CHRIST CHURCH GRAMMAR SCHOOL

YEAR 11

PHYSICS ATAR

FINAL EXAMINATION 2016

SOLUTION

1		
2		
3		
Total		/ 150 = %

Time allowed for this paper
Reading time before commencing work: ten minutes
Working time for paper: two hours and thirty 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, eraser, correction tape/fluid, ruler, highlighters

Special items: non-programmable calculators approved for use in the WACE examinations, drawing templates, drawing compass and a protractor

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	12	12	40	46	30%
Section Two: Problem-Solving	6	6	75	75	50%
Section Three: Comprehension	1	1	35	29	20%
				Total	150

Instructions to candidates

1. Write your answers in this Question/Answer Booklet
2. When calculating numerical answers, show your working or reasoning clearly. Give final answers to three significant figures and include appropriate units where applicable.
3. 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.

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ATAR PHYSICS
FINAL EXAMINATION 2016

Section One: Short Response

This section has **twelve (12)** questions. Answer **all** questions. Write your answers in the space provided.

Suggested working time for this section is **40 minutes**.

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Question 1 **(3 marks)**

There is an inherent danger involved with the use of electricity in the home, industry or at school. Briefly explain how a Residual Current Device (RCD) functions to reduce the danger to people through electrocution.

- An RCD detects a difference in current between the live and neutral wires.
- There should be the same amount of current in the live wire as the neutral wire, if not, current is flowing through the ground wire (most likely through a person to ground).
- When tripped, the RCD creates an open circuit, so no current flows through the circuit.

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Question 2 **(3 marks)**

A person is watching a small anchored boat move up and down on the river as regular waves pass by. He watches for 30.0 seconds and counts 18.5 oscillations. Calculate the period of the waves.

$T = t/f$ (1)

$T = 30/18.5$ (1)

$T = 1.62\ s$ (1)

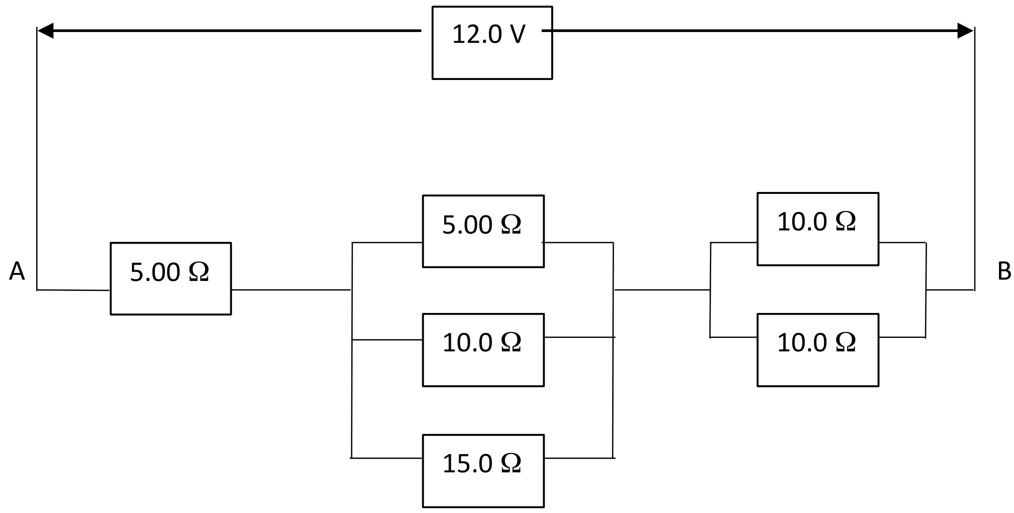
Question 3 **(4 marks)**

Explain why when walking towards a music room in which students are practicing, you will hear a low frequency instrument such as a cello, before hearing a higher pitched instrument such as a violin.

- The low frequency sounds are associated with longer wavelengths than for the higher frequencies
- As the speed of sound in air is constant and v=fλ
- For the same size opening, the longer wavelengths will diffract better Bending around the doorway and being able to be heard outside the music room (high frequencies will only be heard when directly opposite the door).

Question 4 **(5 marks)**

The following diagram shows **part** of an electric circuit.



(a) Calculate the total resistance between points A and B.

(3 marks)

$\frac{1}{R_1} = \frac{6}{30} + \frac{3}{30} + \frac{2}{30} = \frac{11}{30}$ 1/2 $R_1 = \frac{30}{11} = 2.73\ \Omega$ 1/2

$\frac{1}{R_2} = \frac{1}{10} + \frac{1}{10} = \frac{2}{10}$ 1/2 $R_2 = 5.00\ \Omega$ 1/2

$R_T = 5.00 + 2.73 + 5.00 = 12.73 = 12.7\ \Omega$ 1

(b) The potential difference between point A and B is 12.0 V. Calculate the current flowing through the 15.0 Ω resistor.

(2 marks)

$V = IR$ 1/2

I = 12/ 12.7

I = 0.945 A

$(0.945)(2.73) = 2.58\ V$ 1/2 $\frac{2.58}{15.0} = 0.172\ A$ 1

Question 5 **(4 marks)**

In an experiment two gliders are set up on a linear air track. Glider One with a velocity of 0.368 ms^{-1} hits and joins with a stationary glider, Glider 2, that has a mass of 0.250 kg. After joining they both move off at 0.230 ms^{-1}. Calculate the mass of Glider One.

$\Sigma P_i = \Sigma P_f$ 1

$m_1u_1 + m_2u_2 = (m_1 + m_2)\,v$

$(m_1 \times 0.368) + 0.250 \times 0 = (m_1 + 0.250) \times 0.230$ 1

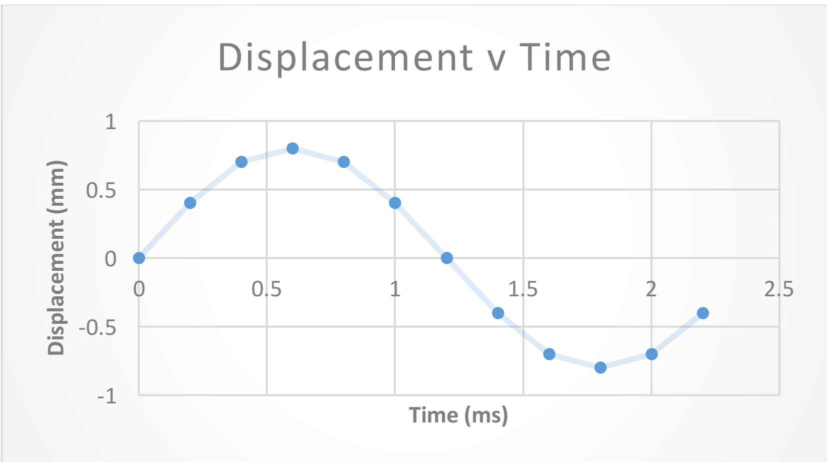
$0.368\,m_1 + 0 = (0.230 \times m_1) + (0.250 \times 0.230)$ 1

$0.368\,m_1 - 0.230\,m_1 = 0.0575$

$\frac{0.0575}{0.138} = m_1 = 0.417\text{ kg}$ 1

Question 6 **(4 marks)**

The graph below shows the displacement of a particle in a longitudinal wave.



Use the graph to calculate:

(a) Amplitude to 2 significant figures. (1 mark)

Amplitude = 0.81 mm or 8.1 x 10^{-3} m

(b) Period to 3 significant figures. (1 mark)

Period = 2.42 ms or 2.42 x 10^{-3} s

(c) Frequency to 3 significant figures. (2 marks)

$f = \frac{1}{T} = \frac{1}{2.42 \times 10^{-3}}$ 1 $f = 4.13 \times 10^{2}\text{Hz}$ 1

Question 7 **(4 marks)**

An excited Stephen Smith takes a magnificent catch in slips and celebrates by throwing the ball directly up into the air from 1.50 m above the ground and catches it again at the same height. When thrown into the air, the ball reaches a height of 18.0 m above the ground. Calculate the initial velocity of the throw.

$v^2 - u^2 = 2as$ (1)

$v^2 - 0^2 = 2\times 9.8\times 16.5$ (1)

$v = \sqrt{323.4}$ (1)

$\mathrm{v} = 18.0\ \mathrm{ms^{-1}}\ up$ (1)

-1/2 if no direction specified

Question 8 **(5 marks)**

A 2.40 x 10^2 V toaster element operates using a 5.00 A current.

(a) Calculate the resistance of the toaster element.

(2 marks)

$\mathrm{V} = \mathrm{I}\times\mathrm{R}$ (1/2)

$\mathrm{R} = \frac{240}{5.00}$ (1/2)

$\mathrm{R} = 48.0\ \Omega$ (1)

(b) Calculate how much electrical energy is converted into heat energy every second as the toaster is used.

(3 marks)

$\mathrm{E} = \mathrm{V}\times\mathrm{I}\times\mathrm{t}$ (1)

$\mathrm{E} = 240\times 5.00\times 1$ (1)

$\mathrm{E} = 1.20\times 10^3\ \mathrm{J}$ (1)

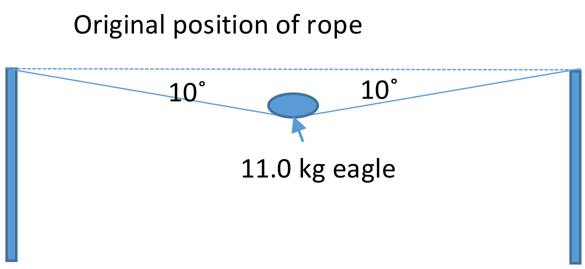
Question 9 **(3 marks)**

Other than vibrating columns of air, describe an example in which resonance may be observed. In the example that you chose, explain how resonance occurs.

Any suitable example that includes
- a statement/definition of the driving or forcing frequency
- matching the natural frequency of the object that is resonating
- resulting in an increased amplitude of the sound produced.

Question 10 **(4 marks)**

A rope is fixed level between two posts. An 11.0 kg eagle lands on the middle of the rope causing the rope to move such that each end makes an angle of 10˚ to its original position as shown in the diagram below.



Calculate the resulting magnitude of the tension in the rope.

$$W = mg = 11.0 \times 9.8 = 107.8 \text{ N}$$ (1)

$$\Sigma F = ma$$

$$\Sigma F_v = Tsin10 + Tsin10 - mg = 0$$ (1) (1)

$$T = \frac{107.8}{(2)(sin10)}$$ (1/2)

$$T = 310.4 = 310\ N$$ (1)

Question 11 **(3 marks)**

In walking to school Jack walks from the end of his driveway at 1.50 ms^{-1} S for 10 minutes, turns a corner then runs at 2.75 ms^{-1} S45˚W for 3 minutes, before walking at 1.25 ms^{-1} W for a further 4 minutes. Calculate how far Jack travels to school.

(3 marks)

$s = v \times t$ (1/2)

$s_1 = 1.50 \times 10 \times 60 = 900m$ (1/2)

$s_2 = 2.75 \times 3 \times 60 = 495m$ (1/2)

$s_3 = 1.25 \times 4 \times 60 = 300m$ (1/2)

$s_t = 900 + 495 + 300 = 1695 \text{ m} = 1.70 \times 10^3 \text{m}$ (1)

Question 12 **(4 marks)**

Using the data from question 11, calculate using the component method of vectors, Jack's displacement from where he leaves from the end of his driveway at home to get to school.

$s = 900\,S + 495\,S45^\circ W + 300\,W$

Using component of vector method

= 900S + 495 x sin45 +0 S = 900+350 +0 = 1250m S (1/2)

= 0 W + 495 cos 45 + 300 = 350 +300 = 650m W (1/2)

$c = \sqrt{1250^2 + 650^2} = 1.41 \times 10^3 m$ (1)

$(Tan\theta)^{-1} = \frac{650}{1250} = 27.5^\circ$ (1)

$1.41 \times 10^3 m\ \ S27.5^\circ W$ (1)

End of Section One

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Section Two: Problem-Solving

This section has **six (6)** questions. Answer **all** questions. Write your answers in the space provided.

Suggested working time for this section is **75** minutes.

NAME:_______________________________________

Question 1 **(13 marks)**

A QANTAS A380 plane has a maximum take off mass of 575 000 kg on a flight between Melbourne and Los Angeles. To lift off fully loaded from Melbourne Airport it must achieve a velocity of 343 kmh^{-1} from a stationary start.

(a) The minimum safe distance that a fully loaded A380 can achieve lift off in is 2950 m. Calculate the acceleration required to achieve lift off.

(4 marks)

343/3.6 = 95.3 ms^{-1} (1)

$v^2 - u^2 = 2as$ (1)

$\frac{95.3^2 - 0^2}{2 \times 2950} = a$ (1)

$1.54\ ms^{-2}$ in the direction of travel (1)

- 1 mark if do not convert to ms^{-1} and -1/2 if no direction

(b) Calculate the time it would take the A380 to achieve lift off from a stationary start.

(3 marks)

$v = u + at$ (1)

$t = \frac{95.3 - 0}{1.54}$ (1)

$t = 61.9\ s$ (1)

(c) When sitting on a plane such as an A380, explain why you are 'pushed back into your seat' during take off.

(2 marks)

- As the plane takes off you are experiencing the effects of inertia
- Your body has mass and wants to remain stationary as the plane accelerates beneath you, forcing the seat into your back that gives the impression of pushing you back into the seat.

(d) On landing in Los Angeles the plane has used up 1.96 x 10^5 kg of fuel. The minimum landing speed of the A380 is 252 kmh^{-1}. Calculate the average braking force required to bring the plane to a complete stop in a minimum distance of 1525 m.

(4 marks)

$v^2 - u^2 = 2 \times a \times s$ (1)

$$\frac{252}{3.6} = 70.0\, ms^{-1}$$

$$\frac{(70.0^2 - 0.00^2)}{-3050} = a = -1.61\, ms^{-2}$$ (1)

$$F = ma = (5.75 \times 10^5 - 1.96 \times 10^5) \times -1.61\, ms^{-2}$$ (1)

$F = 610$ kN opposite to direction of travel (1)

-1/2 if no direction specified

OR use $\Delta E_k = \frac{1}{2}mv^2 = Fs$

Question 2 **(19 marks)**

A group of intelligent physics students are on a School camp where they find a tyre attached to the bough of a tree by a rope. They observe that the tyre can be used as a swing over a bend in a river. When swinging it out over the water, they realise that it acts in the same way that a pendulum would. In a physics lesson they remember being taught that the period (T) of oscillation of a pendulum is related to its length (l) and the acceleration of gravity (g) using the equation:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

(a) They swung the tyre out over the river and timed that it took 39.5 s to complete 10 oscillations. Calculate the length of rope attached to the tyre.

(3 marks)

Period of 1 oscillation =39.5/10 = 3.95 s (1)

$T^2 = \frac{4\pi^2 l}{g}$ $l = \frac{T^2 g}{4\pi^2}$ (1/2)

$$l = \frac{3.95^2 \times 9.8}{4\pi^2}$$ (1/2)

$l = 3.87\ m$ (1)

(b) On returning to school the boys decided to use their initiative to conduct an experiment to find the relationship between the length of a pendulum and its period. Their results are shown below.

Length of pendulum *l* (m)	Time for 10 Oscillations (s)	T (s)	T^2 (s^2)
0.10	5.5	0.55	0.30
0.20	6.9	0.69	0.48
0.30	10.9	1.09	1.19
0.40	12.5	1.25	1.56
0.50	15.0	1.50	2.25
0.60	18.5	1.85	3.42

All values to 2 decimal places

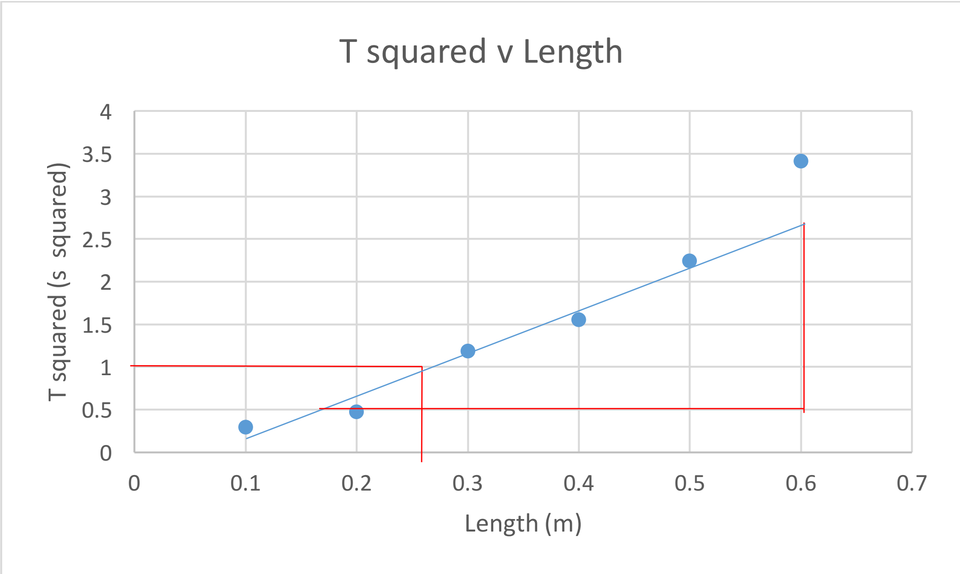
(c) Complete the data table.

(2 marks)

(d) Use the data from your table to enable a plot of a straight line graph on the grid on the following page, that would show the relationship between the period of oscillation squared (T^2) and the length of a pendulum (l).

1 mark correct axes, labelled with units, 1 mark plot of points, 1 mark line of best fit, 1 marks for line of best fit not going through origin of graph

(4 marks)



(e) Use your graph to determine the pendulum length that gives a period of 1.00 s.

(3 marks)

1 mark showing evidence (lines drawn to determine length with period of 1 second).

$$T = 1\, s \; when \; T^2 = 1.00\, s^2$$

1 mark L = 0.26 m (L between 0.2 and 0.3 m)

1 mark 1 or 2 sig figures

(f) Determine the gradient of your graph using a line of best fit.

(4 marks)

1 mark triangle on graph, 1 marks calculation showing values used, 1 mark value (allow between 4.0-6.0), 1 mark correct unit (s^2m^{-1})

$$Gradient = \frac{rise}{run}$$

$$Gradient = \frac{2.6 - 0.50}{0.60 - 0.16}$$

$$Gradient = 4.77\ s^2m^{-1}$$

-1 mark if used data points and not line of best fit, -1/2 mark if values used from line of best fit not shown in calculation.

(g) Use your gradient to determine the magnitude of the experimental value for the acceleration of gravity (g).

(3 marks)

$$\text{As } T^2 = \frac{4\pi^2}{g}L, \ \text{gradient} = \frac{4\pi^2}{g}$$ (1)

$$\text{g} = \frac{4\pi^2}{gradient}$$ (1)

$$\text{g} = \frac{4\pi^2}{4.77} = 8.27\ ms^{-2}$$ (Allow 6.6 - 9.9) ms^{-2} (1)

Question 3 **(12 marks)**

A basketball player bounces a 0.500 kg ball on the court floor. Just before it hits the floor it is moving at 3.00 ms^{-1}. It rebounds from the floor at 2.00 ms^{-1}.

(a) Calculate the change in momentum of the ball.

(3 marks)

p = mv (1/2) Δp = mv - mu (1/2) take up as +

Δp = 0.5 (+2.00) - (-3.00) (1/2)

Δp =0.5 x 5.00 (1/2)

Δp = 2.50 kgms^{-1} up (1)

-1/2 if no direction specified

(b) Calculate the kinetic energy of the ball just before it hits the court.

(3 marks)

$E_k = \frac{1}{2}mv^2$ (1)

$E_k = \frac{1}{2}\times0.5\times3.00^2$ (1)

$E_k = 2.25$ J (1)

(c) Calculate the kinetic energy after rebounding from the court.

(3 marks)

$E_k = \frac{1}{2}mv^2$ (1)

$E_k = \frac{1}{2}\times0.5\times2.00^2$ (1)

$E_k = 1.00$ J (1)

(d) Does this situation contravene (break) the Law of Conservation of Energy? Explain.

(3 marks)

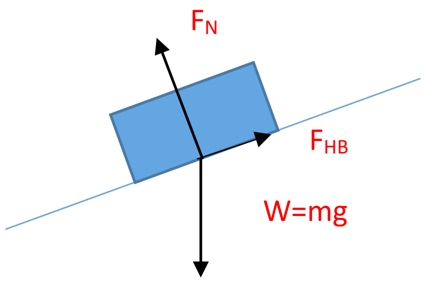
- The Law of Conservation of energy states that energy can not be created or destroyed only transformed or transferred
- The kinetic energy has been reduced but in the act of bouncing other forms of energy are apparent including sound and heat
- so the Law of Conservation of energy is not contravened

Question 4 **(10 marks)**

A 3.50 x 10^3 kg truck is sitting stationary at a set of traffic lights on a section of road that slopes 15.5˚ upwards.

(a) Draw a free body diagram that shows all of the forces acting on the truck if a handbrake is used to hold the truck in position.

(3 marks)



1 mark each correctly labelled force

(b) Calculate the force exerted by the handbrake to hold the truck in this stationary position.

(3 marks)

$\Sigma F = 0$ (1)

$\Sigma F = W + F_N + F_{HB} = 0$ *or other suitable statement*

$F_{HB} = W \sin 15.5$ (1)

$F_F = 34300 \times \sin 15.5$ = 9170 N up the slope (or 15.5˚ above the horizontal) (1)

-1/2 if no direction specified

(c) When the lights change to green, each of the four tyres produce 4.50 kN of frictional force with the road to drive forward. Calculate the acceleration of the truck.

(4 marks)

$\Sigma F = F_F + F_{HB} = (4 \times 4500) - 9170 \text{ N} = 8830 \text{ N}$ (1)

$F = ma$ (1)

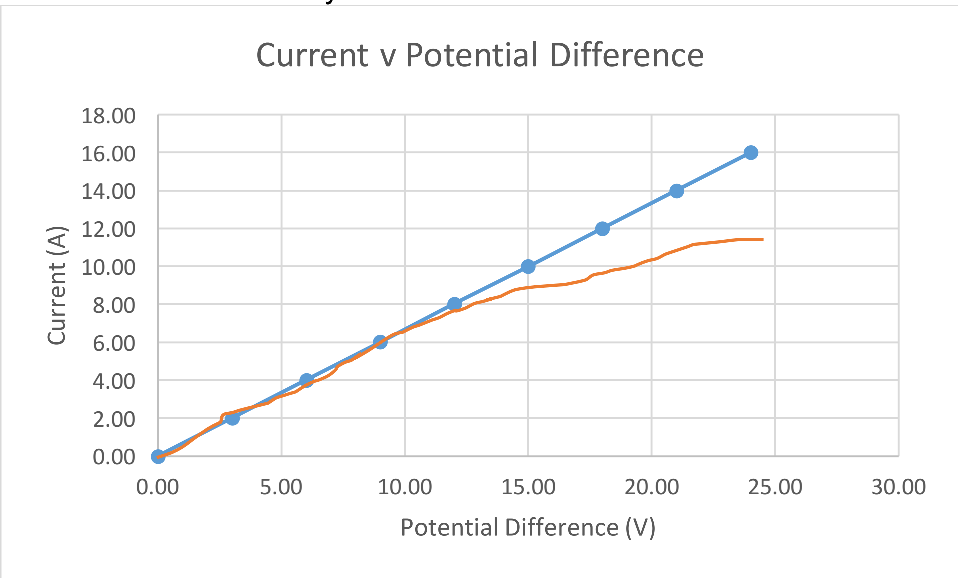
$a = \frac{8830}{3500}$ (1)

$a = 2.52\ ms^{-2}$ up the slope (or 15.5˚ above the horizontal) (1)

-1/2 if no direction specified

Question 5 **(11 mark)**

The graph below shows the current measured flowing through a conductor wire by a group of students as they varied the potential difference across the wire under normal laboratory conditions.



(a) Calculate the resistance of the conducting wire used. (3 marks)

Resistance is the inverse of the gradient of the line of best fit gradient (1)

$V = I \times R$ $R = \frac{V}{I}$

$$R = \frac{15.0 - 0}{10.0 - 0}$$ (1)

$R = 1.50\ \Omega$ (1)

-1/2 if values used to determine gradient not shown

(b) The conducting wire used was 1.00 m in length and had a diameter of 1.20 mm. Calculate the resistivity of the wire used in the experiment. (3 marks)

$$R = \frac{\rho \times L}{A}$$ (1)

$$\rho = \frac{R \times A}{L}$$

$$\rho = \frac{1.50 \times \pi (\frac{1.2 \times 10^{-3}}{2})^2}{1.00}$$ (1)

$\rho = 1.70 \times 10^{-6}\ \Omega m$ (1)

(c) One student estimated that the resistance of the conducting wire would be equal to 133 Ω if the potential difference across it was 200 V, when the potential difference was left connected for 20 seconds. Comment on the validity of this estimate, justifying your reasoning.

(3 marks)

- If the device is left on for 20 seconds the wire will gradually heat up
- As resistance is proportional to temperature
- The resistance would increase so this is a reasonable estimation

(d) On the graph on the previous page, draw in a line of best fit that would represent the relationship between current and potential difference for a non-ohmic conductor.

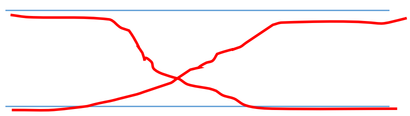
(2 marks)

Question 6 **(10 marks)**

A pan pipe is an instrument made originally by certain South American Indian tribes out of open lengths of bamboo and lashed lashed together with twine as shown in the image.

(a) Complete the particle displacement diagram below that shows the wave envelope/profile for the fundamental frequency of a bamboo tube 10.0 cm in length.

(2 marks)



L = 10.0 cm

(b) Calculate the fundamental frequency of this pipe if played in air on a day when the speed of sound measured 346 ms^{-1}.

(3 marks)

$$f_n = \frac{nv}{2L}$$ (1)

$$f_n = \frac{1 \times 346}{2 \times 0.10}$$ (1)

$$f_n = 1730\ Hz$$ (1)

(c) If the person playing the instrument used their finger to block the bottom opening of the 10.0 cm bamboo pipe being played, explain what effect this would have on the frequency of the note heard.

(2 marks)

- Blocking the bottom of the tube converts it into a closed tube where $f_n = \frac{nv}{4L}$
- As L is constant, λ is doubled so this has the effect of halving the fundamental frequency to 865Hz.

If answers state only that frequency decreases -1/2 mark

(d) Calculate the length of open bamboo pipe required to make a note with 1/3 of the fundamental frequency of the 10.0 cm pipe as in part (b).

(3 marks)

$$f_n = \frac{nv}{2L}$$ (1)

$$\frac{1730}{3} = \frac{1 \times 346}{2L} \qquad 2L = \frac{3 \times 346}{1730}$$ (1)

$$L = 0.300\ m$$ (1)

End of Section Two

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Section Three: Comprehension

This section has **one (1)** question. Answer all questions. Write your answers in the space provided.

Suggested working time for this section is **35** minutes.

NAME:_______________________________________

Question 1 **(29 marks)**

Vehicle Occupant Restraint Systems

Vehicle occupant restraint systems (VORS) are devices fitted to a vehicle that prevent injury in the event of a crash. A crash could be a collision with another vehicle or objects such as walls, crash barriers or trees. Such systems include lap, lap sash and inertia reel seatbelts, baby capsule and child seat restraints and airbags.

Examples of vehicle occupant restraint systems

Inertial reel seatbelts are seatbelts connected to a sensor that detects rapid forward movement. When rapid forward movement is detected the seatbelt is locked in position which prevents the occupant from continuing to move forward. A lap sash seatbelt holds an occupant in a position as the seatbelt has limited mobility once activated. In modern cars, most seatbelts are inertial reel lap sash seatbelts.

(a) Explain, making reference to any appropriate law/s, how an inertial reel lap sash seatbelt would provide protection for a car's occupant in an accident.

(5 marks)

- A body at rest or moving with constant speed will remain at rest or continue to move at constant speed unless acted upon by an externally unbalanced force (Newton's 1st Law - the Law of inertia).
- In an accident the car which has mass and therefore inertia, is subjected to an externally unbalanced force.
- The inertia of the occupant sees them continuing to move forward until the sensor locks the seatbelt in position
- This seatbelt exerts an equal and opposite force (Newton's 3rd Law) preventing the occupants moving further forward
- preventing injury caused by a secondary collision with structural parts of the car (such as the window, dash or steering wheel for front passengers or front seats for rear seat passengers).

(b) Explain why the seatbelt mechanism would be called an **inertial** reel.

(3 marks)

- The sensor and locking mechanism are reacting to a rapid change in the force exerted by the occupants on their seatbelt
- On impact the occupants continue to move forward at the speed at which the car was travelling at
- exerting an unbalanced force on the inertial reel mechanism which is anchored to the rapidly decelerating car causing it to lock in position.

An airbag module inflates to provide cushioning for a passenger in a crash event. Any airbag module is designed to inflate rapidly and then to quickly deflate when the vehicle experiences a rapid and sudden deceleration.

Each airbag module consists of a flexible fabric bag known as an airbag cushion, an inflation module and an impact sensor. The sensors are linked to a central airbag control unit (ACU) which monitor a number of related sensors within the vehicle including accelerometers, impact sensors, side (door) pressure sensors, wheel speed sensors, gyroscopes, brake pressure sensors and seat occupancy sensors.

Airbags are fitted in different positions in a vehicle, the most common being inside the steering wheel (driver airbag module) and the dash immediately in front of the passenger seat (passenger airbag module). Air bags are designed to protect the head, neck, and chest of occupants in the front of vehicles from slamming into the dash, steering wheel or windshield in the event of a front-end crash, where the vehicle collides with something with the front of the car. These modules are not designed to inflate in rear-end or rollover crashes or in most side crashes.

Deployed driver and passenger airbag modules and side impact cushions

Airbags do not reduce the change in momentum of the car occupants, but are designed to reduce the forces acting on them.

(c) Explain how airbags can reduce the force acting on a car's occupants if their change in momentum is not reduced.

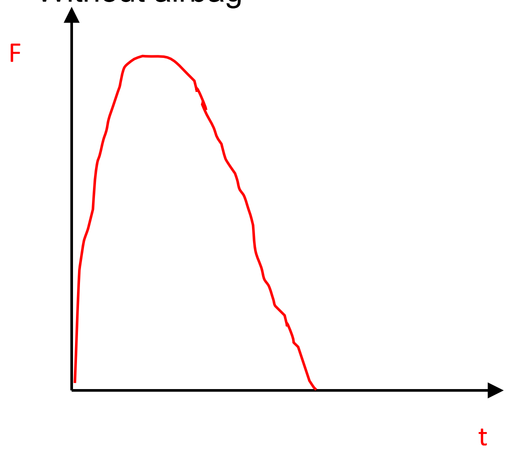
(3 marks)

- Impulse = change in momentum = Force x time
- The change in momentum is constant but the airbag is increasing the time over which the average force is acting in the collision and
- as $F \propto \frac{1}{\Delta t}$ this results in a decrease of the average force acting on the occupants of the car during the collision

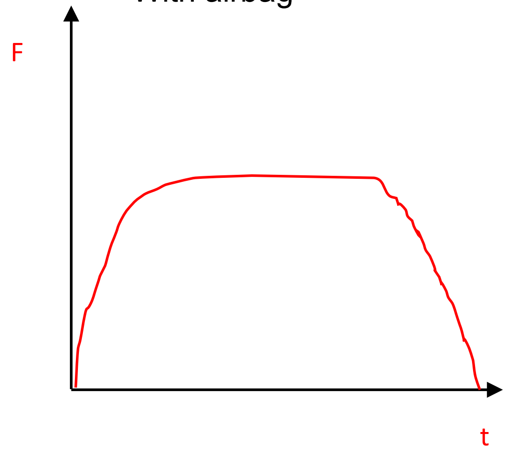
(d) Sketch labelled graphs of Force vs Time for the collision between the driver of a car and the steering wheel with and without airbags.

(4 marks)

Without airbag



With airbag



(e) State what quantity should be the same for both graphs.

(1 mark)

The area under the graph

Generally, air bags are designed to deploy when the severity of a crash reaches a preset threshold value. During an impact, the vehicle's crash sensor(s) provide crucial information to the airbag controller unit (ACU), including collision type, angle and severity of impact. Using this information, the airbag ACU's crash algorithm determines if the crash event meets the criteria for deployment and triggers various firing circuits to deploy one or more airbag modules within the vehicle. Working as a supplemental restraint system to the vehicle's seatbelt systems, airbag module deployments are triggered through a pyrotechnic process that is designed to be used only once. Newer side-impact airbag modules usually consist of compressed air cylinders that are triggered only in the event of a vehicle impact from either side.

Depending on the specific vehicle model, the ACU has a threshold that is normally equivalent to a vehicle crashing into a solid wall at 13-23 km/h. Airbags most often deploy when a vehicle collides with another vehicle or with a solid object like a tree.

(f) Explain why a threshold value is used for airbag deployment.

(3 marks)

- Airbags need to be replaced if activated
- Low speed collisions result in much lower changes in momentum and lower forces acting on the occupants of the car
- That are less likely to result in injury so do not require an airbag to prevent injury

Also allow:

- expensive and
- also in lower impacts, the activation of the airbag can actually increase the risk of minor injury.

(g) A crash test dummy of mass 75.0 kg in a car travelling at 60 kmh^{-1}, hits a wall and comes to a stop. Calculate the change in momentum the crash test dummy experiences in this collision.

(4 marks)

$\Delta P = mv - mu$ (1)

$\Delta P = 75.0\ (\frac{0 - 60}{3.6})$ (1)

$\Delta P = 75.0\ (-16.7)$ (1)

$\Delta P = 1.25 \times 10^3\ kgms^{-1}$ *opposite to direction of travel* (1)

-1/2 if no direction indicated

-1 if used speed in kmh^{-1}

Driver and passenger airbag modules inflate when the ACU detects a front-end crash severe enough to trigger their deployment. The ACU sends an electric signal to start a chemical reaction that inflates the airbag with harmless nitrogen gas. All this happens faster than the blink of an eye.

(h) Explain why it is necessary for the airbag to inflate 'faster than the blink of an eye'.

(3 marks)

- The initial movement of the occupant is at the speed of the car
- The distance travelled (s = v x t) would put them in danger of hitting structural features of the car
- Reducing the time of inflation of the airbag decreases the physical time/distance the occupant can move before experiencing a collision with and the benefit of the deflating airbag.

Airbags have vents, so they deflate immediately after the initial impact of an occupant.

(i) Explain what would happen if airbags did not have vents to enable deflation immediately after an impact with an occupant.

(3 marks)

- The occupant would experience an elastic collision with the airbag
- causing a larger change in momentum (and impulse) in a shorter time period
- that would result in significant whiplash injuries to the neck and inertia impacts of the brain with the skull

End of Section Three

End of Examination