Kirkuk University

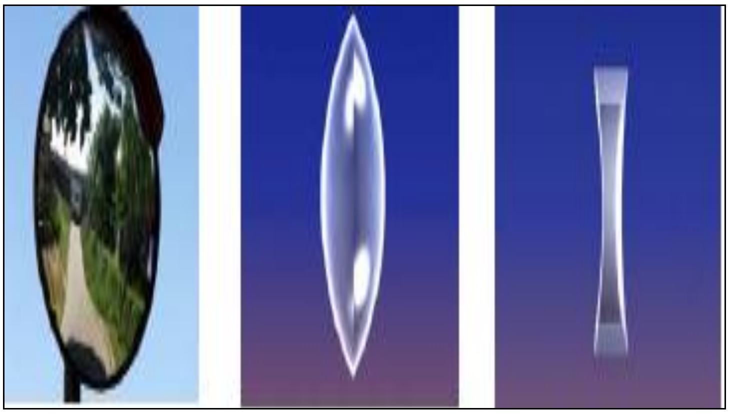
Science College

Physics Department

Lectures of

GEOMETRIC OPTICS

Lecture – 6 –



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Lecture 6: Spherical Mirrors - Convex Mirror – Part (2)

6 – 1 Image Characteristics - Convex Mirror

- Previously in Lecture **3**, ray diagrams were constructed in order to determine the location, size, orientation, and type of image formed by concave mirrors**.**
- The ray diagram constructed for a convex mirror in Lecture **5**, revealed that the image of the object was virtual, upright, reduced in size and located behind the mirror**.**
- But will these always be the characteristics of an image produced by a convex mirror**?** Can convex mirrors produce real images**?** Inverted images**?** Magnified Images**?**
- To answer these questions, we will look at three different ray diagrams for objects positioned at different locations along the principal axis in front of convex mirror, as shown in Fig.(**6-1**).

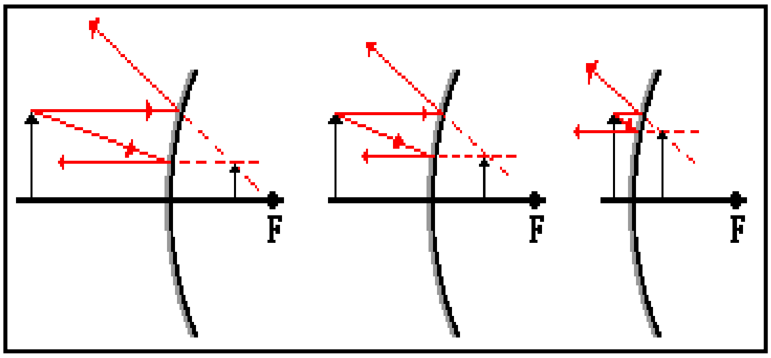

Fig.(6-1) : The three different ray diagrams for objects positioned at different locations along the principal axis in front of convex mirror

- The diagrams above show that in each case, the image is **:-**

1. Located behind the convex mirror**.**
2. A virtual image**.**
3. An upright image**.**
4. Reduced in size (i.e., smaller than the object)**.**

- Unlike concave mirrors, convex mirrors always produce images that share these characteristics**.**
- As such, the characteristics of the images formed by convex mirrors are easily predictable**.**
- Another characteristic of the images of objects formed by convex mirrors pertains to how a variation in object distance affects the image distance and size**.**

- The Fig.(**6-2**) below shows seven different object locations in front of convex mirror and their corresponding image locations**.**

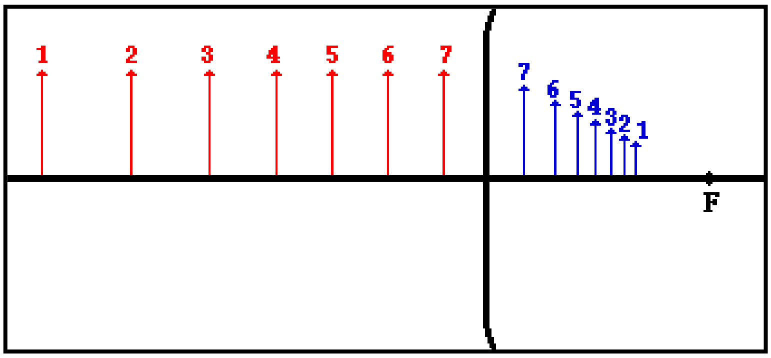

Fig.(6-2) : Seven different object locations in front of convex mirror and their corresponding image locations

- The Fig.(**6-2**) above shows that as the object distance is decreased, the image distance is decreased and the image size is increased**.**
- So as an object approaches the mirror, its virtual image on the opposite side of the mirror approaches the mirror as well; and at the same time, the image is becoming larger**.**

6 – 2 The Mirror Equation - Convex Mirror

- Ray diagrams can be used to determine the image location, size, orientation and type of image formed of objects when placed at a given location in front of a mirror.
- Ray diagrams provide useful information about object-image relationships, yet fail to provide the information in a quantitative form.
- While a ray diagram may help one determine the approximate location and size of the image, it will not provide numerical information about image distance and image size.
- To obtain this type of numerical information, it is necessary to use the **Mirror Equation** and the **Magnification Equation.**
- The mirror equation expresses the quantitative relationship between the object distance (d_o), the image distance (d_i), and the focal length (f).
- The equation is stated as follows that shown in Fig.(**6-3**)**:**

$$\frac{1}{f}=\frac{1}{d_\circ}+\frac{1}{d_i} \quad ...(6-1a) \quad \text{or} \quad \frac{2}{R}=\frac{1}{d_\circ}+\frac{1}{d_i} \quad ...(6-1b)$$

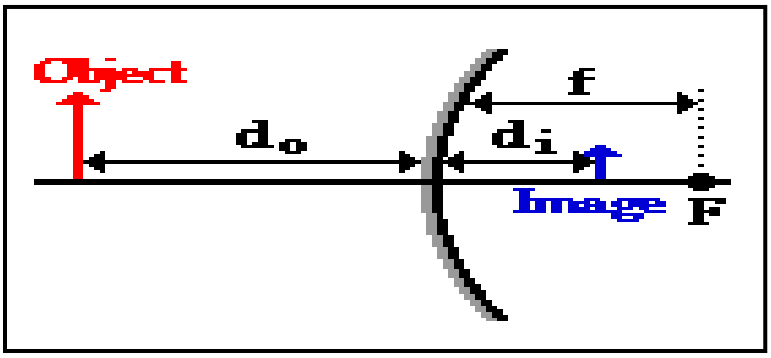

Fig. (6-3): The Variables of Mirror Equation – Convex Mirror

- The magnification equation relates the ratio of the image distance (d_i) and object distance (d_o) to the ratio of the image height (h_i) and object height (h_o).
- The magnification equation is stated as follows **:**

$$M = \frac{h_i}{h_\circ} = -\frac{d_i}{d_\circ} \quad ...(6-2)$$

- These two equations can be combined to yield information about the image distance and image height if the object distance, object height, and focal length are known.
- Their use was demonstrated in Lecture **3** for concave mirrors and demonstrated here for convex mirrors.
- As a demonstration of the effectiveness of the mirror equation and magnification equation, consider the examples problems and its solution in the next lecture.

6 – 3 The +/- Sign Conventions – Convex Mirror

- The sign conventions for the given quantities in the mirror equation and magnification equations are as follows:

- (f) is $(-)$ if the mirror is a convex mirror.
- (d_i) is $(-)$ if the image is a virtual image and located behind the mirror.
- (h_i) is $(+)$ if the image is an upright image (and therefore, also virtual).
- (R) is $(-)$ if center of curvature is in back of mirror (convex mirror).
- (M) is $(+)$, image is upright.