IGCSE PHYSICS 0625 · TOPICAL PAST PAPERS

Sound

Paper 2 — Theory / Structured Questions (topical compilation)

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M.Eng NUS Singapore · B.Eng NUST · 15+ years of teaching experience in Singapore, UAE & Pakistan · 60,000+ subscribers and 20 million+ video lecture views.

1 Ultrasound may be used to measure the depth of the sea. Fig. 11.1 shows a pulse of ultrasound sent down to the sea bed and the reflected pulse returning to the ship.

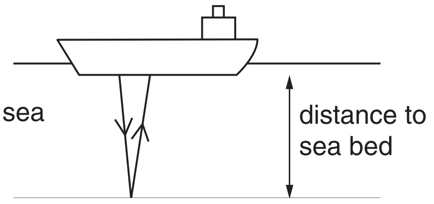

Fig. 11.1

(a) Describe what is meant by *ultrasound*. [2]

(b) Fig. 11.2 is a cathode-ray oscilloscope (c.r.o.) trace of the pulses of ultrasound sent from the ship and the reflected pulses.

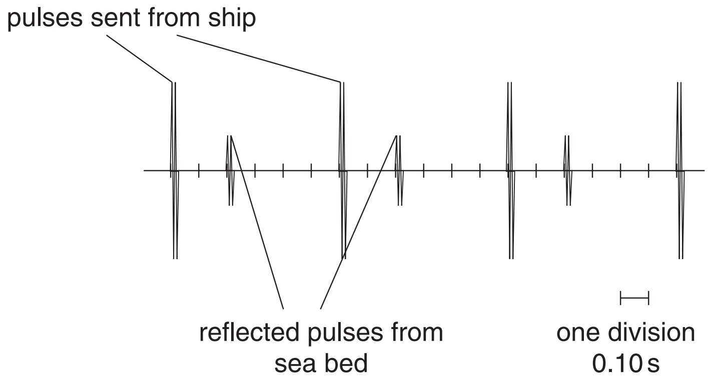

Fig. 11.2

The speed of ultrasound in water is 1500 m/s and the wavelength of the ultrasound wave is 0.030 m. The time-base setting for the *x*-axis on the c.r.o. is 0.10 s/division.

Calculate

(i) the frequency of the ultrasound wave,

(ii) the time taken for the ultrasound pulse to reach the sea bed,

(iii) the distance to the sea bed.

[7]

(c) The ship moves to a place where the sea is deeper.

(i) State and explain two changes that would occur to the reflected pulses on the c.r.o. trace. You may give diagrams of the old and new traces to show the changes.

(ii) When the sea is more than 450 m deep, the ultrasound pulses must be sent out less often. Using data from Fig. 11.2, explain why this is necessary.

[6]

5054/02/M/J/03/Q11

2 Fig. 4.1 shows a student clapping in front of a vertical wall. The wall reflects the sound.

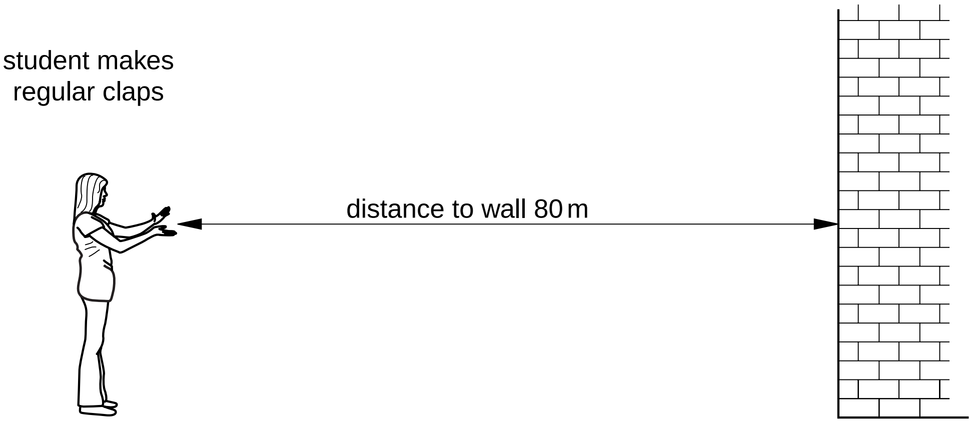

Fig. 4.1

The student changes the number of claps made in 1 minute until the reflection of each clap returns to her at exactly the same time as she makes the next clap.

The speed of sound in air is 330 m/s.

(a) Explain what is meant by *speed*.

....

....[1]

(b) Calculate the time between claps.

time = …………………….. [3]

(c) Calculate the number of claps in 1 minute.

number of claps = ……………….. [2]

5054/02 M/J/04/Q4

3 Fig. 6.1 shows how ultrasound is used to produce an image of the heart.

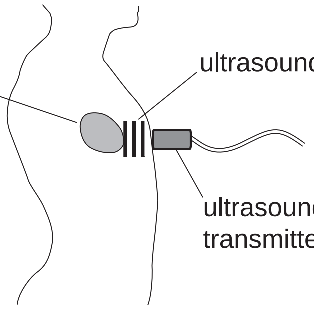

Fig. 6.1

(a) Define *ultrasound*.

....

.... [1]

(b) The ultrasound has a wavelength of 1.2×10^{-3} m. The speed of the ultrasound in the human body is 1500 m/s.

Calculate the frequency of the ultrasound.

frequency = ... [2]

(c) Ultrasound is a longitudinal wave.
Describe how particles in the body move as the ultrasound passes.

You may draw a diagram if you wish.

....

....

.... [2]

(d) There are small bubbles of gas in the body.

Explain why these bubbles expand and contract as the ultrasound passes.

....

....

.... [1]

5054/02/M/J/09/Q6

4 **(a)** Describe a method for measuring the speed of sound in air. In your account, state clearly
- how the sound is made,
- what measurements are taken,
- how the result is calculated,
- one precaution to produce an accurate result.

....

....

....

....

....

....

....

....

....

....

....

.... [5]

(b) Ultrasound is used in quality control to detect cracks in metal.

Pulses of ultrasound are sent into the metal from a transmitter. A detector is placed next to the transmitter on the front surface of the metal.

Fig. 10.1 shows the oscilloscope trace of the ultrasound pulses produced if the metal contains no cracks.

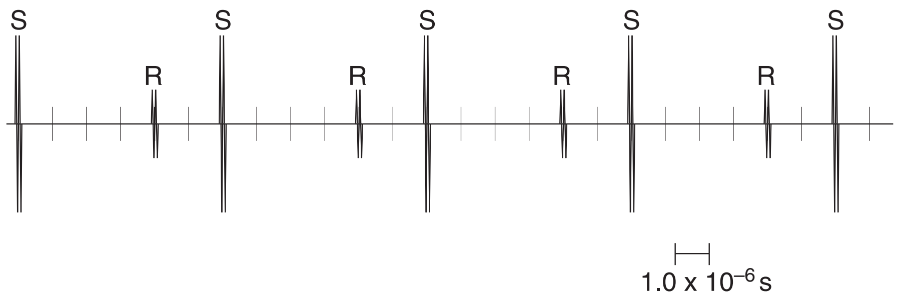

Fig. 10.1

One division along the *x*-axis represents 1.0×10^{-6} s.

Pulses labelled S are the pulses initially sent out from the transmitter. Each pulse labelled R is the reflection from the back surface of the metal of the previous pulse S.

(i) State what is meant by *ultrasound*.

....

....[2]

(ii) Use Fig. 10.1 to calculate the number of pulses sent out by the source in one second.

number = ...[2]

(iii) Suggest two reasons why the amplitude of R is less than the amplitude of S.

1. ....

....

2. ....

....

[2]

(iv) Some time later, the piece of metal is tested again. It now has a small crack half-way between the front surface and the back surface.

On Fig. 10.1, draw the position and size of the pulses produced by this crack.

Label each of these pulses C. [2]

(v) A second beam of ultrasound has a frequency of 8.0×10^6 Hz and a speed of 4000 m/s in the metal.

Calculate the wavelength of this ultrasound in the metal.

wavelength = ...[2]

5054/22/M/J/10/Q10

5 Fig. 6.1 shows a bat.

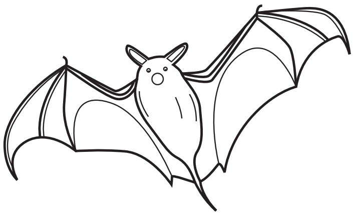

Fig. 6.1

Bats emit short bursts of ultrasound. The echoes of the ultrasound help the bat find insects and prevent the bat flying into objects.

(a) State what is meant by an *echo*.

....

.... [1]

(b) Fig. 6.2 shows the variation with time of air pressure caused by a burst of ultrasound.

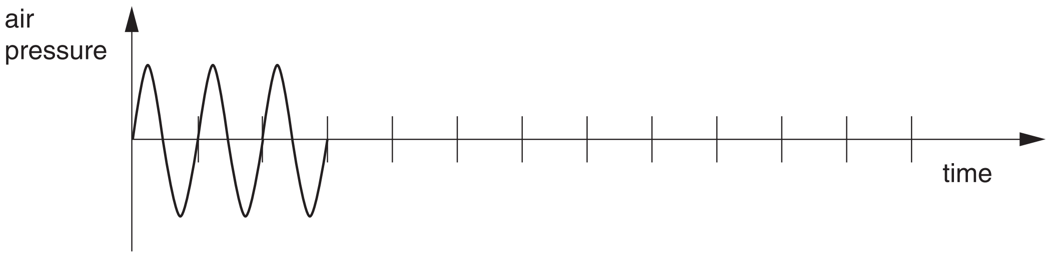

Fig. 6.2

On Fig. 6.2, draw a possible echo formed by this burst of ultrasound. [2]

(c) State

(i) the approximate range of frequencies of sound audible to humans,

.... [1]

(ii) how the frequency of ultrasound differs from frequencies in this audible range.

....

.... [1]

5054/21/M/J/11/Q6

6 A sound from an electronic organ is played into a microphone which is connected to a cathode-ray oscilloscope (c.r.o.). Fig. 6.1 shows the trace on the c.r.o. produced by the sound.

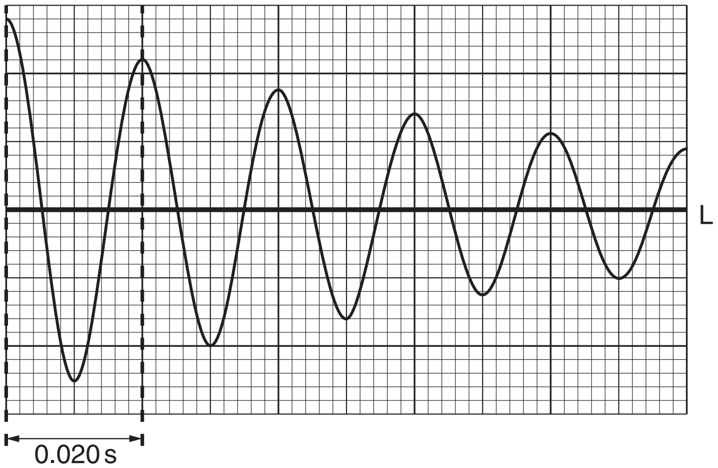

Fig. 6.1

The horizontal line marked L is the trace seen when there is no sound.

(a) **(i)** State how Fig. 6.1 shows that the loudness of the sound decreases with time.

....[1]

(ii) State how Fig. 6.1 shows that the pitch of the sound is constant.

....

....[1]

(b) **(i)** State what is meant by the *frequency* of a wave.

....

....[1]

(ii) The time for one complete cycle of the wave in Fig. 6.1 is 0.020 s.
Calculate the frequency of the wave.

frequency = ...[2]

(iii) Determine the time taken for the amplitude of the trace in Fig. 6.1 to decrease to half its initial value.

time = ...[1]

5054/21/M/J/12/Q6

7 A sound wave travels through air.

(a) Explain what is meant by the *wavelength* of a wave.

....

.... [1]

(b) Fig. 10.1 represents air molecules in the sound wave at one instant.

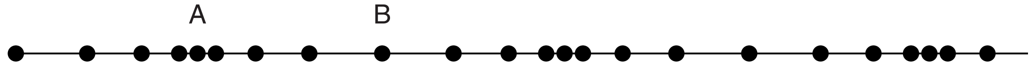

Fig. 10.1

(i) Describe the motion of a molecule of air due to the sound.

....

.... [2]

(ii) State one difference between the motion of molecule A and the motion of molecule B.

....

.... [1]

(c) Describe an experiment that shows that a medium is needed to transmit sound waves. Draw a labelled diagram of the apparatus.

....

....

....

....

....

.... [4]

(d) A short pulse of sound waves produces an echo from a wall 20 m away. The echo arrives back at the source of the sound 0.12 s after the pulse is produced.

The wavelength of the sound wave is 30 mm.

(i) State what is meant by an *echo*.

....

.... [1]

(ii) Calculate the speed of the sound.

speed = ... [2]

(iii) Calculate the frequency of the sound.

frequency = ... [3]

(iv) The sound wave produces compressions and rarefactions in the air as it passes.

Calculate the distance between a compression and the nearest rarefaction.

distance = ... [1]

5054/21/M/J/14/Q10

8 **(c)** A loudspeaker produces a sound of frequency 2.0 kHz. The wavelength of this sound in air is 16 cm.

(i) Calculate the speed of sound in air.

speed = ...[2]

(ii) **1.** State the range of frequencies that can be heard by a healthy human ear.

....[1]

2. Calculate the smallest wavelength of sound that can be heard by a healthy human ear.

wavelength = ...[1]

(iii) Describe a simple experiment to show that sound waves obey the law of reflection.
You may draw a diagram if you wish.

....

....

....

....[3]

5054/21/M/J/17/Q10

9 **(b)** A sound wave has a frequency of 3.8 kHz and a speed of 330 m / s.

(i) Calculate the wavelength of the sound.

wavelength = ...[2]

(ii) A different sound has a frequency of 3.8 Hz.

State and explain whether a human with normal hearing is able to hear this sound.

....

....

....[1]

5054/22/M/J/17/Q6

10 **(b)** A student reads in a textbook that the speed of sound in air is about 300 m / s.

He plans an experiment to check this value.

He asks another student to stand a long distance away in a large open space.

One student has a starting pistol. The pistol, when fired, produces a loud sound and a puff of smoke at the same instant.

(i) Other pieces of apparatus are needed for this experiment in order to measure the speed of sound.

Name two other pieces of apparatus that are needed.

1. ....

2. ....
[2]

(ii) Describe how all the measurements are made.

....

....

....

....

....

....

....

.... [3]

(iii) State typical values for the speed of sound in:

1. a liquid

....

2. a solid.

....
[2]

5054/21/M/J/19/Q10

11 Ultrasound and X-rays are both used in medical imaging.

(a) (i) Define what is meant by *ultrasound*.

....

.... [2]

(ii) Describe what happens to ultrasound waves as they meet the boundary between two different materials.

....

.... [2]

(iii) To produce the image of an unborn child, an ultrasound emitter and receiver are placed close together on the mother's skin.

Fig. 9.1 shows pulses detected by the receiver.

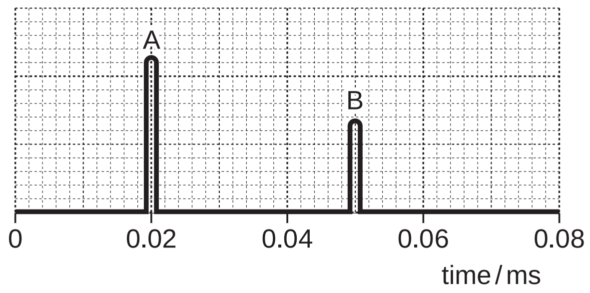

Fig. 9.1

Pulse A is the emitted pulse and pulse B is the first pulse that returns from the unborn child.

The average speed of ultrasound in human tissue is 1500 m / s.

Calculate the distance between the emitter and the child.

distance = ... [3]

(iv) The speed of ultrasound in human tissue is close to the speed of sound in water.

Suggest approximate values for the speed of sound in gases and solids.

speed in gases ....

speed in solids ....
[2]

5054/21/M/J/20/Q9

12 **(a)** In a demonstration, a teacher uses a loud ticking clock, two hollow tubes A and B, a barrier and a smooth surface. The clock is used as a source of sound.

Fig. 4.1 shows tube A and the clock, both fixed in position on the left of the barrier.

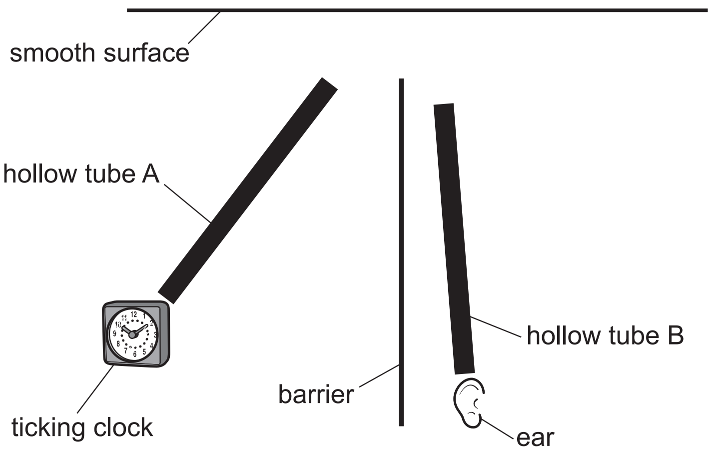

Fig. 4.1

Sound from the ticking clock passes along tube A and is incident on the smooth surface.

A student listens to the sound passing along tube B, which is on the right of the barrier.

(i) On Fig. 4.1, draw tube B in the position where the sound heard by the student is loudest. [1]

(ii) Explain your answer to **(i)**.

....

....

.... [2]

(b) The speed of sound in air is 330 m/s.

State a typical value for the speed of sound in a solid.

.... [1]

5054/22/M/J/21/Q4

13 A student measures the speed of sound in a laboratory, as shown in Fig. 11.1.

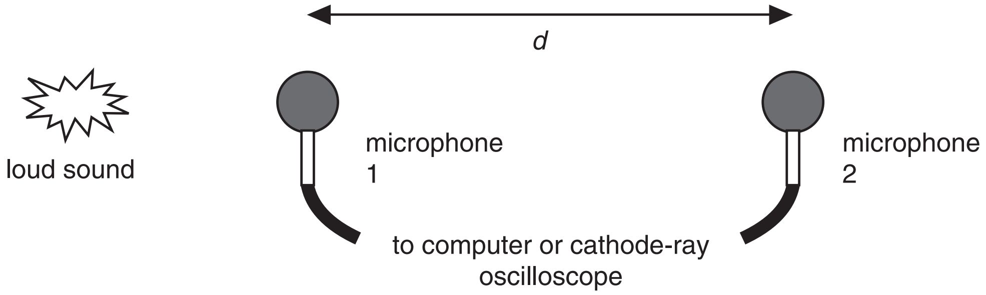

Fig. 11.1

The sound is received by two microphones placed a distance *d* apart. The time interval *t* between the sound arriving at the two microphones is recorded.

(a) **(i)** Explain how sound travels through the air to the microphones.

(ii) Explain why microphone 2 detects a quieter sound than microphone 1.

[5]

(b) Fig. 11.2 shows average values for *t* as *d* is varied.

d / m	1.00	2.00	3.00	4.00
t / s	0.0032	0.0060	0.0092	0.0121

Fig. 11.2

(i) Draw a distance-time graph from the results given in Fig. 11.2.

(ii) Using your graph, calculate the speed of sound in air.

[4]

(c) Fig. 11.3 shows the trace observed when the signals from the microphones are fed to the two inputs of a cathode-ray oscilloscope.

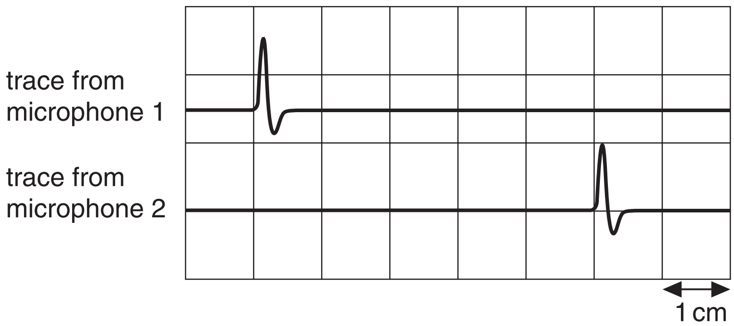

Fig. 11.3

The time-base setting on the cathode-ray oscilloscope is 1.0 ms / cm.

(i) Determine the time interval *t* from the trace in Fig. 11.3.

(ii) Using your answer to **(b)(ii)**, determine the distance *d* between the microphones.
[2]

(d) Give two reasons why it is difficult to measure the speed of sound inside a building using only a stopwatch and a metre rule. [2]

(e) The experiment in **(b)** and **(c)** is repeated under water where the microphones can still detect the sound. State and explain how the experimental results differ. [2]

5054/2/O/N/02/Q11

14 A sound wave in air is illustrated in Fig. 4.1.

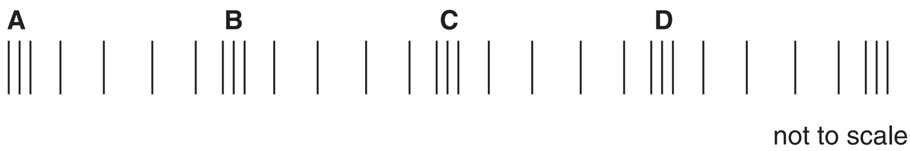

Fig. 4.1

Points **A**, **B**, **C** and **D** are at the centres of regions of compression.

(a) Describe what happens as one complete sound wave moves past a point.

....

....

....

.... [2]

(b) The sound wave in Fig. 4.1 has frequency 2000 Hz and speed 320 m/s.

(i) Define the *frequency* of a wave.

....

....

....

(ii) Calculate the distance between points **A** and **D**.

State clearly any equation that you use.

distance = ...
[5]

5054/02/O/N/03/Q4

15 This question is about the sound produced by a mobile phone and the energy changes while it is operating.

(a) The sound produced by a ringing phone consists of two notes, one after the other.

Fig. 5.1 shows the trace on an oscilloscope screen produced by the first of the notes.

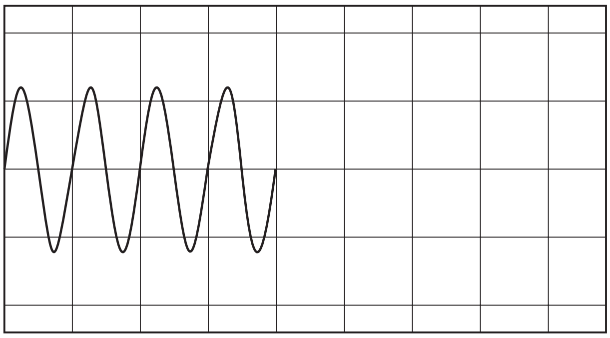

Fig. 5.1

The second note is louder and has a higher pitch.

(i) On Fig. 5.1, continue the trace to show what happens when the second note is sounding. [1]

(ii) Explain the differences between the two traces.

....

....

....

....

.... [2]

5054/02/O/N/05/Q5

16 Fig. 6.1 shows the cone of a loudspeaker.

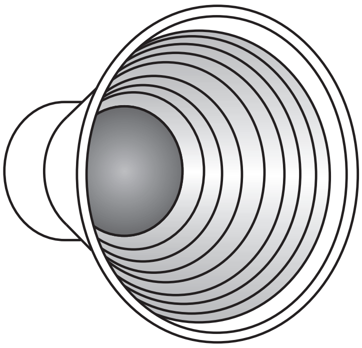

Fig. 6.1

(a) Sound is being produced. Describe in detail the behaviour of the cone and the air near to it.

....

....

....

....

.... [2]

(b) The lowest frequency that a human can hear is 20 Hz.

(i) State the highest frequency that a human with normal hearing can hear.

.... [1]

(ii) Calculate the longest wavelength of sound that a human can hear. The speed of sound in air is 340 m/s.

wavelength = ... [2]

5054/02/O/N/07/Q6

17 Fig. 9.1 shows one swimmer in a race starting before the signal.

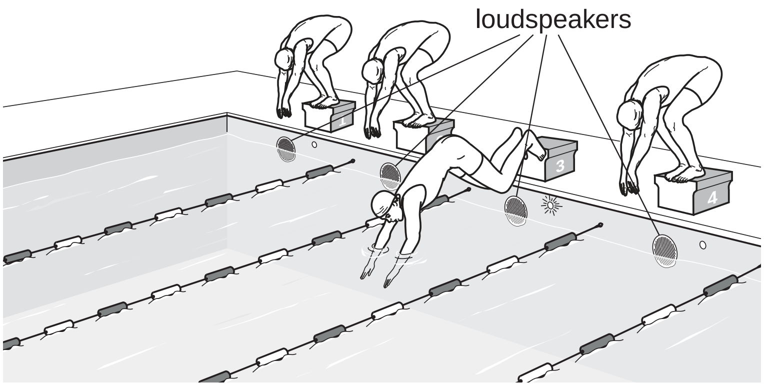

Fig. 9.1

The swimmer is called back by a loud, low-pitched sound from a loudspeaker positioned just at water level. The speed of sound in air is 330 m / s.

(a) **(i)** Describe how the loudspeaker causes sound to travel through the air. [3]

(ii) Explain, in terms of wave properties, what is meant by *loud* and *low-pitched*. [3]

(iii) The swimmer is 0.57 m from the loudspeaker when he hears the sound. Calculate the time taken for the sound to reach him through the air. [2]

(iv) Explain how the time taken differs when sound travels the same distance through air and through water. [2]

(b) The loudspeaker produces sound of frequency 0.20 kHz.

(i) Calculate the wavelength of this sound. [3]

(ii) Draw a diagram to show what is meant by the term *wavelength* when applied to a **longitudinal** wave such as sound. [2]

5054/02/O/N/08/Q9

18 Fig. 5.1 is a full-scale diagram that represents a sound wave of frequency 5.1 kHz in air.

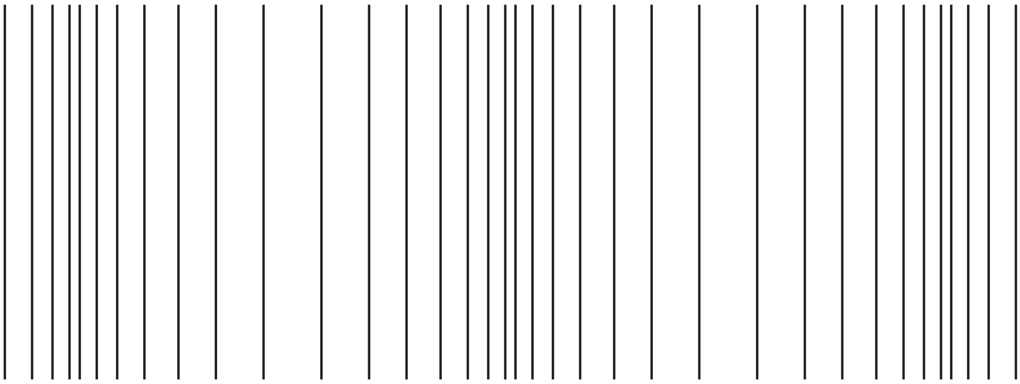

Fig. 5.1

(a) **(i)** On Fig. 5.1, mark the position of one compression with the letter C and of one rarefaction with the letter R. [2]

(ii) Using the full-scale diagram, measure the wavelength of this sound wave.

wavelength = ... [1]

(iii) Calculate the speed of sound in air.

speed = ... [3]

(b) A sound wave is longitudinal. Describe how a longitudinal wave differs from a transverse wave.

....

....

.... [2]

5054/02/O/N/09/Q5

19 A microphone is connected to a cathode-ray oscilloscope (c.r.o.). A note produced by a musical instrument causes a trace on the screen. The trace is stored electronically in the c.r.o.

Fig. 5.1 shows the stored trace displayed on the screen.

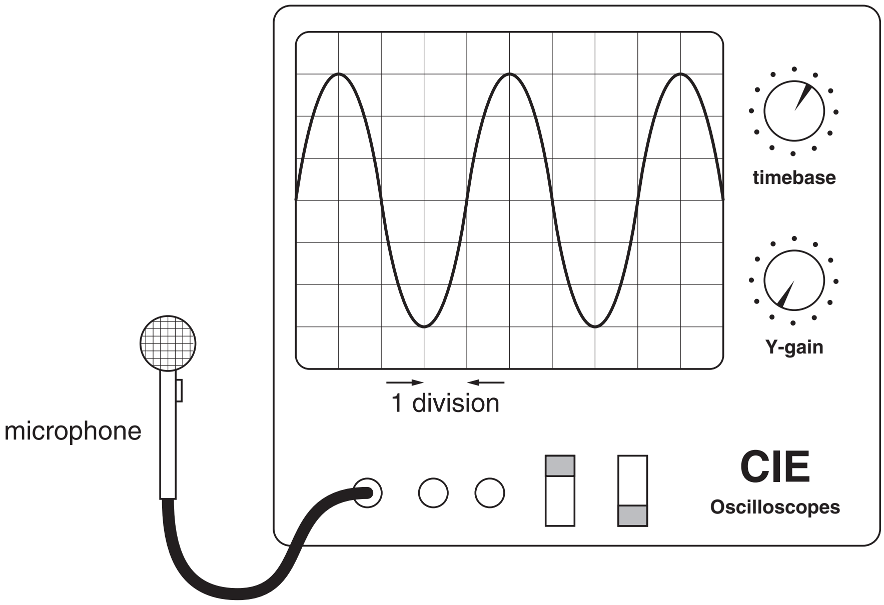

Fig. 5.1

The timebase setting on the oscilloscope is 0.20 ms / division.

(a) Determine the frequency of this note.

frequency = ... [3]

(b) A note from a second musical instrument is played and the trace S produced by the new note is also displayed on the screen. Fig. 5.2 shows the screen displaying both the original trace and S.

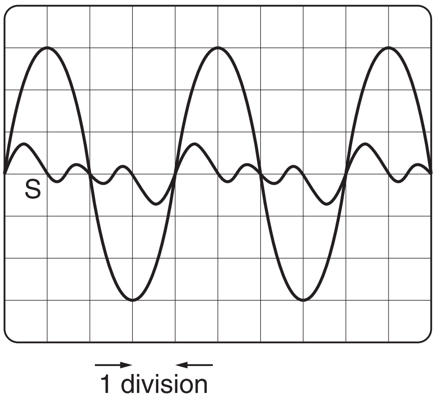

Fig. 5.2

In each of the three spaces below, describe either a similarity or a difference between the **sounds** made by the two notes.

1. ....

2. ....

3. ....
[3]

5054/22/O/N/10/Q5

20 Fig. 7.1 is the circuit diagram for the volume control of a loudspeaker.

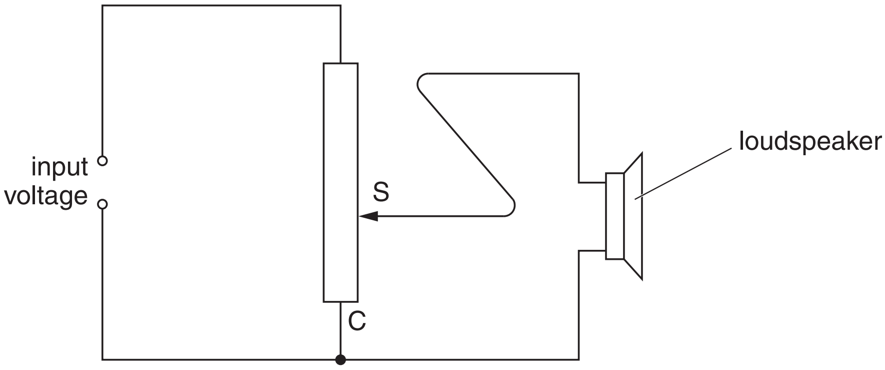

Fig. 7.1

The circuit includes a variable potential divider (potentiometer). The input voltage is connected across the ends of the potential divider. The loudspeaker is connected between the sliding contact S and the terminal C.

(a) The sliding contact S is moved towards C. State and explain the effect on the sound produced.

....

....

....[2]

(b) The loudspeaker emits a sound of constant pitch. Over a period of time, this sound becomes louder and louder. State the effect, if any, on the amplitude and on the frequency of the sound wave during this time.

the amplitude ....

the frequency ....
[2]

5054/21/O/N/11/Q7

21 **(c)** The submarine uses ultrasound to detect obstacles.

(i) State what is meant by *ultrasound*.

....

.... [2]

(ii) The ultrasound is produced by a vibrating source.

Describe how the ultrasound is transmitted through the water.

....

....

....

.... [3]

(iii) An ultrasound pulse is emitted. At a later time, the reflected pulse is detected. The time between the emission and the detection of the pulse is t.

1. State the other quantity that must be known in order to determine the distance of the obstacle from the submarine.

.... [1]

2. State how the distance of the obstacle from the submarine is calculated.

.... [1]

(iv) State one other use of ultrasound.

....

.... [1]

5054/21/O/N/12/Q9

22 A student goes for a walk in the mountains. During a storm, she sees lightning strike a hillside in the distance. Several seconds later, she hears the thunder caused by the lightning.

(a) **(i)** Explain why she hears the thunder several seconds after she sees the lightning.

....

....[1]

(ii) The student knows the distance to the hillside. She waits for lightning to strike the hillside again. Describe how she can determine a value for the speed of sound in air.

....

....

....

....[2]

5054/21/O/N/13/Q10

23 A physics textbook states that sound is a longitudinal pressure wave with a frequency within the audible range.

(a) Explain what is meant by a *longitudinal wave*.

....

....

.... [2]

(b) **(i)** State the approximate range of audible frequencies.

highest frequency: ....

lowest frequency: ....

[2]

(ii) The speed of sound in air is 330 m / s. Using your answer in **(i)**, calculate the shortest wavelength in air of sound in the audible range.

wavelength = ... [2]

5054/22/O/N/13/Q5

24 The device shown in Fig. 5.1 uses the reflection of ultrasound to measure distances.

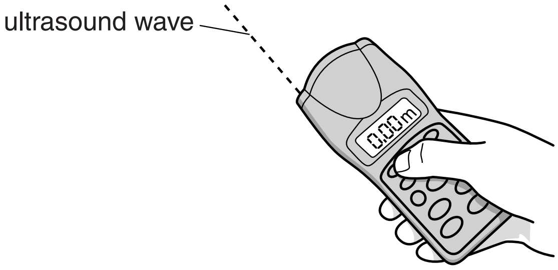

Fig. 5.1

(a) State what is meant by *ultrasound*.

....

....

....[2]

(b) Fig. 5.2 shows a builder using the ultrasound device to measure the width of a room.

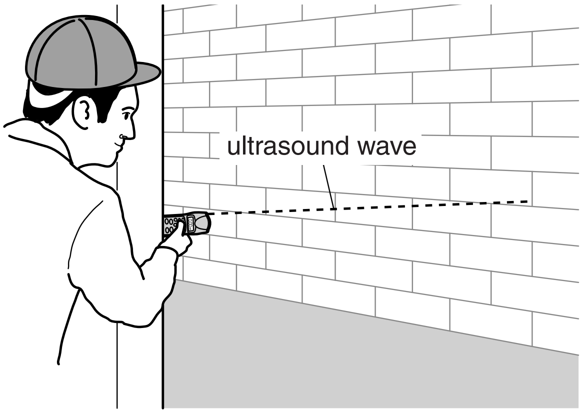

Fig. 5.2

The ultrasound device is placed against one wall and it emits an ultrasound wave that reflects back from the opposite wall.

The time between sending out the ultrasound wave and receiving the reflection is 0.030 s. The speed of ultrasound in air is 340 m/s.

Calculate the distance between the device and the opposite wall.

distance = ...[2]

5054/21/O/N/14/Q5

25 Audible sound waves and ultrasound waves both consist of compressions and rarefactions.

(a) Describe one difference between a compression and a rarefaction.

....

....

.... [1]

(b) In a particular medium, the speed of both audible sound and ultrasound waves is v.

(i) State the equation that relates the wavelength λ of a sound wave to its frequency f.

....

.... [1]

(ii) Explain how, in this medium, the wavelength of an audible sound wave compares with the wavelength of an ultrasound wave.

....

....

....

.... [1]

(c) Describe one use of ultrasound waves.

....

....

....

....

.... [2]

5054/21/O/N/15/Q7

26 Fig. 5.1 shows a loudspeaker inside a glass bell-jar that contains air.

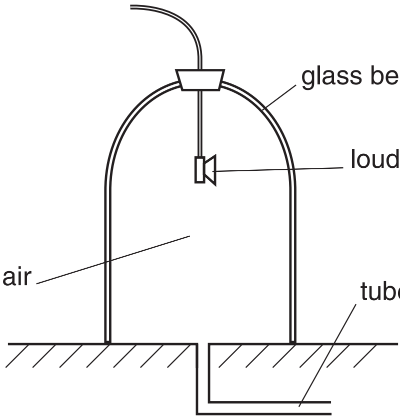

Fig. 5.1

The loudspeaker produces a sound of frequency 2200 Hz.

(a) State what is meant by the *frequency* of a sound.

....

....

....[1]

(b) **(i)** The speed of sound in air is 330 m / s.

Calculate the wavelength of the sound in the air.

wavelength = ...[2]

(ii) The sound passes from the air into the glass.

State what happens to

1. the frequency of the sound,

....

2. the speed of the sound.

....

[1]

(c) **(i)** Describe

1. how sound is produced by the loudspeaker,

....

....

....[1]

2. how sound is transmitted through the air.

....

....

....[2]

(ii) A pump is connected to the tube at the bottom of the glass bell-jar. The pump is switched on and it removes the air from the glass bell-jar.

Explain why the volume of the sound heard outside the glass bell-jar decreases.

....

....

....[1]

5054/21/O/N/16/Q5

27 Some medical processes involve the use of ultrasound.

(a) Explain what is meant by *ultrasound*.

....

....

....

.... [2]

(b) Explain briefly how ultrasound is used in pre-natal scanning.

....

....

....

....

....

.... [3]

5054/21/O/N/17/Q5

28 Fig. 6.1 shows a girl standing a few hundred metres in front of a large building.

Fig. 6.1 (not to scale)

The girl uses a signal generator and a loudspeaker to send a short pulse of sound towards the building. The sound has a frequency of 3700 Hz.

A short time later, the girl hears an echo.

(a) State what is meant by the term *echo*.

....

....[1]

(b) The pitch of the echo is the same as that of the original sound but the echo is not as loud.

State what has happened to

(i) the amplitude of the sound wave,

....[1]

(ii) the frequency of the sound wave.

....[1]

(c) The speed of sound in air is 330 m / s.

Calculate the wavelength of this sound.

wavelength = ...[2]

5054/22/O/N/17/Q6

29 Both sound and ultrasound are waves that travel in solids, liquids and gases.

(a) State how sound differs from ultrasound.

....

.... [1]

(b) Sound and ultrasound are longitudinal waves that consist of compressions and rarefactions.

(ii) Fig. 9.1 represents a longitudinal wave of frequency 25 000 Hz travelling in oil.

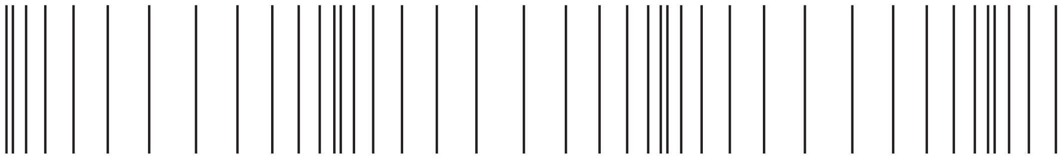

Fig. 9.1 (full scale)

1. On Fig. 9.1, mark two points at the centre of two different rarefactions and label each one R. [1]

2. On Fig. 9.1, draw a double-headed arrow to indicate a distance that is equal to one wavelength of the wave. [1]

3. Measure the length of the arrow drawn on Fig. 9.1 and use it to determine the speed of the wave in oil.

speed = ... [2]

(c) A sound wave travelling in a liquid, passes into air.

(i) State what happens to the speed of the sound wave as it enters the air.

.... [1]

(ii) The wave in the liquid travels towards the surface at an angle. Fig. 9.2 shows the centres of the compressions of the sound wave in the liquid.

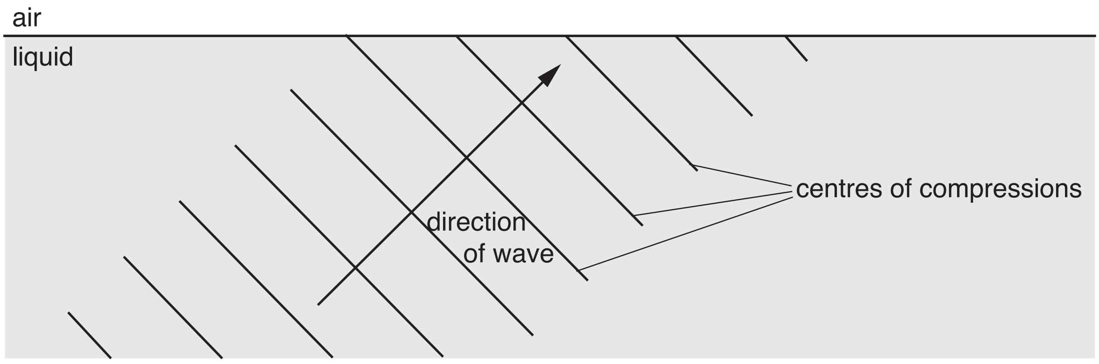

Fig. 9.2

Some compressions shown have reached the liquid-air boundary. The parts of these compressions in the air are not shown on Fig. 9.2.

On Fig. 9.2, draw the parts of these compressions that are in the air. [3]

(d) Describe, in outline, how ultrasound is used in cleaning.

....

....

....

....

.... [3]

5054/22/O/N/18/Q9

30 Both sound and ultrasound are longitudinal waves.

(a) Describe what is meant by *longitudinal*.

....

....

.... [2]

(b) Fig. 5.1 shows an ultrasound cleaner being used to clean jewellery.

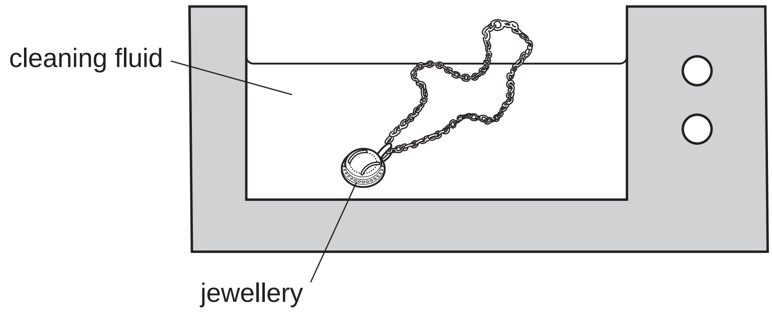

Fig. 5.1

The jewellery is lowered into the cleaning fluid and ultrasound waves of frequency 42 000 Hz are produced in the fluid.

(i) The speed of ultrasound in the fluid is 1500 m/s.

Calculate the wavelength of the ultrasound in the fluid.

wavelength = ... [2]

(ii) Describe how the ultrasound cleans the jewellery.

....

....

.... [2]

5054/22/O/N/19/Q5

31 A loudspeaker is made from a coil of wire fixed to a cardboard tube. The tube is attached to a cardboard cone.

Fig. 8.1 shows part of the arrangement of the loudspeaker.

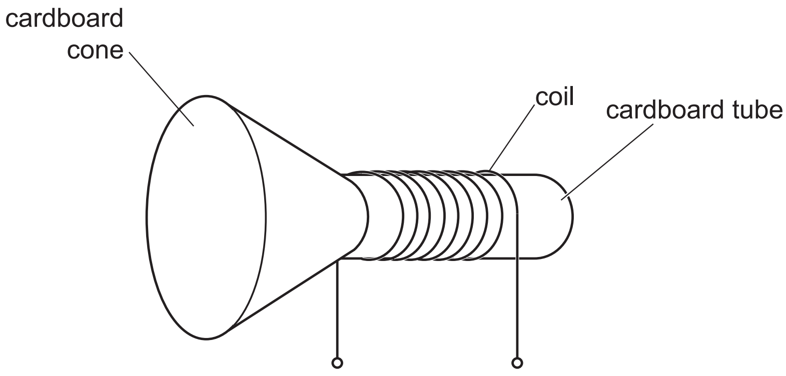

Fig. 8.1

When there is a current in the coil, the coil experiences a force.

(b) A student connects the coil to the output of an alternating current (a.c.) generator. Fig. 8.2 shows how the electromotive force (e.m.f.) produced by the generator varies with time.

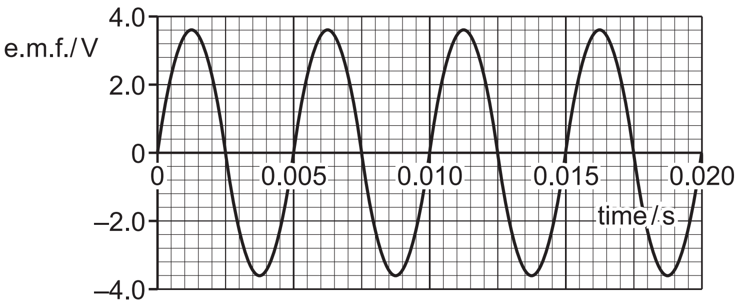

Fig. 8.2

The coil, tube and cone vibrate backwards and forwards.

(ii) The vibrating cone produces sound in the surrounding air.

Explain, in terms of molecules, how the cone produces a sound wave that travels through the air.

....

....

....

....

.... [3]

(iii) Sound is a longitudinal wave.

Describe the difference between a longitudinal wave and a transverse wave.

....

....

....

.... [2]

(iv) Using Fig. 8.2, determine the number of times that the cone reverses its direction of motion in 1.0 s.

number = ... [2]

(v) The speed of sound in air is 340 m / s.

Calculate the wavelength of the sound.

wavelength = ... [2]

(c) The student adjusts the generator so that the maximum voltage of the output is now 3.0 V. Everything else stays the same as the output shown on the graph in Fig. 8.2.

(i) Explain any effect on the loudness of the sound.

....

.... [2]

(ii) Explain any effect on the pitch of the sound.

....

.... [1]

5054/21/O/N/21/Q8