Mark schemes

Q1.

(a) myopia ✓

Allow short sightedness

1

(b) Max one from ✓

- Evidence of with $u = \infty$ and $v = -6$ ✓a
- Correct use of a power equation ✓b

$$P\left(=\frac{1}{f}\right)=-0.17\,(\mathrm{D})\checkmark$$

✓b $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$ *with:*

- $u = \infty$, $v = (-)6$
- $u = \infty$, $v = 0.02$
- $u = 6$, $v = 0.02$

Where $u = \infty$, *condone missing* $\frac{1}{u}$

Allow $\frac{1}{(-)6}+\left(\frac{1}{\infty}\right)$ *if u and v not defined*

Correct answer ✓✓

Max 1 mark for correct answer where clear statement that $v = \infty$ *and* $u = -6$

ECF for hypermetropia/ long sightedness on ***part (a)***

$\frac{1}{f}=\frac{1}{0.25}+\frac{1}{(-)6}$ ✓

= 3.83 ✓*(D)*

2

(c) spherical cylinder axis ✓

1

[4]

Q2.

(a) Use of ratio or tan used consistently ✓

$d = 7.14 \times 10^{-5}$ m or 3.57×10^{-5} m OR image size 4.2×10^{-4}

OR their number of pixels = $\frac{0.01}{\text{their } d}$ OR number of cones= $\frac{\text{their image size}}{(2\times)1.5\times10^{-6}}$ ✓

140 (pixels per cm) ✓

Condone POT error in MP1 and MP2

For MP3 allow 280 pixels per cm only when d represents the distance from the centre of one dark pixel to the centre of the next dark pixel.

Expect to see

$$\frac{2\times1.5\times10^{-6}}{21\times10^{-3}} = \frac{d}{0.5}$$

$d = 7.14 \times 10^{-5}$ m

Answer $= \frac{0.01}{7.14\times10^{-5}} = 140$ *(pixels per cm)*

3

(b) Viewed by rods not cones ✓

Multiple rods share a nerve ✓

Idea that there must be one unstimulated receptor between stimulated ones

OR

separation on retina needs to be larger for resolution

OR

Idea that it will be impossible to determine which rod was activated (with MP2) ✓

Max 2 if suggests rods are larger

Allow 'only rods'; do not allow 'fewer cones'

Ignore references to the spacing of rods

*For MP3 allow idea that the light receptors have an increased **effective** diameter*

Alternative for 1 mark:

Correct reference to change in pupil size (increase in dark) and less diffraction OR correct reference to pupil size and eye's ability to focus is further reduced✓

3

(c) 0.875/0.500 = 1.75 (≥ 2 sf)

OR

0.500 x 2 compared to 0.875

OR

0.875 ÷ 2 compared to 0.500✓

Allow 0.850-0.900 for red; 0.450-0.525 for green (gives range 1.62- 2.00)

1

(d) Green (520): Green cone 0.80 OR Red cone 0.15 OR

Red (650): Red cone 0.25 ✓$_1$

Green = 0.80 and Red = 0.15 + 0.25 = 0.40 OR

Green = 2 × Red ✓$_2$

If average red cone value can award ✓$_1$ and ✓$_3$
e.g. 0.20 Red, Green = 4 × Red, leading to answer in range 520 to 530 nm

If no recognition that green LED contributes to red cone value can award ✓$_1$ and ✓$_3$
e.g. Green = 3.2 x Red, leading to answer in range 530 to 540 nm

Leading to wavelength = 546 ✓$_3$ nm

allow 540 to 550 nm. Bald answer receives zero marks.

3

[10]

Q3.

(a) hypermetropia ✓

1

(b) Use of $P = \frac{1}{u} + \frac{1}{v}$ correctly. Must see correct substitution for u

or calculation for v, $v = \left(4 - \frac{1}{0.75}\right)^{-1}$ $_1$✓ (= 0.375 m)

Correct substitution in $m = \frac{v}{u}$ $_2$✓ $\left(= \frac{0.375}{0.75}\right)$

0.50 $_3$✓

Correct substitution may be inferred from using the answer as the top line in

Allow PoT for $_1$✓ and $_2$✓

Allow ecf for $_2$✓ (allow ecf for mixing up u and v for this mark, expect to see an answer of 2 for magnification)

No ecf or PoT for $_3$✓

Condone 1SF

MAX 2 if incorrect negative sign seen.

3

(c) **X** – cornea, **Y** – lens, **Z** – iris ✓

X / cornea
form image (on retina) / (primary) refractor / (most of) refraction takes place ✓

First mark is for correctly naming all three parts

Other marks can be gained for attaching the correct description to either the label or the name (if parts not correctly identified)

Treat non optical functions as neutral.

Do NOT allow "to direct the light" for refraction

Y / lens
Accommodation /
varies the focal length / power (of eye) ✓

Condone "change shape to view / focus on objects at different distances" for Y

Z / iris
Control the amount of light entering the eye ✓

Condone intensity if linked to retina or back of the eye.

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[8]