1 The 2010 Football World Cup was held in South Africa and is remembered for the noise of the vuvuzelas.

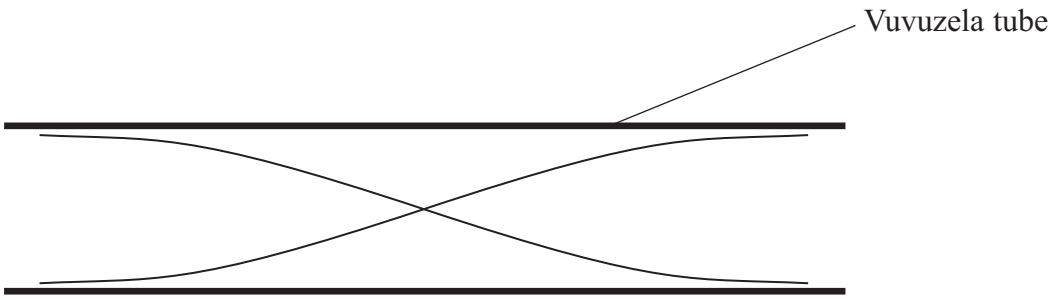
The vuvuzela is a musical instrument which works by making the air inside the vuvuzela vibrate so that a standing wave is produced.

*(a) Explain how a standing wave is produced.

(3)

(b) The vuvuzela makes a noise because it is producing standing waves of different frequencies.

The diagram shows the standing wave with the lowest frequency.



Calculate the frequency of this standing wave.

length of the vuvuzela 60 cm

speed of sound in air 330 m s ^{1}

(3)

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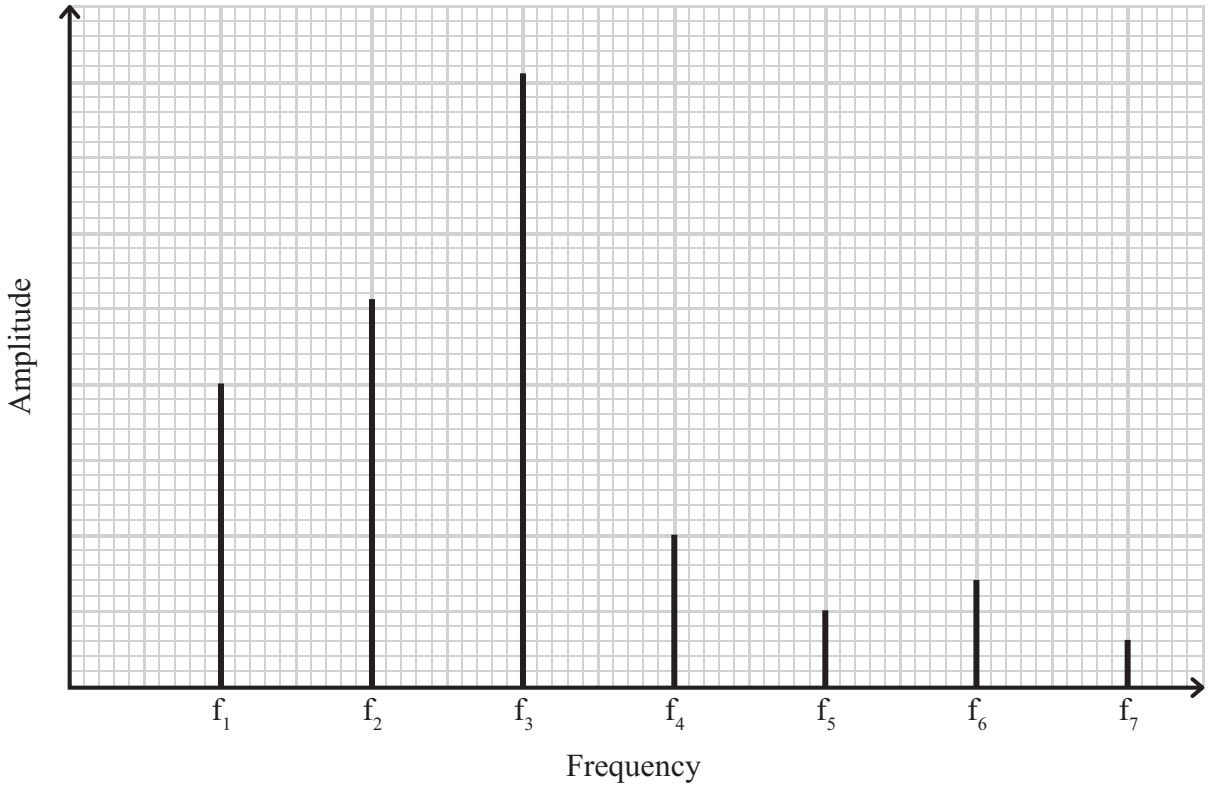
Frequency .....

(c) Human speech contains a continuous range of frequencies.
When the vuvuzela's sound is analysed it is found to contain only certain fixed frequencies which can be heard by humans.



At the Football World Cup the noise of the vuvuzelas made it difficult for the television commentators to be heard. A solution was to use a filter that removed some of the frequencies produced by the vuvuzelas.

Suggest which **two** frequencies it would be best to remove, the effect this would have and the disadvantage of removing all of the frequencies.

(3)

(d) Noise cancelling headphones work by detecting a sound and producing another sound that is in antiphase and so causing destructive interference.

(i) Explain what is meant by antiphase and destructive interference.

(3)

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(ii) Explain why the headphones could not be used to cancel the noise of the vuvuzelas.

(1)

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(Total for Question 13 marks)

2 (a) A tiger's roar includes sounds at frequencies below the range of human hearing known as infrasound.

Infrasound of wavelength 45 m travels at 330 m s ^{1} in air.

Calculate the frequency of this infrasound.

(2)

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Frequency .....

(b) The roar of a tiger in a zoo can be heard by visitors at the entrance, even though the tiger can not be seen because there is a hill in the way.

Name and explain this effect.

(2)

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(Total for Question 4 marks)

3 Waves may be transverse or longitudinal.

(a) The table shows three types of wave. Complete the table by putting tick(s) in the box(es) to show which waves are longitudinal.

(1)

Type of wave	Longitudinal
Radio waves	
Ultrasound	
Visible light	

(b) Some waves can be plane polarised. Explain why longitudinal waves cannot be plane polarised.

(2)

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(Total for Question 3 marks)

4 (a) A transverse wave travelling along a wire under tension has a speed v given by

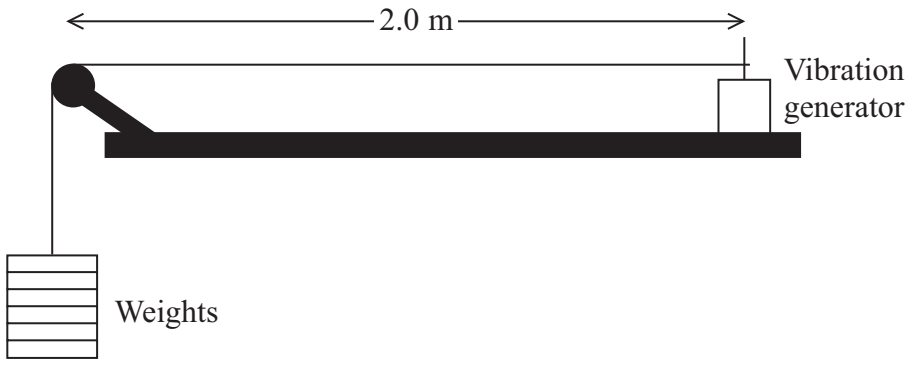
$$v = \sqrt{\frac{T}{\mu}}$$

where T is the tension in the wire and μ is the mass per unit length of the wire.

Show that the units on both sides of the equation are the same.

(3)

(b) The diagram shows a wire held under tension by hanging weights at one end and supported by a vibration generator at the other end. The frequency of the vibration generator is slowly increased from zero until a standing wave is formed.



(i) Explain how the standing wave is produced.

(3)

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(ii) Calculate the wavelength of the standing wave.

(1)

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Wavelength .....

(iii) The weight is 150 N and the mass per unit length of the wire is 0.0050 kg m^{-1}.

Using the equation given in (a), calculate the speed of the transverse wave along the wire.

(2)

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Speed of transverse wave .....

(iv) The wire is observed as the frequency of the vibration generator is steadily increased to several times the frequency that produced the first standing wave.

Describe and explain what is seen as the frequency is increased.

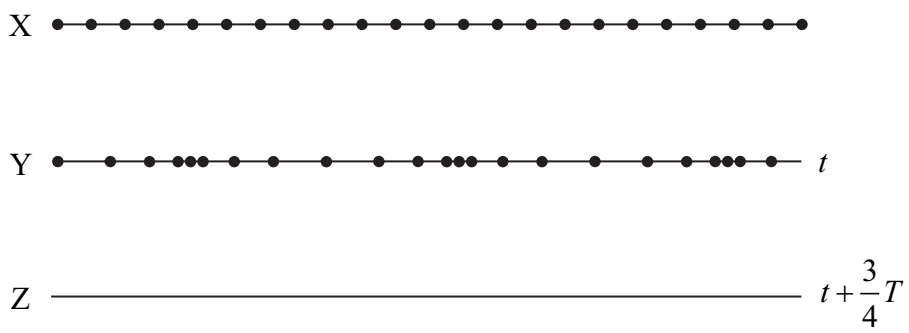
(4)

(Total for Question 13 marks)

5 In the diagram, line X represents the equilibrium positions of a line of molecules in a solid.

A sound wave of wavelength λ and frequency f passes through the solid from left to right.

Line Y represents the positions of the same molecules at a time t.



(a) Explain how the diagram shows that the wave is longitudinal.

(1)

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(b) On line Y

(i) identify **two** compressions and label them C;

(ii) identify **two** rarefactions and label them R;

(iii) label the wavelength λ of the wave.

(3)

(c) The period of the wave is T.

On the line Z mark the positions of two compressions at a time $t+\frac{3}{4}T$ and label them P.

(2)

(Total for Question 6 marks)

6 A radio station broadcasts at a frequency of 198 kHz.

(a) Calculate the wavelength of these radio waves.

(3)

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Wavelength .....

*(b) Obstacles such as buildings and hills can make it difficult to receive some radio signals with shorter wavelengths.

Explain why this is less of a problem for this radio station.

(3)

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(Total for Question 6 marks)

7 (a) Ultrasound scanning can be used by doctors to obtain information about the internal structures of the human body without the need for surgery. Pulses of ultrasound are sent into the body from a transmitter placed on the skin.

(i) The ultrasound used has a frequency of 4.5 MHz.

State why waves of this frequency are called ultrasound.

(1)

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(ii) A pulse of ultrasound enters the body and its reflection returns to the transmitter after a total time of 1.6×10^{4} s.

Calculate how far the reflecting surface is below the skin.

average speed of ultrasound in the body $1500\ m\ s^{1}$

(3)

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Distance .....

(iii) State why the ultrasound is transmitted in pulses.

(1)

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(b) Another way of obtaining information about the internal structures of the human body is by the use of X-rays.

(i) Give **one** property of X-rays which makes them more hazardous to use than ultrasound.

(1)

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(ii) State **two** other differences between X-rays and ultrasound.

(2)

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(Total for Question 8 marks)

8 Frequencies below the audible range for humans are called infrasound. Infrasound is produced by earthquakes.

(a) Describe how sound waves travel through air.

(3)

(b) State what is meant by frequency.

(1)

(c) An infrasound wave has a wavelength of 1500 m and a frequency of 2.0 Hz.

Calculate the speed of infrasound in the ground.

(2)

Speed =

(d) In 2004, a huge earthquake produced a very large tidal wave which swept across the Indian Ocean towards Sri Lanka. Many large animals in Sri Lanka moved away from the coast before the tidal wave hit.

Suggest a reason for the animals behaving in this way.

(2)

(Total for Question = 8 marks)