35 + 15

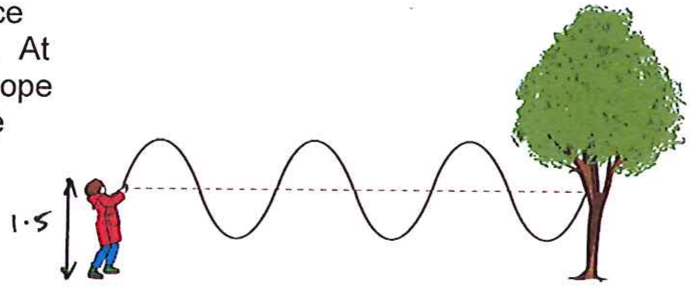
Name: Solutions.

Stage 3 Physics – Sound and Waves Test 2015

Write your answers in the space provided following each question. Total marks = 50.

Question 1 **(2 marks)**

You can make a wave move along a piece of rope by moving one end up and down. At a particular instant, the shape of such a rope is as shown in the diagram. Estimate the amplitude and wavelength of the wave moving along the rope. (no explanation required)



Amplitude: 0.5m (1)

Wavelength: 2.0m (1)

· Assume person is 1.5m high.
ie: 1cm = 1m.

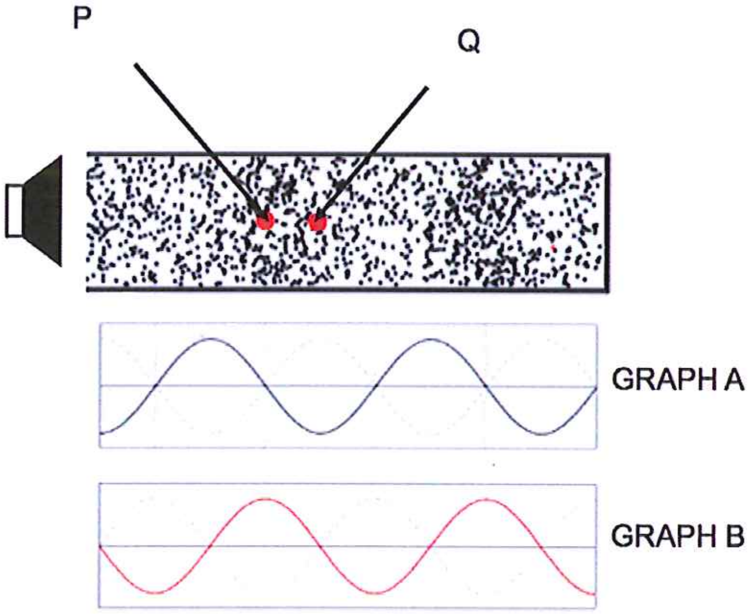
Question 2 **(2 marks)**

A diffraction horn is a special type of loud speaker that is designed to produce a wide spread of sound into a listening area. Using your knowledge of diffraction suggest how this type of loud speaker is able to produce a wider spread of sound.

- The speaker is designed so that the sound waves "emerge" through an opening (1)
- This will encourage diffraction and therefore a wider spread of sound. (1)

Question 3 **(9 marks)**

The diagram below shows a closed tube, with a small speaker at the open end. A standing wave is established in the tube. P and Q are two particles of air in the tube.



a) Which graph (A or B) shows the displacement variation along the tube? A (1)

b) What type of variation does the other graph show? pressure (1)

c) Which particle is undergoing negligible displacement (P or Q)? P (1)

d) Which particle (P or Q) is at a "quiet" point in the tube? P (1)

e) Which harmonic is established in the tube? 9th (1)

f) Given that the tube has a length of 22.5 cm, find the wavelength of the standing wave.

$L = \frac{9}{4}\lambda$ (1) $\therefore \lambda = \frac{4}{9} \times 0.225$

$= 0.1 \text{ m}$ (1)

g) Find the fundamental frequency for the tube.

$F_9 = \frac{v}{\lambda}$

$= \frac{346}{0.1}$

$= 3460 \text{ Hz}$ (1)

$\therefore F_1 = \frac{3460}{9}$ (1)

$= 384 \text{ Hz}$.

uestion 4 **(4 marks)**

Some Scotch boys start a rock band and are rehearsing in one of their parents' steel shed. It doesn't take long for neighbours to complain about the noise.

a) Suggest what the boys may be able to do to reduce the noise problem for their neighbours, be sure to explain the Physics behind your suggestions.

- Insulate the walls.
- eg: foam, pink batts etc. (1)

This will absorb, rather than transmit sound energy. (1)

b) The band discovered that their high noise output problem was partially due to wall panels vibrating dramatically at certain frequencies of their music. Explain how this might occur.

- It is likely that certain frequencies matched the resonant frequencies (1) of the metal panels.
- This would cause large amplitude vibrations in the panel, amplifying the (1) sound.

Question 5 **(4 marks)**

(a) Briefly describe the difference between a **musical note** and **noise**.

- A musical note has a regular repeating pattern.
- Noise has no pattern and is random. (1)

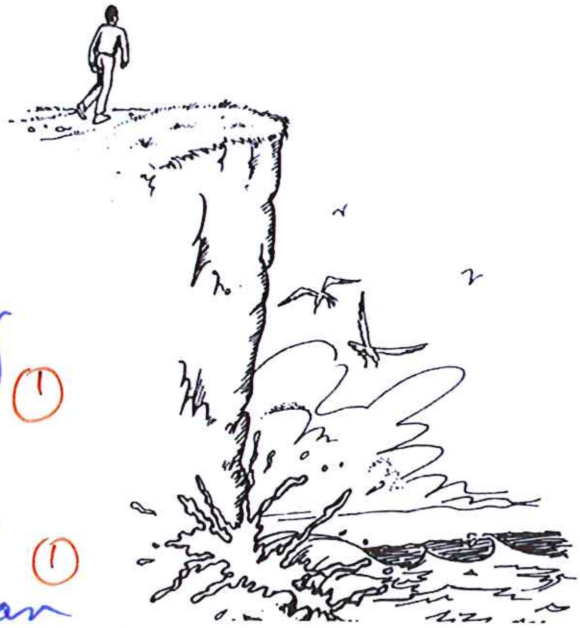
(b) What Physics terminology best describes **Pitch, Loudness** and **Quality** (timbre).

Pitch: frequency (1) **Loudness:** amplitude (1)

Quality: absence or presence of various harmonics (1)

Question 6 **(5 marks)**

a) You are walking along a path on a cliff about a surf beach. The path is not quite on the cliff edge, so you cannot actually see the surf, nor can you see the seagulls that are flying below the cliff.



Explain why you **can** hear the pounding of the surf, but you **cannot** hear the cries of the gulls.

- The waves have a lower frequency (longer wavelength) than the gulls. (1)
- Low frequency sounds diffract better so can bend around top of clif. (1)

b) The diagram at the right shows a series of wave crests transitioning from deep water to shallower water.

DEEP WATER SHALLOW WATER

i). Does the wave speed up or slow down when it enters shallow water?

Slow down (1)

ii). What wave behaviour is illustrated in the diagram?

refraction (1)

iii). What property of the wave is unchanged as it enters the shallow water?

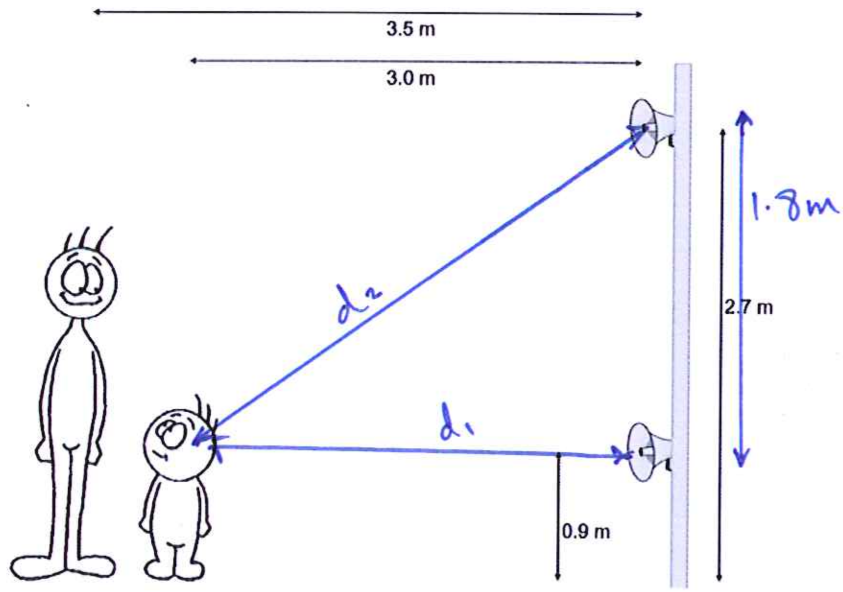
frequency. (1)

Question 7 **(4 marks)**

Bert, who is 1.8 m tall and Ernie, who is 90 cm tall are standing near two speakers at a concert. The speakers are at different heights on a pole as shown in the diagram. Bert and Ernie are 3.5 m and 3.0 m from the pole respectively.

During a sound test, the speakers produce a constant note of relatively low frequency.

Bert complains that the sound is very loud. However, Ernie claims that the he can barely hear any sound.



a) Explain this observation.

Ernie is equidistant from the two speakers so is at an antinodal (loud) point. Const Int

Bert is at a point of Destructive interference and ∴ at a nodal (quiet) point. (2)

b) Find the minimum frequency possible, that is being produced by the speakers for the above observations to be made.

$d_2^2 = 1.8^2 + 3^2$

$\therefore d_2 = 3.5\,m$

$d_1 = 3.0\,m$

$\therefore pd = 3.5 - 3 = 0.5\,m$ (1)

$\therefore 0.5 = \frac{\lambda}{2}$

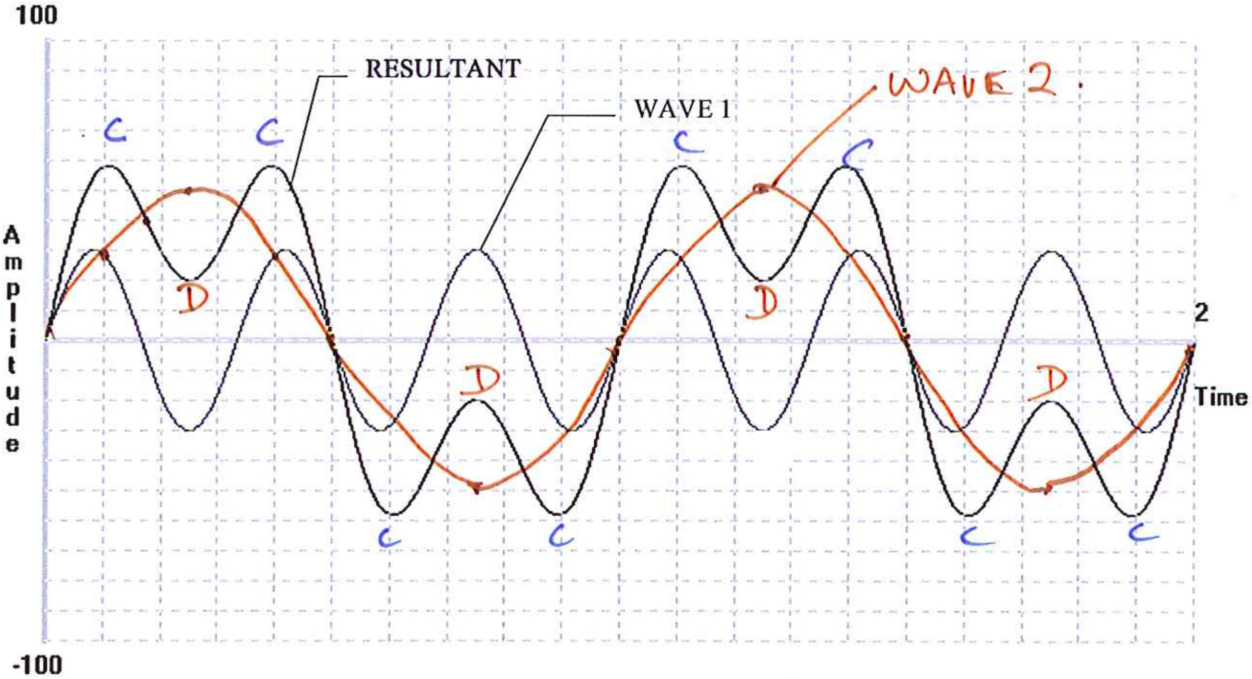
$\lambda = 1.0\,m$

$\therefore f = \frac{346}{1}$ (1)

$= 346\,Hz$.

Question 8 **(5 marks)**

The picture below shows the resultant of two waves, WAVE 1 (shown) and WAVE 2 (not shown). Study the picture carefully, and answer the questions that follow.



a) Sketch WAVE 2, so that the resultant of WAVE 1 and WAVE 2 is as shown above.

b) Complete the following information about WAVE 1, WAVE 2 and the RESULTANT

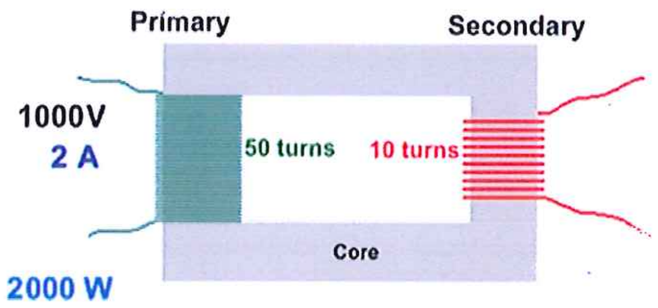
	WAVE 1	WAVE 2	RESULTANT
AMPLITUDE	30	50	60
FREQUENCY	3	1	1
PERIOD	0.33	1	1

3

c) Label with a "C" all points of **maximum constructive interference.** 2
Label with a "D" all pints of **maximum destructive interference**

Question 9 **(15 marks)**

The diagram at right shows a basic transformer, with the supply voltage to the primary coil being 1000 V AC.



(a) By examining the diagram, determine the output voltage from the secondary coil. [2 marks]

$V_S = \frac{10}{50} \times 1000$ ①

$= 200\ V$ ①

(b) Why is it essential that the supply to the primary coil should be an A.C voltage? [1 mark]

· The secondary coil needs to experience an alternating flux, ∴ the primary voltage needs to be AC to provide this. ①

(c) Suggest a material for the core. Give a reason for your choice. [2 marks]

Iron ①

Iron has a high magnetic permeability ①
ie: conducts flux well.

(d) State an essential design feature of the core AND explain why it is necessary. [2 marks]

· The core needs to be constructed with thin laminations ①

· This produces many small eddy currents due to the changing flux, rather than large eddy currents. As power lost $\propto I^2$, this improves the efficiency. ①

The four large generators at Muja A power station near Collie can deliver a maximum electrical power of 800 MW. This power helps supply the electricity needs of Perth and is stepped-up to a voltage of 330 kV before transmission along cables connecting the power station to the city. These transmission cables have a total resistance of 4.5 Ω. At the city end, the transmission lines are connected to a series of step-down transformers to reduce the voltage to 240 V.

(e) Explain why transformers are used to step-up and then step-down the voltage at different stages of power transmission. [2 marks]

P lost due to the resistance of the cables is $\propto I^2$, (1)

$\therefore$ reducing the current by increasing the voltage has a large effect on the efficiency of transmission. (1)

(f) Calculate the current flowing in the cables when the power station is delivering maximum power. [2 marks]

$I = P/V$

$= \frac{800 \times 10^6}{330 \times 10^3}$ (1)

$= 2420 A$ (1)

(g) What is the voltage drop along the cables, and what is the voltage supplied at the city end of the transmission cables? [2 marks]

$V = IR$

$= 2420 \times 4.5$

$= 10\,900 V$ (1)

$\therefore V_{City} = 330 - 10.9$

$= 319 kV$. (1)

(d) Determine the electrical power lost as heat in the cables, and the percentage power lost in the transmission lines. [2 marks]

$\therefore P_{lost} = V_{lost} \times I$

$= 26.4 MW$. (1)

$\therefore \% \text{ lost} = \frac{26.4}{800} \times \frac{100}{1}$

$= 3.3\%$. (1)

END OF TEST ☺