Unit 14 · Reflection at Curved Mirrors

HARDER PRACTICE QUESTIONS

Full marks 34

Write your answers on separate paper. Show your working. Use the "real is positive" sign convention: real objects and images positive, virtual ones negative; f positive for a concave mirror, negative for a convex one.

1 Spot the error [3]

Find the mistake in the working and correct it.

Nishant was asked: "An object is 30 cm in front of a convex mirror of radius of curvature 40 cm. Find the image." He wrote:
"f = R/2 = 20 cm. 1/v = 1/f − 1/u = 1/20 − 1/30 = 1/60, so v = **60 cm**: a real image, 60 cm in front of the mirror, twice the size."

2 Work backwards [4]

A concave mirror forms a real image three times as tall as an object. When the object is moved 5 cm farther from the mirror, the real image is only twice as tall.

i. Show that, for a real image of magnification m, the object distance is $u = f(m + 1)/m$.
ii. Find the focal length of the mirror and the two object distances.

3 Check the readings [4]

Sneha measured the object and image distances for a concave mirror with a candle and a screen.

u (cm)	20	25	30	40	50
v (cm)	59.5	45.0	30.4	23.8	21.5

i. Copy the table and add a row for $1/u + 1/v$ (in cm^{-1}).
ii. Find the focal length of the mirror.
iii. One reading does not fit. Which one, and what should v have been?
iv. Suggest how she might have made that mistake.

4 Predict, then explain [3]

Write your prediction first, then explain it.

An object moves along the axis of a concave mirror of focal length 20 cm, from 60 cm to 40 cm from the mirror, in 2 s. Predict whether the image moves towards or away from the mirror, and whether it moves faster or slower than the object. Then check with the mirror formula.

5 Show that [3]

Using the mirror formula, show that a real object placed between the focus and the center of curvature of a concave mirror always gives a real, inverted and enlarged image beyond the center of curvature.

6 How near is near enough? [3]

A small reflecting telescope has a concave mirror of focal length 1.2 m. It is pointed at a tower 30 m tall, 3.0 km away.

i. Find the image distance, and show that the image is practically at the focus.
ii. How tall is the image?

7 A real setting [4]

A convex mirror of focal length 1.0 m stands on a blind bend. A bus 3.0 m tall comes towards it, first 20 m away and then 5.0 m away.

i. Find the height of the image at each distance.

ii. The bus came 4 times closer. By what factor did its image grow?

iii. Use your answer to explain why drivers find it hard to judge distance in a convex mirror.

8 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

Riya wrote: “A convex mirror has a positive focal length, because its focus is behind it. If you put a concave mirror under water its focal length gets longer, as a lens's does. A real image is always upright, because the light really reaches it.”

9 Design it [3]

Kriti wants a make-up mirror that shows her face upright and twice as big when she holds it 20 cm away. What kind of mirror, and what radius of curvature, should she buy? Would it still work if she held it 50 cm away?

10 Think [2]

A torch has a lamp at the focus of its reflector. Why does a wide **spherical** reflector give a beam that spreads, while a **parabolic** one gives a beam that stays narrow?

11 Make your own [2]

Write a problem about a concave mirror whose answer is “the object must be 10 cm from the mirror”, with an image that is virtual. Solve it to show it works.