Name ..... Mark

30

Class ..... Date .....

GCSE Science/Physics

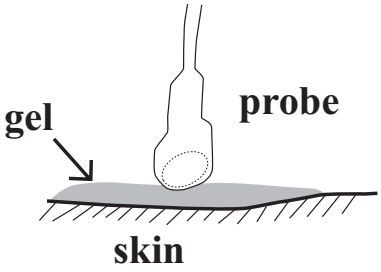
Internally Assessed Activity Unit P1b

Topic 11 – Now You See it, Now You Don't

Ultrasound

Janet is pregnant. She has an ultrasound scan to see the embryo in her womb. To do this the medical technician, Sarah, moves the ultrasound probe over Janet's abdomen. The probe sends and receives ultrasound waves.

ultrasound image of embryo



Sarah puts a gel between the probe and the skin. This helps the waves travel into Janet's body.

Question 1

(a) (i) Use words from the box to complete the following sentences.

radiated	reflected	refracted

When ultrasound waves enter the skin they change direction. These waves are ..... as they change direction.

If there is air between the probe and the skin most of the waves will be ..... by the skin.

2 marks

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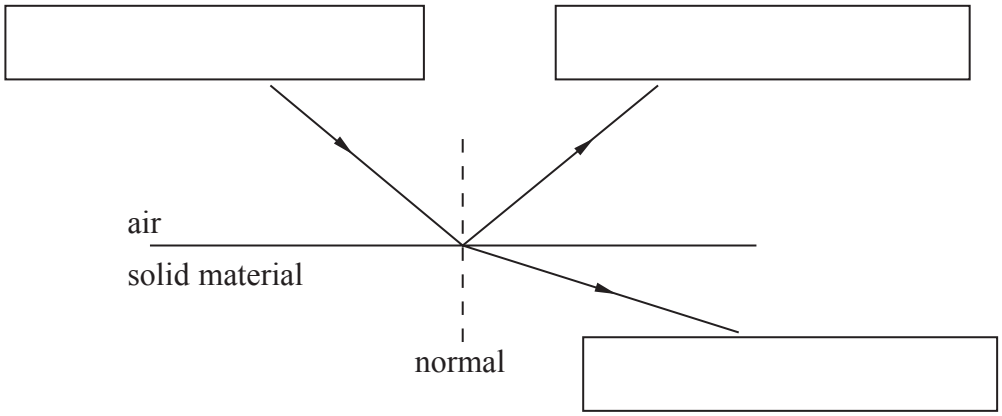
(ii) Label the diagram about ultrasound waves using words from the box.

convected	incident	reflected	transmitted



3 marks

(b) Janet's partner, John, has come with her to see the scan of their unborn baby.

Tick the **three** boxes which could be ethical issues.

Deciding which probe to use when there are several, with different sizes and operating frequencies. ☐

Deciding whether or not to tell Janet about a tumour that Sarah has just noticed. ☐

Deciding to tell Janet and John the sex of the baby whether they asked or not. ☐

Deciding whether or not to use the special gel. ☐

Deciding to ask John to leave the room because the scan is not appropriate for a man to see. ☐

Deciding whether to show the image in black and white or colour. ☐

3 marks

(8 marks)

Question 2

When ultrasound waves meet a boundary between two different substances, only some of the waves pass into the second material. The table shows the percentage of waves that are reflected at different boundaries.

boundary between	percentage (%) of waves reflected
brain and skull bone	66
muscle and fat	10
fat and kidney	8
muscle and blood	3
soft tissue and water	5
air and soft tissue	more than 99

(a) What percentage of the ultrasound waves would

(i) be reflected at the boundary between fat and kidney? .....
1 mark

(ii) pass into fat from muscle? .....
1 mark

(iii) pass into soft tissue from air? .....
1 mark

(b) The gel makes sure that there is no air between the ultrasound probe and the skin.

Using the information in the table:

(i) Explain why using gel increases the amount of ultrasound waves that pass from the probe into Janet's abdomen.

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.....
2 marks

(ii) Gels are water-based. Estimate the percentage of waves that are reflected as they enter or leave the gel.

.....
1 mark

(iii) The bladder is near the womb.

Why does Janet need to have a full bladder when she goes for an ultrasound scan?

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2 marks

(8 marks)

Question 3

Sarah found data showing the speed of ultrasound waves in different substances in the body.

substance	speed (m/s)
fat	1450
brain	1540
bone	4080
blood	1570

(a) Sarah knows that ultrasound waves travel at 330 m/s in air.

Explain why this speed is slower than the speed in different substances in the body.

.....

.....

1 mark

(b)

$$\text{time} = \frac{\text{distance}}{\text{speed}}$$

Sarah has worked out that ultrasound waves take 6.2×10^{-5} s to travel through 9 cm of fat.

Calculate the time taken for ultrasound waves to travel through 10 cm of the brain.

Answer …….……s

2 marks

(c) When waves travel from one substance to another the change in direction depends upon the change in speed.

Between which pair of substances would you expect the amount of refraction to be the least? Explain your answer.

The substances are ..... and .....

Explanation .....

.....

.....

2 marks

(d) $\text{speed} = \text{frequency} \times \text{wavelength}$

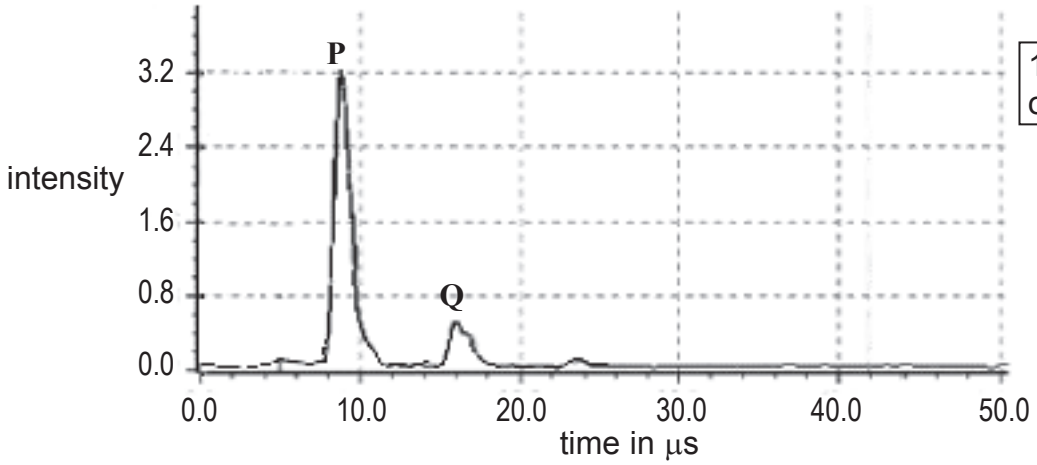
Calculate the wavelength in the brain of an ultrasound wave of frequency 1 MHz (1×10^6 Hz).

3 marks

(8 marks)

Question 4

The graph shows a pulse of ultrasound sent into the body at time t = 0.0 μs.



1 μs is one millionth of a second

The pulse reflects off two boundaries inside the body, giving peaks **P** and **Q**.
(The speed of ultrasound in the body was 1540 m/s.)

(a) Suggest why peak **Q** has a lower intensity than peak **P**.

.....

.....

1 mark

(b) Describe how you would find the depth below the skin of the boundary that caused peak **P** (no calculation required).

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2 marks

(3 marks)
27 marks

Quality of written communication **/3**

Total 30 marks