Name:

Date:

P6 - Test 6
Waves
Advanced

GCSE

PHYSICS

AQA - Triple Science

Mark

Grade

Materials

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

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1. Light is usually described as a wave. Light can also be described as a stream of particles.

These are two different scientific models of light.

(a) Which statement describes a scientific model?

Tick **one** box.

A small scale version of a real object. ☐

A way of guessing what will happen. ☐

An idea used to explain observations and data. ☐

(1)

(b) Why do scientists sometimes have different models like the wave and particle models of light?

_____

_____

(1)

(c) Sometimes an old scientific model is replaced by a new model.

Explain why scientists replace an old scientific model with a new model.

Include an example from Physics in your answer.

_____

_____

_____

_____

_____

_____

_____

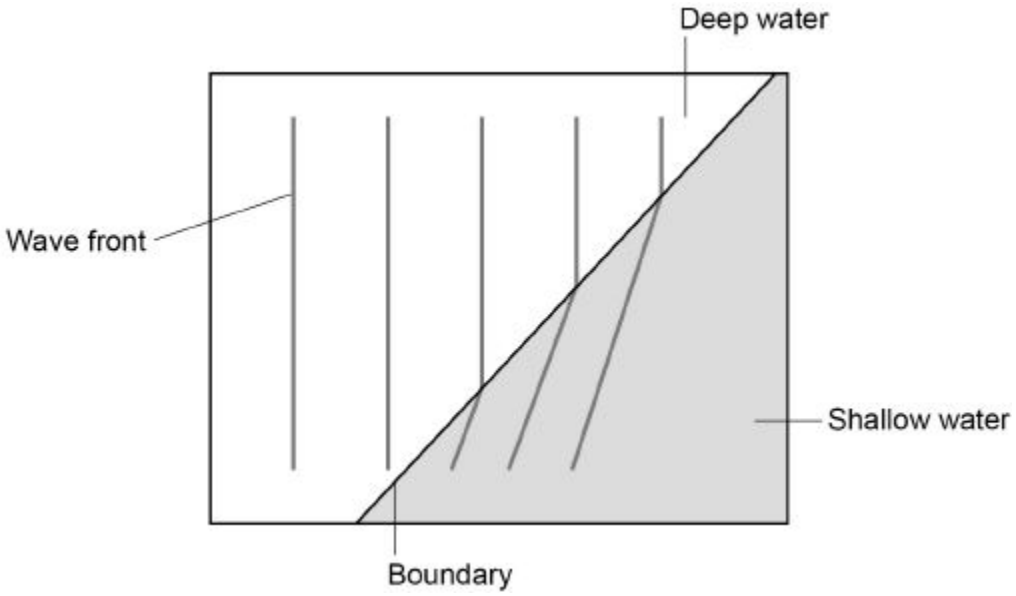
_____

(4)

Some students used water waves in a ripple tank to model the behaviour of light waves.

(d) **Figure 1** shows what happens to the wave fronts as they pass the boundary between deep water and shallower water.

Figure 1



Explain why refraction happens at the boundary between the deep water and shallower water.

_____

_____

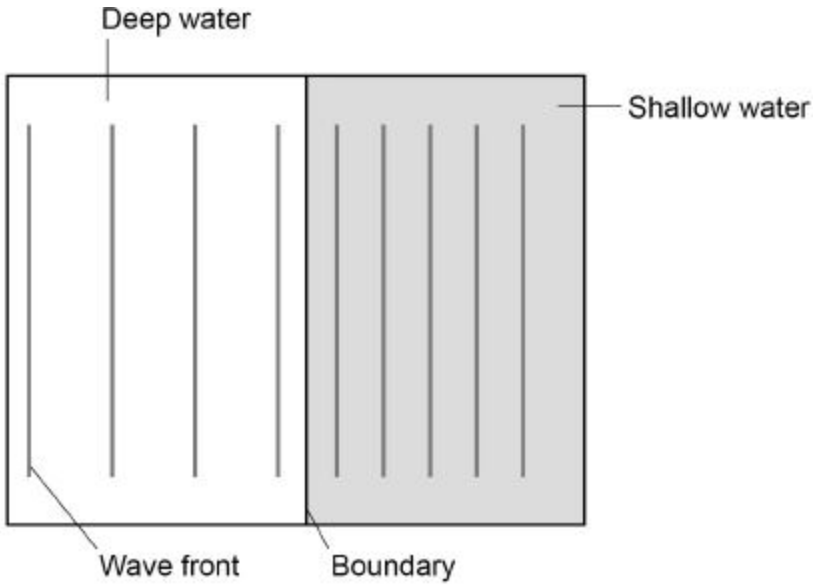
_____

_____

(3)

(e) **Figure 2** shows the wave fronts travelling parallel to the boundary between deep water and shallower water.

Figure 2



Explain why the wave fronts in **Figure 2** do not refract at the boundary.

_____

_____

_____

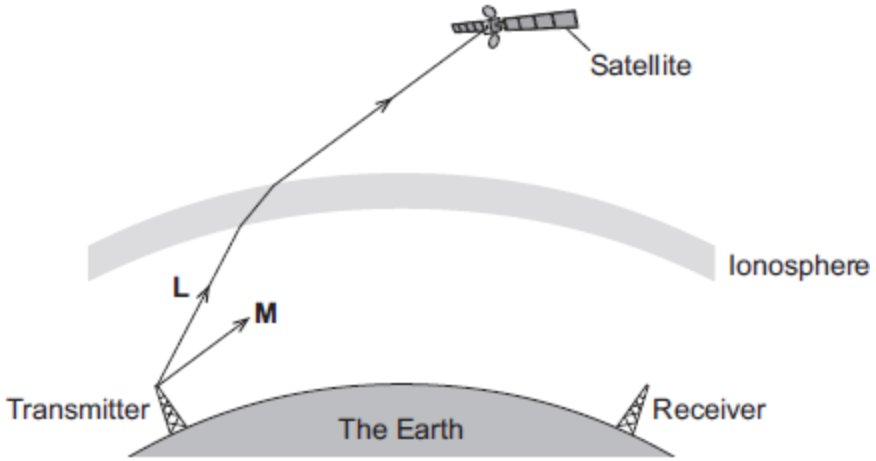
_____

(2)

(Total 11 marks)

2. Different parts of the electromagnetic spectrum are useful for different methods of communication.

The diagram shows a transmitter emitting two electromagnetic waves, **L** and **M**.



(a) (i) Wave **L** is used to send a signal to a satellite.
Which part of the electromagnetic spectrum does wave **L** belong to?

_____

(1)

(ii) What name is given to the process that occurs as wave **L** passes into the ionosphere?

_____

(1)

(b) Wave **M** is **reflected** by the ionosphere.

(i) On the diagram above, draw the path of wave **M** until it reaches the receiver.

(2)

(ii) On the daigram above, draw a line to show the normal where wave **M** meets the ionosphere. Label the line **N**.

(1)

(c) Give **two** properties of all electromagnetic waves.

1. _____

_____

2. _____

_____

(2)

(Total 7 marks)

3. 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.

_____

_____

_____

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.

_____

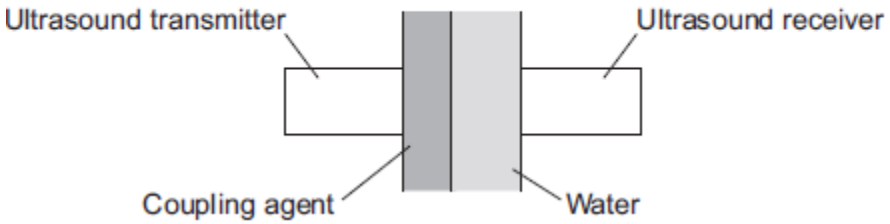
_____

(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)

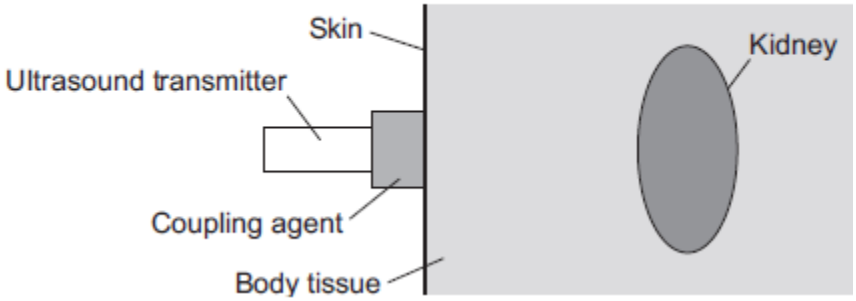
(ii) Which coupling agent performs the same for both frequencies? ☐

(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



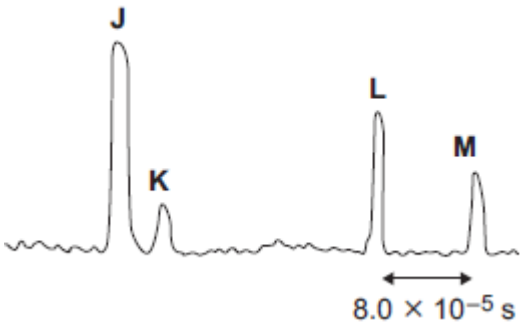
The transmitter also detects the ultrasound waves.

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.

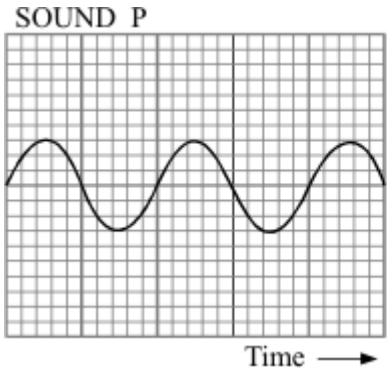
Use information from **Figure 3** to calculate the maximum width of the kidney.

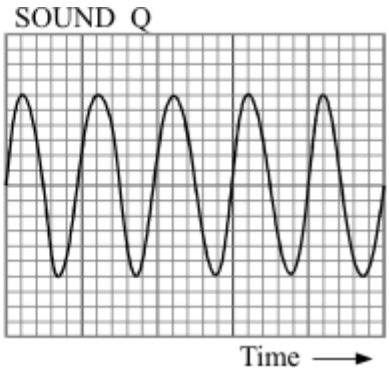
Maximum width of kidney = _____ m

(3)

(Total 19 marks)

4. The diagram shows the oscilloscope traces of two different sounds P and Q. The oscilloscope setting is exactly the same in both cases.





P and Q **sound** different.
Write down **two** differences in the way they sound.
Explain your answers as fully as you can.

1. _____

_____

_____

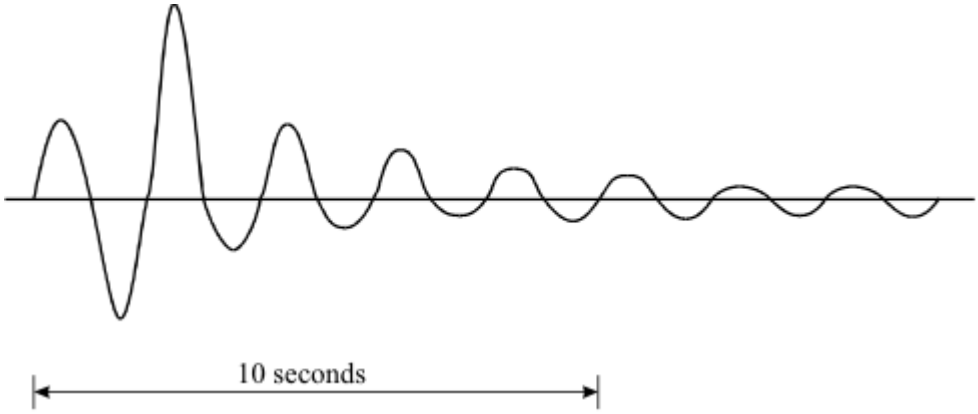
2. _____

_____

_____

(Total 5 marks)

5. The vibration caused by a P wave travelling at 7.6 km/s has been recorded on a seismic chart.



(i) How many waves are produced in one second?

_____

(1)

(ii) Write down the equation which links frequency, wavelength and wave speed.

_____

(1)

(iii) Calculate the wavelength of the P wave. Show clearly how you work out your answer and give the unit.

_____

_____

_____

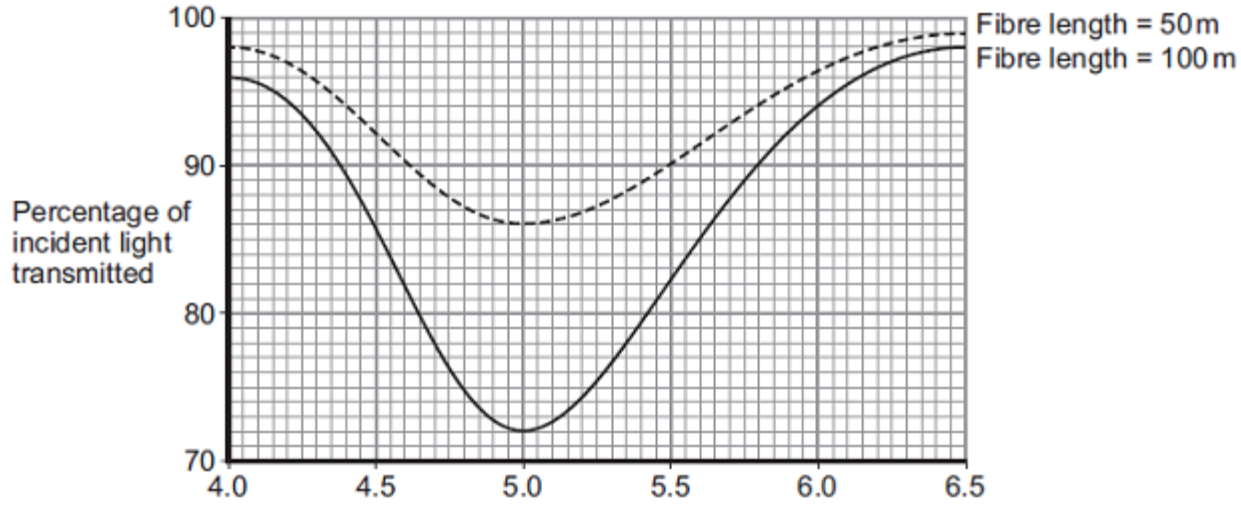
Wavelength = _____

(2)

(Total 4 marks)

6. Different wavelengths of light can be used to transmit information along optical fibres.

The graph below shows how the percentage of incident light transmitted through a fibre varies with the wavelength of light and the length of the fibre.



Compare the percentages of incident light transmitted through the two different fibres over the range of wavelengths shown.

(Total 3 marks)

7. (a) Electromagnetic waves form a continuous spectrum with a range of wavelengths.

What is the approximate range of wavelengths of electromagnetic waves?

Tick (✓) **one** box.

10^{-15} metres to 10^{4} metres ☐

10^{-4} metres to 10^{15} metres ☐

10^{-6} metres to 10^{6} metres ☐

(1)

(b) Infrared waves and microwaves are used for communications.

(i) Give **one** example of infrared waves being used for communication.

_____

_____

(1)

(ii) A mobile phone network uses microwaves to transmit signals through the air. The microwaves have a frequency of 1.8×10^{9} Hz and travel at a speed of 3.0×10^{8} m/s.

Calculate the wavelength of the microwaves.

Give your answer to **two** significant figures.

_____

_____

_____

Wavelength = _____ m

(3)

(c) Some scientists suggest there is a possible link between using a mobile phone and male fertility.

The results of their study are given in the table.

Mobile phone use in hours per day	Sperm count in millions of sperm cells per cm^3 of semen
0	86
less than 2	69
2 – 4	59
more than 4	50

The results show a negative correlation: the more hours a mobile phone is used each day, the lower the sperm count. However, the results do **not** necessarily mean using a mobile phone causes the reduced sperm count.

Suggest **one** reason why.

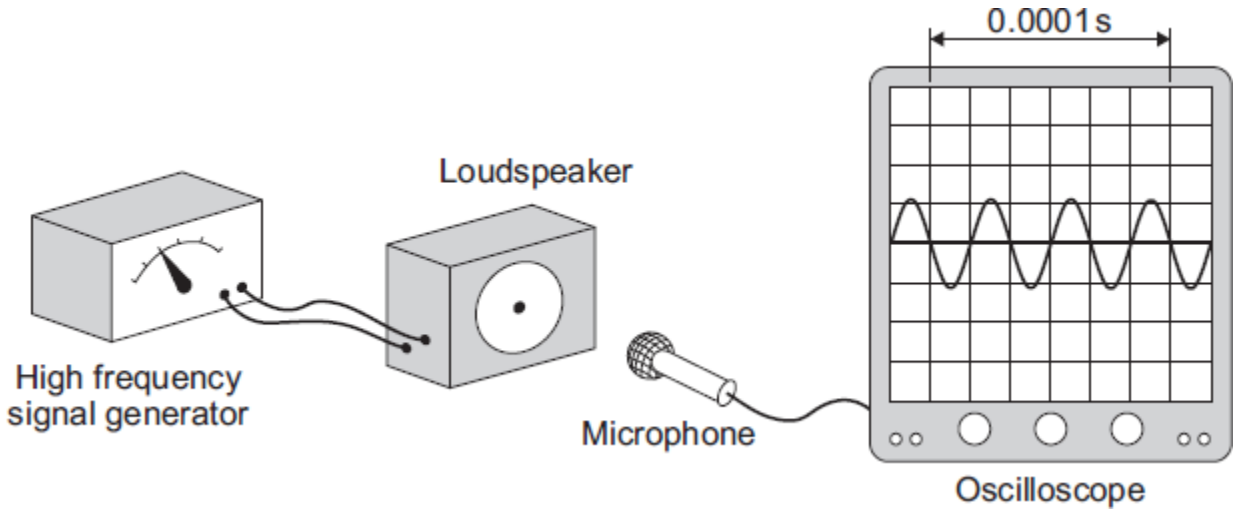
_____

_____

(1)

(Total 6 marks)

8. (a) The diagram shows a microphone being used to detect the output from a loudspeaker. The oscilloscope trace shows the wave pattern produced by the loudspeaker.



(i) How many waves are produced by the loudspeaker in 0.0001 seconds?

_____

(1)

(ii) How many waves are produced by the loudspeaker every second?
Assume the input to the loudspeaker does not change.

_____

_____

(1)

(iii) A person with normal hearing cannot hear the sound produced by the loudspeaker.

Explain why.

_____

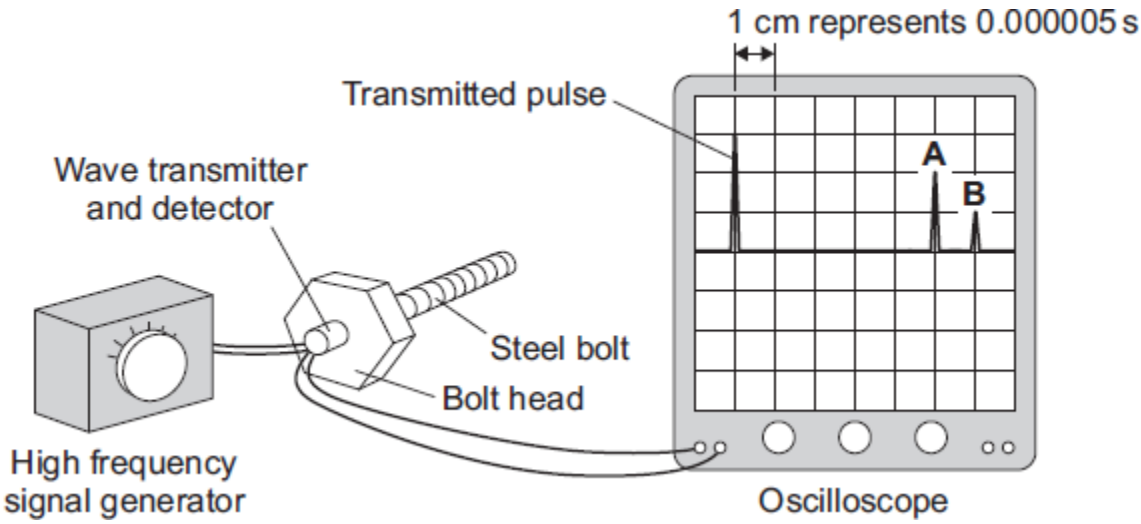
_____

_____

_____

(2)

(b) The diagram shows how a very high frequency sound wave can be used to check for internal cracks in a large steel bolt. The oscilloscope trace shows that the bolt does have an internal crack.



(i) Explain what happens to produce pulse **A** and pulse **B**.

_____

_____

_____

_____

(2)

(ii) Use the information in the diagram and the equation in the box to calculate the distance from the head of the bolt to the internal crack.

distance = speed × time

Speed of sound through steel = 6000 m/s

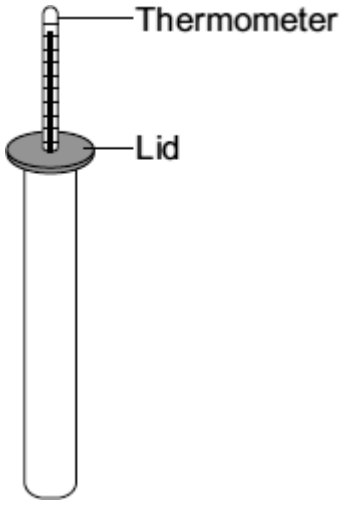
Show clearly how you work out your answer.

(3)

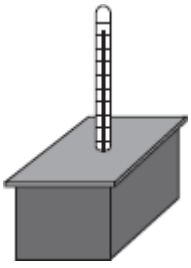
(Total 9 marks)

9. A student investigated the effect of shape and colour on heat transfer.

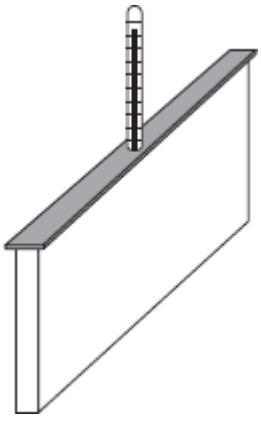
The student used metal containers with the same volume but with different shapes and outside colour. The containers were each filled with water at 100 °C.
After 20 minutes the temperature of the water inside each container was measured.



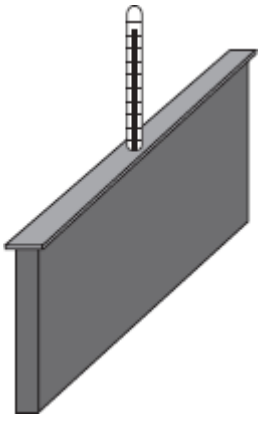
A



B



C



D

The results from the investigation are given in the table.

Container	Colour	Temperature after 20 minutes in °C	Temperature fall in °C
A	White	86	14
B	Black	86	14
C	White	73	27
D	Black	60	40

(i) The student uses the results in the table to see if shape has affected heat transfer.

Which containers should the student compare to do this?

_____

Give a reason for your answer.

_____

_____

(1)

(ii) Explain why the temperature of the water in both containers **A** and **B** fell by the same amount.

_____

_____

_____

_____

(2)

(iii) A central heating system has several radiators joined together. The hot water goes from the boiler, through each radiator in turn and then back to the boiler for reheating.

Give **one** reason, other than appearance, why it might **not** be a good idea to paint radiators black.

_____

_____

(1)

(Total 4 marks)

10. (a) The diagrams show oscilloscope traces for the same musical note played on two different instruments. The oscilloscope settings are not changed.

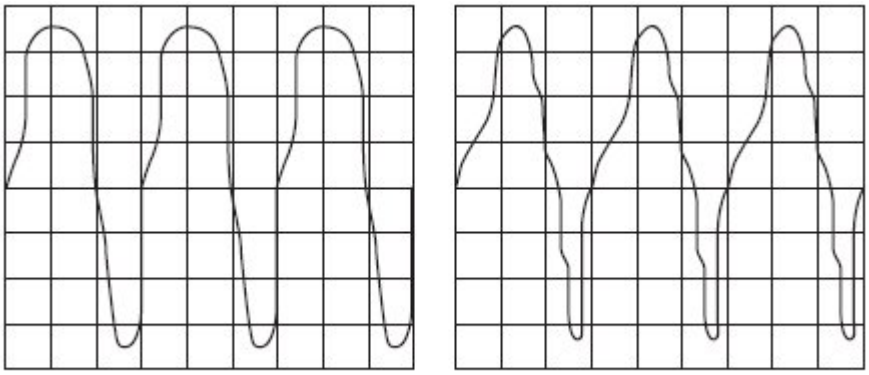


Diagram X

Diagram Y

(i) How can you tell, from the diagrams, that it is the same musical note?

_____

_____

(1)

(ii) How can you tell, from the diagrams, that the musical note has been played on different instruments?

_____

_____

(1)

(b) This passage is from an electronics magazine.

> *Electronic systems can be used to produce ultrasound waves. These waves have a higher frequency than the upper limit for hearing in humans.*
> *Ultrasound waves are partially reflected when they meet a boundary between two different media.*

(i) Approximately what is the highest frequency that humans can hear?

State the number and the unit.

_____

(1)

(ii) What does the word *media* mean when it is used in this passage?

_____

_____

(1)

(iii) What happens to the ultrasound which reaches the boundary between two different media and is **not** reflected?

_____

_____

_____

_____

(2)

(Total 6 marks)