HOLY CROSS COLLEGE
Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2019

Question/Answer Booklet

11 PHYSICS

Test 5 - Wave Motion

Name Solutions

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

Mark: $\frac{}{35}$ 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	5	5	6	5	12.5
Section Two: Problem-solving	9	9	44	35	87.5
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 four times every three seconds. The frequency of the drumming is:

   (a) 0.40 Hz.
   (b) 2.50 Hz.
   (c) 1.33 Hz.
   (d) 3.00 Hz.

2. When the particles of a medium are vibrating at right angles to the direction of energy transport, then the wave is a ____ wave.

   (a) longitudinal
   (b) sound
   (c) standing
   (d) transverse

3. The frequency of light of wavelength 420 nm travelling at 2.98×10^{8} ms^{-1} is:

   (a) 7.36×10^{14} Hz
   (b) 7.10×10^{14} Hz
   (c) 7.36×10^{-4} Hz
   (d) 7.10×10^{-4} Hz

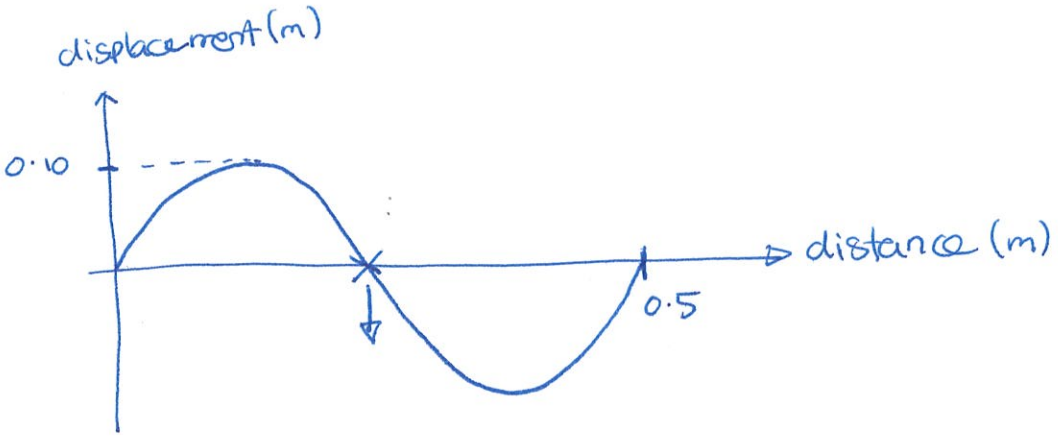
4. Which of the following do all waves transfer from one point to another?

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

5. As a wave travels through a uniform medium, the speed of the pulse ____.

   (a) decreases
   (b) increases
   (c) remains constant
   (d) changes direction

6. (a) Sketch a displacement versus distance graph representing the movement of the particles with the following properties:
wavelength = 0.5 m, amplitude = 0.10 m. (2 marks)



(b) Use a ***cross*** to indicate the location of the particle on the graph at a distance of 0.25 m from the origin.
If the wave is travelling to the left, 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 waves particles displace in direction parallel to wave direction

transverse waves particles displace in direction perpendicular to wave direction

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

transverse: guitar string

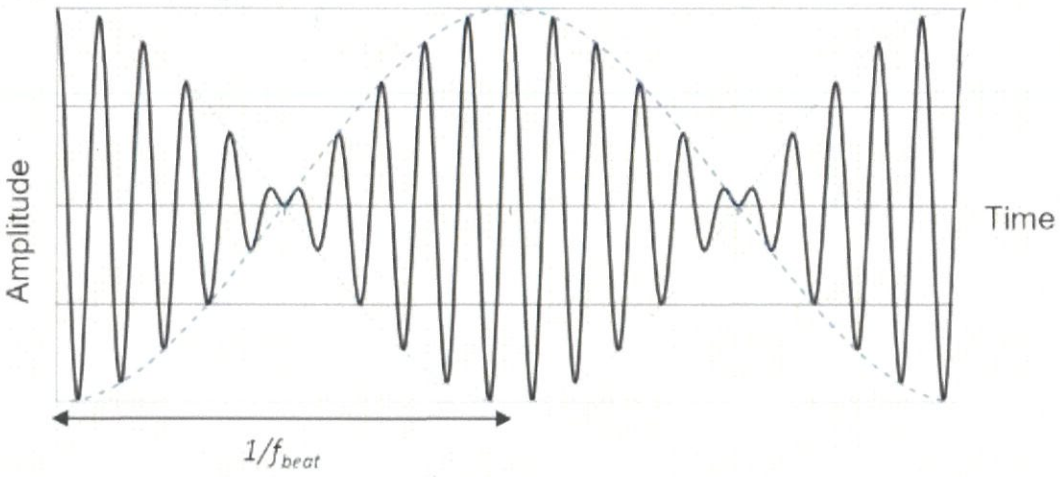
longitudinal: sound waves

8. When determining the speed of sound using a glass column, a column of water, and a tuning fork, we used 2 adjacent resonant points and found the difference in air column length between the 2 points. Why did we do this instead of just using 1 resonant point?

(2 marks)

using 2 points allows us to calculate the wavelength of the standing wave and thus the velocity of sound through the wave equation.

9. Below is an oscilloscope trace of two waves that have interfered to produce a beat pattern.



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

two waves need to interfere
the frequency of the waves needs to be no dif more than 10 Hz in difference

(b) If the period of the beat labelled $1/f_{beat}$ is 0.100 seconds and we know one of the frequencies is 440 Hz then calculate the second frequency that is needed to create our beat.

(2 marks)

$f_{beat} = 10.0$ Hz

$f_1 = 440$ Hz $\therefore$ $f_2 =$ 430 or 450 Hz

10. You stand a certain distance from a source of light and measure its intensity. You then move three times further away and measure its intensity again. How will your two measurements differ?

(2 marks)

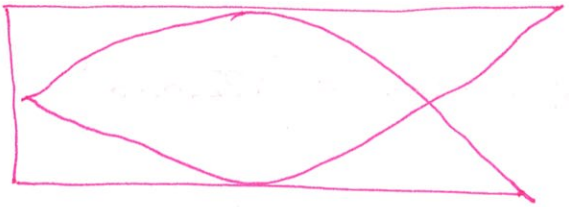
intensity $\propto \frac{1}{r^2}$

$\therefore \quad i_1 = \frac{1}{r^2} \qquad i_2 = \frac{1}{(3r)^2} = \frac{1}{9(r^2)}$

∴ the intensity after moving further away will be $\frac{1}{9}$ the power.

11. During a concert at the Perth concert Hall, a clarinet player produced a pure note that caused the 45.0 cm air column to resonate at its second harmonic. Assume that the clarinet acts as a closed end air column and that the air temperature is 25 °C.

(a) Draw a diagram to show the clarinet resonating at its second harmonic.



$\lambda = \frac{4l}{3} = \frac{4 \times 0.45}{3} = 0.60\,m$

(2)

(2 marks)

(b) Calculate the frequency that the clarinet is producing.

$\lambda = 0.60\,m$ (2)

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

$= \frac{346}{0.60}$

$\approx 576.7\ Hz$ (2)

assume $v = 346\ m.s^{-1}$

(4 marks)

(c) What is the fundamental frequency of the clarinet?

$\lambda_1 = 4l = 1.8m$

$f_1 = \frac{346}{1.8} = 192.2\ Hz$ (1)

(1 mark)

12. A large earthquake hits the Indian Ocean near Christmas Island. The time of the earthquake is 6:00 AM local time on Thursday August 15 in Perth. Authorities estimate that the wavelength of the resulting tsunami will be approximately ~~60.9 m~~ 61 m; however, the frequency of the wave is expected to be only 2.00 Hz. The site of the earthquake is 2630 Km from Perth.

There is a sandcastle building contest scheduled for 11:00 AM till 1:00 PM Perth time on Thursday, August 15 at Cottesloe beach. Should authorities cancel the contest because of the incoming tsunami or will the contest finish before the wave arrives?

(3 marks)

(1) $v = f\lambda$

$v = 2.00\,Hz \times 61\,m = 122\,m.s^{-1}$

(2) $s = vt$

$t = \frac{s}{v} = \frac{2630\,Km}{122\,m.s^{-1}} = 21\,557.4$ seconds

$= 359.3$ minutes

≈ 6 hours

0600 hrs + 6 hrs $\approx$ 1200 hours

(3) the authorities should cancel the event

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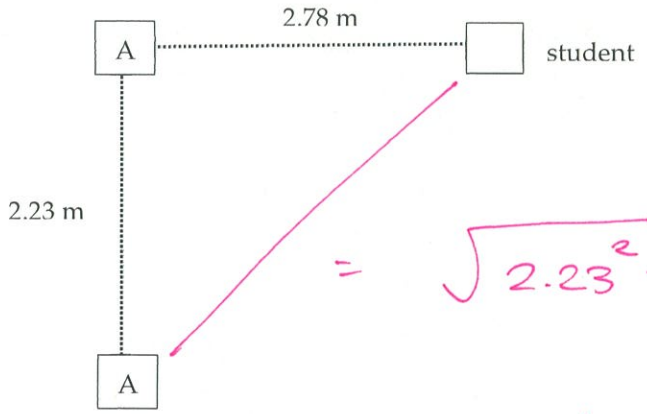
14. A student was investigating the effect of path difference from two speakers in a laboratory. the speakers are in phase and emitting a 440 Hz note. The student is 2.78 m in front of speaker A as shown in the diagram. Assume the velocity of sound is 346 ms^{-1}.

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



$= \sqrt{2.23^2 + 2.78^2}$ ①

pd = ~~2.78~~ $3.56 - 2.78$ ①

$= 0.78$

440 Hz sub ~ s $\lambda = 0.78$

$v = f\lambda \quad \lambda = \frac{v}{f}$ ①

∴ as the phase difference is 0.78 is the same as a wavelength then the sound will be loud due to constructive interference. (2)