St. Mary's Anglican Girls' School

Year 12

Physics

Sound Test

2008

NAME _____

SCORE _____/ 55 MARKS

Refer to constants sheet for all numerical constants

Show all working out for numerical answers accurate to 3 significant figures.

1 On the graphs below accurately sketch the following…

a) The same note becoming louder.

(2 marks)

b) The wave pattern of a guitarist sliding her finger down the neck of a guitar as the sound fades

(2 marks)

c) The fundamental frequency and then the next harmonic of a closed pipe as executed by an air particle at the open end of the pipe. (Note - two waves are required on the same axis – label each)

(2 marks)

2. A person is conducting an experiment into their "aural reflexes" to determine the shortest quantity of time that can exist between two sounds such that they can just be distinguished from each other. The person decides to use echoes to assist them. The air on this day is dry and at 25.0^0C. The person walks away from a wall slowly, and claps their hands with each small step. At what **range** of distances from the wall do you expect most people will just begin to discern an echo? Support you answer with calculations, a diagram and state your reasonable assumptions.

(3 marks)

3 A person is traveling to a tropical island on a light aircraft that has two engines, one on each wing. The person can hear a throbbing sound when the sound waves from the two engines interact.

a) What is the name of this phenomenon? (1 mark)

b) The person is invited to go up to the cockpit to see the pilot. On looking over the pilots shoulder at a dial the passenger sees that one of the engines is turning at 4000 RPM. If the passenger can hear 7 rises and falls in loudness each second, what is the frequency (in Hz) of the second engine?

(3 marks)

c) If the plane is flying on a perfectly still day with no wind and the rudder is perfectly straight, will the plane fly "on course" in a straight line? Explain why or why not?

(2 marks)

d) What can the pilot try to stop the throbbing sound?

(1 mark)

e) How will the pilot know if she is successful or unsuccessful?

(2 marks)

***4.** A farmer is interested to see how the loudness of a cow will vary with distance. A cow "moos" with a loudness of 80.0 dB when measured from 2.00 m in front of the cow.

a) Assuming that the cow puts out sound equally in all directions and that the ground is a perfect absorber, what will be the **loudness** of the cow in decibels from a distance of 0.500 kilometers?

(4 marks)

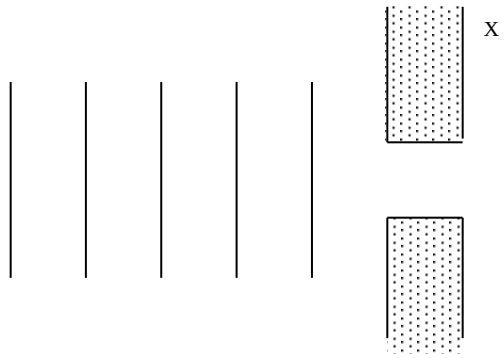
b) A bunch of cows have recently contracted mad cow disease. This causes the herd of 32 cows to "moo" in unison and equally loud (80.0 dB). How will this change the **intensity** of what the farmer hears 0.500 kilometers away?

(2 marks)

5. Complete the below diagrams to indicate who the wave will behave as it passes through the gap or around the obstacle.

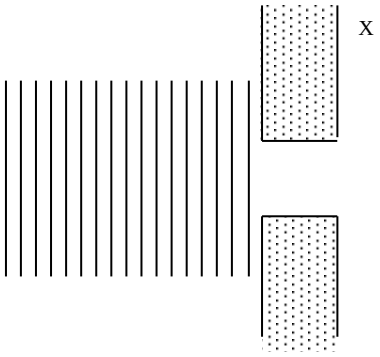
a)

(1 mark)



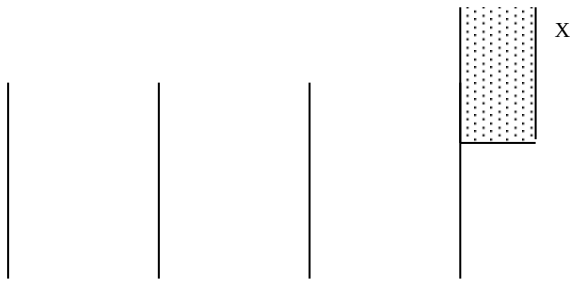
b)

(1 mark)



c)

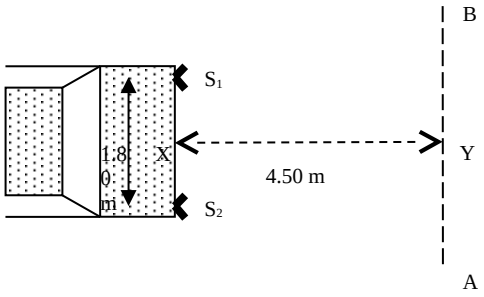
(1 mark)



d) Assuming that the above waves are sound waves that are in an audible frequency range, in which diagram(s) will the sound be audible at the location marked X? Explain.

(2 marks)

6. A farmer has just mounted onto the front of his ute (car), two speakers (one on each side just below the left and right head lights) 1.80 m apart. He wishes to play a frequency of 2000 Hz through the speakers when driving to scare away kangaroos and so prevent colliding with them. He is testing the speaker system while the ute is stationary. Please assume all of the wiring to the speakers is correct.



a) Only one speaker is initially activated and is producing a 2000 Hz sound. Will the farmer be able to here it? Explain.

(1 mark)

b) The farmer now activates both speakers and walks across the front of the car along the line A - B to the mid point Y. The farmer hears the sound fluctuate in loudness as he walks to this position and wonders if the speakers are faulty. Are the speakers faulty? Explain why or why not.

(2 marks)

c) The farmer now stands on the line A – B directly in front of speaker S_1. How will this spot sound compared to the sound of just one speaker (part a)? Explain.

(3 marks)

d) The farmer is concerned that a kangaroo may stand at a quiet spot and decides to alter the frequency put out by the speakers. Should he choose a higher or a lower frequency? Explain. (Note no calculations are necessary but the spacing between the ears of the average kangaroo is a bout 15.0 cm.)

(2 marks)

7. An 8 year old brother is amusing his 2 year old sister by buzzing (blowing raspberries) down the tube of a vacuum cleaner pipe, pretending is a didgeridoo. The pipe is 1.40 m long.

a) Is the vacuum cleaner pipe being used as an open or a closed pipe? Explain with reference to the air particle movement at the ends of the tube.

(2 marks)

b) What is the longest wavelength that the brother will be able to produce in the air in the pipe?

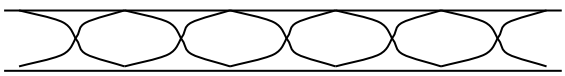
(3 marks)

c) What is the largest (highest) audible overtone that the pipe will be able to resonate too assuming the boy can vibrate his lips that fast? State any assumptions.

(3 marks)

d) Draw the standing wave in the pipe resonating at its 5^{th} harmonic.

(1 mark)



e) Label the above diagram with pressure nodes (0) and pressure antinodes (*)

(1 mark)

8. A student is watching a vertical flag pole bend from side to side during an earthquake. The ground moves forwards and backwards at a constant frequency and amplitude but, the pole seams to bend and flex forwards and backwards with increasing violence until it snaps.

a) Name the phenomenon that is occurring in the flag pole.

(1 mark)

b) Explain using physics principals what has occurred.

(1 mark)

c) Where did the flag pole snap? Why?

(2 marks)

9. A metal pipe has a piece of string attached to one end and is hung vertically. When the pipe is struck in the middle the pipe makes a frequency of 840 Hz. The pipe is then reduced in length **by** 1/3 rd. What is the new frequency of the pipe when it is tapped in its new middle? Show all working and explain any reasonable assumptions. Note - The string does not inhibit the resonating of the pipe.

(4 marks)

End of Test
If you don't believe me turn of over the page.

Made you look!

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Year 12

Physics

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Answers

NAME _____

SCORE _____/ 55 MARKS

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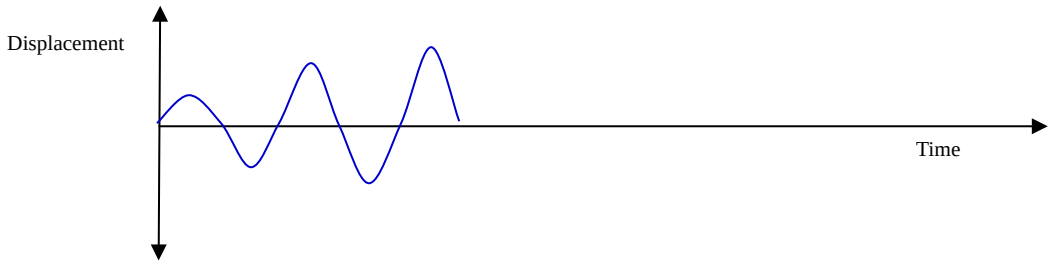
Show all working out for numerical answers accurate to 3 significant figures.

1 On the graphs below accurately sketch the following…

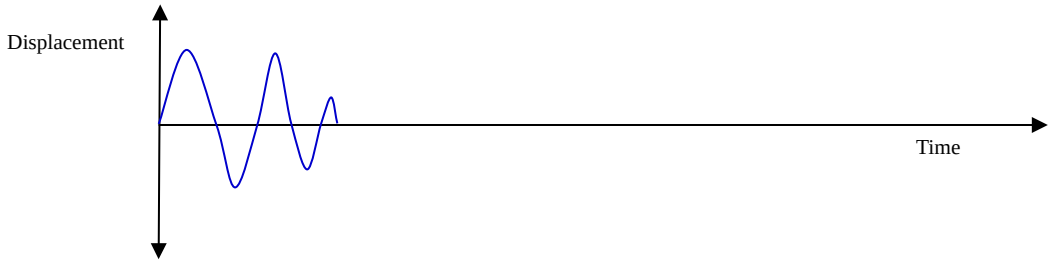
a) The same note becoming louder.

(2 marks)



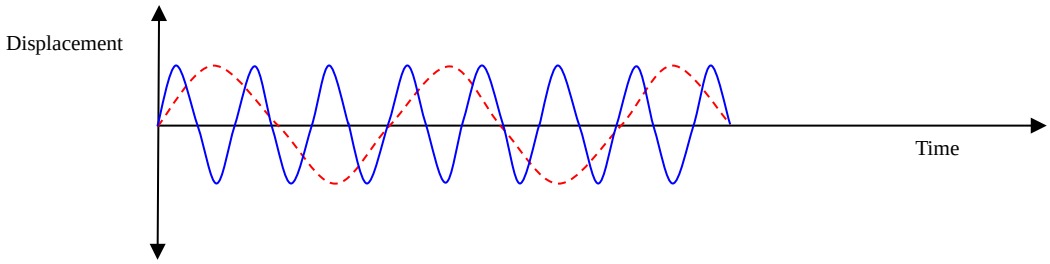
b) The wave pattern of a guitarist sliding her finger down the neck of a guitar as the sound fades

(2 marks)



c) The fundamental frequency and then the next harmonic of a closed pipe as executed by an air particle at the open end of the pipe. (Note - two waves are required on the same axis – label each)

(2 marks)



2. A person is conducting an experiment into their "aural reflexes" to determine the shortest quantity of time that can exist between two sounds such that they can just be distinguished from each other. The person decides to use echoes to assist them. The air on this day is dry and at 25.0^0C. The person walks away from a wall slowly, and claps their hands with each small step. At what **range** of distances from the wall do you expect most people will just begin to discern an echo? Support you answer with calculations, a diagram and state your reasonable assumptions.

(3 marks)

t = 0.100 s	**t = 0.125 s**
v = s /t 346 = 2 d / 0.1 d = 17.3 m	v = s /t 346 = 2 d / 0.125 d = 21.6 m

Range = 17.3 to 21.6 m from the wall

3 A person is traveling to a tropical island on a light aircraft that has two engines, one on each wing. The person can hear a throbbing sound when the sound waves from the two engines interact.

a) What is the name of this phenomenon? (1 mark)

Beats

b) The person is invited to go up to the cockpit to see the pilot. On looking over the pilots shoulder at a dial the passenger sees that one of the engines is turning at 4000 RPM. If the passenger can hear 7 rises and falls in loudness each second, what is the frequency (in Hz) of the second engine?

(3 marks)

$f = 4000 / 60$

$f = 66.7$ Hz

$f_{beats} = |f_1 - f_2|$

$7 = | 66.7 - f_2|$

$f_2 = 66.7 + \text{or} - 7$

$f_2 = 73.7$ Hz or 59.7 Hz

c) If the plane is flying on a perfectly still day with no wind and the rudder is perfectly straight, will the plane fly "on course" in a straight line? Explain why or why not?

(2 marks)

No

The engine that is turning faster (higher frequency) will cause the plane to travel faster on that side resulting in the plane executing a very large circle.

d) What can the pilot try to stop the throbbing sound?

(1 mark)

The pilot can adjust the speed of one of the engines by altering the throttle position. This will alter the frequency of the engine and so alter the frequency of the sound it creates.

e) How will the pilot know if she is successful or unsuccessful?

(2 marks)

Successful the number of beats per second will gradually slow and decrease to zero.

Unsuccessful the number of beats per second will gradually speed up and increase to beyond 10 resulting in dissonance.

***4.** A farmer is interested to see how the loudness of a cow will vary with distance. A cow "moos" with a loudness of 80.0 dB when measured from 2.00 m in front of the cow.

a) Assuming that the cow puts out sound equally in all directions and that the ground is a perfect absorber, what will be the **loudness** of the cow in decibels from a distance of 0.500 kilometers?

(4 marks)

Convert 80 dB to intensity

$80 = 10 \text{ Log } (I / 1 \times 10^{-12})$

$I = 1 \times 10^{-4}$ W m^{-2}

Find the power

$P = I \times A$

$P = 1 \times 10^{-4} \times 4 \text{ pi } (2^2)$

$P = 5.0265 \times 10^{-3}$ W

Calculate the intensity at a distance of 500 m

$I = P / A$

$I = 5.0265 \times 10^{-3} / 4 \text{ pi } 500^2$

$I = 1.6 \times 10^{-9}$ W m^{-2}

Convert back to loudness

$L = 10 \text{ Log } (1.6 \times 10^{-9} / 1 \times 10^{-12})$

L = 31.9 dB

b) A bunch of cows have recently contracted mad cow disease. This causes the herd of 32 cows to "moo" in unison and equally loud (80.0 dB). How will this change the **intensity** of what the farmer hears 0.500 kilometers away?

(2 marks)

Original intensity x 32

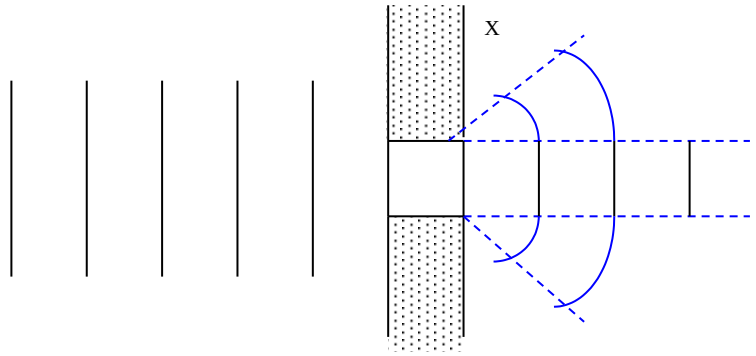
Resultant = $1.6 \times 10^{-9} \times 32$

Resultant intensity = 5.12×10^{-8} W m^{-2}

Change in intensity = increase by factor of 32 or increase by 4.96×10^{-8} W m^{-2}.

5. Complete the below diagrams to indicate who the wave will behave as it passes through the gap or around the obstacle.

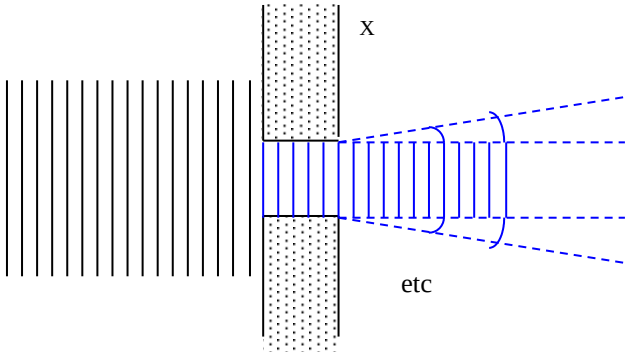
a)



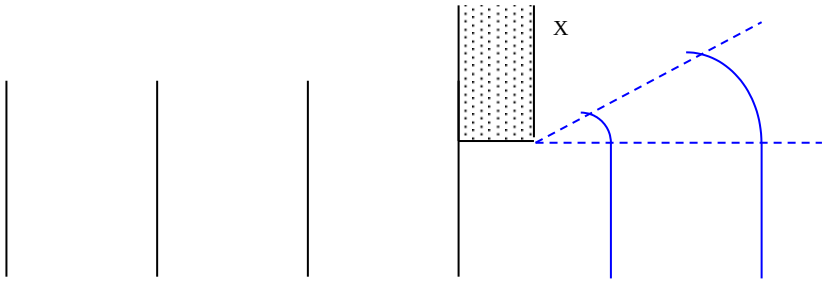
(1 mark)

b)

(1 mark)



c)



(1 mark)

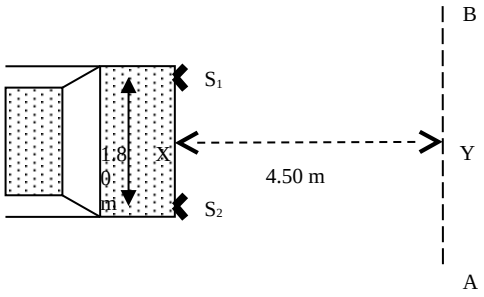
d) Assuming that the above waves are sound waves that are in an audible frequency range, in which diagram(s) will the sound be audible at the location marked X? Explain.

(2 marks)

None of them

Base of the gap formula (diffraction = λ / gap) non of the refraction patterns will be large enough to extend into the region marked X.

6. A farmer has just mounted onto the front of his ute (car), two speakers (one on each side just below the left and right head lights) 1.80 m apart. He wishes to play a frequency of 2000 Hz through the speakers when driving to scare away kangaroos and so prevent colliding with them. He is testing the speaker system while the ute is stationary. Please assume all of the wiring to the speakers is correct.



a) Only one speaker is initially activated and is producing a 2000 Hz sound. Will the farmer be able to here it? Explain.

(1 mark)

Yes.
This frequency is n the audible range of he human ear (between 20 Hz and 20000 Hz)

b) The farmer now activates both speakers and walks across the front of the car along the line A - B to the mid point Y. The farmer hears the sound fluctuate in loudness as he walks to this position and wonders if the speakers are faulty. Are the speakers faulty? Explain why or why not.

(2 marks)

No the speakers are not faulty.
The fluctuation in loudness is due to constructive an destructive interference (superstition).

c) The farmer now stands on the line A – B directly in front of speaker S_1. How will this spot sound compared to the sound of just one speaker (part a)? Explain.

(3 marks)

L1 = 4.5 m, L2 = Square root of ($4.5^2 + 1.8^2$), L2 = 4.84 m
$\lambda = 346 / 2000$, $\lambda = 0.173$ m

$n = (L1 – L2) / \lambda$
$n = 1.96$.

This is constructive interference hence louder than just 1 speaker operating.

d) The farmer is concerned that a kangaroo may stand at a quiet spot and decides to alter the frequency put out by the speakers. Should he choose a higher or a lower frequency? Explain. (Note no calculations are necessary but the spacing between the ears of the average kangaroo is a bout 15.0 cm.)

(2 marks)

Based on argument made to remove node form occurring in both ears at the same time.

Can accept longer or shorter wavelength - Best answer is shorter wavelength because it provides a greater contrast between loud and soft cover a shorter distance (nodes move closer together than 15.0 cm).

7. An 8 year old brother is amusing his 2 year old sister by buzzing (blowing raspberries) down the tube of a vacuum cleaner pipe, pretending is a didgeridoo. The pipe is 1.40 m long.

a) Is the vacuum cleaner pipe being used as an open or a closed pipe? Explain with reference to the air particle movement at the ends of the tube.

(2 marks)

Open.

The source of the sound (mouth / lips) is by definition an open end because it is capable of movement.
The other end is also and open end.

Hence open pipe.

b) What is the longest wavelength that the brother will be able to produce in the air in the pipe?

(3 marks)

$\lambda_1 = 2L$
$\lambda_1 = 2 \times 1.4$
$\lambda_1 = 2.8$ m

c) What is the largest (highest) audible overtone that the pipe will be able to resonate too assuming the boy can vibrate his lips that fast? State any assumptions.

(3 marks)

Assume highest audable frequency is 20 000 Hz (kids are young and so have goo hearing)

$f = nv / 2L$

$20\,000 = n\ 346 / 2.8$

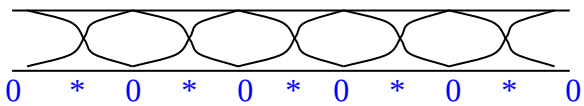
$n = 161.8$

round down otherwise outside hearing range. $n = 161$

overtone = 161 – 1, overtone = 160 th overtone.

d) Draw the standing wave in the pipe resonating at its 5th harmonic.

(1 mark)



e) Label the above diagram with pressure nodes (0) and pressure antinodes (*)

(1 mark)

8. A student is watching a vertical flag pole bend from side to side during an earthquake. The ground moves forwards and backwards at a constant frequency and amplitude but, the pole seams to bend and flex forwards and backwards with increasing violence until it snaps.

a) Name the phenomenon that is occurring in the flag pole.

(1 mark)

Resonance

b) Explain using physics principals what has occurred.

(1 mark)

The frequency of the vibration matches the natural frequency of the object resulting in energy building up in the object as a standing wave until the pole breaks.

c) Where did the flag pole snap? Why?

(2 marks)

The base is a displacement node, which is pressure antinode, which experiences large force which snaps the pole.

9. A metal pipe has a piece of string attached to one end and is hung vertically. When the pipe is struck in the middle the pipe makes a frequency of 840 Hz. The pipe is then reduced in length **by** 1/3 rd. What is the new frequency of the pipe when it is tapped in its new middle? Show all working and explain any reasonable assumptions. Note - The string does not inhibit the resonating of the pipe.

(4 marks)

$F(a) = n\ v / 2\ L$

$840 = 1\ v / 2\ l$

$F(b) = n\ v / 2l$

$F\ (b) = 1\ v / 2\ (2/3)\ l$

Sub

$F(b) = F(a) \times 3/2$

F(b) = 1260 Hz

End of Test
If you don't believe me turn of over the page.

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