CAMBRIDGE IGCSE™ PHYSICS 0625 | TOPICS 3.2 · 3.3

FREE SAMPLE

Light & the Electromagnetic Spectrum

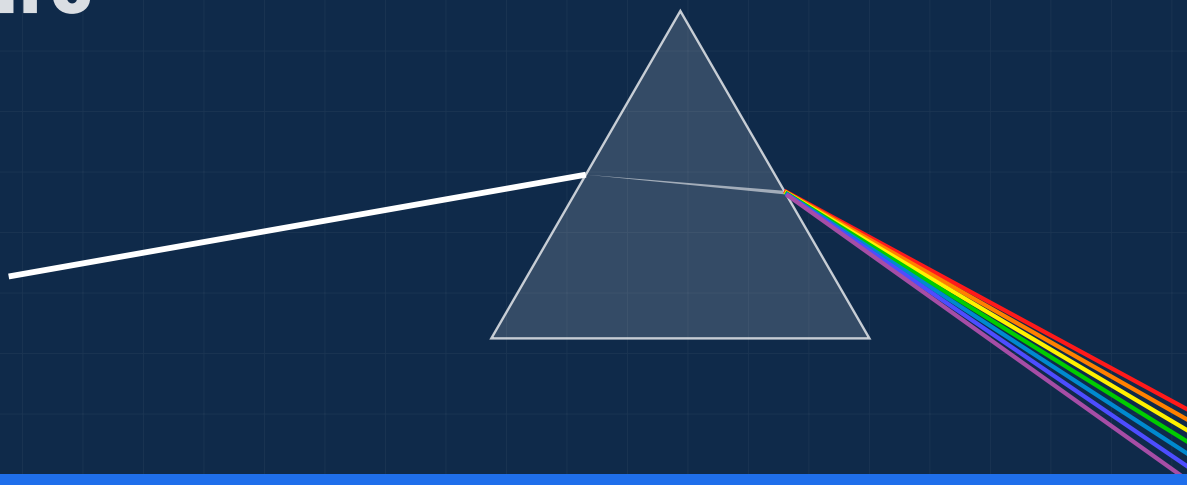
Free sample: knowledge organiser and Worksheet 1 with answers

Reflection | Refraction | Total internal reflection | Thin lenses | Dispersion

EM spectrum | Exam-style questions

$$n = \sin i / \sin r$$

$$n = 1 / \sin c$$



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Physics that finally makes sense.

Free sample

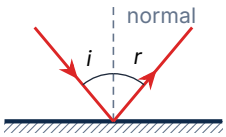
Full pack: worksheets, exam paper, answers

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Knowledge organiser

LIGHT AND THE EM SPECTRUM ON ONE PAGE

Reflection (plane mirror)

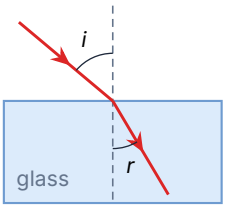


Angles are measured from the **normal** (the line at 90° to the surface).

Angle of incidence = angle of reflection.

Plane-mirror image: same size, same distance behind the mirror as the object is in front, **virtual** (cannot be formed on a screen).

Refraction



Into glass: light **slows down**, bends **towards** the normal. Out into air: bends **away**. Along the normal: no bending.

SUPPLEMENT $n = \dfrac{\text{speed in air}}{\text{speed in material}}$

SUPPLEMENT $n = \dfrac{\sin i}{\sin r}$

Total internal reflection

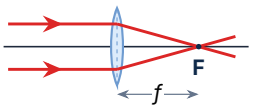
Critical angle c**:** angle of incidence (in the denser material) for which the angle of refraction is 90°.

Total internal reflection: light going from a denser to a less dense material **and** angle of incidence **greater than** c. Examples: periscope prisms, diamonds, optical fibres.

SUPPLEMENT $n = \dfrac{1}{\sin c}$ SUPPLEMENT

Optical fibres carry visible light or infrared (cable TV, broadband) by repeated total internal reflection.

Thin lenses



Converging: parallel rays meet at the **principal focus** F; f is the **focal length**.

Diverging lens: parallel rays spread out as if from F.

Rays: parallel → through F; through centre → straight on.

Object beyond $2f$: diminished, inverted, real.
Between f and $2f$: enlarged, inverted, real.
Virtual image: rays traced back; not on a screen.

SUPPLEMENT Inside f: enlarged, upright, virtual (magnifier). Short sight: diverging lens; long sight: converging.

Dispersion and the electromagnetic spectrum

radio	microwave	infrared	visible	ultraviolet	X-rays	gamma

frequency increases, wavelength decreases

Dispersion: a prism splits white light; violet is refracted most. Red, orange, yellow, green, blue, indigo, violet: frequency increases. SUPPLEMENT One frequency: **monochromatic**.

Same speed in a vacuum for all EM waves; SUPPLEMENT 3.0×10^8 m/s.

Satellites: **microwaves**; geostationary or low orbit.

SUPPLEMENT **Digital** (two levels) is regenerated accurately: higher data rate, greater range than **analogue**.

	Uses	Danger
radio	radio/TV, astronomy, RFID	
microwave	satellite TV, mobile phones, ovens	heats cells
infrared	grills, remotes, alarms, thermal imaging	skin burns
visible	vision, photography, lighting	
ultraviolet	security marks, fake notes, sterilising water	skin cancer, eyes
X-rays	medical and security scanners	cell mutation
gamma	sterilising, detecting and treating cancer	cell mutation

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Reflection and plane mirrors

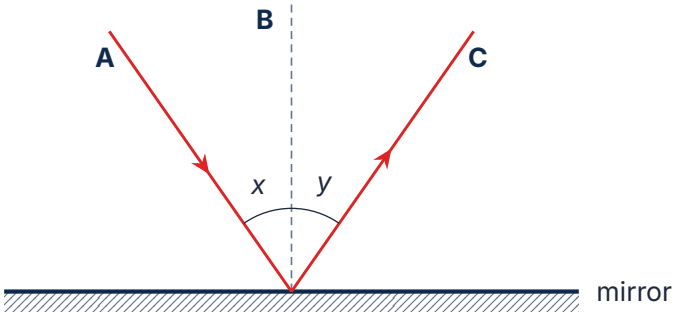
WORKSHEET 1

CORE SUPPLEMENT

You will: use the terms normal, angle of incidence and angle of reflection, describe the image formed by a plane mirror, and (Extended) use constructions and calculations for reflection by plane mirrors.

CORE all students SUPPLEMENT Extended (Supplement) students CHALLENGE stretch question

1 CORE The diagram shows a ray of light reflected by a plane mirror.



(a) Name the lines A, B and C. [3]

A _____ B _____ C _____

(b) Name the angles *x* and *y*. [2]

.....

.....

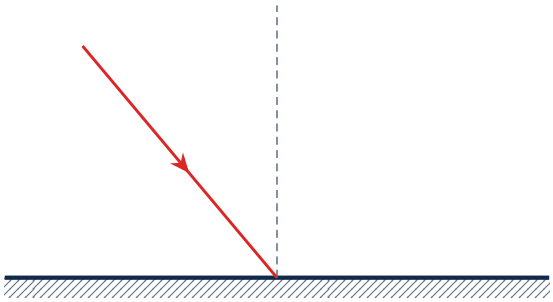
(c) State the law of reflection. [1]

.....

(d) The angle between the incoming ray and the surface of the mirror is 55°. Calculate the angle of reflection. [1]

angle of reflection = _____

2 CORE A ray of light strikes a plane mirror at an angle of incidence of 40°. Use a protractor to draw the reflected ray. [2]



normal drawn at the point where the ray strikes the mirror

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3 CORE A ray of light strikes a plane mirror along the normal. Describe the path of the reflected ray. [1]

.....

4 CORE Amira stands 1.5 m in front of a large plane mirror and looks at her image.

(a) State the distance between the mirror and her image. [1]

distance = _____

(b) State the distance between Amira and her image. [1]

distance = _____

(c) Amira walks 0.5 m towards the mirror. Calculate the new distance between Amira and her image. [1]

distance = _____

(d) State **three** characteristics of the image formed by a plane mirror. [3]

.....

.....

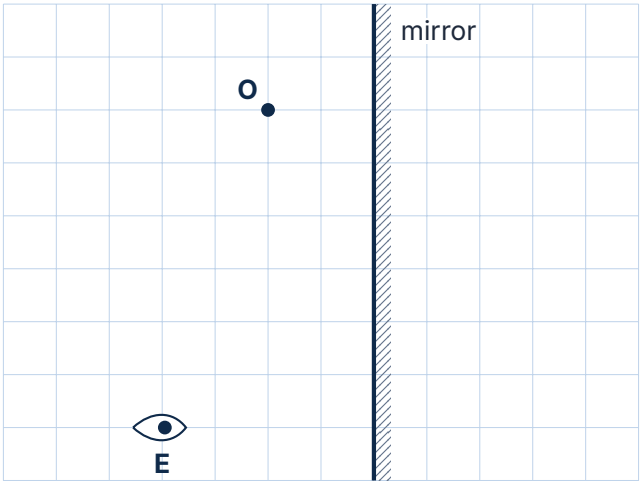
.....

(e) The image is virtual. Explain what this means. [1]

.....

Exam tip Always measure angles from the **normal**, not from the surface of the mirror. If you are given the angle to the surface, subtract it from 90°.

5 SUPPLEMENT The diagram shows an object O in front of a plane mirror, and a person's eye at E. Each square of the grid represents 10 cm.



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(a) On the grid, mark the position of the image of O. Label it I. [1]

(b) State the distance between O and its image. [1]

distance = _____

(c) On the diagram, draw a ray of light that travels from O, reflects from the mirror and enters the eye at E. Show the direction of the ray with arrows. [2]

(d) State the angle of incidence of this ray at the mirror. [1]

angle = _____

6 SUPPLEMENT CHALLENGE A ray of light strikes a plane mirror with an angle of incidence of 25°.

(a) Calculate the angle between the incident ray and the reflected ray. [1]

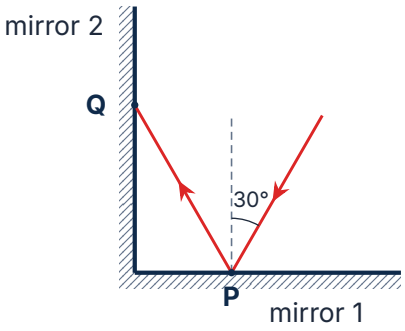
angle = _____

(b) The mirror is turned so that the angle of incidence increases to 35°. The incident ray does not move. Calculate the angle through which the reflected ray turns. [2]

.....

angle = _____

7 SUPPLEMENT CHALLENGE Two plane mirrors are fixed at 90° to each other. A ray of light strikes mirror 1 at P with an angle of incidence of 30°. It reflects and then strikes mirror 2 at Q.



(a) State the angle of reflection at P. [1]

angle = _____

(b) Calculate the angle of incidence at Q. Explain your working. [2]

.....

angle = _____

(c) On the diagram, draw the normal at Q and the ray reflected from mirror 2. [1]

(d) Describe the direction of the ray that leaves mirror 2 compared with the ray that arrives at mirror 1. [1]

.....

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Answers: Worksheet 1

Mark codes: B1 independent mark C1 method mark, implied by a correct final answer A1 correct answer with unit. Accept answers that round correctly; allow error carried forward from earlier parts. For drawings, accept angles within ±2° and positions within half a square.

Worksheet 1 – Reflection and plane mirrors

1 **(a)** A incident ray B1; B normal B1; C reflected ray B1
(b) *x* angle of incidence B1; *y* angle of reflection B1
(c) The angle of incidence is equal to the angle of reflection. B1
(d) $90 - 55 = \mathbf{35°}$ B1

2 Reflected ray drawn on the other side of the normal B1, at 40° to the normal (±2°), with an arrow pointing away from the mirror. B1

3 It is reflected straight back along the normal (back along its own path). B1

4 **(a)** **1.5 m** B1
(b) **3.0 m** B1
(c) $2 \times 1.0 = \mathbf{2.0\ m}$ B1
(d) Any three: same size as the object; the same distance behind the mirror as the object is in front; virtual; upright; laterally inverted (left and right swapped). B3
(e) It cannot be formed on a screen: no light actually passes through it; the rays only appear to come from it. B1

5 **(a)** I is 2 squares behind the mirror, level with O. B1
(b) 4 squares = **40 cm** B1
(c) Straight line from I to E crosses the mirror at M, 4 squares above E's level B1; ray drawn O → M → E with arrows towards E (the part behind the mirror dashed or omitted). B1
(d) **45°** B1

6 **(a)** $25 + 25 = \mathbf{50°}$ B1
(b) new angle between the rays = 35 + 35 = 70° C1; the reflected ray turns through $70 - 50 = \mathbf{20°}$ A1 (twice the angle the mirror turns)

7 **(a)** **30°** B1
(b) The reflected ray makes $90 - 30 = 60°$ with mirror 1; the angles in the triangle P–corner–Q add up to 180°, so the ray makes $180 - 90 - 60 = 30°$ with mirror 2 C1; angle of incidence = 90 − 30 = **60°** A1
(c) Horizontal normal drawn at Q; reflected ray at 60° to it, going up and to the right. B1
(d) It is parallel to the incoming ray but travels in the opposite direction. B1

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Get the full pack

You have just used Worksheet 1. The full Light & the Electromagnetic Spectrum pack contains:

- **Worksheet 1:** Reflection and plane mirrors
- **Worksheet 2:** Refraction of light
- **Worksheet 3:** Total internal reflection
- **Worksheet 4:** Thin lenses
- **Worksheet 5:** Dispersion and the EM spectrum
- **Multiple-choice practice:** 10 Paper 1/2-style questions
- **Practical skills:** an Alternative to Practical (Paper 6) question
- **Exam-style questions:** a 40-mark paper
- **Revision checklist** and knowledge organiser

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