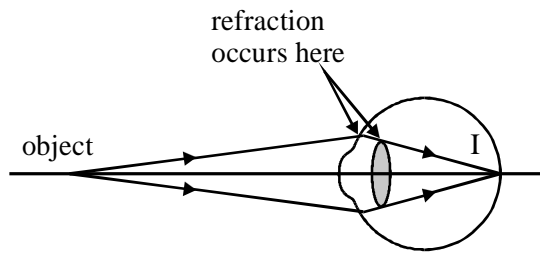


## The EYE answers - Medical Physics Option

1. (a) (i)

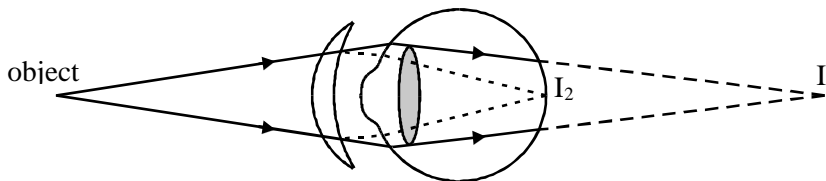


refraction at cornea and lens (1)  
correct rays (1)

(ii) greatest refraction occurs at the cornea (1)  
because greatest difference in refractive index at cornea (1)

4

(b)



converging correcting lens (accept bi-convex) (1)  
image formed behind retina without correcting lens (labelled I<sub>1</sub>) (1)  
corrected image formed on retina (labelled I<sub>2</sub>) (1)  
dotted lines show paths of corrected rays when  
converging correcting lens is used (1)

4

(c) (i)  $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$   
 $u = 0.25$   
 $v = -1.25$

$$\frac{1}{f} = \frac{1}{0.25} - \frac{1}{0.25} \quad (1) = \frac{5-1}{1.25} = 3.2, \text{ power} = 3.2\text{D} \quad (1)$$

(ii) positive (1)

3

[11]

2. (a) (i) astigmatism usually caused by an irregularity in the curvature of the cornea (1)

(ii) a person with astigmatism would see an image which was less well-focussed in one particular plane [direction] (1)

(ii) defect is corrected using a (correctly orientated) cylindrical lens (1)

3

(b) (i)  $P = \frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{\infty} - \frac{1}{0.8} \quad (1) = -1.25 \text{ dioptre} \quad (1)$   
[no marks if  $v$  is not negative]

(ii)  $\frac{1}{u} = \frac{1}{f} - \frac{1}{v} = -1.25 - \frac{1}{-0.15} \quad (1) = -1.25 + 6.67 = 5.42$   
 $u = 0.18\text{m} \quad (1)$

4

[7]

## The EYE answers - Medical Physics Option

3. (a) (i) short sight [myopia] (1)  
 (ii) lens produces virtual image at uncorrected far point (1)  

$$P = \frac{1}{f} = \frac{1}{-0.5} = -2.0\text{D [allow dioptre or m}^{-1}\text{]} (1) (1)$$
 maximum one mark if unit or negative sign omitted  
 (iii) rays cross in front of retina from parallel incident rays (1)  
 (iv) image on retina, object at uncorrected far point (1)  
 (v) long eyeball [or strong lens or eye insufficiently relaxed] (1) max 6
- (b) (i) towards film (1)  
 (ii)  $f = 36.4 - 1.2 = 35.2 \text{ mm} (1)$   
 (iii)  $\frac{1}{u} + \frac{1}{36.4} = \frac{1}{35.2} (1)$   
 $u = 1068 \text{ mm [1.1 m]} (1)$   
 (iv) image height (=object height  $\times \frac{v}{u}$ ) [or magnification correctly calculated] (1)  
 $= 0.60 \times \frac{36.4}{1068} = 0.020 (1)$   
 $0.020 < 0.024 \therefore \text{yes [or conclusion consistent with calculation]} (1) \quad 7$
- (c) at focal point of objective (1)  
 long exposure allows more detail to be observed (1) 2

**[15]**

4. (a) treatment of defects of vision  
 welding of detached retina  
 removal of birthmarks any two (2)  
 treatment of tumours  
 used as cutting instrument 2
- (b) method of application:  
 pulsed beams  
 delivered via optical fibres any two (1) (1)  
 specific wavelength of radiation needed  
 safety features:  
 lack of reflective surfaces  
 short focal length lens used at point of application  
 use of goggles any two (1) (1)  
 keep patient still 4

The Quality of Written Communication marks are awarded for the quality of answers to this question.

**[6]**

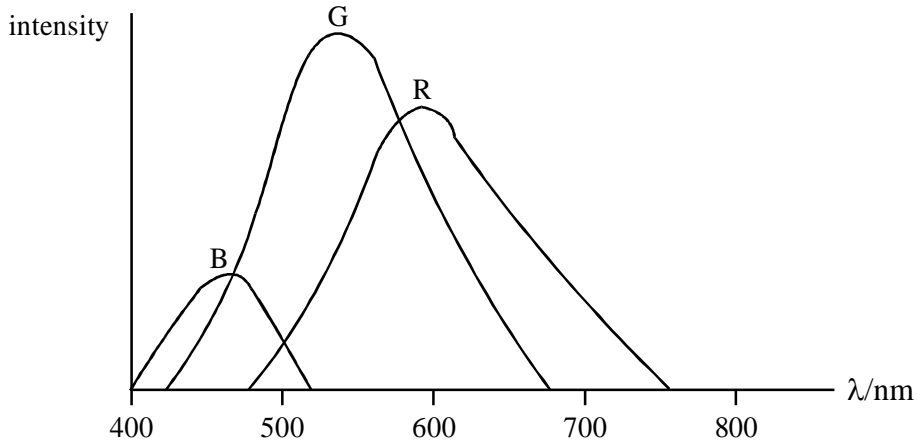
5. (i) non-spherical cornea (1)  
 (ii) image in one plane is focused, but image in plane at right angles is out of focus (1)  
 (iii) cylindrical lens (1)

The EYE answers - Medical Physics Option

- (iv) power of the lens (1)  
 angle of correction (1) 5

[5]

6. (a)



three overlapping colour curves labelled blue, green and red (1)  
 unit and scale on wavelength axis (1)  
 peaks at  $\approx 430$  (blue),  $520$  (green),  $570$  (red) (1)( $\pm 30$  for each)  
 ranges  $\approx 400 - 520$  (blue),  $430 - 670$  (green),  $480 - 730$  (red) (1) ( $\pm 30$ ) 4

- (b) (i) two stimulated receptors must be separated by  
 (at least) one unstimulated receptor (1)
- (ii) (in bright light) cones activated (1)  
 cones smaller than rods (1)  
 angular separation thus smaller (1) max 3
- (c) (i) lights flashing at  $\geq 20$  Hz appear steady  
 [or image appears steady although stimulus is flashing] (1)
- (ii) any correct example e.g. cine films, television (1) 2

[9]

7. (a) (i) myopia or short sight (1)  
 (ii) eyeball too long  
 [or cornea too curved/powerful] (1)  
 (allow C.E. if (i) is incorrect) 2

- (b) 1st diagram: rays focused on retina (1)  
 2nd diagram: rays focussed before retina (1)  
 3rd diagram: rays diverging from lens and appear  
 to come from point 2.5m away (1)  
 rays (after diverging) focused on retina max 3

- (c) (i) (use of  $P = \frac{1}{f}$  gives)  $P = \frac{1}{(-)2.5}$  (1)  
 $= -0.4$  D (1)

## The EYE answers - Medical Physics Option

(ii) (use of  $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$  gives)  $\frac{1}{-2.5} = \frac{1}{u} + \frac{1}{-0.2}$  (1)  
 $\left(\frac{1}{u} = \frac{23}{5}\right)$  and  $u = 0.22$  m (1) 4

**[9]**

8. (a) diagram to show: rays reflected inwards at cornea (1)  
 rays reflected at lens (1)  
 rays focused at optic axis on retina (1) max 2
- (b) only cones at fovea (1)  
 moving away from fovea, more rods, less cones (1) 2
- (c) (i) to control the intensity of light reaching retina (1)  
 (ii) forms a small pupil (1) 2
- (d) (i) accommodation: ability of the eye/lens to (change and) focus  
 on different object distances (1)  
 [adjustment of the eye/lens to form a clearly focused image on the retina]
- (ii) changing the shape of the lens  
 [or using the ciliary muscles] (1) 2

**[8]**

9. (a) (i) (use of  $f \frac{1}{f} = \frac{1}{u} + \frac{1}{v}$  gives)  $\frac{1}{f} = \frac{1}{0.25} - \frac{1}{0.60}$  (1) (= 2.33)  
 (use of  $P = \frac{1}{f}$  gives)  $P = (+)2.3$  D (1)
- (ii)  $m\left(\frac{0.60}{0.25}\right) = 2.4$  (1) 3
- (b) diagram to show: two correct rays to locate image (1)  
 correct (virtual) image (1)  
 two distances shown (1) 3
- (c) (i) long sight (1)  
 (ii) aided far point at focal length of lens (1)  
 $f = \frac{1}{2.33} = 0.43$  m (1)  
 aided near point is 0.25 m (1) 4

**[10]**

10. (a) (i) non-spherical cornea (1)  
 (ii) when one plane is in focus, plane at 90° is out of focus (1)  
 (iii) cylindrical (lens) (1)  
 (iv) power and angle of alignment/orientation (1) 4

## The EYE answers - Medical Physics Option

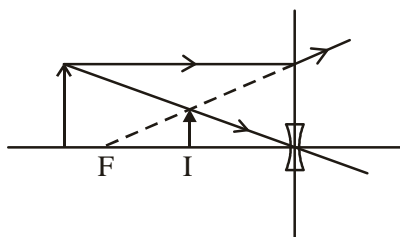
(b) (i)  $P = \frac{1}{f} = \frac{1}{0.25} - \frac{1}{0.65}$  (1)  
 $= 2.5 \text{ D}$  (1) (2.46 D)

(ii)  $u = \frac{1}{P} = 0.41 \text{ m}$  (1) (0.406 m)  
 (allow C.E. for value of  $P$  from (i))

3

[7]

11. (a)



ray diverging from F (1)  
 ray through centre of lens to form marked image (1)

2

(b) (i) myopia/short sight (1)

(ii) (use of  $P = \frac{1}{u} + \frac{1}{v}$  gives)  $-3.0 = \frac{1}{u} + \frac{1}{(-0.21)}$  (1)

$u = 0.57 \text{ m}$  (1)  
 (0.568 m)

3

[5]

12. (a) (both answers, for bright light and dim light, are required to gain a mark)

**bright light**

cones  
 colour  
 detail seen  
 optic axis

**dim light**

rods (1)  
 black and white (1)  
 lack of detail (1)  
 periphery (1)

Max 3

(b) (i) short sight/myopia (1)

(ii)  $P = \frac{1}{-2.0} = -0.5 \text{ D}$  (1)

$0.5 = \frac{1}{u} - \frac{1}{0.22}$  (1)

$u = 0.25 \text{ m}$  (1) (0.247 m)

(allow C.E. for value of  $P$  from (ii))

4

[7]