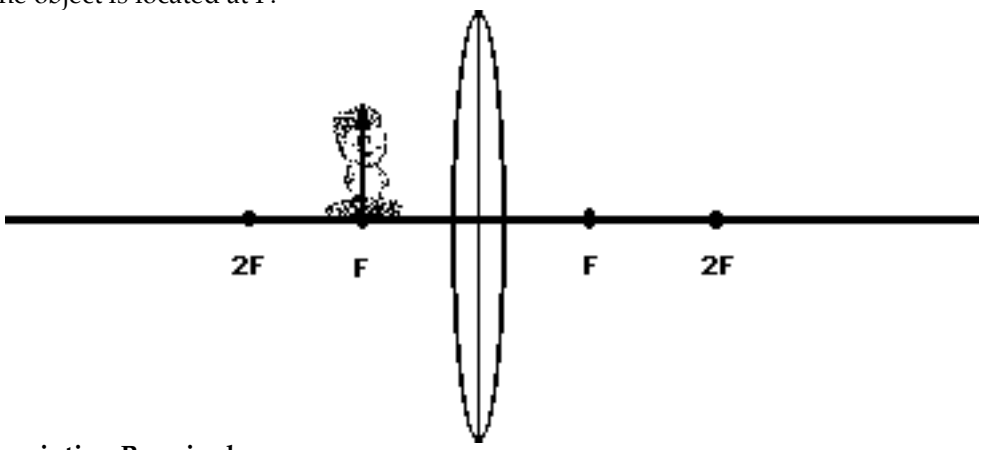


Description of Image:

Location: _____

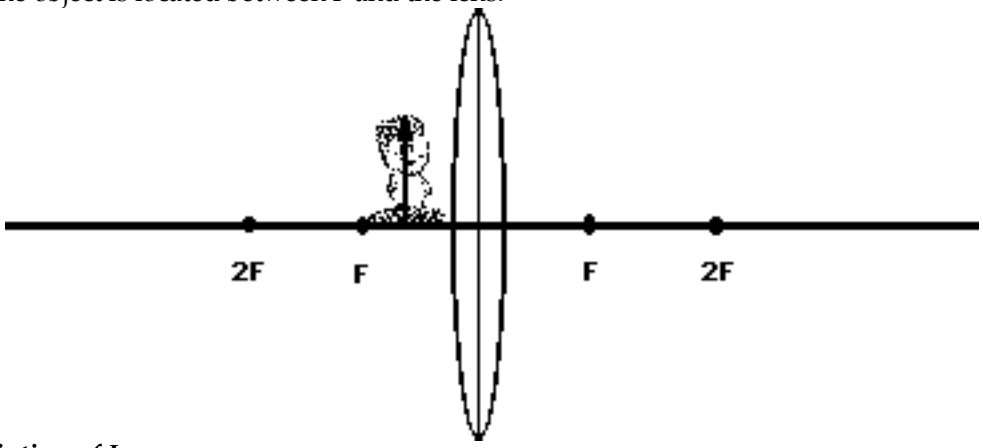
O: Upright or Inverted **S:** Magnified or Reduced **T:** Real or Virtual

Case 4: If the object is located at F:



No Description Required

Case 5: If the object is located between F and the lens:



Description of Image:

Location: _____

O: Upright or Inverted **S:** Magnified or Reduced **T:** Real or Virtual

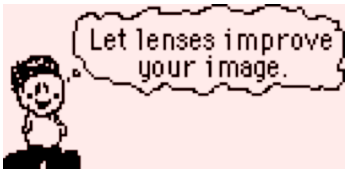
Ray Diagrams for Diverging Lenses

Read from **Lesson 5** of the **Refraction and Lenses** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/refrn/u14l5ea.html
http://www.physicsclassroom.com/Class/refrn/u14l5eb.html

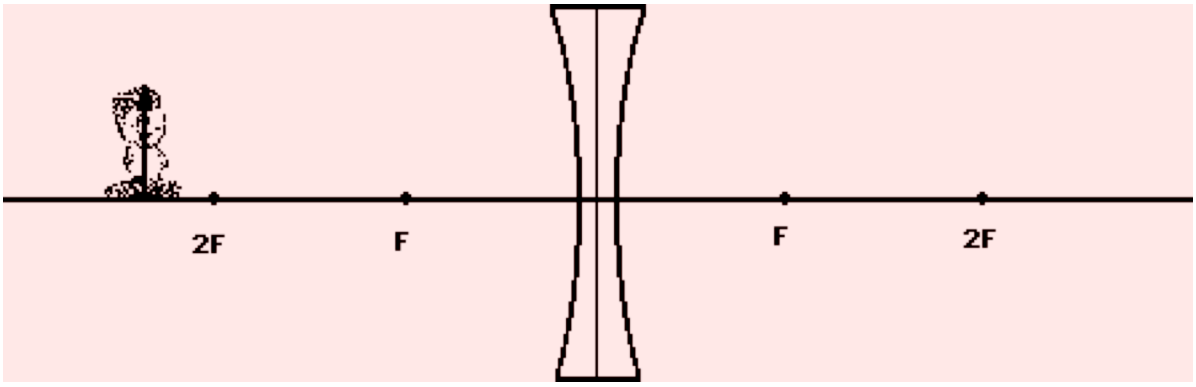
MOP Connection: Refraction and Lenses: sublevels 10 and 11

For the following lenses and corresponding object positions, construct ray diagrams. Then describe the **L**ocation of the image, **O**rientation (upright or inverted) of the image, the relative **S**ize of the image (larger or smaller than object), and the **T**ype of image (real or virtual).



NOTE: 1) All light rays have arrowheads which indicate the direction of travel of the ray.
2) Always draw in the image once located (an arrow is a good representation).
3) Exactness counts. Use a straight-edge and be accurate.

Case 1: If the object is located far away from the lens:

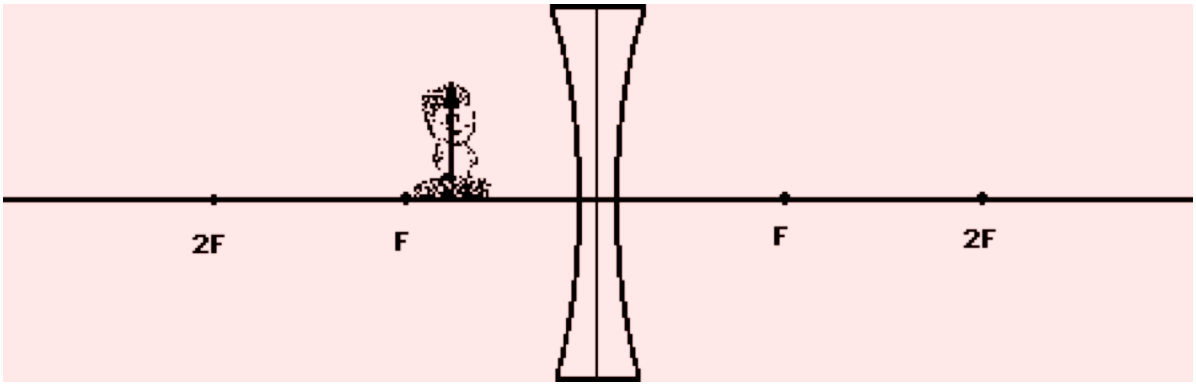


Description of Image:

Location: _____

O: Upright or Inverted **S:** Magnified or Reduced **T:** Real or Virtual

Case 2: If the object is located nearby the lens:



Description of Image:

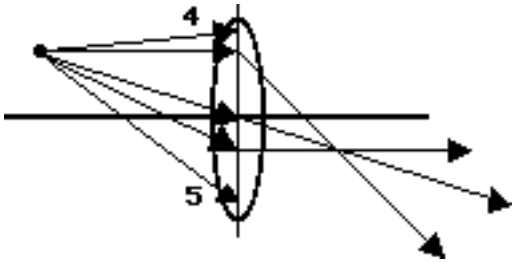
Location: _____

O: Upright or Inverted **S:** Magnified or Reduced **T:** Real or Virtual

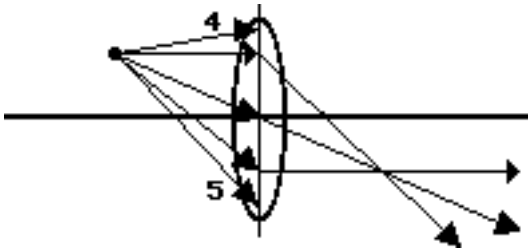
Lenses and Mirrors - Applying Concepts

1. Light emanates in a variety of directions from the following point objects; some of this light is incident towards the mirror or lens. The behavior of a few such incident rays are shown below. Show how the third, fourth and/or fifth incident rays refract or reflect.

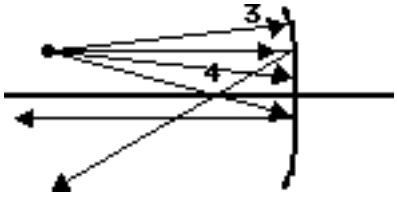
Converging Lens



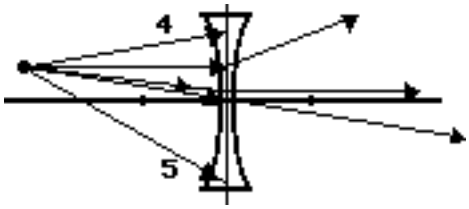
Converging Lens



Concave Mirror



Diverging Lens



2. Several statements about images are given below. Identify which optical device applies to the given statement. Place the appropriate marks in the blanks. Mark all that apply.

A = plane mirrors **B = concave mirrors** **C = convex mirrors**
D = converging lenses **E = diverging lenses**

a. Are capable of producing real images. _____

b. Only produce virtual images. _____

c. Are capable of producing enlarged images. _____

d. Can only produce images which are smaller than the object. _____

e. Capable of producing images the same size as the object. _____

3. Identify the following statements as being either true (**T**) or false (**F**).

a. If reflected or refracted rays diverge, there is no image. _____

b. If an object is located in front of a focal point, there is no image. _____

c. Virtual images cannot be seen. _____

d. All images are formed by the actual convergence of reflected or refracted light. _____

e. Just three rays of light from an object can intersect at the image location. _____

Lens Practice

Read from **Lesson 5** of the **Refraction and Lenses** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/refrn/u14l5f.html

Use the lens equation and magnification equation to solve the following problems.

1. Determine the image distance and image height for a 4.0-cm tall object placed 54.0-cm from a converging lens having a focal length of 18.0 cm.

2. Determine the image distance and image height for a 4.0-cm tall object placed 36.0-cm from a converging lens having a focal length of 18.0 cm.

3. Determine the image distance and image height for a 4.0-cm tall object placed 24.0-cm from a converging lens having a focal length of 18.0 cm.

4. Determine the image distance and image height for a 4.0-cm tall object placed 12.0-cm from a converging having a focal length of 18.0 cm.

5. A magnified, inverted image is located a distance of 32.0 cm from a converging lens with a focal length of 12.0 cm. Determine the object distance and tell whether the image is real or virtual.

6. **ZINGER:** An inverted image is magnified by 2 when the object is placed 22 cm in front of a converging lens. Determine the image distance and the focal length of the lens.

7. A diverging lens has a focal length of -12.8 cm. An object is placed 34.5 cm from the lens's surface. Determine the image distance.

8. Determine the focal length of a diverging lens which produces an image which is 12.9 cm behind the lens when the object is 32.4 cm from the lens.

9. A 2.85-cm diameter coin is placed a distance of 31.4 cm from a diverging lens which has a focal length of -11.6 cm. Determine the image distance and the diameter of the image.

10. The focal point is located 20.0 cm from a diverging lens. An object is placed 12.0 cm from the lens. Determine the image distance.