Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

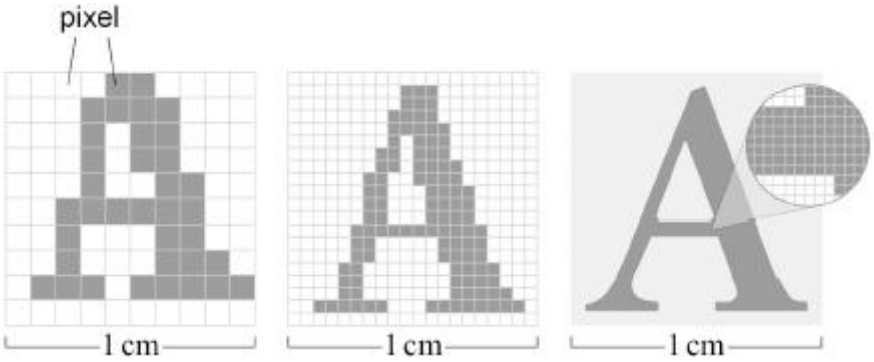
Q1.

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)

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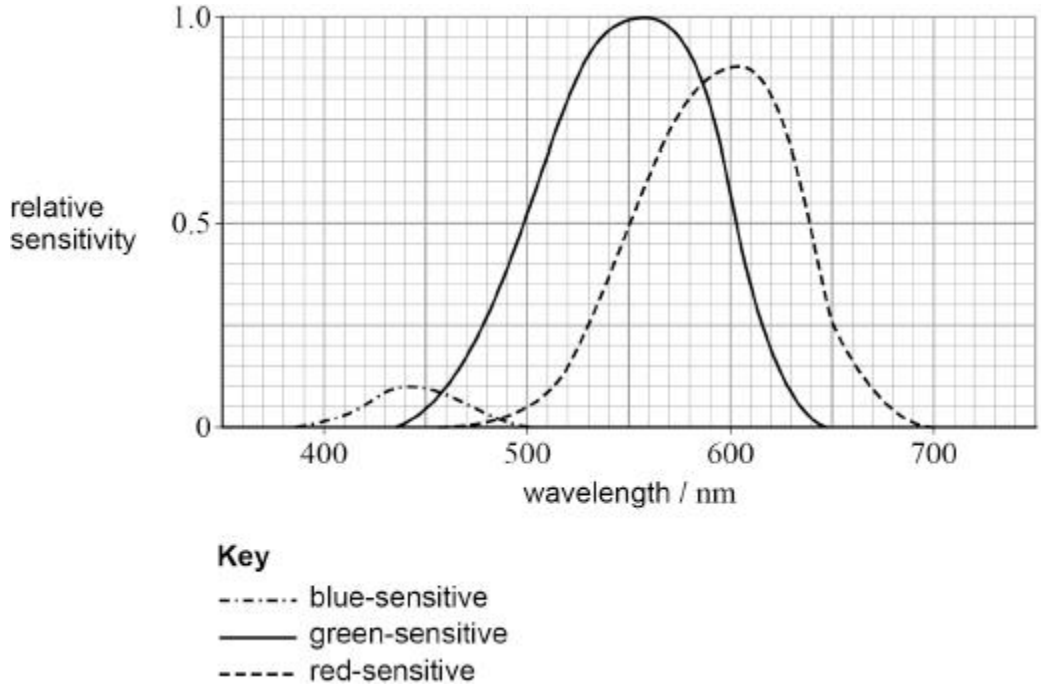
(b) On a different electrophoretic screen, two dark pixels separated by one light pixel can just be resolved at a particular distance when the external light source is bright.

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.

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(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)

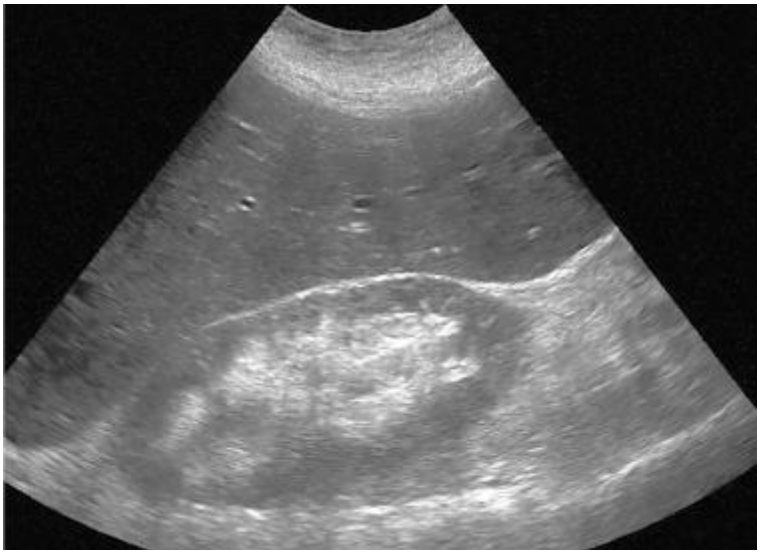
Q2.

Different ultrasound techniques are used to investigate the health of a patient's kidneys.

(a) **Figure 1** shows the results of an ultrasound scan of a kidney using one technique.

Figure 1

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Identify the type of ultrasound scan used to produce **Figure 1**.

Explain your answer.

_____

_____

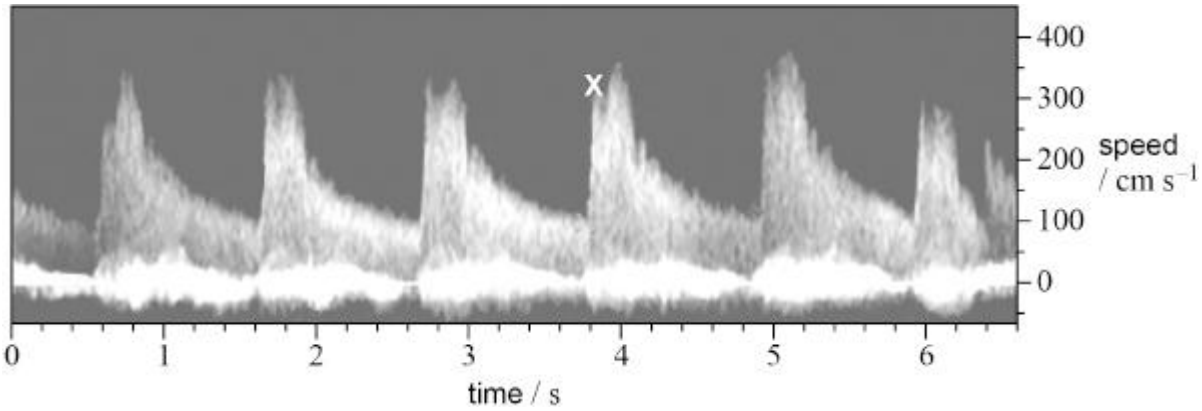
_____

(1)

Another ultrasound technique is used to measure the speed of blood flow in one of the kidney's blood vessels.

Figure 2 shows an image formed using this technique. It shows how the speed of flow through the blood vessel varies with time.
Point **X** shows this speed at one instant of time.

Figure 2



(b) Determine the patient's heart rate in beats per minute.

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heart rate = _____ beats per minute

(3)

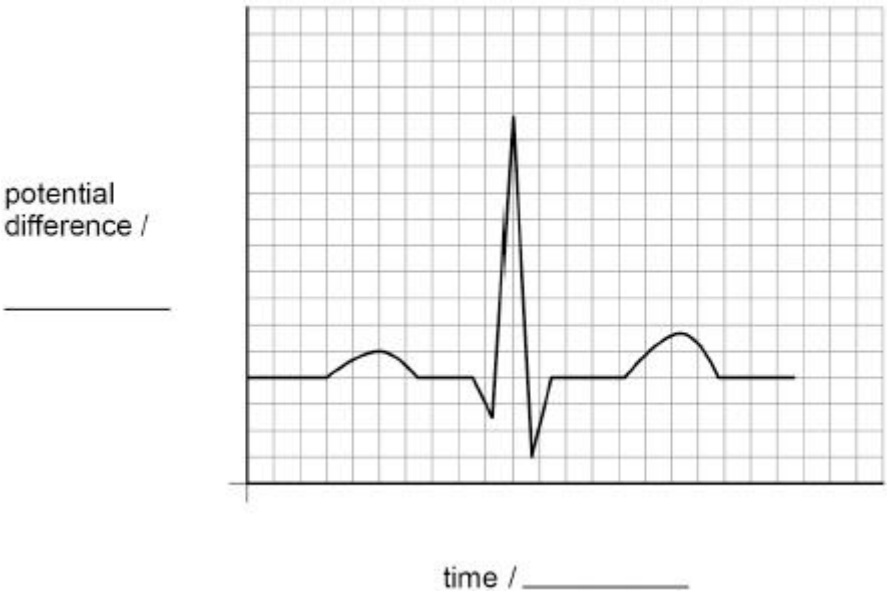
(c) An ECG was made for the patient in part (b).

Figure 3 shows one heartbeat from the ECG.

Annotate **Figure 3** to show:

- units on both axes
- scales on both axes
- point **Y** that corresponds to point **X** on **Figure 2**.

Figure 3



(4)

(d) A backing gel is used between an ECG pad and the skin of the patient.
The gel is sticky. This property ensures that the pad is securely attached to the skin.

Explain:

- one other reason why the backing gel is needed
- one other property of the backing gel
- how the skin is prepared for the pad to be applied.

_____

_____

_____

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_____

_____

(3)
(Total 11 marks)

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