Q1.

(a) A human eye has a far point of 6.0 m.

State the name of this defect of vision.

_____

(1)

(b) Calculate the power of the correcting lens required for this eye.

power = _____ D

(2)

(c) An eye with astigmatism requires the following prescription:

−4.00 –0.75 ×30

Which row identifies the meaning of each number?

Tick (✓) **one** box.

−4.00	**−0.75**	**×30**	
axis	cylinder	spherical	
cylinder	axis	spherical	
spherical	cylinder	axis	
cylinder	spherical	axis	

(1)

(Total 4 marks)

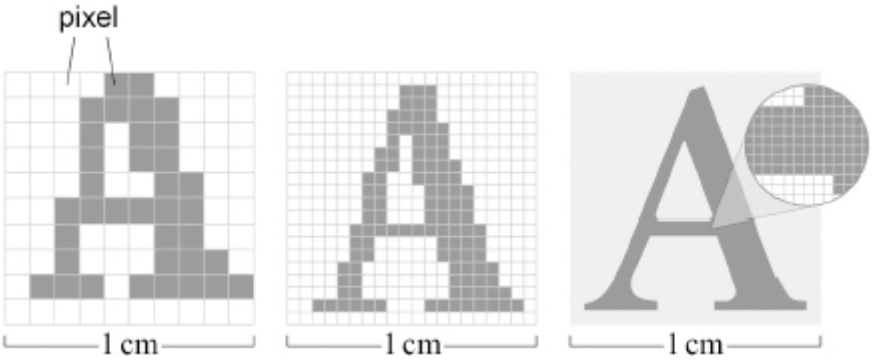
Q2.

Electrophoretic screens are used in handheld electronic devices.

The screen contains individual squares known as pixels. Pixels can be changed independently from light to dark to create the shapes of letters and numbers. An external light source is needed in order to read the screen.

Figure 1 shows a letter formed by three electrophoretic screens that have different pixel line densities. Pixel line density is the number of pixels along a 1.0 cm length of the screen.

Figure 1



(a) A particular screen is designed so that two dark pixels separated by one light pixel cannot be resolved as separate images by the eye when viewed from a distance of 0.50 m.

Determine, in pixels per cm, the minimum pixel line density required for this screen.

typical diameter of cones in a human eye at the fovea = 1.5 μm
typical length of the human eye = 21 mm

pixels per cm = _____

(3)

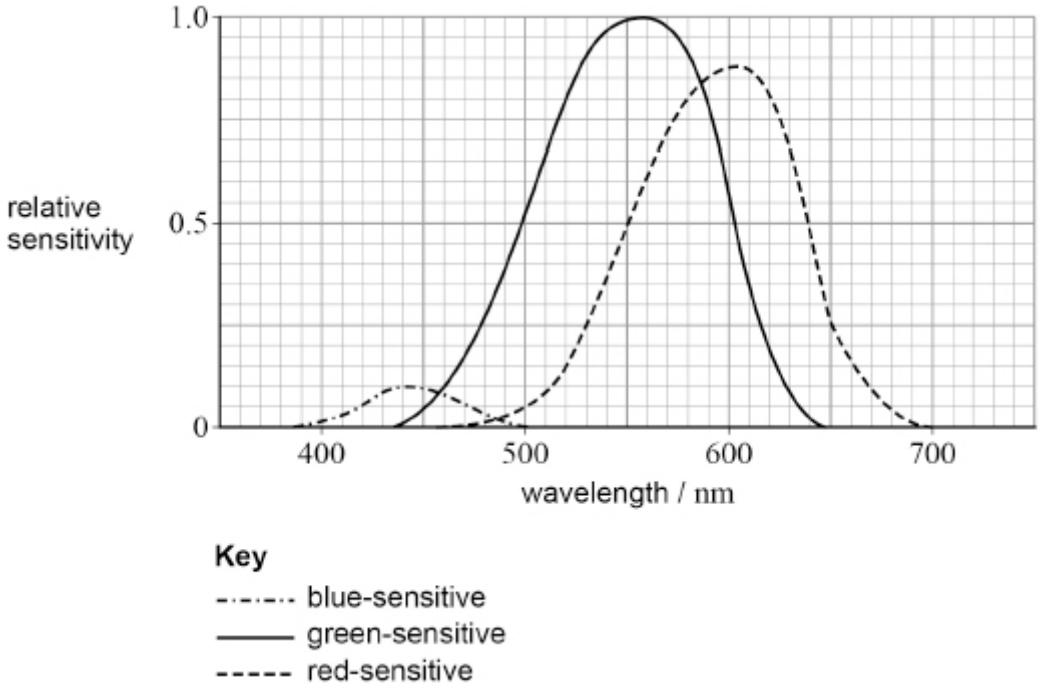
(b) On a different electrophoretic screen, two dark pixels separated by one light pixel can just be resolved at a particular distance when the external light source is bright.

Explain why these pixels cannot be resolved at the same distance when the intensity of the external light source is reduced.

(3)

Figure 2 shows the spectral response of the three different types of cone in a human eye.

Figure 2



(c) The eye is illuminated by light of wavelength 603 nm.

Show that the response of a red-sensitive cone is approximately double the response of a green-sensitive cone.

(1)

(d) Other types of screen use blue, green and red pixels to produce coloured images.

The table below shows the wavelength of the light emitted by each pixel when it is turned on.

Pixel	**Wavelength / nm**
blue	450
green	520
red	650

On one screen, the blue pixels are turned off.
When the green pixels and the red pixels are turned on, they emit light with the same intensity. A human eye that has the spectral response shown in **Figure 2** responds to this light.

Determine, in nm, the **single** wavelength of light that will produce the same response in the same human eye as the light emitted from the green and red pixels.

wavelength = _____ nm

(3)

(Total 10 marks)

Q3.

An eye condition is corrected using a $+4.0\text{D}$ lens.

(a) Which eye condition could be corrected by using this lens?

Tick (✓) **one** box.

astigmatism ☐

hypermetropia ☐

myopia ☐

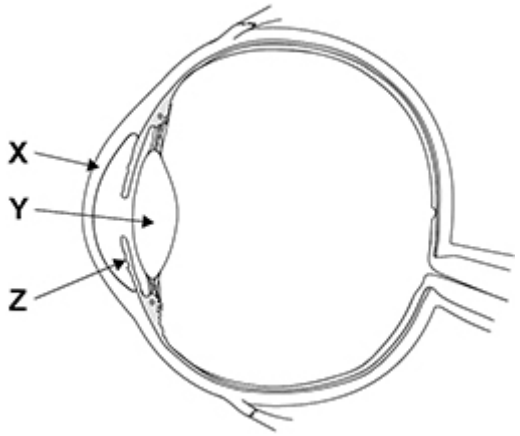
(1)

(b) Calculate the magnification produced by the $+4.0\text{D}$ lens when viewing an object $75\ \text{cm}$ from this lens.

magnification = _____

(3)

(c) The figure below shows a diagram of an eye.



State the name and primary optical function of **X**, **Y** and **Z**.

Name of **X** _____

Primary optical function of **X** _____

_____

_____

_____

Name of **Y** _____

Primary optical function of **Y** _____

_____

_____

_____

Name of **Z** _____

Primary optical function of **Z** _____

_____

_____

_____

(4)

(Total 8 marks)