

Question	Answer	Mark
1(a)(i)	Sketch of <u>curved</u> optic fibre with light ray undergoing at least one total internal reflection	B1
(a)(ii)	Light travels down (optic) fibres into or out of body To examine internal organ/part Light travels both ways into and out of body OR To destroy (cancerous) cells by heating OR Endoscope/fibre bundle inserted into body To view internal organ body part OR for keyhole surgery	B1 B1 B1 (B1) (B1) (B1) (B1)
(b)	Light in air: $3 \times 10^8 \text{ m/s}$ Microwaves in vacuum: $3 \times 10^8 \text{ m/s}$ Sound in steel: 6000 m/s	B1 B1 B1
(c)	$n = \text{speed in air} / \text{speed in glass (or rearranged)}$ OR $1.5 = 3 \times 10^8 / \text{speed in glass (or rearranged)}$ $2.0 \times 10^8 \text{ m/s}$	C1 A1
		Total: 9

- 2 (a) (i) Reflection in a more dense material where there is no refracted ray or wtte
OR All light in a more dense material is reflected or wtte B1
- (ii) e.g. The greatest angle of incidence (in the material) at which refraction occurs
OR The angle of incidence (in the material) at which the refracted ray travels along the boundary / angle of refraction is 90° B1
OR The angle of incidence / (in the material) above which total internal reflection occurs
- (b) (i) (refractive index =) speed of light in air / speed of light in glass
OR $3.0 \times 10^8 / 2.0 \times 10^8$
= 1.5 M1
A1
- (ii) $\sin c = 1/n$ OR $1/1.5$ seen
($c = 42^\circ$) B1
- (iii) No change of direction at first face B1
Total internal reflection at hypotenuse with $i = r$ by eye B1
Refraction with r greater than i at lower face B1

[Total: 8]

- 3 (a) (i) all three of: max. B2
- virtual,
 - upright / erect / same way up,
 - magnified / large(r) (than object)
- award 1 mark for one or two correct description(s) which are not contradicted
- (ii) RS B1
- (iii) eye placed to right of lens B1
- (b) any two correct rays from: max. B2
- ray parallel to axis refracted through F
 - ray passing through centre of lens undeflected
 - ray through added focus to left of lens refracted parallel to axis
- image from intersection of rays clearly shown as inverted B1
- 3 correct rays drawn on Fig. 7.2, from tip of O to intersection of other two rays and refracted correctly at lens
note: the third ray does not have to be one of those listed above B1

[Total: 8]

- 4 (a) (i) $n = v_a \div v_g$ in any form B1
- (ii) 2.0×10^8 OR 2×10^8 m/s B
- (b) (i) $n = \sin(i) \div \sin(r)$ OR $\sin(r) = 1.5 \times \sin 41^\circ$
OR $\sin^{-1}(r) = 0.98$ C1
- (r =) 80° A1
- (ii) total (internal) reflection OR no refraction OR all light reflected B1
- (c) some indication of multiple reflections in optical fibre, accept from diagram B1
- appropriate further information,
e.g. endoscope OR looking/illuminating inside body B1
- 5 (a) (i) A (on principal axis) between the lens and one focal point AND E somewhere on other side of lens B1
- (ii) on same side as A **and** further than the principal focus from lens B1
- (iii) **virtual** underlined B1
upright underlined B1
- (b) (i) 1. decreases/becomes smaller B1
2. stays the same/unchanged B1
- (ii) smaller B1

[Total: 7]

- 6 (a) (i) boxes ticked:
enlarged
upright
virtual B3
- (ii) E marked anywhere to right of lens B1
- (iii) magnifying glass(es) or lens / eyepiece of telescope / microscope / binoculars
- (b) object in correct position and correct size and F in correct position from label or correct ray intersection with axis B1
two correct rays M1
image between 28 mm and 38 mm from lens and labelled as word or letter A1

[Total: 8]