YEAR 12 PHYSICS
TEST 6: SOUND

NAME: SOLUTIONS **TOTAL:** ___/38

1. When a person in a room coughs, one or two of the lower notes of a piano in the same room are often heard to sound. Name the physical phenomenon of which this is an example and explain why only a few notes sound.

Resonance. (1)

The frequency of the cough matches the natural frequency of one or two notes. (2)

The strings resonate accordingly.

(3)

2. A tuning fork of frequency of 256 Hz gives four beats per second when sounded with a second tuning fork. When a piece of plasticine is attached to the first fork, the number of beats increases to five per second. What is the frequency of the second fork? Show some working to justify your answer.

INITIAL : 4 beats 252 Hz 256 Hz 260 Hz (1)

FINAL : 5 beats is an increase.

Since f_1 is lower, the upper value must be correct.

$\therefore$ $f_2 = 260$ Hz. (2)

(3)

3. A light string of length 3.00 m is fixed at one end in a Science laboratory. A wave is generated through it by an oscillating arm fixed to a remodelled speaker operating at a frequency of 125 Hz. A wave pattern was produced and maintained with five nodal points that appeared stationary, ***not including the end points***.

(a) What type of wave pattern is being produced?

standing wave.

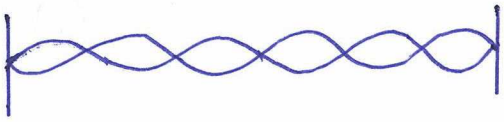
(1)

(b) What conditions are necessary for this to occur?

Two waves of equal amplitude, wavelength and speed travelling in opposite directions in the same medium.

(2)

(c) Which harmonic is the string showing? ***Draw a diagram to show it.***



(1)

6^{th} harmonic (1)

(2)

(d) Determine the wavelength of the waves produced.

$l = \frac{6\lambda}{2} = 3.00$ (1)

$\Rightarrow \lambda = 1.00\,m$ (1)

(2)

(e) Determine the speed of the wave in the string.

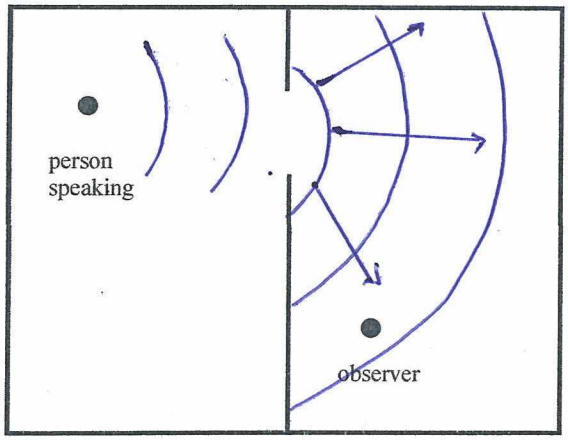
$v = f\lambda$

$= (125)(1.00)$ (1)

$= 125\ ms^{-1}$. (1)

(2)

4. A person is talking in another room with the connecting door open. Explain why it is possible to hear the person but not able to see the person. Use the diagram provided.



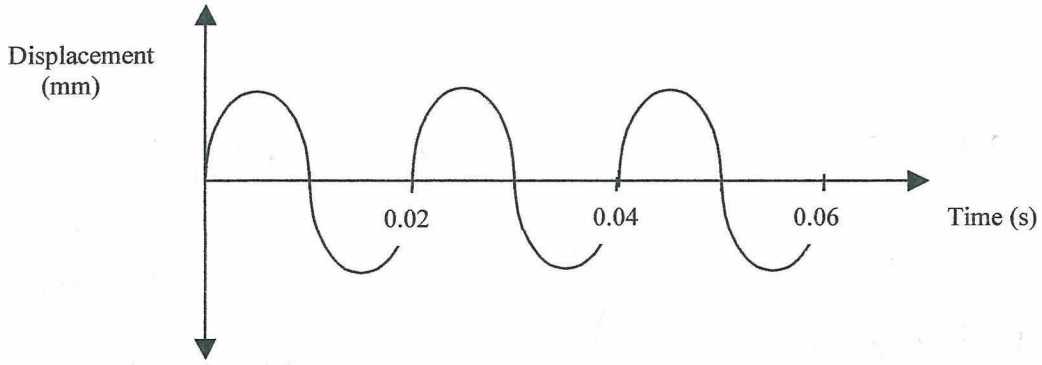
(1)

Wavelength of sound waves are similar to width of the door. (1)

Sound diffracts into the room, spreading out. (1)

(3)

5. A sound wave moving at 3.40×10^2 ms^{-1} in air is represented below.



(a) Determine the period of the wave.

$T = 0.02\ s.$ (1)

(1)

(b) Determine the frequency.

$f = \frac{1}{T}$

$= \frac{1}{0.02}$ (1)

$= 50.0\ Hz$ (1)

(2)

(c) What is the wavelength of the wave?

$v = f\lambda$

$\Rightarrow \lambda = \frac{v}{f}$

$= \frac{3.40 \times 10^{2}}{50.0}$

$= 6.80\ m$ (2)

(d) Given that the intensity of the sound wave is $5.00 \times 10^{-9}\ Wm^{-2}$, and considering your answers to parts (a), (b) and (c) above, determine if this sound could be heard by a human. Give ***two reasons*** for your answer.

$L = 10 \log \frac{I}{I_0}$

$= 10 \log \left(\frac{5.00 \times 10^{-9}}{1.00 \times 10^{-12}} \right)$

$= 37.0\ dB$ (1)

$\therefore$ Sound is above threshold of hearing and is 50Hz, which is audible. (2)

(3)

6. During the interform athletics carnival, a group of Physics students decided to test the loudness of the starter's gun using sound level meters. One person 13.0 m away measured 102 dB while a second person standing 7.00 m away missed the reading due to a distraction.

(a) Calculate the sound level recorded (but not seen) on the second meter.

$L_1 = 10 \log \frac{I_1}{I_0}$

$\Rightarrow 102 = 10 \log \frac{I_1}{1.00 \times 10^{-12}}$

$\Rightarrow I_1 = 1.585 \times 10^{-2}\ Wm^{-2}$ (2)

$\frac{I_2}{I_1} = \left(\frac{d_1}{d_2} \right)^2$

$\Rightarrow \frac{I_2}{1.585 \times 10^{-2}} = \left(\frac{13.0}{7.00} \right)^2$

$\Rightarrow I_2 = 5.467 \times 10^{-2}\ Wm^{-2}$ (1)

$L_2 = 10 \log \frac{I_2}{I_0}$

$= 10 \log \left(\frac{5.467 \times 10^{-2}}{1.00 \times 10^{-12}} \right)$

$= 107.4\ dB$ (1)

(4)

(b) Why should the starter wear ear muffs? Do an estimate calculation to support your answer. (Remember: The threshold of pain is 120 dB.)

Estimate: $d_2 = 1.0\ m$

$$\frac{I_2}{1.585\times10^{-2}} = \left(\frac{13.0}{1.00}\right)^2$$

$$\Rightarrow I_2 = 2.679\ W m^{-2} \quad (1)$$

$$L = 10 \log \frac{I_2}{I_0}$$

$$= 10 \log \left(\frac{2.679}{1.00\times10^{-12}}\right)$$

$$= 124.3\ dB. \quad (1)$$

$\therefore$ Must wear ear muffs to avoid ear damage. (1)

* Answer will vary, depending on the estimate of d_2.

(3)

7. Some people have been silly and inhaled helium gas from party balloons to talk like Mickey or Minnie Mouse. It is not advisable as it starves the brain of oxygen, which can lead to dizziness and fainting! The human vocal tract acts as a closed pipe and is about 18.0 cm long.

(a) Calculate the frequency of the sound produced when the vocal tract of a person resonates at its third harmonic.

$$f = \frac{nv}{4L} \quad (1)$$

$$= \frac{3\,(9.85\times10^2)}{4\,(0.180)} \quad (1)$$

$$= 4.10\times10^3\ Hz \quad (1)$$

(3)

(b) After expelling all of the gas, the person's voice returns to normal. Explain why this occurs.

Velocity of sound returns to $346\ ms^{-1}$ for air. (1)

He has been expelled from the tract.

Frequency is 3 times lower. (1)

(2)