**BAL BHARATI PUBLIC SCHOOL, PITAMPURA, DELHI – 110034**

**SUBJECT:-PHYSICS**

**CHAPTER- LIGHT – REFLECTION and REFRACTION**

**GUIDELINES:**

Dear Students,

- There is only **1 Assignment** :

  Assignment 5: Based on Mirror formula and Magnification, Sign convention for Reflection by spherical mirrors

- Complete the Assignment in the Physics Notebook.
- **Video links** have been provided for better understanding of the concept through visuals. Watch the videos carefully as these will help you in doing the assignment.
- Read the lesson from **NCERT textbook** also.
- Link for the lesson :- http://ncert.nic.in/textbook/pdf/jesc110.pdf (page no. 168 to 171)

**SUB TOPICS:**

1. **Sign convention for Reflection by Spherical mirrors**
2. **Mirror formula and Magnification.**

**Let's begin the journey of learning:**

## 1. SIGN CONVENTION FOR REFLECTION BY SPHERICAL MIRRORS

The following sign convention called the ***New Cartesian Sign Convention*** is used while dealing with reflection of light by spherical mirrors. Please note that the pole of the mirror is taken as origin and distance is measured from the pole of the mirror. The x- axis of the coordinate system is taken as the principle axis of the mirror. The conventions are as follows:

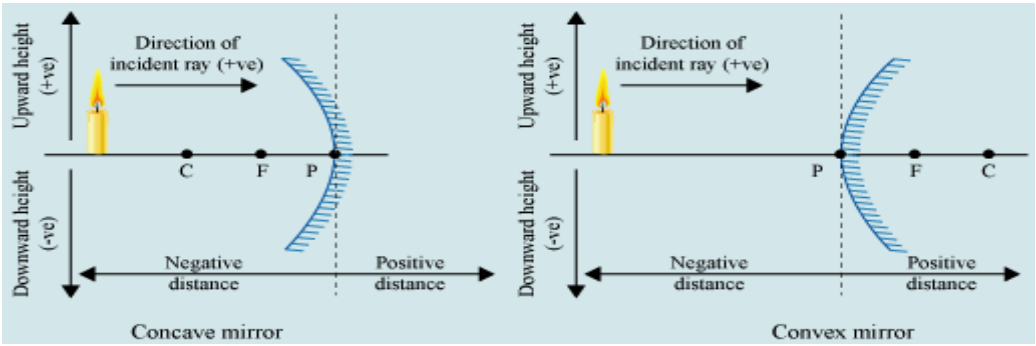
(i) The object is always placed to the left of the mirror. That means light from the object i.e. incident ray falls on the mirror from the left side.

(ii) Distance measured in the direction of incident ray i.e. to the right of origin (along positive x- axis) is taken as positive.

(iii) Distance measured in the direction opposite to that of incident ray i.e. to the left of origin (along negative x- axis) is taken as negative.

(iv) Distance measured perpendicular to and above the principle axis (along positive Y- axis) is taken as positive.

(v) Distance measured perpendicular to and below the principle axis (along negative Y- axis) is taken as negative.



## 2. MIRROR FORMULA and MAGNIFICATION

**MIRROR FORMULA:**

Let us understand the following terms:

(a) **Object Distance (u):** It is the distance of object from the pole of the spherical mirror.
(b) **Image Distance (v):** It is the distance of image from the pole of the spherical mirror.
(c) **Focal length (f):** Distance of principle focus from the pole of the spherical mirror.

**Mirror formula is the relation between Object distance (u), Image distance (v) and Focal length (f).**

(a) The mirror formula is:

(1/object distance) + (1/image distance) = (1/focal length)

i.e. 1/u + 1/v = 1/f.

The above formula is applicable for both concave and convex mirror in all situations for all positions of the object.
It is important to note that while using the mirror formula for solving problems, you must use the ***New Cartesian Sign Convention*** while putting the numerical values for u, v, f and R in the formula.

(b) U, V and f are three terms. Out of these three terms, if the numerical values of any of the two terms are given in the problem, the numerical value of the unknown term can be obtained. Following rule must be followed:

- The numerical values of known terms should be used with proper signs as per ***New Cartesian Sign Convention.***
- While solving the numerical problem, no sign should be attached to the unknown term. Its sign will come on its own after calculation.

**MAGNIFACTION (m)**

- It is ratio of the height of image to the height of the object. It is denoted by letter m.

- If h' is the height of the image and h is the height of the object,
  m = height of image/height of object
  m = h'/h

- Magnification has no unit.

- Magnification can also be expressed in terms of object distance (u) and image distance (v). The expression is
  m = - v/u.

**<u>Significance of SIGN of Magnification:</u>**

The object is always placed above the principle axis therefore as per sign convention, **height of object (h) is always positive.**
Since m = h'/h
Therefore Sign of magnification (m) depends on the sign of the height of the image (h').

- For **VIRTUAL IMAGE**, height of image **(h') is positive** (virtual images are always erect), therefore **magnification (m) is positive.**
- For **Real IMAGE**, height of image **(h') is negative** (real images are always inverted), therefore **magnification (m) is negative.**

**Signification of MAGNITUDE of Magnification:**

- ***When magnitude of magnification is less than 1: (m<1)***

  $m < 1$
  $h'/h < 1$
  $h' < h$

  i.e. if the magnitude of magnification is less than 1, the **height of image is less than the height of the object.**

- ***When magnitude of magnification is equal to 1: (m=1)***

  $m = 1$
  $h'/h = 1$
  $h' = h$

  i.e. if the magnitude of magnification is equal to 1, the **height of the image is equal to the height of the object.**

- **When magnitude of magnification is greater than 1: (m>1)**

  $m > 1$
  $h'/h > 1$
  $h' > h$

  i.e. if the magnitude of magnification is greater than 1, the **height of the image is greater than the height of the object.**

**NOTE:**

- If magnification is negative, mirror is always concave in nature.
- If magnification is positive, mirror can be Plane, convex or concave in nature.
  For this check the magnitude of magnification (m)
  - If the magnitude of m < 1, mirror is always convex in nature.
  - If magnitude of m = 1, mirror is always Plane in nature.
  - If magnitude of m > 1, mirror is always concave in nature.

**SOME SOLVED PROBLEMS ON MAGNIFICATION & MIRROR FORMULA FOR BETTER UNDERSTANDING:**

**Q.1** The magnification of plane mirror is + 1. What does it mean?

Ans. +sign means image is virtual and erect and numerical value 1 means the height of the image is the same as that of the object.

**Q.2** The magnification of a mirror is -1. Identify the mirror.

Ans. Concave Mirror. Negative sign means image is real and inverted. Out of the three mirrors (Plane, Concave and Convex), only Concave Mirror forms real and inverted image.

**Q.3** The magnification of mirror is:

(a) + 0.5 and (b) +2.5

Identify the mirrors.

Ans. (a) + sign means image is virtual and erect.

Numerical value 0.5 means magnitude of magnification is less than one, means h'<h. Therefore mirror is Convex in nature.

(b) + sign means image is virtual and erect.

Numerical value 2.5 means magnitude of magnification is greater than one, means h'>h. Therefore mirror is Concave in nature.

**Q.4** The height of an object is 4 cm. The magnification produced by a mirror is +2. What is the height of the image?

Ans. h= +4 cm. Now m=h'/h, therefore 2 =h'/h

h'= 2 h = 2 x 4 =+ 8 cm.

**Q.5** A concave mirror produces two times magnified real image of an object placed at 10 cm in front of it. What are the possible values of the position of the image?

Ans. u= -10 cm

Since the image is real, therefore m=-2

We have m= - v/u.

-2 = - v/(-10) Therefore v= - 20 cm.

**Q.6** A concave mirror produces three times magnified image of an object placed at 15 cm in front of it. What are the possible values of the position of the image?

Ans. u= -15 cm. v=??

There are two possible cases:

**Case I:** When the *image formed is real.*

We have m= - v/u. Now here m = -3 (because the image is real)

-3 = - v/(-15)

v= - 45 cm.

**Case II:** When the *image formed is virtual.*

We have m= - v/u. Now here m = +3 (because the image is virtual)

+3 = - v/(-15)

v= -+45 cm.

**Q.7** Magnification of image produced by a spherical mirror is + 2/3.

State (a) the type of mirror and (ii) position of the object with respect to the pole of the mirror. Also draw the ray diagram to justify your answer.

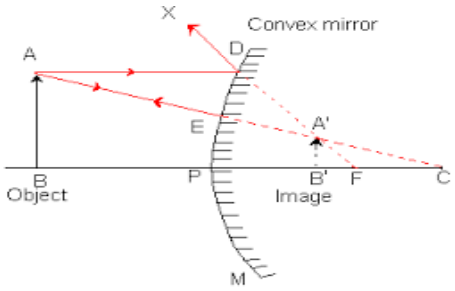
Ans. (a) Sign of magnification is positive, therefore nature of image is virtual.

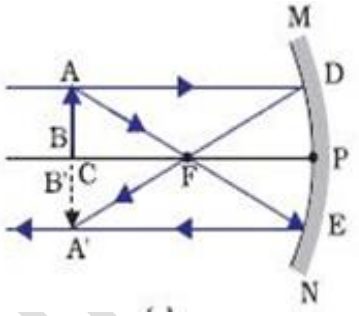
Also magnitude of magnification is less than 1 means h'<h.

Since image is virtual and smaller in size, therefore mirror is **convex in nature.**

b) Since it is a convex mirror, therefore position of the image is between pole and focus.

Ray diagram:




**Q.8** Magnification of image produced by a spherical mirror on the screen is 1.
State the type of mirror. Also draw ray diagram to justify your answer.

Ans. Image is formed on the screen, therefore it is a **real image**
Also, magnitude of magnification is 1, i.e. equal to 1 means h'=h.
Since image is real and of same size, therefore the mirror is **concave in nature.**

**Q.9** Consider three concave mirrors X, Y and Z of focal length 10 cm, 20 cm and 30 cm. For each concave mirror, you perform the experiment of image formation for three values of object distance of 10 cm, 15 cm and 20 cm.
For the three object distances, identify the mirror/mirrors which will form an image of magnification -1.

Ans. Magnification is -1 only when the image is real, inverted and of same size. This can be possible only when the object lies at the Centre of curvature. Hence for the object distance 20 cm, concave mirror X will form real, inverted and same sized image.
Therefore for mirror X, magnification is -1.

**Q.10** A convex mirror used for rear-view on an automobile has a radius of curvature of 3 m. If a bus is located at 5 m from this mirror, find the position, nature and size of the image.

Ans. R = 3 m, therefore f = 3/2 = 1.5 m

(1/f) = (1/v) + (1/u) or (1/v) = (1/f) – (1/u)

(1/v) = (1/1.5) + (1/5), therefore v = + 1.15 m

Magnification, m = h' / h = -v/u = - (1.15/-5) = + 0.23

The image is virtual, erect and smaller in size.

## ASSIGNMENT 5

Q.1 Magnification produced by a Concave mirror may be

(a) less than 1 (b) more than 1 (c) equal to 1 (d) all of these

Q.2 Magnification produced by a convex mirror is always

(a) less than 1 (b) more than 1 (c) equal to 1 (d) all of these

Q.3 Keeping in mind the New Cartesian Sign Convention, give the sign for height of a virtual image.

Q.4 What is the nature of the image formed by a concave mirror if the magnification produced by the mirror is -4?

Q.5 The linear magnification produced by a spherical mirror is – 1/3.

State (a) the type of mirror and (ii) the position of the object with respect to the pole of the mirror. Also draw the ray diagram to justify your answer.

Q.6 A concave mirror of focal length 15 cm forms an image of an object kept at a distance of 10 cm from the mirror. Find the position, nature and size of the image formed.

Q.7 If p. q, r denote the object distance, image distance and the radius of curvature respectively of a spherical mirror, then prove that r= 2pq/(p+q).

Q.8 An object is placed 40 cm in front of a concave mirror of focal length 20 cm. A plane mirror is placed at a distance of 10 cm in front of the concave mirror. Find the final position of the image.

Q.9

| Concave mirror | Object distance (in cm) | Focal length (in cm) |
|---|---|---|
| 1 | 10 | 15 |
| 2 | 20 | 10 |
| 3 | 30 | 20 |

(i) Out of the three, in which case will the mirror form the image which has the same size as the object?

(ii) Which mirror is being used as a shaving mirror?

(iii) Draw the ray diagram for part (i).

Q.10 The image of an object formed by a mirror is real, inverted and of magnification – 1.

(a) If the image is at a distance of 40 cm from the mirror, where is the object placed?

(b) Where would the image be if the object is moved 20 cm towards the mirror?

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**NOTE:** For Better understanding, kindly go through the **video link** given below:

Sign convention, Magnification and Mirror Formula : https://youtu.be/hiiWMPTWyUw