HOLY CROSS COLLEGE
Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2017

Question/Answer Booklet

11 PHYSICS

Test 6 - Wave Motion

Name SOLUTIONS

Student Number: In figures

Mark: $\frac{\quad}{45}$ In words

Time allowed for this paper

Reading time before commencing work: five minutes
Working time for paper: fifty minutes

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet
Formulae and Data Booklet

To be provided by the candidate

Standard items: pens, (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: non-programmable calculators satisfying the conditions set by the School Curriculum and Standards Authority for this course

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Short Answers					
Section Two: Problem-solving	8	8	50	38	100
Section Three: Comprehension					
				Total	100

Instructions to candidates

1. The rules for the conduct of examinations at Holy Cross College are detailed in the College Examination Policy. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer Booklet.

3. Working or reasoning should be clearly shown when calculating or estimating answers.

4. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

5. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

    - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
    - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

6. Answers to questions involving calculations should be ***evaluated and given in decimal form.*** It is suggested that you quote all answers to ***three significant figures***, with the exception of questions for which estimates are required. Despite an incorrect final result, credit may be obtained for method and working, providing these are ***clearly and legibly set out***.

7. Questions containing the instruction "estimate" may give insufficient numerical data for their solution. Students should provide appropriate figures to enable an approximate solution to be obtained. Give final answers to a maximum of two significant figures and include appropriate units where applicable.

8. Note that when an answer is a vector quantity, it must be given with magnitude and direction.

9. In all calculations, units must be consistent throughout your working.

1. Explain the difference between a ***longitudinal wave*** and a ***transverse wave***. Give an example of each. (4 marks)

TRANSVERSE: particles move perpendicular to the direction of (1) propagation.

e.g. water, light. (1)

LONGITUDINAL: particles move parallel to the direction of (1) propagation.

e.g. sound (1)

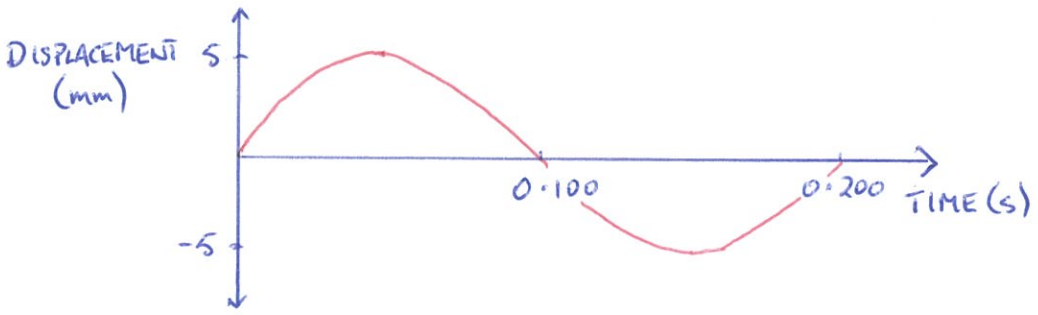
2. A stone dropped into a pool of smooth water produces, after 4.00 s, 20 wave crests spread over 5.00 m of the surface. The height of the wave from ***crest-to-trough*** is 10.0 mm

(a) Calculate the ***wavelength*** and ***speed*** of the waves. (4 marks)

$\lambda = \frac{5.00}{20}$ (1) $= 0.250\ m$ (1)

$v = \frac{5.00}{4.00}$ (1) $= 1.25\ ms^{-1}$ (1)

(b) Draw a ***displacement - time graph*** for the wave motion. (3 marks)



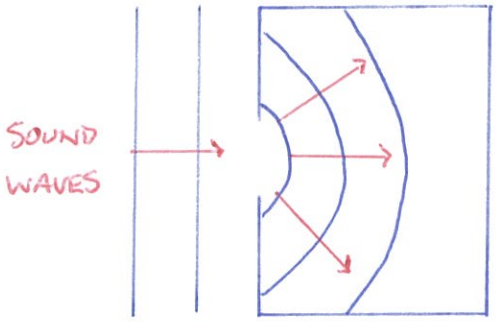
$T = \frac{4.00}{20}$

$= 0.200\ s$ (1)

Labels - 1 mark

Amplitude - 1 mark

3. Why are sounds made outside the door of a room easily heard anywhere within the room? Draw a clear diagram to help your explanation. (3 marks)



(1)

- Width of doorway ≈ λ of sound waves. (1)
- Waves diffract into the room, spreading out, so the sound can be heard clearly. (1)

4. A piston completes 500 oscillations per minute in an engine. Determine:

(a) its frequency. (2 marks)

$f = \frac{500}{60}$ (1)

$= 8.33$ Hz. (1)

(b) its period. (2 marks)

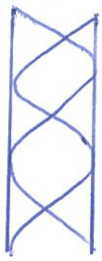
$T = \frac{1}{f}$

$= \frac{1}{8.33}$ (1)

$= 0.120$ s (1)

5. Draw diagrams to show the wave patterns for the following.

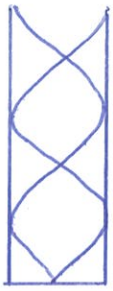
(a) An open pipe resonating at its third harmonic. (1 mark)



$\ell = \frac{3\lambda}{2}$

(1)

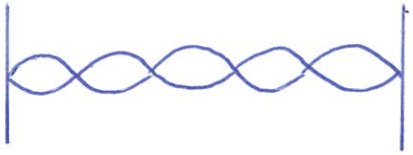
(b) A closed pipe resonating at its third possible mode of vibration. (1 mark)



$\ell = \frac{5\lambda}{4}$

(1)

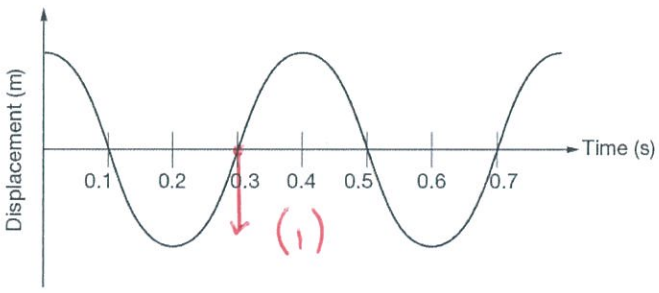
(c) A string resonating at its fifth harmonic. (1 mark)



$\ell = \frac{5\lambda}{2}$

(1)

6. The following graph shows the displacement of one particle of a medium when a wave passes through it.



(1)

(a) Determine the period of the wave. (1 mark)

$T = 0.45$ (1)

(b) Calculate the speed of the wave if the wave moves 2.00 m in the time for one period of the wave to occur. (2 marks)

$v = \frac{s}{t}$

$= \frac{2.00}{0.4}$ (1)

$= 5.0\ ms^{-1}$ (1)

(c) Determine the wavelength of this wave. (2 marks)

$v = f\lambda = \frac{\lambda}{T}$ (since $f = \frac{1}{T}$)

$\Rightarrow \lambda = vT$ (1)

$= (5.0)(0.4)$

$= 2.0\ m$ (1)

(d) On the diagram, indicate the direction of movement of the point at 0.3 s. (1 mark)

7. (a) Outline the conditions that must be met for a ***standing wave*** to be produced. (2 marks)

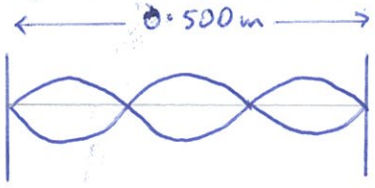
($\frac{1}{2}$) ($\frac{1}{2}$) ($\frac{1}{2}$)

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

($\frac{1}{2}$)

(b) A guitar string is held stationary at a point along the neck of the guitar by pressing a finger on it. This finger is 0.500 m from the fixed end of the string and the string is plucked somewhere along this length, causing it to vibrate in its third harmonic.

(i) Draw a diagram showing the third harmonic of vibration of the string. (1 mark)



$l = \frac{3\lambda}{2}$

(1)

(ii) Calculate the wavelength of the standing wave produced in the string. (2 marks)

$\ell = \frac{3\lambda}{2} \Rightarrow \lambda = \frac{2\ell}{3}$ (1)

$= \frac{2(0.500)}{3}$

$= \underline{0.333\ m}$ (1)

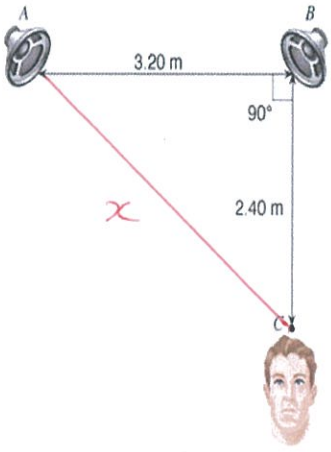
(iii) Determine the speed of the wave in the string if the frequency of the string in the third harmonic is 500 Hz. (2 marks)

$v = f\lambda$

$= (500)(0.333)$ (1)

$= \underline{166\ ms^{-1}}$ (1)

8. Suppose two in-phase loudspeakers, A and B, are separated by 3.20 m. A listener is stationed at point C, which is 2.40 m in front of speaker B. Both speakers are playing identical 214 Hz tones, and the speed of sound is 343 ms^{-1}. Is the sound heard by the listener ***loud*** or ***soft***? Justify your answer by calculation. (4 marks)



$x = \sqrt{(3.20)^2 + (2.40)^2}$

$= 4.00\ m$ (1)

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

$= \frac{343}{214}$

$= 1.60\ m$ (1)

$p.d. = 4.00 - 2.40$

$= 1.60\ m$ (1)

$= \lambda$

$\therefore$ Sound is loud. (1)