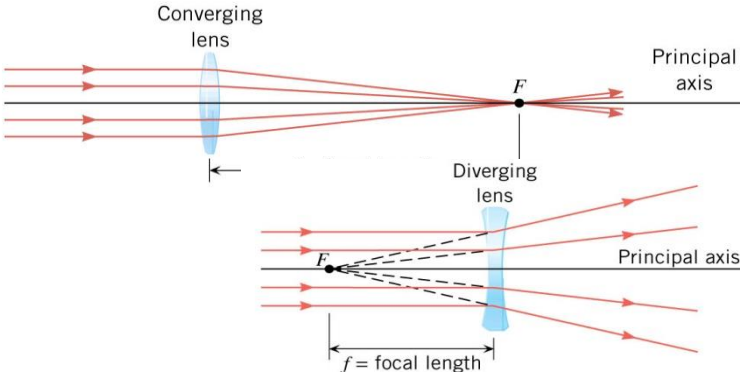
Physics 11-05 Image Formation by Lenses Name: _____

Lenses

- Lens - Made from _____ material, usually with a _____ edge.
- Converging Lens – _____ middle, _____ edge (_____)
- Diverging Lens – _____ middle, _____ edge (_____)
- Power of lens
  - $P = \frac{1}{f}$
  - Unit: _____ (D)

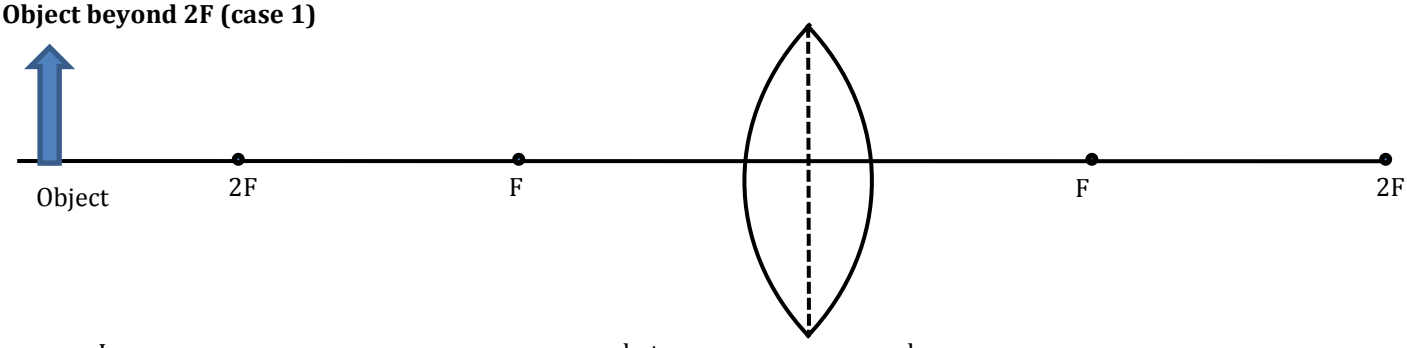


Ray Diagrams

Converging Lenses

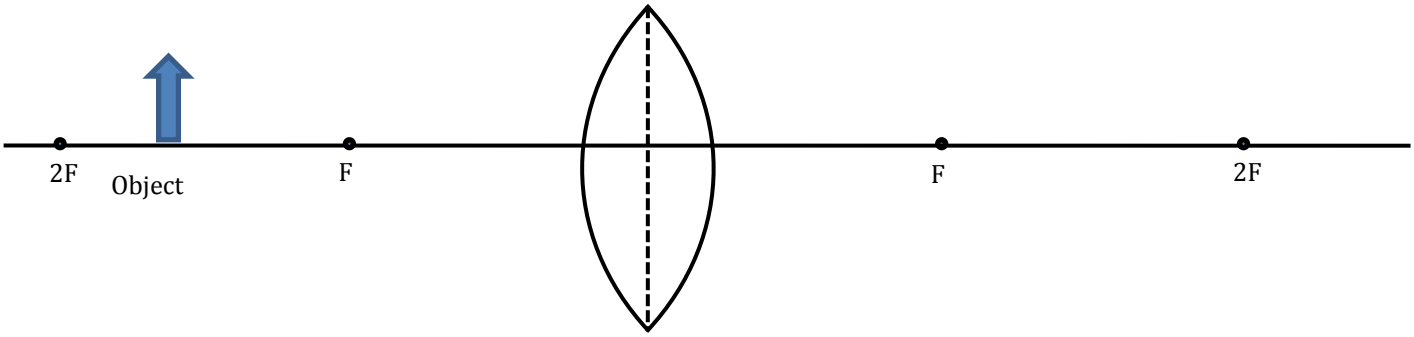
- Ray 1 – _____ to principal _____, bends through _____
- Ray 2 – Through _____, bends _____ to principal axis
- Ray 3 – Goes through _____ of lens, does _____ bend

Object beyond 2F (case 1)



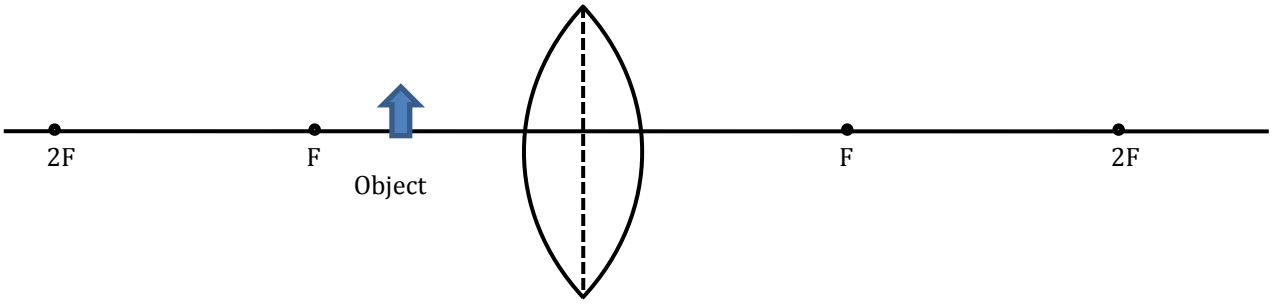
- Image _____, _____, _____, between _____ and _____

Object between F and 2F (case 2)



- Image _____, _____, _____, beyond _____

Object between F and lens (case 3)

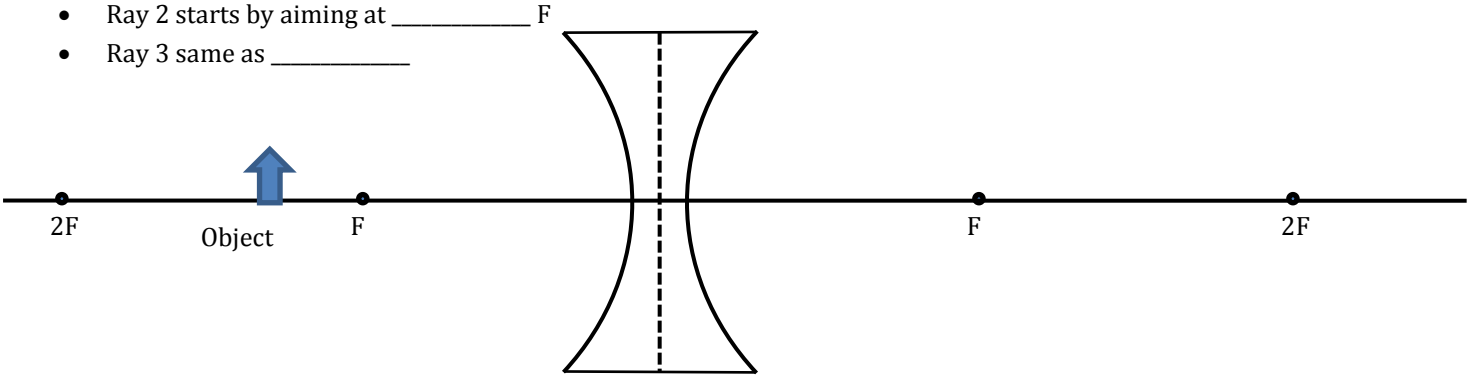


- Image _____, _____, between _____ and _____ on side with _____

Physics 11-05 Image Formation by Lenses Name: _____

Diverging Lens

- Ray 1 now bends _____ from axis so that it looks like it came _____ F
- Ray 2 starts by aiming at _____ F
- Ray 3 same as _____



- Image _____, _____, _____, between _____ and _____

Thin-lens equation

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

- Where f = focal length, d_o = object distance, and d_i = image distance
- Converging Lens
  - f _____
  - d_o _____ if real (left side)
  - d_i _____ if real (right side)
- Diverging Lens
  - f _____
  - d_o _____ if real (left side)
  - d_i _____ if virtual (left side)

Magnification equation

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

Lens Reasoning Strategy

1. Examine the situation to determine that _____ formation by a lens is _____.
2. Determine whether _____ tracing, the _____ lens equations, or _____ are to be employed. A sketch is very _____ even if ray tracing is not specifically required by the problem. Write symbols and values on the sketch.
3. Identify exactly what needs to be _____ in the problem (identify the _____).
4. Make a list of what is _____ or can be _____ from the problem as stated (identify the _____). It is helpful to determine whether the situation involves a case _____, _____, or _____ image. While these are just names for types of images, they have certain characteristics that can be of great use in solving problems.
5. If ray tracing is _____, use the ray tracing _____ listed near the beginning of this section.
6. Most _____ problems require the use of the _____ lens equations.
7. Check to see if the answer is _____: Does it make _____? If you have identified the type of image (case 1, 2, or 3), you should assess whether your answer is _____ with the type of image, magnification, and so on.

A child is playing with a pair of glasses with diverging lenses. The focal length is 20 cm from the lens and his eye is 5 cm from the lens. A parent looks at the child's eye in the lens. If the eye is the object, where is the image located?

If his eye is really 3 cm across, how big does it appear?

Homework

1. When you focus a camera, you adjust the distance of the lens from the film. If the camera lens acts like a thin lens, why can it not be a fixed distance from the film for both near and distant objects?
2. A thin lens has two focal points, one on either side, at equal distances from its center, and should behave the same for light entering from either side. Look through your eyeglasses (or those of a friend) backward and forward and comment on whether they are thin lenses.
3. Will the focal length of a lens change when it is submerged in water? Explain.
4. Your camera's zoom lens has an adjustable focal length ranging from 80.0 to 200 mm. What is its range of powers? (OpenStax 25.37) **12.5 D, 5.00 D**
5. What is the focal length of 1.75 D reading glasses found on the rack in a pharmacy? (OpenStax 25.38) **57.1 cm**
6. How far from the lens must the film in a camera be, if the lens has a 35.0 mm focal length and is being used to photograph a flower 75.0 cm away? Solve using both a ray diagram and the thin lens equation. (OpenStax 25.40) **36.7 mm**
7. A certain slide projector has a 100 mm focal length lens. (a) How far away is the screen, if a slide is placed 103 mm from the lens and produces a sharp image? (b) If the slide is 24.0 by 36.0 mm, what are the dimensions of the image? (OpenStax 25.41) **3.43 m, 80.0 cm × 120 cm**
8. A doctor examines a mole with a 15.0 cm focal length magnifying glass held 13.5 cm from the mole (a) Where is the image? (b) What is its magnification? (c) How big is the image of a 5.00 mm diameter mole? (OpenStax 25.42) **-1.35 m, +10.0, 50.0 mm**
9. A camera lens used for taking close-up photographs has a focal length of 22.0 mm. The farthest it can be placed from the film is 33.0 mm. (a) What is the closest object that can be photographed? (b) What is the magnification of this closest object? (OpenStax 25.45) **6.60 cm, -0.5**
10. Suppose your 50.0 mm focal length camera lens is 51.0 mm away from the film in the camera. (a) How far away is an object that is in focus? (b) What is the height of the object if its image is 2.00 cm high? (OpenStax 25.46) **2.55 m, 1.00 m**
11. (a) What is the focal length of a magnifying glass that produces a magnification of 3.00 when held 5.00 cm from an object, such as a rare coin? (b) Calculate the power of the magnifier in diopters. (c) Discuss how this power compares to those for store-bought reading glasses (typically 1.0 to 4.0 D). Is the magnifier's power greater, and should it be? (OpenStax 25.47) **7.50 cm, 13.3 D, lots stronger**
12. (a) Where is the image that will be produced by a lens of power –4.00 D (such as might be used to correct myopia) if an object is held 25.0 cm away? Solve by using both a ray diagram and the thin lens equation. (b) What is the magnification?(OpenStax 25.48) **-12.5 cm, +0.500**