HOLY CROSS COLLEGE

Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2018

Question/Answer Booklet

11 PHYSICS

Test 5 - Wave Motion

Name SOLUTIONS

Student Number: In figures | | | | | | | | |

Mark: ___/41 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	14	14	50	41	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.

Circle the correct answer in the following five questions. [5 marks]

1. A drummer beats his drum five times every two seconds. The frequency of the drumming is:

   (a) 0.40 Hz.
   (b) 2.50 Hz.
   (c) 1.67 Hz.
   (d) 3.00 Hz.

2. According to wave theory, when two crests collide they:

   (a) pass through each other with no visible effect.
   (b) cancel out each other leaving an area of no disturbance.
   (c) superimpose on one another to momentarily create a larger waveform.
   (d) reflect as if each collided with a solid wall.

3. The frequency of light of wavelength 560 nm travelling at 2.98×10^{8} ms^{-1} is:

   (a) 5.36×10^{14}
   (b) 5.32×10^{14}
   (c) 5.36×10^{-4}
   (d) 5.32×10^{-4}

4. Which of the following do all waves transfer from one point to another?

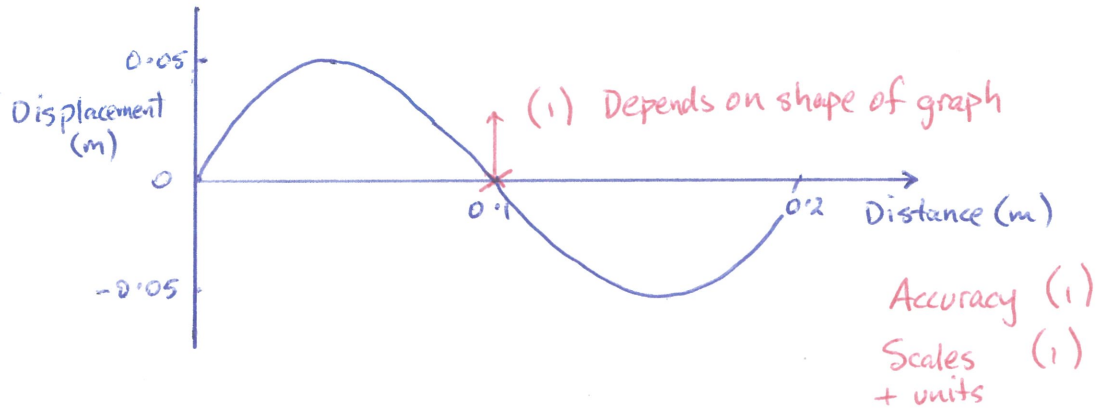
   (a) Matter and information.
   (b) Energy and matter.
   (c) Energy.
   (d) Information and energy.

5. What is the name given to the point of maximum positive displacement along a water wave?

   (a) Rarefaction
   (b) Compression
   (c) Trough
   (d) Crest

[1 mark each]

6. (a) Sketch a displacement versus distance graph representing the movement of the particles with the following properties:
wavelength = 0.2 m, amplitude = 0.05 m. (2 marks)



(b) Use a ***cross*** to indicate the location of the particle on the graph at a distance of 0.1 m from the origin.
If the wave is travelling to the right, use an arrow to indicate the direction (up or down) this particle is moving at the time shown. (1 mark)

7. (a) Explain the difference between a longitudinal wave and a transverse wave. Simple diagrams may help your explanations. (2 marks)

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

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

(b) Give an example of each. (2 marks)

transverse: water wave, light wave (1)

longitudinal: sound wave. (1)

8. A friend sits stationary on a swing and asks you to push them. Explain how the concept of resonance relates to pushing your friend so their height of swing increases over time. (2 marks)

- Energy is transmitted with each push. (1)
- The frequency of each push matches the natural frequency of the swing, so the amplitude (energy) increases. (1)

9. A tuning fork (A) with an unknown frequency is sounded together with a 630 Hz tuning fork (B). Seven beats are noted by an observer. When a small weight is attached to one tine of fork A, which lowers its frequency, the beat frequency noted increases.

(a) Describe ***two*** conditions that are necessary for beats to be heard? (2 marks)

- similar amplitude.
- slightly different frequencies.
- Beat frequency $\leq$ 10 Hz.

Any 2 - 1 mark each.

(b) Determine the frequency of tuning fork A. Show your working or reasoning. (2 marks)

Beat frequency = 7 Hz $\Rightarrow$ A = 623 Hz or 637 Hz (1)

Reducing A increases the beat frequency. $\Rightarrow$ A = 623 Hz. (1)

10. Calculate the wavelength of the waves emitted from radio station 96FM if its frequency of transmission is 96.1 MHz. (3 marks)

$V = 3.00 \times 10^8 \text{ ms}^{-1}$ (1)

$f = 96.1 \times 10^6 \text{ Hz}$

$\lambda = ?$

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

$= \frac{3.00 \times 10^8}{96.1 \times 10^6}$ (1)

$= 3.12 \text{ m}$ (1)

11. (a) What conditions are necessary to produce standing waves? (3 marks)

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

[½ mark off each error]

(b) Draw a diagram to show:

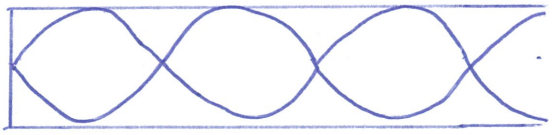
(i) the third harmonic of a string attached at both ends. (2 marks)

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

(1)

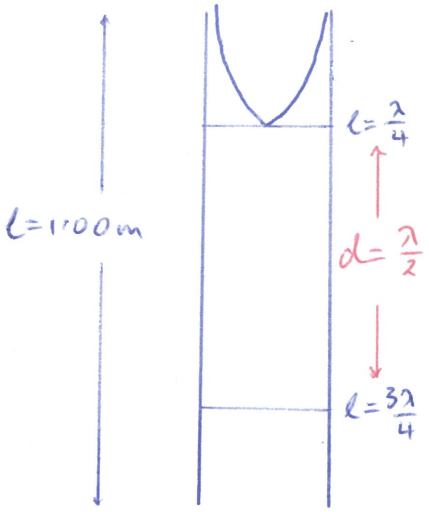
(ii) the seventh harmonic of a closed pipe. (2 marks)

$l = \frac{7\lambda}{4}$ (1)



(1)

12. A narrow vertical tube, open at the top and 1.00 m long, is filled with water, which is allowed to run out slowly from the bottom. For what positions of the water surface will it be possible to obtain resonance with a tuning fork of 336 Hz? (Ignore any end-effect and take the speed of sound as 346 ms^{-1}.) (4 marks)



$v = f\lambda$

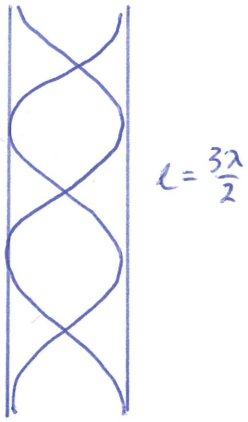
$\Rightarrow \lambda = \frac{346}{336}$ (1)

$= 1.03\,m$ (1)

1st position: $\ell = \frac{\lambda}{4} = \underline{0.257\,m}$ (1)

2nd position $\ell = \frac{3\lambda}{4} = \underline{0.772\,m}$ (1)

13. An open organ pipe is made to resonate at its third harmonic frequency of 1536 Hz. If the velocity of sound is 346 ms^{-1}, determine the ***shortest length*** of pipe required. (4 marks)



$v = f\lambda$

$\Rightarrow \lambda = \frac{346}{1536}$ (1)

$= 0.225\,m$ (1)

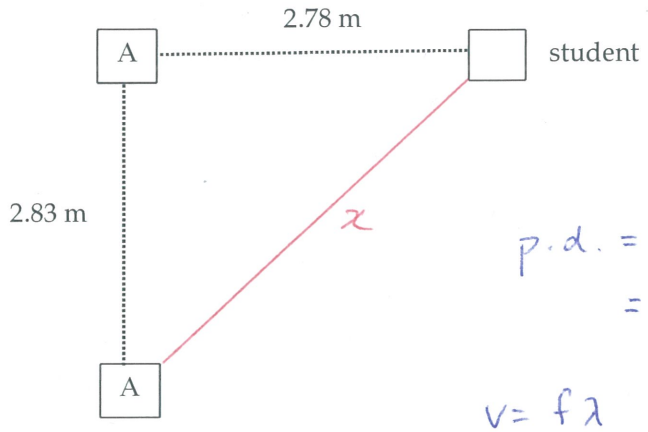
$\ell = \frac{3\lambda}{2}$

$= \frac{3(0.225)}{2}$ (1)

$= \underline{0.338\,m}$ (1)

14. A student was investigating the effect of path difference from two speakers in a laboratory. the speakers are in phase and emitting a 435 Hz note. The student is 2.78 m in front of speaker A as shown in the diagram. Assume the velocity of sound is 346 ms^{-1}.

Does the student hear a loud or soft note? Support your answer by calculation. (5 marks)



$x = \sqrt{(2.78)^2 + (2.83)^2}$

$= 3.97\,m$ (1)

$p.d. = 3.97 - 2.78$

$= 1.19\,m$ (1)

$v = f\lambda$

$\Rightarrow \lambda = \frac{346}{435}$

$= 0.795\,m$ (1)

$p.d. = \frac{1.19}{0.795}$

$= 1.50 \times$ wavelength. (1)

$\therefore$ soft sound (1)