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# Mirror formula (continue)

XII- SCIENCE

**SUBJECT : PHYSICS**
**CHAPTER NUMBER: 9**
**CHAPTER NAME : RAY OPTICS**



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# NUMERICALS ON MIRROR FORMULA

**Question-1:**

An object is placed (i) 10 cm (ii) 5 cm in front of a concave mirror of radius of curvature 15 cm. Calculate the position, nature and magnification of the image in each case.

# NUMERICALS ON MIRROR FORMULA

**Question-1:**An object is placed (i) 10 cm (ii) 5 cm in front of a concave mirror of radius of curvature 15 cm. Calculate the position, nature and magnification of the image in each case.

**Solution:**

(i) Here, f = focal length = —15/2 cm = — 7.5 cm

u object distance = — 10 cm

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\frac{1}{-7.5} = \frac{1}{v} + \frac{1}{-10}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{7.5}$$

$$v = -30\ cm$$

Since v is negative, the image is real and is 30 cm from the mirror on the object side (i.e., in front of the mirror).

# NUMERICALS ON MIRROR FORMULA

**Solution:**

Magnification, $m = -\frac{v}{u} = -3$

Thus, the image is magnified and inverted.

(ii) Here, u = — 5 cm

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\frac{1}{-7.5} = \frac{1}{v} + \frac{1}{-5}$$

$$\frac{1}{v} = \frac{1}{5} - \frac{1}{7.5}$$

$$v = 15\ cm$$

Since v is positive, the image is virtual and is 15 cm at the back of the mirror (i.e., not on the object side).

Magnification, $m = -\frac{v}{u} = +3$

Thus, the image is magnified and erect.

# NUMERICALS ON MIRROR FORMULA

- **Question-2:**

A small candle 2.5 cm in size is placed 27 cm in front of a concave mirror of radius of curvature 36 cm. At what distance from the mirror should a screen be placed in order to receive a sharp image? Describe the nature and size of the image. If the candle is moved closer to the mirror, how would the screen have to be moved?

**Solution:** *u*=-27 cm, *R* = - 36 cm, *f*= R/2 = -18 cm, O = 2.5 cm

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{-18} - \frac{1}{-27}$$

$$v = -54\ cm$$

# NUMERICALS ON MIRROR FORMULA

**Solution:**

As *v* is negative, the image is formed on the same side as the object. Thus, the screen should be placed at a distance of 54 cm from the mirror on the same side as the object.

$$\frac{I}{O} = -\frac{v}{u}$$

$$\frac{I}{2.5} = -\frac{-54}{-27}$$

$$I = -5\ cm$$

Negative sign indicates that the image is inverted, realand magnified. When the candle is moved closer to the mirror, the image moves away from the mirror and as such the screen has also to be moved away from the mirror. Once the candle crosses the focus (i.e., the distance becomes less than f), the image formed would be virtual and hence cannot be obtained on the screen.

# NUMERICALS ON MIRROR FORMULA

- **Question-3:**A 4.5 cm needle is placed 12 cm away from a convex mirror of focal length 15 cm. Give the location of the image and the magnification. Describe what happens as the needle is moved farther from the mirror.

**Solution:** *u* = - 12 cm,*f*= 15 cm, O = 4.5 cm

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{+15} - \frac{1}{-12}$$

$$v = 6.7cm$$

Positive value of *v* indicates that the image is virtual and is formed behind the mirror.

# NUMERICALS ON MIRROR FORMULA

**Solution:**

Magnification, $m = \frac{I}{O} = -\frac{v}{u} = \frac{20/3}{-12} = \frac{5}{9}$

Also, $I = \frac{5}{9}(4.5) = 4.5\ cm$

Thus, the size of the image is reduced.

As the needle moves farther from the mirror, the image moves towards the focus but never crosses it. Itgoes on diminishing in size.

**Note:** When $u = \infty$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{\infty}$$

$$v = f$$

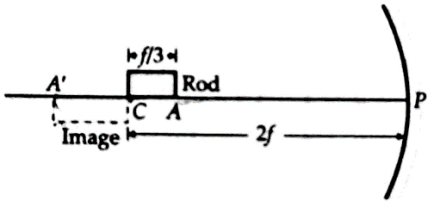
Since *u* cannot be greater than ∞, *v* cannot be more than *f*.

As $m = -\frac{v}{u}$, with increasing *u*, *m* decreases in magnitude.

As $u \to \infty, m \to 0$

# NUMERICALS ON MIRROR FORMULA

- **Question-4:** A thin rod of length f/3 is placed along the optic axis of a concave mirror of focal length f such that its image which is real and elongated, just touches the rod. What will be the magnification?
- **Solution**: The image of the rod placed along the optical axis will touch the rod only when one end of the rod AC is at the centre of curvature of the concave mirror (PC =2f, AC = f/3). Then the image of the end C of the rod will be formed at the same point C.



# NUMERICALS ON MIRROR FORMULA

For the end A of the rod,

*u= PA= PC-AC =2f-(f/3) =5f/3*

From mirror formula,

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$$

$$\frac{1}{v}=\frac{1}{f}-\frac{3}{5f}$$

$$v=\frac{5f}{2}$$

PA'=5f/2

Length of the image = *A'C = PA'-PC = 5f/2 -2f=f/2*

Magnification =*CA'/CA=(f/2)/(f/3)=1.5*

# NUMERICALS ON MIRROR FORMULA

**Question-5:** If you sit in a parked car, you glance in the rear-view mirror R=2m and notice a jogger approaching. If the jogger is running at a speed of 5 m/s, how fast is the image of the jogger moving when the jogger is(a) 39 m (b) 29 m (c) 19 m (d) 9 m away?

# NUMERICALS ON MIRROR FORMULA

**Question-5:** If you sit in a parked car, you glance in the rear-view mirror R=2m and notice a jogger approaching. If the jogger is running at a speed of 5 m/s, how fast is the image of the jogger moving when the jogger is(a) 39 m (b) 29 m (c) 19 m (d) 9 m away?

**Solution:** As the rear-view mirror is convex,

so R=+2 m, f = R/2 =+1m

Froth mirror formula,

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

When u=-39m, v=39/40 m

As the jogger moves at a constant speed of 5m/s the position of the jogger after 1s,

u = -39+5 = -34 m

Position of the image after 1 s,

v'= (34/35) m

Difference in the position of the image in 1 s is

v - v' = 1/280 m

Average speed of the image = (1/280) m/s

Similarly, for u = -29 m, -19 m and 9 m, the speeds of image will be

(1/150) m/s, (1/60) m/s and (1/10) m/s.

# THANKING YOU

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