June 2015 Questions D

Q1. Ultrasound waves can be passed through the body to produce medical images.

When ultrasound waves are directed at human skin most of the waves are reflected.

If a material called a ‘coupling agent is placed on the skin it allows most of the ultrasound waves to pass through the skin and into the body.

(a) What is ‘ultrasound’?

....

....

....

(2)

(b) Two ultrasound frequencies that are used are 1.1 MHz and 3.0 MHz.

The speed of ultrasound in water is 1500 m / s.

Calculate the wavelength of the 3.0 MHz waves in water.

Use the correct equation from of the Physics Equations Sheet.

....

....

....

Wavelength = ... m

(3)

(c) The coupling agent used with ultrasound is usually a gel.

Water would be a good coupling agent.

Suggest why water is **not** used.

....

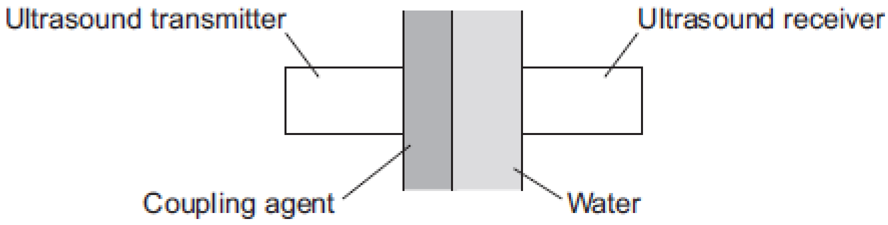
....

(1)

(d) **Figure 1** shows a coupling agent being tested.

- An ultrasound transmitter emits waves.
- The waves pass through the coupling agent and then through the water.
- The waves are detected by the ultrasound receiver.

Figure 1



A scientist tests different coupling agents.

Suggest which variables she must control.

Tick (✓) **two** boxes.

	Tick (✓)
The amount of light in the room	
The colour of the coupling agent	
The width of the coupling agent	
The width of the water	

(2)

(e) The table shows the results for coupling agents **A**, **B**, **C**, **D**, **E**, **F** and **G**.

They were tested using the two frequencies, 1.1 MHz and 3.0 MHz.

The results show how well the waves pass through the coupling agent compared with how they pass through water. The results are shown as a percentage.

100% means that the coupling agent behaves the same as water.

Coupling agent	**Coupling agent percentage using 1.1 MHz**	**Coupling agent percentage using 3.0 MHz**
A	108	100
B	105	100
C	104	98
D	100	98
E	98	98
F	95	99
G	89	88

(i) Which coupling agent allows most ultrasound to pass through at

both frequencies? ☐

(1)

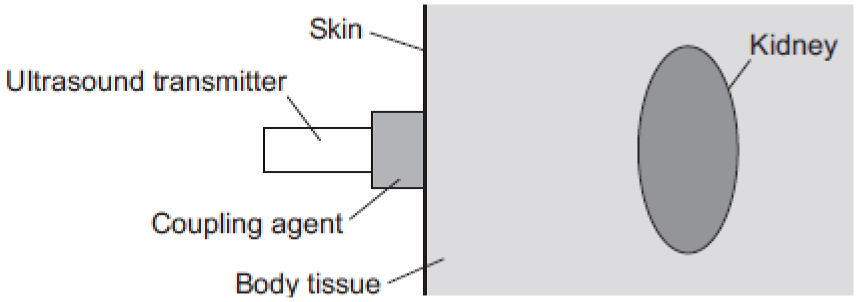
(ii) Which coupling agent performs the same for both frequencies? ☐

(1)

(f) **Figure 2** shows an ultrasound transmitter sending waves into a patient's body.

The waves enter the body and move towards a kidney.

Figure 2



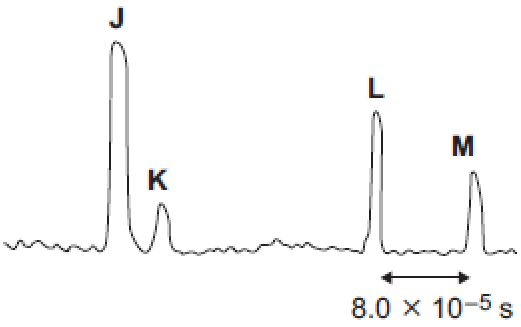
The transmitter also detects the ultrasound waves.

The transmitter is connected to an oscilloscope.

Figure 3 shows the trace on the screen of the oscilloscope.

J represents the intensity of the waves emitted by the transmitter.

Figure 3



(i) Explain the intensities at **K**, **L** and **M**.

....

....

....

....

....

....

....

....

....

....

(6)

(ii) The speed of ultrasound waves in the body is 1500 m / s.

Use information from **Figure 3** to calculate the maximum width of the kidney.

Use the correct equation from the Physics Equations Sheet.

....

....

....

Maximum width of kidney = ... m

(3)
(Total 19 marks)

June 2015 Answers D

M1.(a) high frequency sound (waves)

1

with a frequency above limit of human hearing
or with a frequency greater than 20 000 Hz

above limit of human hearing
***or** greater than 20 000 Hz gains maximum **1** mark*

1

(b) $5(.0) \times 10^{-4}$ (m)
or
0.0005 (m)

*$1500 = 3 \times 10^{6}\ \lambda$ gains **2** marks*
*answer of 500 gains **2** marks*
*$1500 = 3.0\ \lambda$ gains **1** mark*

3

(c) it will run off the surface of the skin
or
water is not a gel

accept water would evaporate

1

(d) The width of the coupling agent

1

The width of the water

1

(e) (i) A

1

(ii) E

1

(f) (i) **K**
reflection from skin

maximum 5 marks if no mention of reflection

1

very little reflection, so small peak

1

L
reflection from front of kidney

1

large amount of reflection, so large peak

1

M
reflection from back of kidney

1

smaller peak due to absorption of ultrasound in kidney
or
smaller peak as further from source
or
front of the kidney already reflected a lot, so there is now less to be reflected

reflection from a boundary gains 1 mark if no other mark given

1

(ii) 0.06 (m)
or
$6(.0) \times 10^{-2}$

*0.12 (m) gains **2** marks*

*distance = $1500 \times 8 \times 10^{-5} \times 0.5$ gains **2** marks*

*distance = $1500 \times 8 \times 10^{-5}$ gains **1** mark*

3

[19]