

Bending light: refraction, critical angle and lenses

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Test answers (mark scheme)

The model answers include mark allocations. Award method marks even if the final answer is slightly wrong, and apply error carried forward when a student uses their own earlier result consistently.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** IGCSE 3.2

Question 1 Law of reflection (2 marks)

- a. The angle of incidence equals the angle of reflection. **$i = r$**
- b. Angle of incidence = $90^\circ - 28^\circ = 62^\circ$, so the angle of reflection is **62°** .

Marking: 1 mark for the law; 1 mark for using the normal to get 62° .

Question 2 Refractive index (3 marks)

- a. $n = \sin 35^\circ \div \sin 22^\circ = 0.574 \div 0.375 = \mathbf{1.53}$
- b. $v = c \div n = 3.0 \times 10^8 \div 1.53 = \mathbf{2.0 \times 10^8 \text{ m/s}}$

Marking: 1 mark for substitution, 1 for answer; 1 mark for the speed.

Question 3 Bending of light (2 marks)

- a. It bends **towards** the normal.
- b. Light travels more slowly in water than in air, so the wavefront turns towards the normal.

Marking: 1 mark for the direction, 1 mark for the slower speed in water.

Question 4 Critical angle (3 marks)

- a. The angle of incidence in the denser material for which the angle of refraction is 90° .
- b. $\sin c = 1 \div 1.62 = 0.617$, so $c = \mathbf{38.1^\circ}$

Marking: 1 mark for the definition; 1 for $\sin c = 1 \div n$ with numbers, 1 for the answer. (Total 3 marks.)

Question 5 Optical fibre (3 marks)

Light enters one end and strikes the glass-air boundary at an angle of incidence **greater than the critical angle**. Light is travelling from the denser glass to less dense air, so it undergoes **total internal reflection**. It repeats this at each boundary down the fibre.

Marking: 1 mark for denser to less dense, 1 for angle greater than c, 1 for repeated total internal reflection along the fibre.

Question 6 Image in a lens (4 marks)

- a. A ray parallel to the axis refracts through the far F; a ray through the centre is not deviated. The two rays cross below the axis, to the right of the lens.
- b. The image is **real, inverted and larger** than the object.

Marking: 1 mark for each correct ray; 2 marks for the image description (1 for real and inverted, 1 for larger).

Question 7 Magnification (2 marks)

- a. $m = 1.8 \div 6.0 = \mathbf{0.30}$
- b. $\text{image} = 0.30 \times 9.0 = \mathbf{2.7 \text{ cm}}$

Marking: 1 mark each part.

Question 8 Real or virtual (1 mark)

A real image can be shown on a screen because light rays actually meet there; a virtual image cannot, because the rays only **appear** to come from it.

Marking: 1 mark for a correct difference.