ALL SAINTS' COLLEGE

Ewing Avenue, Bull Creek, Western Australia

Physics 11 ATAR Waves Test 2016

Time allowed: 50 minutes
Total marks available: 50
Show calculation answers to 3 significant figures

Student Name:____________________

Question 1 **(5 marks)**

Samuel is listening to a loudspeaker emitting a sine wave of frequency 250 Hz. The air temperature is 25ºC

a) Calculate how many compressions arrive at his ear in a time of one minute. (2)

Frequency = 250 Hz
Number of cycles in 60 seconds = 250 x 60 ✓ = 15,000 ✓

b) Calculate the maximum number of compressions that could exist in a distance of 3.00 m between the loudspeaker and his ear at any given time. (2)

$$\lambda = \frac{v}{f} = \frac{346}{250} = 1.384\ m$$ ✓

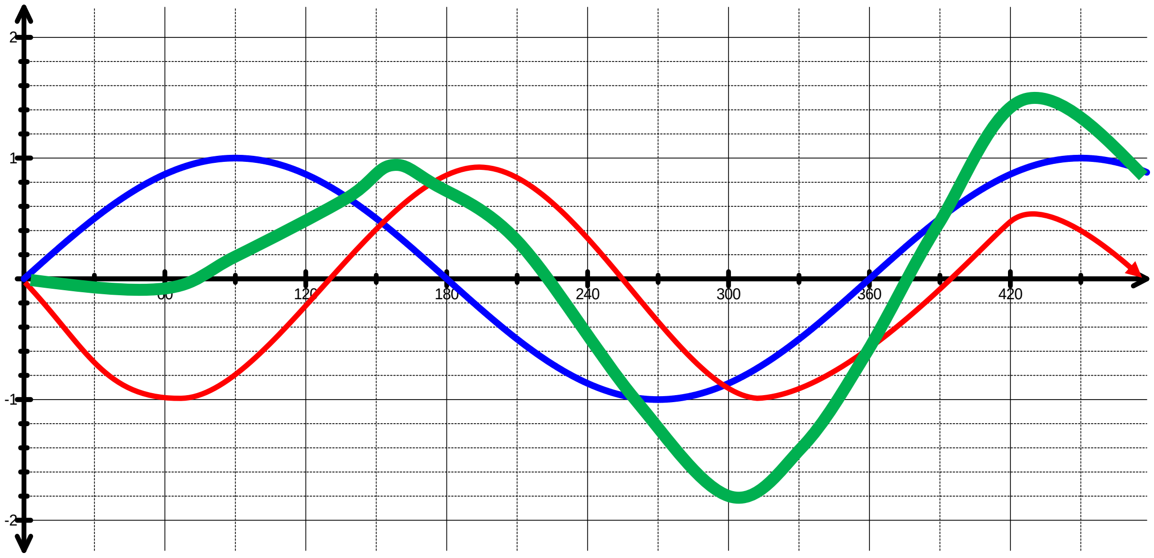
Maximum number that can be contained in 3 m = 3 ✓

c) He listens to the same speaker at the same location later in the day when the air temperature has increased to 30ºC. What happens to the frequency he hears? Circle a response. (1)

a) Increases b) decreases [✓ c) stays the same] d) impossible to determine

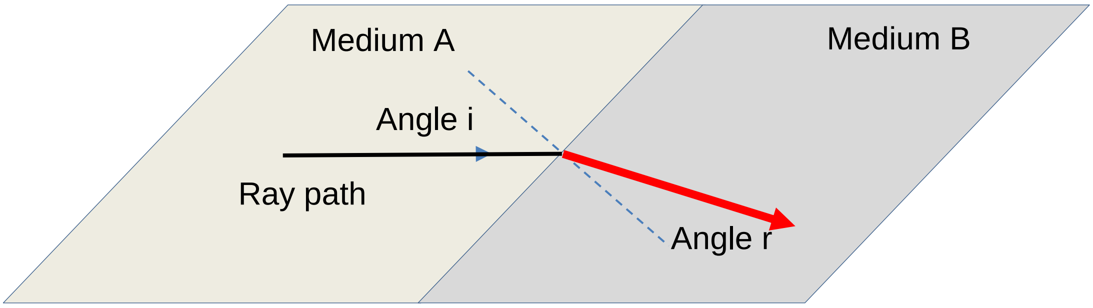
Question 2 **(2 marks)**

Sketch the curve that shows the superposition of the two waves shown in the graph below.



Question 3 **(4 marks)**

As a sound wave crosses the boundary from medium A to medium B its wavelength decreases. The ray path of the wave is shown in medium A as it meets the boundary with medium B in the diagram.



The wave speed in medium B is: (circle a response)

a. faster than A   b. the same as A   [✓ c. slower than A ✓]   d. impossible to determine

On the diagram above, show the general path of the ray as it continues in medium B. You must indicate angles of incidence and refraction on your diagram.

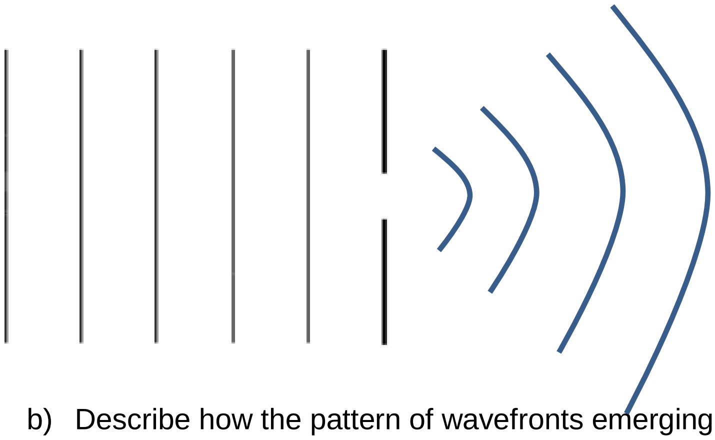
Shows normal✓
Shows angles reference to normal✓
Shows refraction towards normal ✓

Question 4 **(4 marks)**

The diagram shows 5 wavefronts approaching a gap in a barrier. The waves and the gap are drawn to scale.

a) On the figure draw the pattern of the wavefronts as they emerge from the gap.

(2)



diffraction✓
No change in wavelength ✓

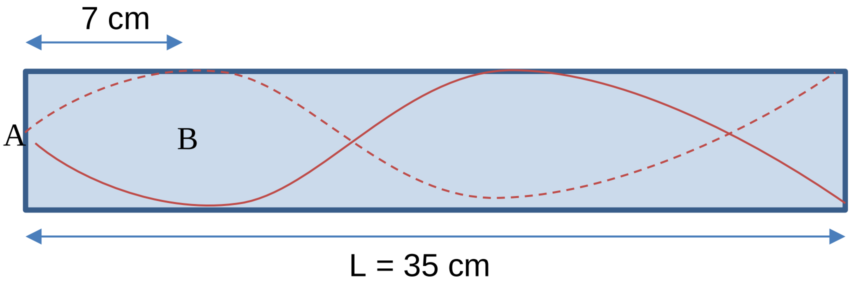
b) Describe how the pattern of wavefronts emerging from the gap would change if the width of the gap were significantly increased.

(2)

Less diffraction (as wavelength is now less than gap width)✓
More directional, less circular (can sketch on diagram) ✓

Question 5 **(7 marks)**

A student is examining a musical instrument based on a simple air column that has an effective length of 35 cm. When she places a small microphone at the left hand end of the pipe (position A) it registers a quiet spot. When she slides the microphone 7.0 cm along to position B the microphone registers a loud spot for the first time.



a) Explain how loud spots and quiet spots have formed within the pipe. (2)

A standing wave has formed as incident wave and reflected waves become superposed✓
Quiet corresponds to stationary points with no pressure fluctuation, loud spots are where pressure fluctuates above and below mean pressure✓

b) Determine the wavelength of the sound wave within the air column. (1)

0.280 m ✓

c) Is the pipe closed or open at the right hand end? Explain briefly (2)

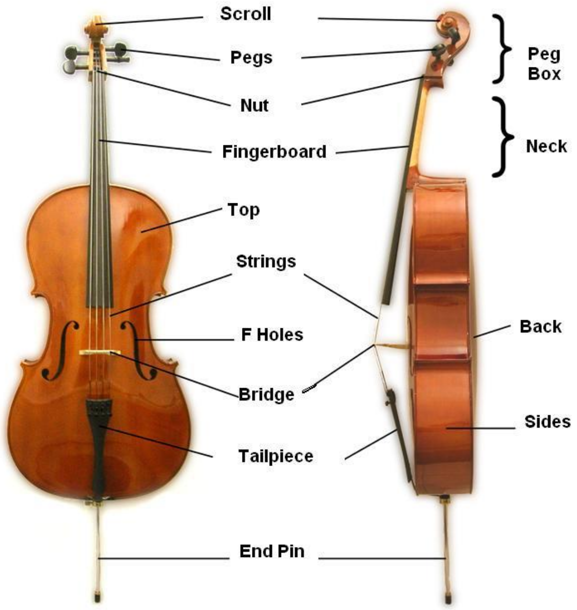
Closed ✓, it must be a loud spot (pressure antinode) because of ratios of lengths to fit into this length ✓

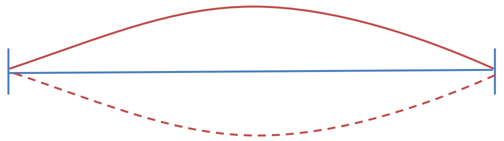
d) Which overtone is she hearing? You must sketch a pressure wave envelope on the diagram above to support your response. (2)

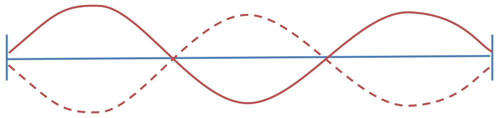
2nd ✓ sketched correctly as above ✓

Question 6 **(10 marks)**

The cello is a stringed instrument. The length of the 3rd string between the nut and the bridge is 70 cm and sounds with a fundamental frequency of 147 Hz (D3)







a) Determine the wave speed along the string.

(2)

At fundamental $\lambda = 2L = 2\ \times 0.70 = 1.40\ m$ ✓

$v = f.\lambda = 147\ \times 1.40 = 205.8\ m\ s^{-1} = 206\ m\ s^{-1}$ ✓

b) On the diagrams above right, sketch the wave envelopes for the fundamental and the third harmonic.

(2)

As above ✓

As above ✓

c) A harmonic of 588 Hz is also heard when this note is played. Which number overtone is this?

(1)

Third ✓

d) Explain how overtones contribute to the quality of sound heard from a cello and why it differs in character to the same notes played on a clarinet which is a pipe closed at one end.

(2)

The ratio and proportion of the overtones present determines the character of sound, this varies from instrument to instrument ✓

The clarinet can only produce odd harmonics so is radically different in timbre compared to the cello that can produce all harmonics ✓

The cello is playing along with a clarinet which is a wind instrument closed at one end

e) If the frequency of the 1st overtone of the clarinet is 470 Hz, calculate its effective length.

(3)

$\lambda = \frac{v}{f} = \frac{346}{470} = 0.7361\ m$ ✓

The 1st overtone corresponds to $\frac{3}{4}$ of a wave within the length

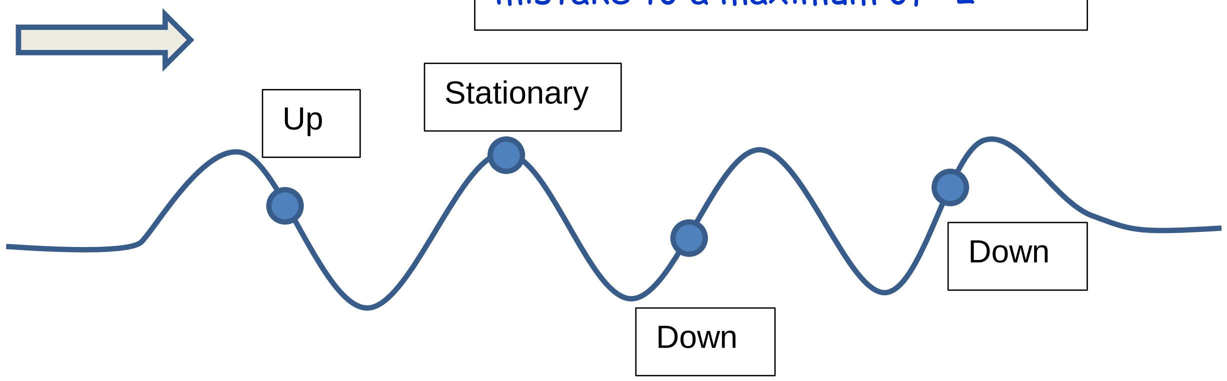
$L = \frac{3}{4} \times \lambda = \frac{3}{4} \times 0.7361$ ✓ $= 0.552$ m ✓

Question 7 **(2 marks)**

A transverse wave train is travelling from left to right across the surface of a pond. Four corks are floating on the pond. They bob up and down as the wave train passes through but are in the same positions as before once the wave has passed.

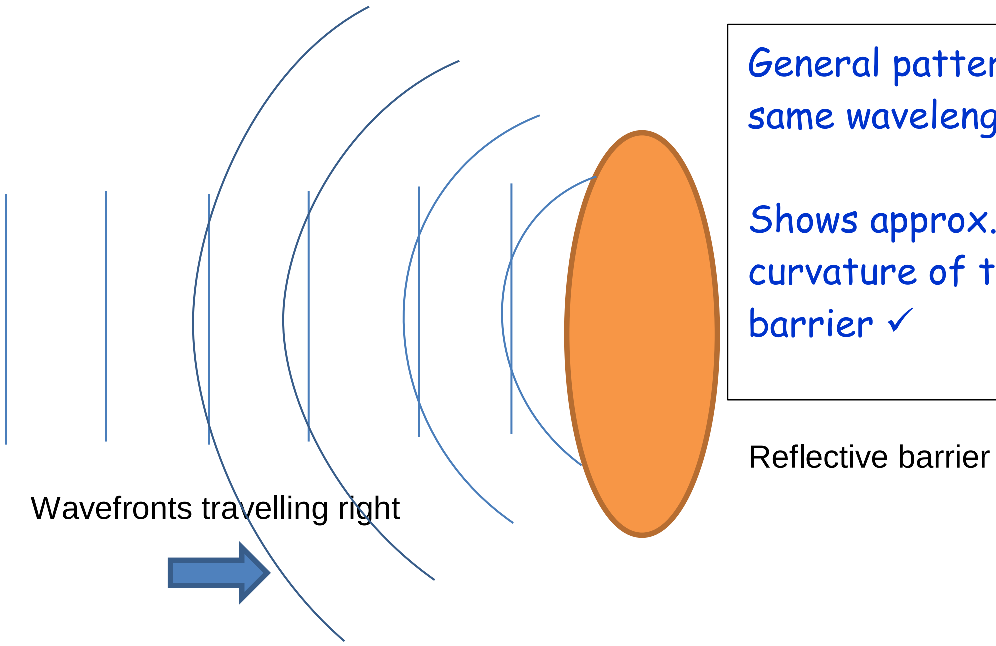
On the diagram below indicate the direction of motion for each cork at this moment in time.

Subtract 1 mark for each mistake to a maximum of -2



Question 8 **(2 marks)**

The diagram shows wavefronts travelling form left to right and meeting a reflective barrier. Sketch the general shape of 4 wavefronts that will be reflected from the barrier.

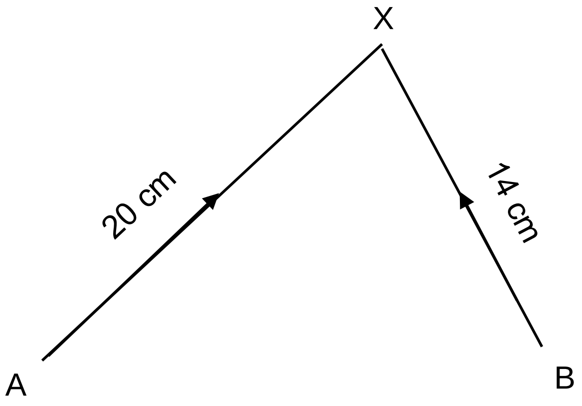


General pattern at same wavelength ✓

Shows approx. double curvature of the barrier ✓

Question 9 **(4 marks)**

Two sound waves are directed from locations A and B so that they both meet at point X. Both waves have the same frequency of 8650 Hz and travel through air at 346 m s^{-1}. The waves are in phase as they leave points A and B. (compressions leave A and B simultaneously). Path length AX is 20 cm. Path length BX is 14 cm.



Consider the interference pattern of the 2 waves at point X. The interference pattern is: (circle a response)

a. Constructive [✓ b. Destructive ✓] c. neither d. both

(4)

Briefly explain your answer with reference to calculations.

$\lambda = \frac{v}{f} = \frac{346}{8650} = 0.04\ m$ ✓

Within the 20 cm path there are 0.20/0.04 = 5 wavelengths
Within the 14 cm path there are 0.14/0.04 = 3.5 wavelengths ✓

Therefore waves are arriving out of phase which leads to destructive interference (e.g. compression + rarefaction = no pressure fluctuation) ✓

Question 10 **(3 marks)**

P-waves and S-waves are sent through the planet Earth as an earthquake happens. Describe 3 differences between P-waves and S-waves

(3)

P-waves are faster, S-waves are slower ✓
P-waves are longitudinal, S-waves are transverse ✓
P-waves can travel through liquid, S-waves cannot travel through liquid ✓
Any reasonable statements

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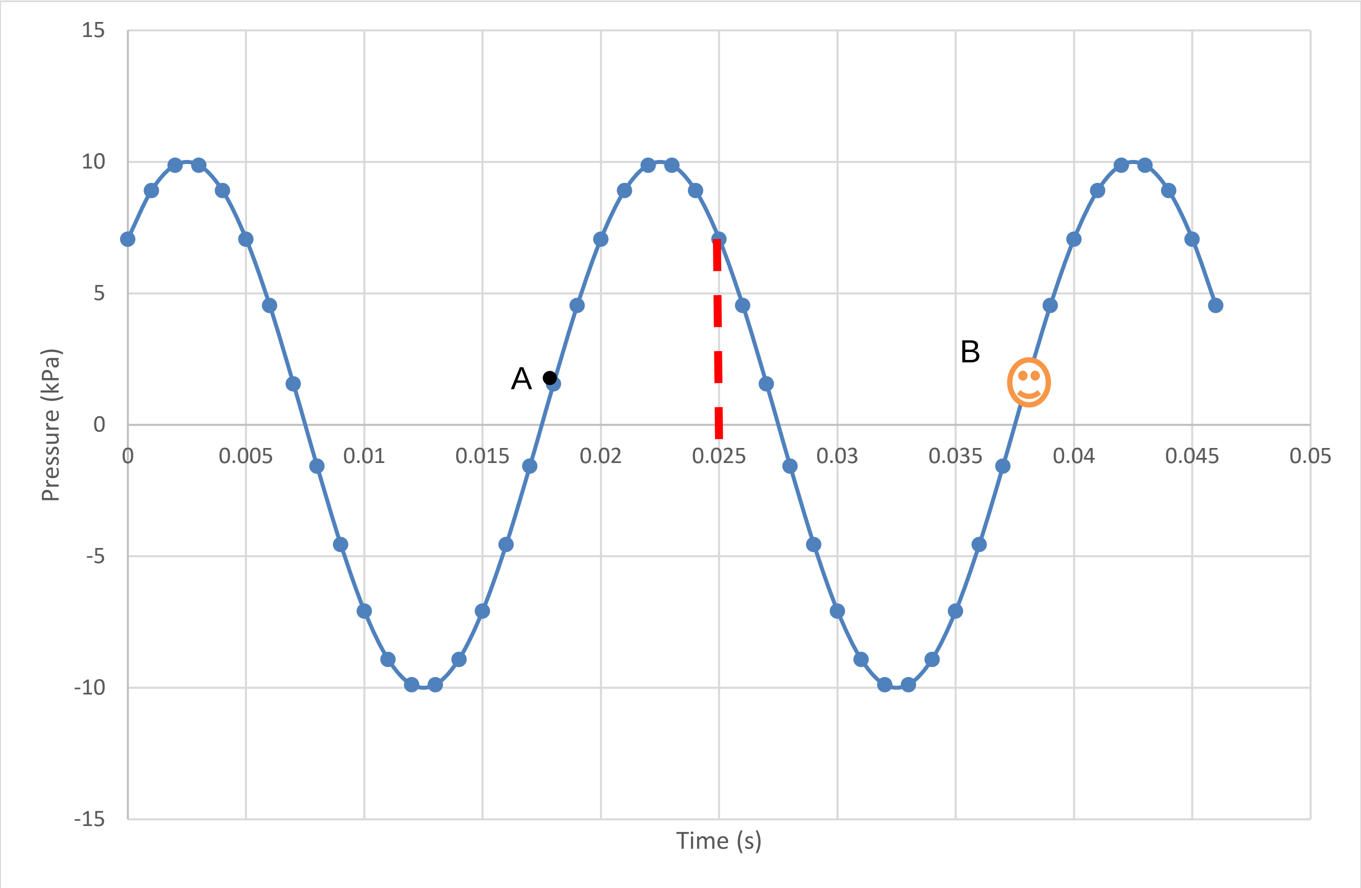
Question 11 **(7 marks)**

The pressure-time graph below represents the pressure recorded by a sound engineer's sound pressure level meter over a 0.046 second time interval.



a) Determine the period of this wave

0.020 s ✓

(1)

b) Calculate how many compressions are recorded by the sound pressure level meter in 0.76 s.

(1)

N = t/T = 0.76 / 0.020 = 38 ✓

c) Calculate the wavelength of the sound wave.

(2)

$f = \frac{1}{T} = \frac{1}{0.02} = 50\ Hz$ ✓ $\lambda = \frac{v}{f} = \frac{346}{50} = 6.92\ m$ ✓

d) Draw location B (on the graph above) which is in phase with A. As above

(1)

e) At time 25.0 ms is the pressure, increasing, decreasing or not changing. Circle your response and explain your answer.

(2)

increasing [✓ decreasing] not changing

By reading the pressure value slightly forward in time from this point on the graph ✓