

Reflection, refraction and images from mirrors and lenses

AP Physics 2 (algebra-based) · Worksheet

Name: _____ Date: _____ Class: _____

These 20 problems cover geometric optics for AP Physics 2: the law of reflection, Snell's law, total internal reflection, images from mirrors and lenses, and magnification. They start with recall and single steps and end with design and explanation tasks. They suit AP students as well as GCSE, IGCSE and A Level learners meeting ray diagrams. Always draw a sketch and write the sign of each distance.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 13

Problem 1 Law of reflection (easy)

A ray strikes a plane mirror at 35° to the normal.

1. State the angle of reflection.
2. Calculate the angle between the ray and the mirror surface.
3. Calculate the angle between the incident and reflected rays.

Problem 2 Refractive index (easy)

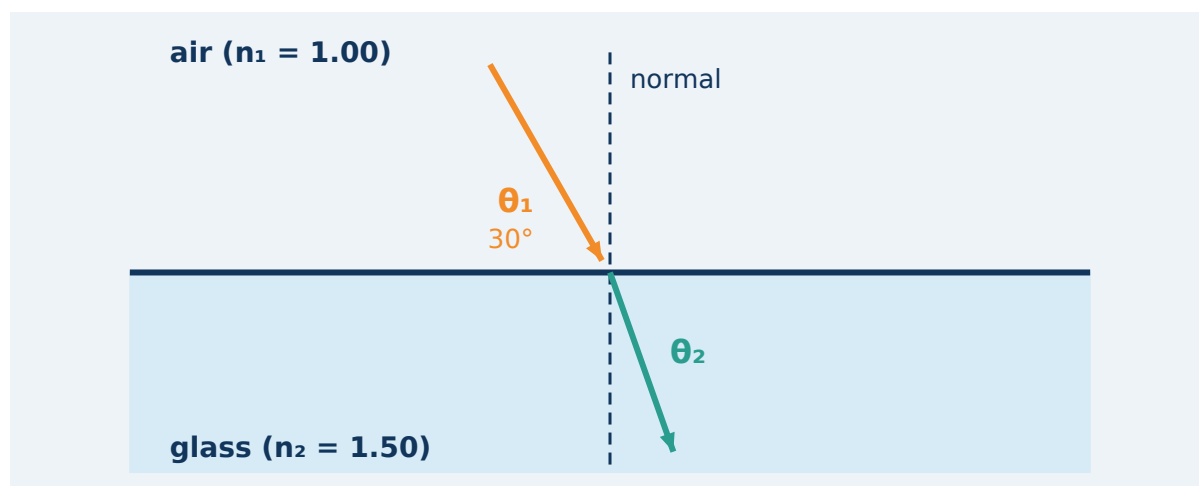
Light travels at 2.00×10^8 m/s in a glass. Use $c = 3.00 \times 10^8$ m/s.

1. Calculate the refractive index of the glass.
2. Calculate the speed of light in water of index 1.33.

Problem 3 Air to glass (easy)

A ray in air strikes glass ($n = 1.50$) at 30° to the normal.

1. Calculate the angle of refraction.
2. State whether the ray bends towards or away from the normal.



Incident ray at 30° in air.

Problem 4 Image in a plane mirror (easy)

Aarav in Pune stands 1.2 m in front of a plane mirror.

1. State the distance from the mirror to his image.
2. Calculate the distance between him and his image.
3. He walks towards the mirror at 0.50 m/s. Calculate the speed at which he approaches his image.

Problem 5 Focal length of a mirror (easy)

A concave mirror has a radius of curvature of 40 cm.

1. Calculate its focal length.
2. State the sign of f in the mirror equation.

Problem 6 Lens facts (easy)

State:

1. the sign of f for a converging lens
2. the type of image formed when an object is beyond $2f$ of a converging lens
3. the type of image always formed by a diverging lens of a real object

Problem 7 Magnification (easy)

An image is 3.0 cm tall and the object is 1.5 cm tall.

1. Calculate the size of the magnification.
2. Give the value of m if the image is inverted.

Problem 8 Real image from a lens (medium)

A converging lens has $f = 15$ cm. An object is 45 cm from the lens.

1. Calculate the image distance.
2. Calculate the magnification.

3. Describe the image.

Problem 9 Magnifying glass (medium)

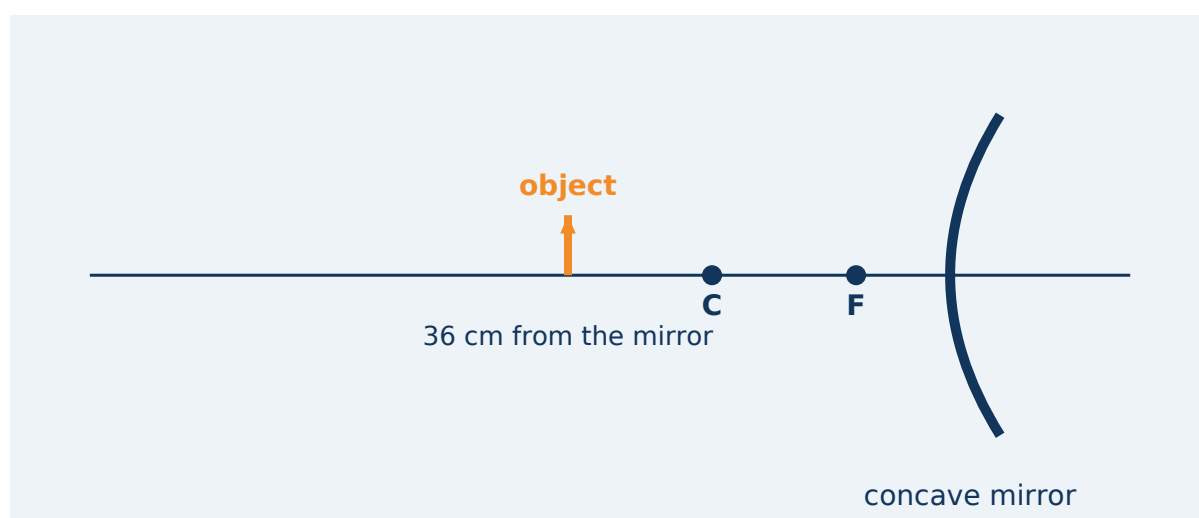
A converging lens of $f = 10$ cm is used as a magnifier with the object 6.0 cm away.

1. Calculate the image distance.
2. Calculate the magnification.
3. State whether the image is real or virtual.

Problem 10 Concave mirror (medium)

A concave mirror has $f = 12$ cm. An object is 36 cm from it.

1. Calculate the image distance.
2. Calculate the magnification.
3. State whether the image can be projected on a screen.



Mirror and object for this problem.

Problem 11 Convex mirror (medium)

A convex mirror has $f = -20$ cm. A car is 60 cm from the mirror (model scale).

1. Calculate the image distance.
2. Calculate the magnification.
3. Explain why convex mirrors are used as wide-view mirrors.

Problem 12 Critical angles (medium)

Calculate the critical angle for light going from:

1. diamond ($n = 2.42$) to air
2. water ($n = 1.33$) to air
3. State which material traps light more easily.

Problem 13 Refraction data (medium)

Wanjiru in Nairobi measures angles for a glass block.

Angle of incidence ($^\circ$): 10, 20, 30, 40, 50

Angle of refraction ($^\circ$): 6.7, 13.2, 19.5, 25.4, 30.7

1. Calculate $\sin \theta_1 / \sin \theta_2$ for the last row.
2. Explain how a graph of $\sin \theta_1$ against $\sin \theta_2$ gives n .
3. State the refractive index.

Problem 14 Water to air (medium)

A ray in water ($n = 1.33$) strikes the surface at 30° to the normal.

1. Calculate the angle at which it leaves into air.
2. State whether it bends towards or away from the normal.

Problem 15 Slide projector (medium)

A projector lens has $f = 8.0$ cm. The screen is 240 cm from the lens.

1. Calculate the distance from the slide to the lens.
2. Calculate the magnification.
3. Calculate the image height for a 24 mm slide.

Problem 16 Camera focusing (hard)

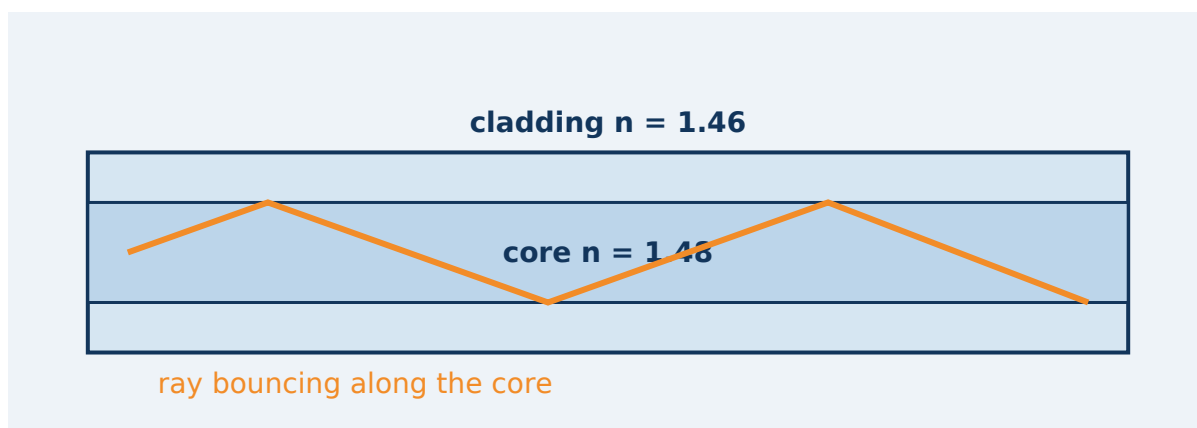
A camera lens has $f = 50$ mm. It is focused on a distant object, then on an object 2.0 m from the lens.

1. State the image distance for the distant object.
2. Calculate the image distance for the object at 2.0 m.
3. Calculate how far the lens moves.

Problem 17 Optical fibre (hard)

A fibre has a core of $n = 1.48$ and cladding of $n = 1.46$.

1. Calculate the critical angle at the core-cladding boundary.
2. Calculate the largest angle a ray in the core can make with the fibre axis and still be totally reflected.



A ray trapped in the core.

Problem 18 Mirror image changes (hard)

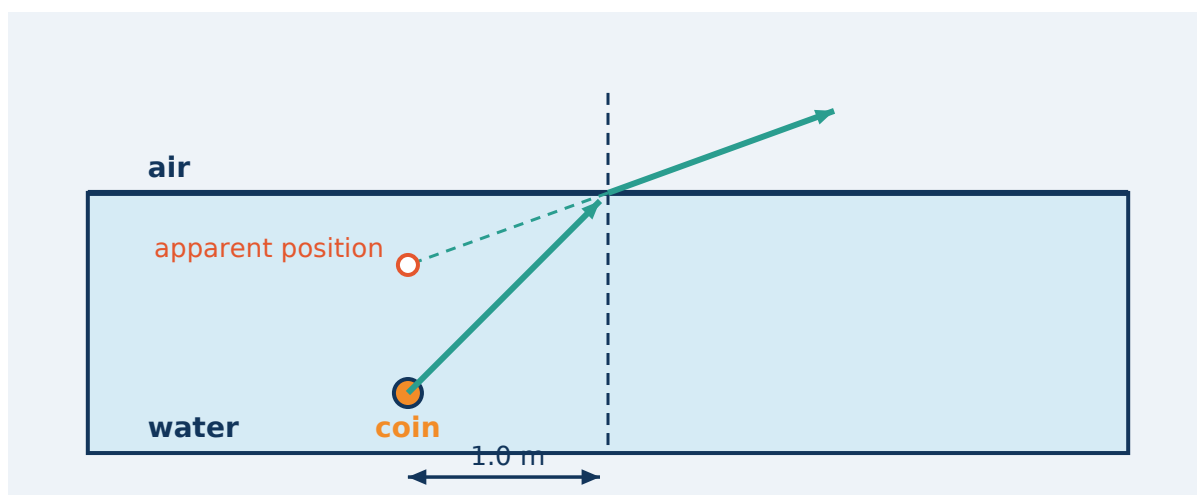
A concave mirror has $f = 15$ cm. A 3.0 cm tall object is placed 20 cm from it, then moved to 10 cm.

1. Calculate the image distance and height for each position.
2. State how the nature of the image changes.

Problem 19 Coin in a pool (hard)

A coin lies on the bottom of a pool 1.0 m deep. A ray leaves it and reaches the surface at a point 1.0 m horizontally away. Use $n = 1.33$ for water.

1. Calculate the angle of incidence in the water.
2. Calculate the angle of refraction in air.
3. Explain why the coin appears shallower.



The eye sees the coin along the bent ray.

Problem 20 Spot the errors (hard)

A student writes: (i) "Light speeds up and bends away from the normal when it enters glass."
(ii) "A diverging lens can form a real image of a real object."

1. Correct statement (i).

2. Correct statement (ii) and calculate d_i and m for $f = -10$ cm and $d_o = 30$ cm.