The Use of Waves for Communication

Question Paper

Level	IGCSE
Subject	Physics (4403)
Exam Board	AQA
Unit	P1
Topic	Waves for Communication; Universe Expanding
Sub-Topic	The Use of Waves for Communication
Booklet	Question Paper

Time Allowed: **57 minutes**

Score: **/57**

Percentage: **/100**

Grade Boundaries:

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'?

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.....

.....

(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.

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.....

.....

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.

.....

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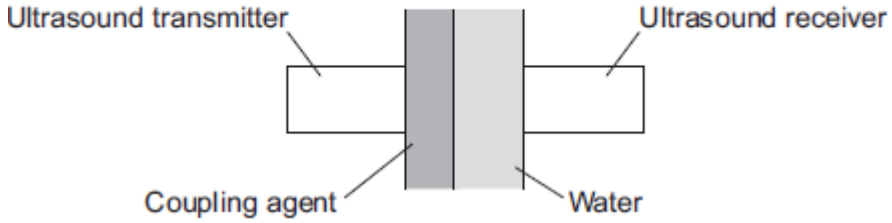
(1)

(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)

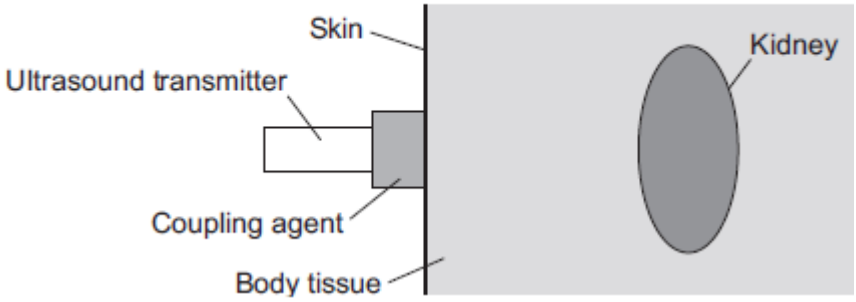
(ii) Which coupling agent performs the same for both frequencies? ☐

(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



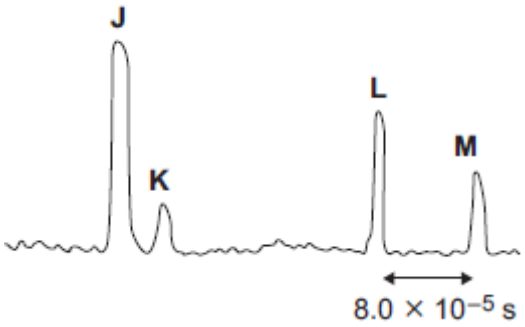
The transmitter also detects the ultrasound waves.

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**.

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(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)

Q2. Light changes direction as it passes from one medium to another.

(a) Use the correct answer from the box to complete the sentence.

diffraction	**reflection**	**refraction**

The change of direction when light passes from one medium to another is called ..... .

(1)

(b) Draw a ring around the correct answer to complete the sentence.

When light passes from air into a glass block, it changes

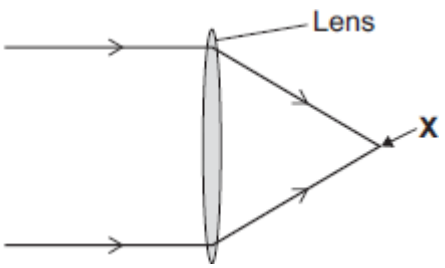
direction

away from the normal.
towards the normal.
to always travel along the normal.

(1)

(c) **Diagram 1** shows light rays entering and passing through a lens.

Diagram 1



(i) Which type of lens is shown in **Diagram 1**?

Draw a ring around the correct answer.

concave **convex** **diverging**

(1)

(ii) In **Diagram 1**, what is the point **X** called?

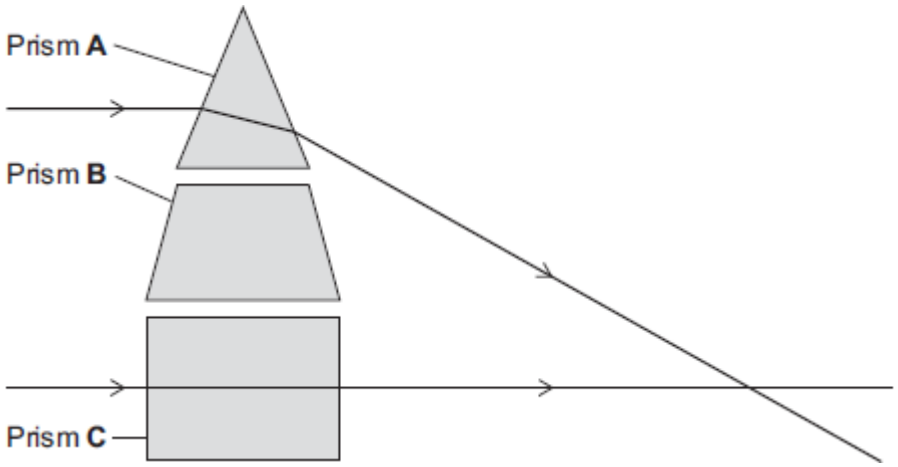
.....

(1)

(d) A lens acts like a number of prisms.

Diagram 2 shows two parallel rays of light entering and passing through prism **A** and prism **C**.

Diagram 2



Draw a third parallel ray entering and passing through prism **B**.

(4)

(e) What **two** factors determine the focal length of a lens?

1 .....

2 .....

(2)

(f) A converging lens has a focal length of 20 cm.

Calculate the power, in dioptre, of the lens.

Use the correct equation from **Section B** of the Physics Equations Sheet.

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Power of the lens = ... dioptre

(2)

(Total 12 marks)

Q3. Different parts of the electromagnetic spectrum have different uses.

(a) The diagram shows the electromagnetic spectrum.

Radio waves	Microwaves	Infrared	Visible light	Ultraviolet	X-rays	Gamma rays

(i) Use the correct answers from the box to complete the sentence.

amplitude	**frequency**	**speed**	**wavelength**

The arrow in the diagram is in the direction of increasing .....

and decreasing ..... .

(2)

(ii) Draw a ring around the correct answer to complete the sentence.

The range of wavelengths for waves in the electromagnetic

spectrum is approximately 10^{-15} to 10^{4} metres.

10^{-4} to 10^{4}
10^{4} to 10^{15}

(1)

(b) The wavelength of a radio wave is 1500 m.
The speed of radio waves is 3.0×10^{8} m / s.

Calculate the frequency of the radio wave.

Use the correct equation from **Section B** of the Physics Equations Sheet.

Give the unit.

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.....

.....

Frequency = ...

(3)

(c) (i) State **one** hazard of exposure to infrared radiation.

.....

(1)

(ii) State **one** hazard of exposure to ultraviolet radiation.

.....

(1)

(d) X-rays are used in hospitals for computed tomography (CT) scans.

(i) State **one** other medical use for X-rays.

.....

.....

(1)

(ii) State a property of X-rays that makes them suitable for your answer in part **(d)(i)**.

.....

.....

(1)

(iii) The scientific unit of measurement used to measure the dose received from radiations, such as X-rays or background radiation, is the millisievert (mSv).

The table shows the X-ray dose resulting from CT scans of various parts of the body.

The table also shows the time it would take to get the same dose from background radiation.

Part of the body	X-ray dose in mSv	Time it would take to get the same dose from background radiation
Abdomen	9.0	3 years
Sinuses	0.5	2 months
Spine	4.0	16 months

A student suggests that the X-ray dose and the time it would take to get the same dose from background radiation are directly proportional.

Use calculations to test this suggestion and state your conclusion.

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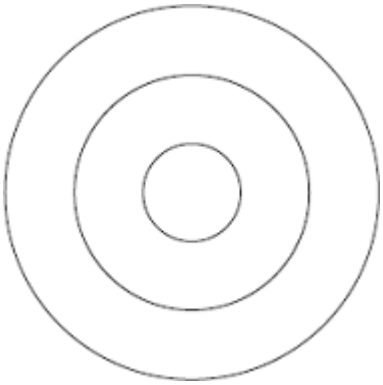
(3)
(Total 13 marks)

Q4.A teacher demonstrates the production of circular waves in a ripple tank.

Diagram 1 shows the waves at an instant in time.

Diagram 1



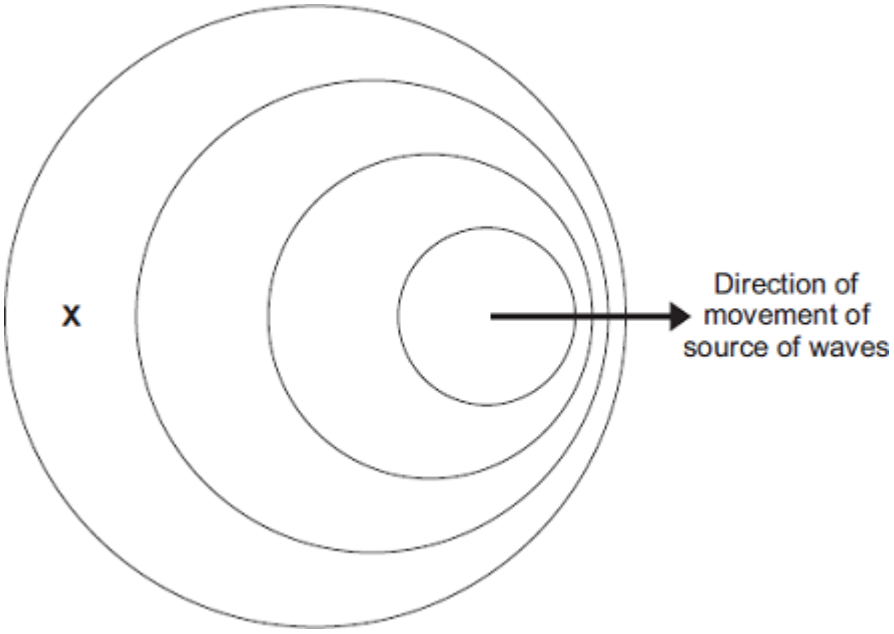
(a) Show on **Diagram 1** the wavelength of the waves.

(1)

(b) The teacher moves the source of the waves across the ripple tank.

Diagram 2 shows the waves at an instant in time.

Diagram 2
(Actual size)



(i) Use the correct answer from the box to complete each sentence.

decreased	**increased**	**stayed the same**

In **Diagram 2**, the observed wavelength of the waves at **X**

has ..... .

In **Diagram 2**, the frequency of the waves at **X**

has ..... .

(2)

(ii) Take measurements from **Diagram 2** to determine the wavelength of the waves received at **X**.

Give the unit.

.....

.....

Wavelength = ...

(3)

(c) The teacher uses the waves in the ripple tank to model the changes in the wavelengths of light observed from distant galaxies.

When observed from the Earth, there is an increase in the wavelength of light from distant galaxies.

(i) State the name of this effect.

.....

(1)

(ii) What does this increase in wavelength tell us about the movement of most galaxies?

.....

.....

(1)

(iii) Explain how this observation supports the Big Bang theory of the formation of the Universe.

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(4)

(iv) State **one** other piece of evidence that supports the Big Bang theory of the formation of the Universe.

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(1)
(Total 13 marks)