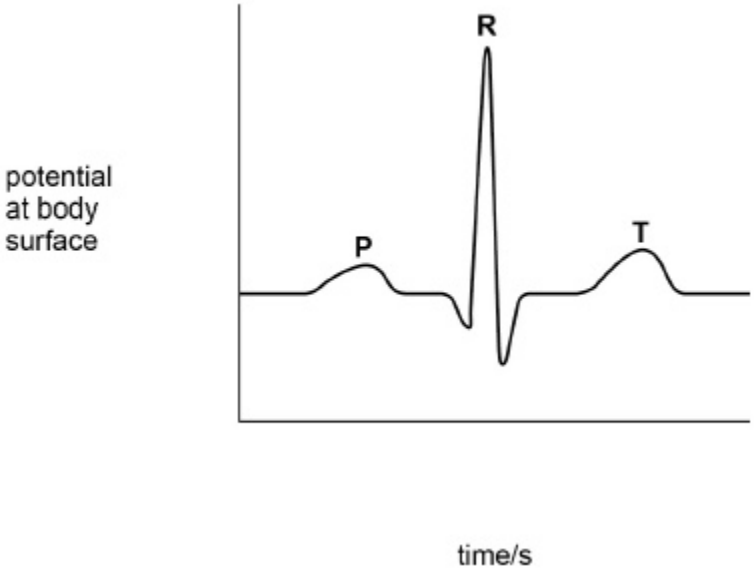
1. (a) **Figure 1** shows an ECG trace for a healthy person.

Complete **Figure 1** by adding a suitable unit and scale to the potential axis, and a suitable scale to the time axis.

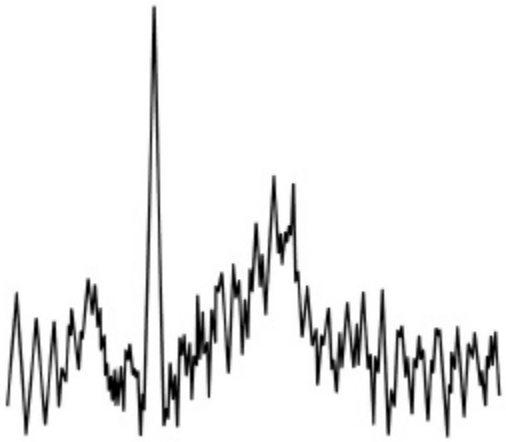
Figure 1



(2)

(b) **Figure 2** shows a faulty ECG trace which was obtained for another healthy person.

Figure 2



Discuss **three** possible reasons why this faulty trace was obtained.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

2. Ultrasound is commonly used in medical procedures.

(a) An ultrasound A-scan is used to find the length l of an eye as shown in **Figure 1**. **Figure 2** shows the simplified A-scan for the eye. A short pulse of ultrasound is transmitted at time $t = 0$

The average speed of ultrasound in the eye = 1560 m s^{-1}.

Figure 1

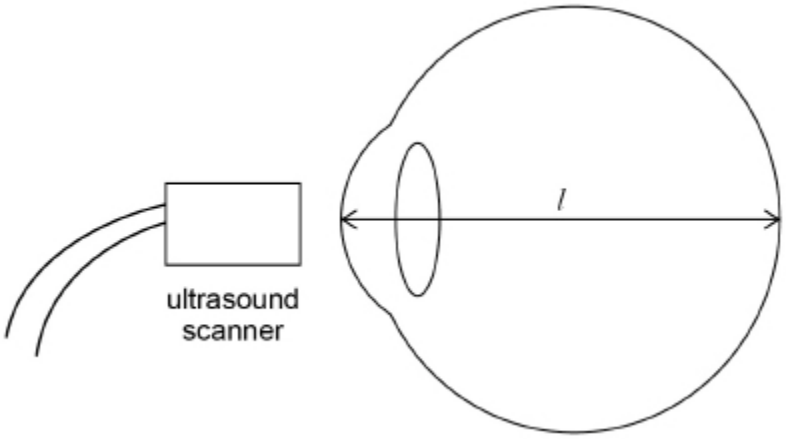
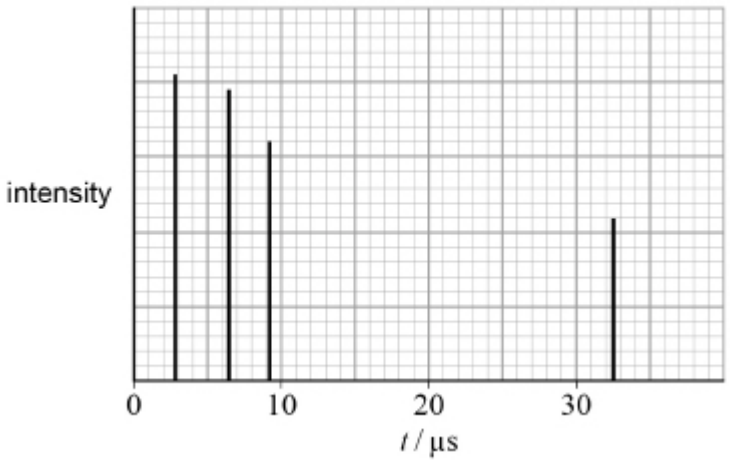


Figure 2



Calculate l.

l _____ m

(3)

(b) Amniocentesis is a procedure where a tube is inserted into a uterus to remove some cells and fluid from around a foetus. For the procedure to be carried out safely the positions of the needle, foetus and placenta must be determined accurately.

Discuss whether an A-scan or a B-scan should be used for amniocentesis.

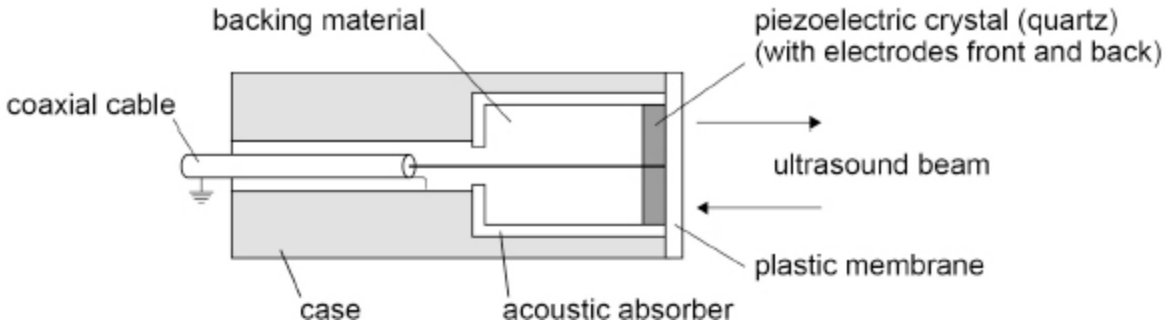
In your answer, you should:

- outline the differences between an A-scan and a B-scan
- describe the advantages and disadvantages of each type of scan
- explain why your chosen scan should be used for this procedure.

(6)

(Total 9 marks)

3. The diagram shows an ultrasound transducer used to perform medical scans.



(a) Explain how the transducer in the diagram above operates in medical diagnosis.

In your answer you should explain how

- an ultrasound pulse is produced by the transducer
- the reflected ultrasound pulse is detected by the transducer
- the transducer can both transmit a pulse and receive the reflected pulse.

(6)

(b) Ultrasound of frequency 1.0 MHz is used to scan a person's liver.

Estimate the resolution of the scan.

speed of sound in liver tissue = 1600 m s^{-1}

resolution = _____ mm

(1)

(c) Ultrasound travels from a transducer through the chest wall to an air pocket inside the lung. From the air pocket, the ultrasound is then incident on lung tissue.

Calculate the percentage of the incident ultrasound intensity that is transmitted into the lung tissue.

speed of sound in lung tissue = 1580 m s^{-1}

density of lung tissue = 1075 kg m^{-3}

speed of sound in air = 330 m s^{-1}

density of air = 1.3 kg m^{-3}

percentage = _____ %

(4)

(d) Discuss whether an ultrasound scan would be suitable to investigate a tumour inside a lung.

_____

_____

_____

_____

_____

_____

(2)

(Total 13 marks)

4. (a) An endoscope is used to view an area inside the body. The endoscope contains two bundles of optical fibres.

Name each bundle and explain its use in the process.

Bundle 1 _____

_____

_____

_____

_____

Bundle 2 _____

_____

_____

_____

_____

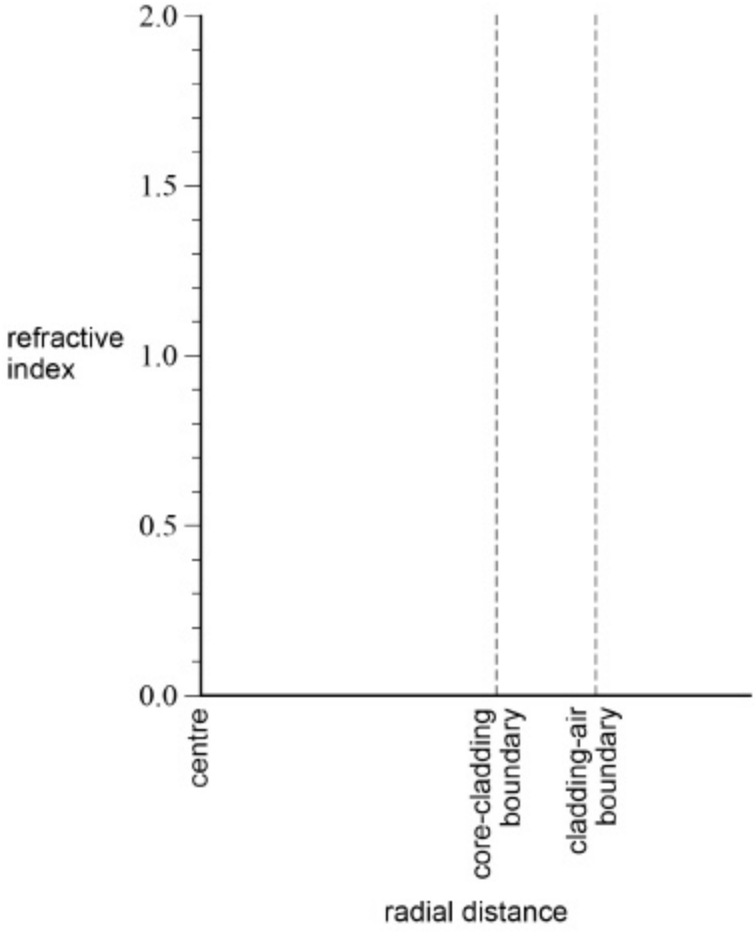
(4)

(b) A single optical fibre is placed in air. The optical fibre has a core surrounded by cladding. The critical angle is 75° at the core-cladding boundary.

Complete the graph to show how the refractive index varies with radial distance from the centre of the core to the air surrounding the fibre.

Your answer should be supported by a suitable calculation.

refractive index of core = 1.6



(2)

(Total 6 marks)