CHRIST CHURCH GRAMMAR SCHOOL

YEAR 11

PHYSICS ATAR

FINAL EXAMINATION 2016

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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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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.

Question 2 **(3 marks)**

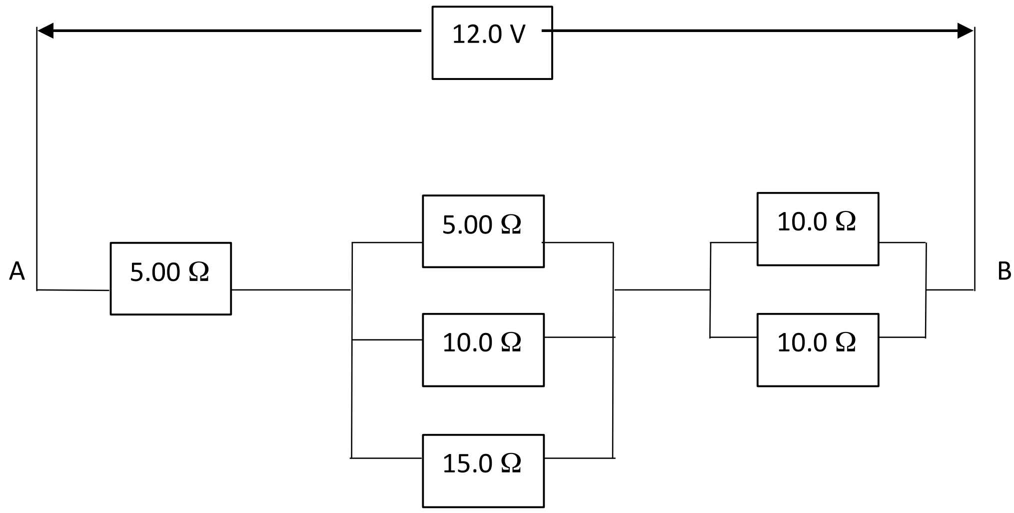
A person is watching a small anchored boat move up and down on the river as regular waves pass by. He watches for 30.0 seconds and counts 18.5 oscillations. Calculate the period of the waves.

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.

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)

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

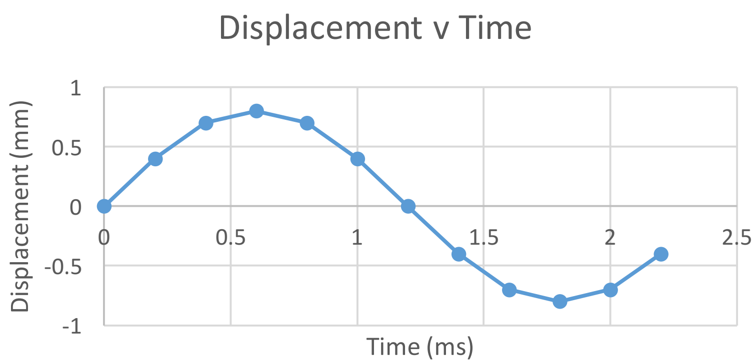
(2 marks)

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.

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)

(b) Period to 3 significant figures.

(1 mark)

(c) Frequency to 3 significant figures

(2 marks)

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.

Question 8 **(5 marks)**

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

(a) Calculate the resistance of the toaster element.

(2 marks)

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

(3 marks)

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.

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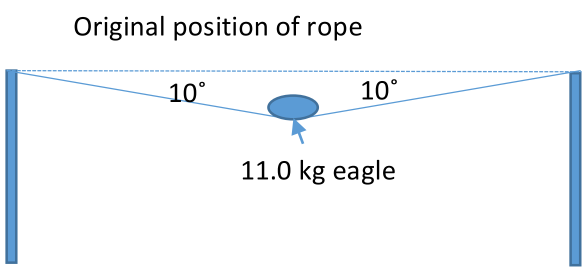
Question 10 **(4 marks)**

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 tension in the rope.

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.

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.

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)

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

(3 marks)

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

(2 marks)

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(d) On landing in Los Angeles the plane has used up 1.96×10^5 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)

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)

(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		
0.20	6.9		
0.30	10.9		
0.40	12.5		
0.50	15.0		
0.60	18.5		

(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).

(4 marks)

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

(3 marks)

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

(4 marks)

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

(3 marks)

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)

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

(3 marks)

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

(3 marks)

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

(3 marks)

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Question 4 **(10 marks)**

A 3.50×10^3 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)

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

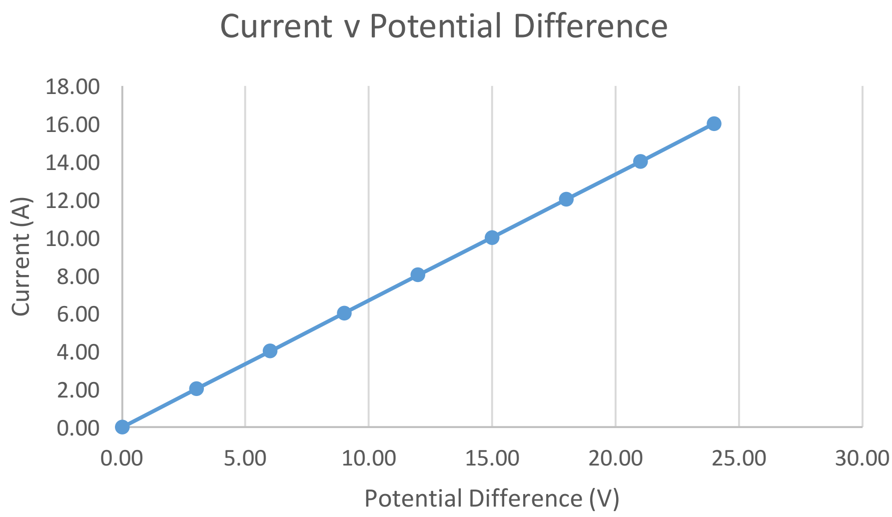
(3 marks)

(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)

Question 5 **(11 marks)**

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)

(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)

(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)

(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 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 in air measured 346 ms^{-1}.

(3 marks)

(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)

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

(3 marks)

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)

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

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

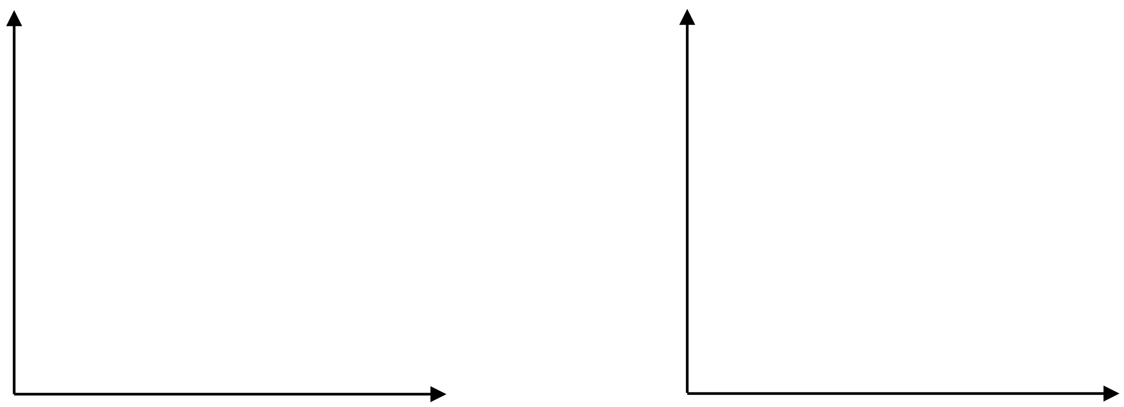
Airbags do not reduce the change in momentum of the car occupants, but are designed to reduce the forces acting on them.

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

(3 marks)

(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)



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

(1 mark)

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)

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(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)

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)

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)

End of Section Three

End of Examination

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