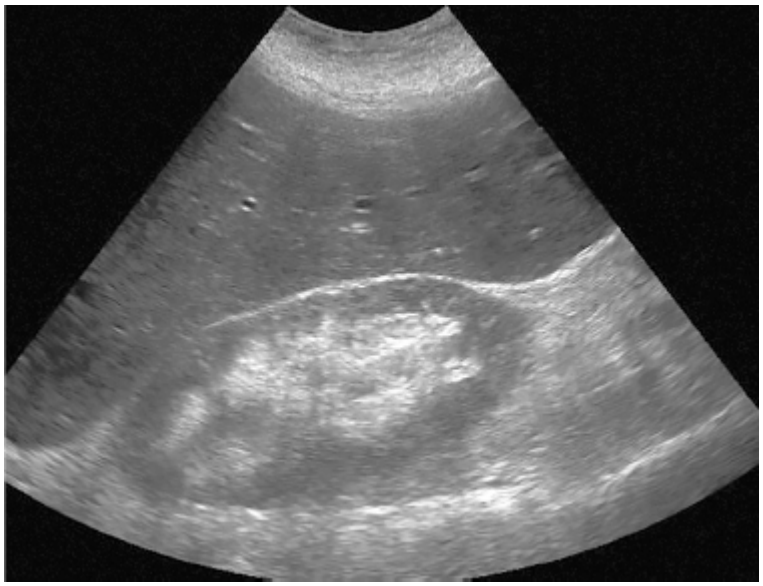
Q1.

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



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

Explain your answer.

_____

_____

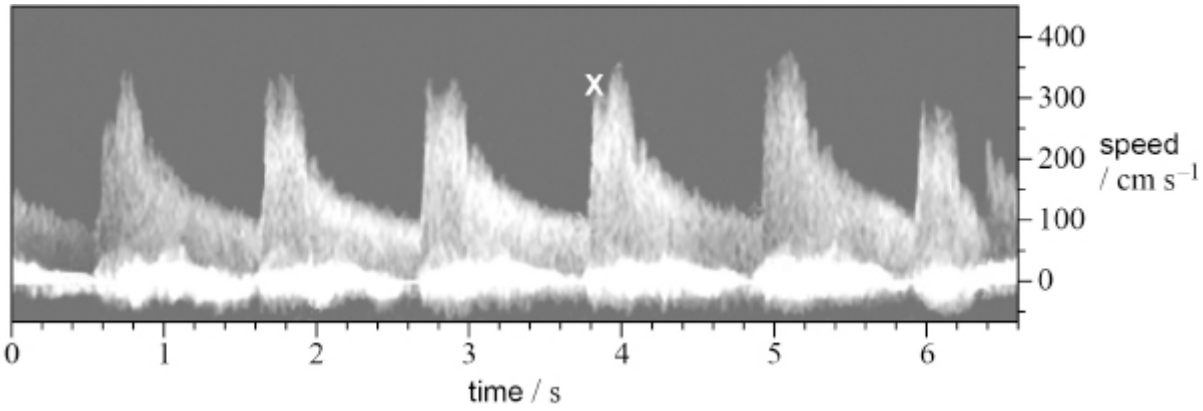
_____

(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.

heart rate = _____ beats per minute

(3)

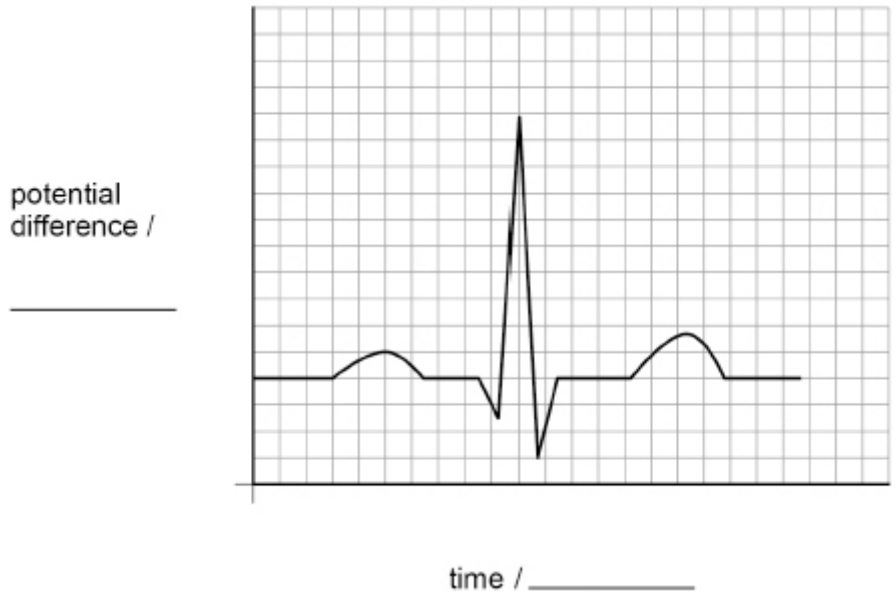
(c) An ECG was made for the patient in part (b).

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.

(3)

(Total 11 marks)

Q2.

(a) Name the two types of optical fibre bundle used in an endoscope.
Go on to discuss whether the optical fibres in either of these bundles require cladding.

(4)

(b) Modal and material dispersion can cause problems in fibre-optic communications.

Discuss why the methods used to reduce modal and material dispersion are not required in an endoscope.

In your answer you should:

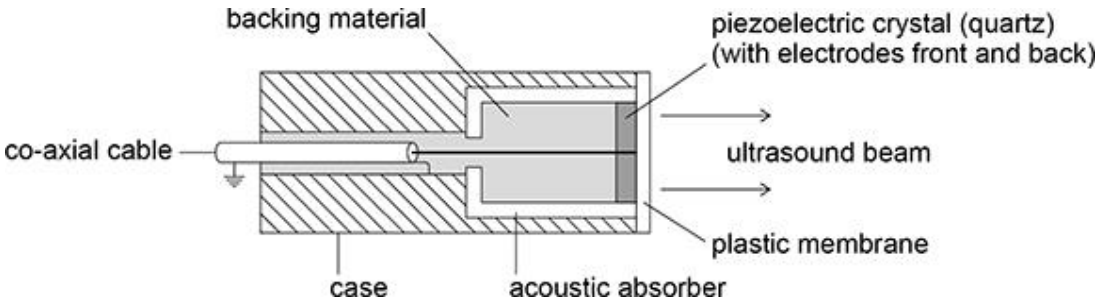
- describe the methods used to reduce dispersion in an optical fibre used for communication
- explain why the methods are not required in an endoscope
- explain how using these methods in an endoscope would affect its function.

(6)

(Total 10 marks)

Q3.

(a) The figure below shows a transducer used in a medical ultrasound scanner.



Explain why a backing material is used.

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_____

_____

_____

_____

(2)

(b) A beam of ultrasound is transmitted from muscle into bone.

Calculate the percentage of the incident intensity that is transmitted.

acoustic impedance of bone = 5.3×10^6 kg m^{-2} s^{-1}
density of muscle = 1100 kg m^{-3}
speed of ultrasound in muscle = 1600 m s^{-1}

percentage = _____ %

(3)

(Total 5 marks)

Q4.

A patient has calcium kidney stones.
Three types of scan are available to investigate the condition:

- a magnetic resonance (MR) scan
- a CT scan
- an ultrasound scan.

Calcium kidney stones contain no water and appear similar to bone in each of the scans.

Discuss the advantages and disadvantages of each option.
In your answer you should

- refer to the relevant quality of the image obtained from each scan
- identify other factors that should be considered
- justify the type of scan you would recommend.

(Total 6 marks)

Q5.

(a) State the purpose of the magnetic field in a magnetic resonance scanner.

_____

_____

_____

_____

(1)

(b) Describe the role of the radio frequency pulses in a magnetic resonance scanner.

_____

_____

_____

_____

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_____

(2)

(Total 3 marks)