

Exercise walk-through

13.2

Images Formed by Mirrors

AP Physics 2

Images formed by mirrors

Mirror equation

$$\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}, \quad m = -\frac{s_i}{s_o}$$

- **real** ($s_i > 0$): can be projected on a screen
- **virtual** ($s_i < 0$): only appears behind the mirror
- $m < 0$ inverted; $|m| > 1$ enlarged

Worked example

Object 30 cm, concave $f = 10$ cm:

$$\frac{1}{30} + \frac{1}{s_i} = \frac{1}{10} \Rightarrow s_i = 15 \text{ cm}$$

$$m = -\frac{15}{30} = -0.5$$

Real, inverted, half size.

Mirrors, and the number that bends light

Concave mirror

A **concave mirror** curves inward and converges light: a real inverted image beyond the focal point, a virtual upright one inside it.

Convex mirror

A **convex mirror** curves outward and diverges light – always a virtual, upright, reduced image, which is why it is used for a wide view.

The equation

$\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}$, with $f = R/2$ and a sign convention that decides real from virtual.

Index of refraction

The **index of refraction** $n = c/v$ says how much slower light travels in the material – and Snell's law $n_1 \sin \theta_1 = n_2 \sin \theta_2$ follows from it.

Draw two principal rays. The intersection is the image; whether the rays actually meet there decides real against virtual.

Exercises 2.1-2.3

2.1 An object is 20 cm from a concave mirror of focal length 10 cm. Find the image distance. [2]

2.2 State whether a plane mirror forms a real or a virtual image. [1]

2.3 Find the magnification when $s_i = 15$ cm and $s_o = 30$ cm. [2]

Exercises 2.1-2.3

2.1 An object is 20 cm from a concave mirror of focal length 10 cm. Find the image distance. [2]

2.1

- $\frac{1}{s_i} = \frac{1}{10} - \frac{1}{20} = \frac{1}{20} \Rightarrow s_i = 20 \text{ cm}$

2.2 State whether a plane mirror forms a real or a virtual image. [1]

2.2

- virtual

2.3 Find the magnification when $s_i = 15 \text{ cm}$ and $s_o = 30 \text{ cm}$. [2]

2.3

- $m = -\frac{s_i}{s_o} = -\frac{15}{30} = -0.5$

Exercise 3.1

3.1 The mirror equation is

[1]

☐

A $\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}$

B $s_o + s_i = f$

C $s_o s_i = f^2$

D $s_i - s_o = f$

Exercise 3.1

3.1 The mirror equation is

[1]

- ☐ **A** $\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}$
- B** $s_o + s_i = f$
- C** $s_o s_i = f^2$
- D** $s_i - s_o = f$

3.1 A

• $\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}.$

Exercise 3.2

3.2 A virtual image formed by a mirror is

[1]

☐

A in front of the mirror and inverted

B behind the mirror and upright

C always at the focus

D always larger than the object

Exercise 3.2

3.2 A virtual image formed by a mirror is

[1]

☐

A in front of the mirror and inverted

B behind the mirror and upright

C always at the focus

D always larger than the object

3.2 B

- behind the mirror and upright.

Exercise 3.3 (a)

3.3 An object is placed 24 cm from a concave mirror of focal length 8.0 cm.

(a) Find the image distance.

[3]

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(a) Find the image distance.

[3]

(a)

$$\bullet \quad \frac{1}{s_i} = \frac{1}{8.0} - \frac{1}{24} = \frac{3 - 1}{24} = \frac{1}{12} \Rightarrow s_i = 12 \text{ cm}$$

Exercise 3.3 (b)

3.3 An object is placed 24 cm from a concave mirror of focal length 8.0 cm.

(b) State whether the image is real or virtual.

[1]

Exercise 3.3 (b)

3.3 An object is placed 24 cm from a concave mirror of focal length 8.0 cm.

(b) State whether the image is real or virtual.

[1]

(b)

- real ($s_i > 0$)