CORPUS CHRISTI COLLEGE
SEQUERE DOMINUM

YEAR 12 ATAR PHYSICS
UNIT 3 and 4
SEMESTER TWO
EXAMINATION 2018

Teacher: W O'CALLAGHAN / K ROURKE
(Circle)

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

In words _____

_____

Time allowed for this paper Reading time before commencing work: 10 minutes
Working Time: 3 hours

Materials required/recommended for this paper

To be provided by the supervisor This Question/Answer Booklet
Formulae and Constants Booklet

To be provided by the candidate
Standard items: pens, pencils, eraser, correction fluid/tape, 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	11	11	50	60	30
Section Two: Problem-solving	8	8	90	100	50
Section Three: Comprehension	2	2	40	…..	20
				180?	100

Instructions to candidates

1. The rules for the conduct of examinations at Corpus Christi 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.

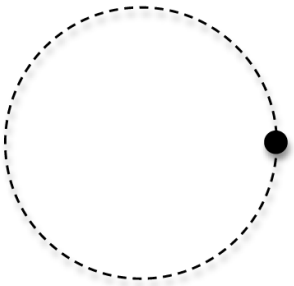
Section One: Short response **30% (60 Marks)**

This section has **11** questions. Answer **all** questions.

Suggested working time: 50 minutes.

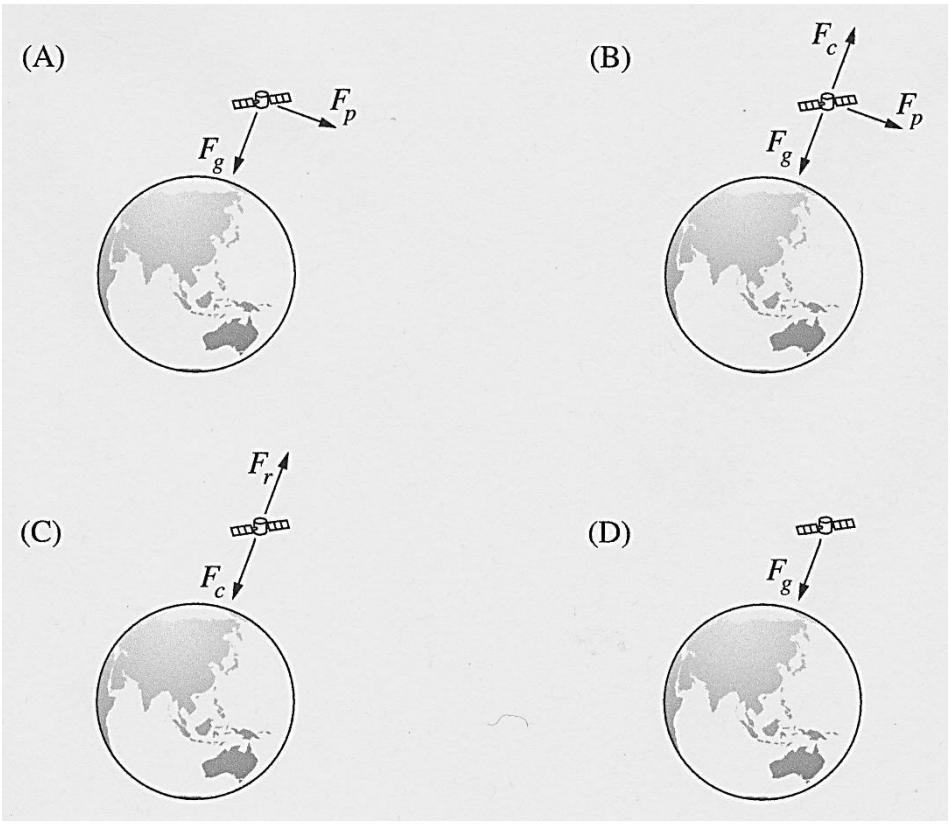
Question 1 **(3 marks)**

(a) An object moves in a circle **in a counter-clockwise direction** with constant speed. On the diagram below draw and label the correct velocity and acceleration vectors for the object. (2 marks)



(b) Which of the following diagrams correctly represents the force(s) acting on a satellite in a stable circular orbit around Earth? Circle the correct answer. (1 mark)

F_g = gravitational force	F_p = propulsive force
F_c = centripetal force	F_r = reaction force



Question 2 **(5 marks)**

Digital television in New Zealand can be accessed by using a satellite dish pointed at a satellite in space. The satellite used to transmit the signals appears to stay still above the equator.

The satellite, with a mass of 300 kg, is actually travelling around the Earth in a geostationary orbit at a radius of 4.22×10^7 m from the centre of the Earth.

(a) Calculate the force acting on the satellite. (2 marks)

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(b) Show that the speed of the satellite is about 3×10^3 m s^{-1}. (3 marks)

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Question 3 **(4 marks)**

Estimate the force that is exerted on each arm when you execute a perfect push-up. You must provide all the relevant data and state all reasonable assumptions in determining your answer. (Show all working details.)

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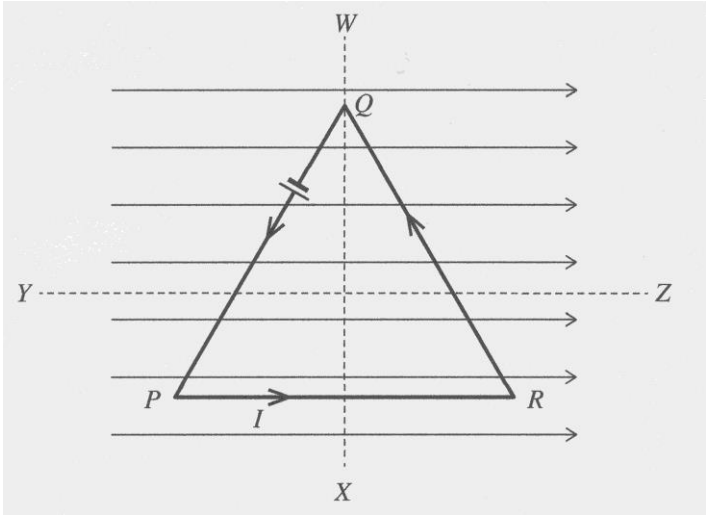
Question 4 **(5 marks)**

(a) A triangular piece of wire is placed in a magnetic field as shown.



When current I is supplied as shown, how does the wire move? Circle the correct answer. (1 mark)

	Axis of rotation	*Direction of movement*
A	YZ	Q into page
B	YZ	Q out of page
C	WX	R into page
D	WX	R out of page

(b) A current is sent through a helical coil spring, as shown in the diagram below. When the current is flowing the spring contracts, as though it had been compressed.

Explain why this is so. [Hint: Annotate and refer to the diagram in your answer or even draw an alternative diagram]. (4 marks)

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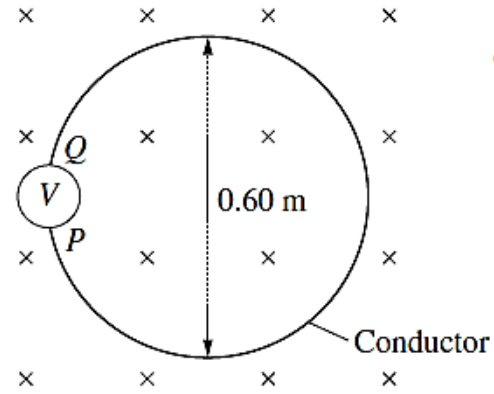
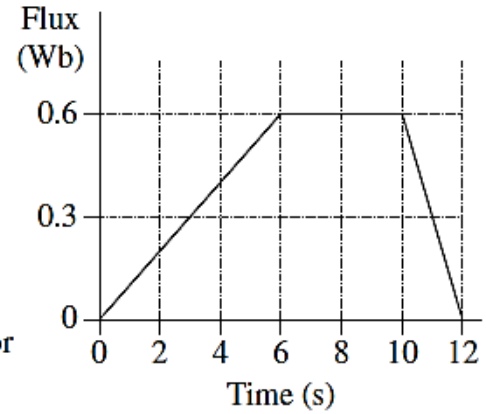
Question 5 **(5 marks)**

The diagram shows an electric circuit in a magnetic field directed into the page. The graph shows how the flux through the conductive loop changes over a period of 12 seconds.





(a) Calculate the maximum magnetic field strength within the stationary loop during the 12-second interval. (2 marks)

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(b) Calculate the maximum voltage generated in the circuit by the changing flux. In your answer, indicate the polarity of the terminals *P* and *Q* when this occurs. (3 marks)

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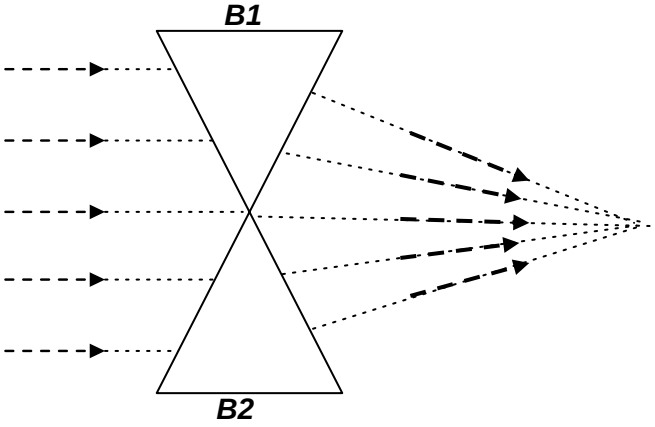
Question 6 **(8 marks)**

An electron microscope uses a "magnetic lens" to focus a wide beam of electrons to a point as shown in the diagram. Assume that all electrons have the same speed.

(a) Illustrate the directions of the magnetic fields *B1* and *B2* inside the triangular "magnetic" lenses (1 mark)



(b) Calculate the deflecting force on electrons travelling with a velocity of 1.50×10^6 ms^{-1} if the magnetic field strength is 0.100 T. (3 marks)

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(c) (i) Calculate the de Broglie wavelength of an electron that has a velocity of 1.50×10^6 ms^{-1}. (1 mark)

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(ii) Use this result to explain why an electron microscope is capable of much higher magnifications and has a greater resolving power than a light microscope, allowing it to see much smaller objects in finer detail. (3 marks)

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Question 7 **(11 marks)**

A beam of 35.0 keV electrons strike a molybdenum target, generating X-rays.

(a) (i) Determine the cut-off wavelength of the X rays produced. (λ_{min}). (3 marks)

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(ii) Are these X-rays hard or soft? Give a possible use for these X-rays. (2 marks)

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(b) Given that the power supplied to the X-ray tube in (a) is 18 kW, estimate how many X-ray photons would be produced in a 5.0 ms period of usage. (4 marks)

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(c) Multiple Choice (2 marks)

(i) The main advantage of using X-rays produced by a synchrotron rather than X-rays produced in a conventional X-ray tube in an X-ray machine is that

A X-rays from an X-ray machine cannot be tuned using a monochromator.

B X-rays from an X-ray machine can only be used to investigate biological materials.

C the beamline of a synchrotron can produce an intense single-wavelength X-ray beam.

D radiation from a synchrotron will scatter more readily than the conventionally produced X-rays.

(ii) In the Australian Synchrotron, electrons are accelerated in several stages and their final speed approaches the speed of light.

Which of the following best describes the order in which the various components accelerate the electrons?

	First	Second	Third
A.	linac	electron gun	booster ring
B.	linac	booster ring	electron gun
C.	electron gun	linac	booster ring
D.	electron gun	booster ring	linac

Question 8 **(3 marks)**

The wavelength of the H_β line in the spectrum of the star Megrez in the constellation Ursa Major (the Great Bear) is 486.112 nm. Laboratory measurements demonstrate that the normal wavelength of this spectral line is 486.133 nm. Is the star coming towards us or moving away from us? Justify your answer. Give an explanation for this. (3 marks)

Are we expecting a calculation?
If so, give the formula in the data sheet.

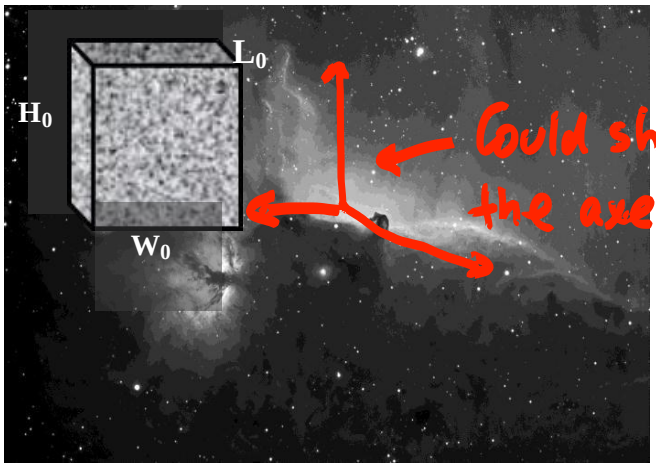
Question 9 **(4 marks)**

An astronaut is floating freely in space in the Orion Nebula.

The astronaut is stationary and the view in the diagram (shown right) is what she sees from her faceplate.

A "Borg" spaceship, in the form of a cube with side length 5 km, is travelling at 20% of the speed of light (i.e. 0.2c) and is on a heading directly towards the astronaut.

The dimensions of the Borg ship are labelled L_o, W_o, and H_o in the diagram.



Could show the axes.

(a) Which of the following options best describes the dimensions (L, W and H) of the box as observed by the astronaut outside the spaceship compared to the measurements made by the passenger?

ANSWER? "A" if component of W considered as well???

The axes would give the direction so components aren't an issue.

A. $L < L_o$, $W < W_o$, $H = H_o$

B. $L > L_o$, $W = W_o$, $H = H_o$

C. $L < L_o$, $W = W_o$, $H = H_o$

D. $L < L_o$, $W < W_o$, $H < H_o$

Answer: _____ (1 mark)

(b) Carefully explain why you selected your answer. (3 marks)

Raja – were you expecting a calculation here as well? Eg

No calculation required.
Just indicate length contraction in the direction of motion.

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Question 10 **(4 marks)**

An alien spacecraft traveling at relativistic speed is flying overhead at a great distance as you stand in your backyard. You see its searchlight blink on for 0.190 s.

(a) The first officer on the spacecraft measures that the searchlight is on for 1.20s. What is the speed of the spacecraft relative to the earth expressed as a fraction of the speed of light? (2 marks)

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(b) Would the time between blinks that we measure on Earth be longer or shorter than what the alien measures on the spacecraft? Explain your reasoning. (2 marks)

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Question 11 **(8 marks)**

Towards the end of the 20th century scientists suggested that quarks were the basic building blocks of protons and neutrons. Quarks have the following properties:

- They have mass.
- They can have electromagnetic charges of +1/3, +2/3, -1/3 and -2/3
- They have colour charge.
- They have spin.

Raja – Is this info now necessary considering the 2017 Data Sheet???

(a) Classify the following sub-atomic particles as either Hadrons, Leptons or Neither. (2 marks)

Proton		Neutrino	
Muon		Photon	

(b) A member of the $\sum$ group of particles consists of two *u* quarks and an *s* quark.

(i) What is its charge? Show your working. (2 marks)

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(ii) What is its Baryon Number? Show your working. (1 mark)

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(iii) Is the particle a fermion or a boson? Show your working. (1 mark)

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(iv) Calculate its mass in terms of c. Show your working. (1 mark)

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(v) State the value of its Strangeness. …… (1 mark)

Outside the course?

Section Two: Problem-solving **50% (100 Marks)**

This section has **eight (8)** questions. Answer **all** questions. Write your answers in the spaces provided.

Suggested working time: 90 minutes.

Question 12 **(5 marks)**

Figure 1 shows a model of a system being designed to move concrete building blocks from an upper to a lower level.

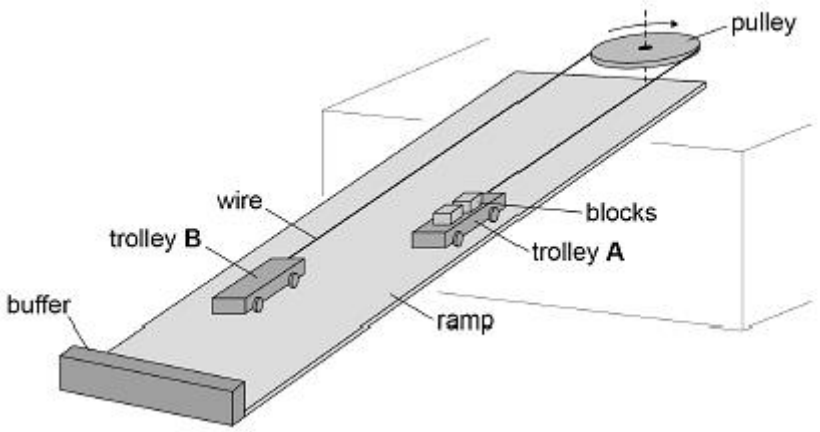

Figure 1

The model consists of two identical trolleys of mass ***M*** on a ramp which is at 35° to the horizontal. The trolleys are connected by a wire that passes around a pulley of negligible mass at the top of the ramp.

Two concrete blocks each of mass ***m*** are loaded onto trolley **A** at the top of the ramp. The trolley is released and accelerates to the bottom of the ramp where it is stopped by a flexible buffer. The blocks are unloaded from trolley **A** and two blocks are loaded onto trolley **B** that is now at the top of the ramp. The trolleys are released and the process is repeated.

Figure 2 shows the side view of trolley **A** when it is moving **down** the ramp.

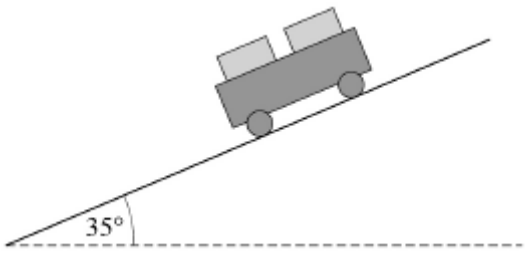

Figure 2

The tension in the wire when the trolleys are moving is **T**.

(a) Draw and label arrows on **Figure 2** to represent the magnitudes and directions of any forces and components of forces that act on trolley **A** parallel to the ramp as it travels down the ramp. (2 marks)

We don't normally show components - only the forces acting.

(b) Assume that no friction acts at the axle of the pulley or at the axles of the trolleys and that air resistance is negligible.

Show that the acceleration ***a*** of trolley **A** along the ramp is given by

$$a = \frac{m\ g \sin 35°}{M + m}$$

(3 marks)

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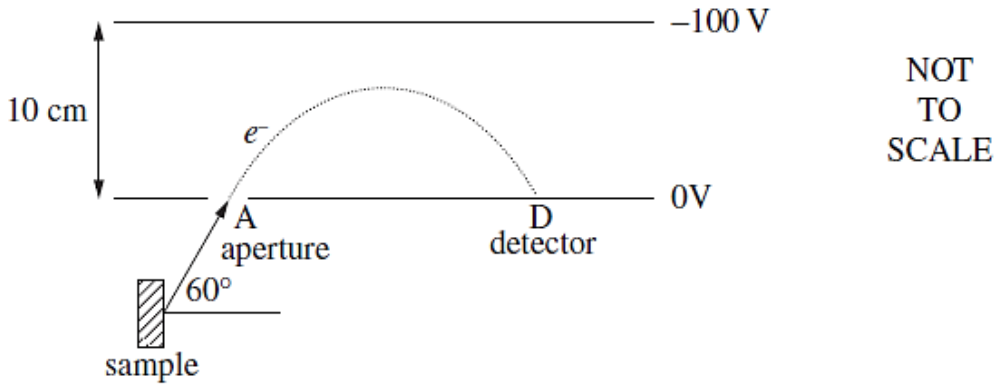
Question 13 **(8 marks)**

An electron is emitted from a mineral sample, and travels through aperture **A** into a spectrometer at an angle of 60.0° with a speed of 6.00×10^{6} m s^{-1}.



(a) Calculate the magnitude and direction of the force experienced by the electron inside the spectrometer. (3 marks)

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(b) The electron experiences constant acceleration and eventually strikes the detector, D. What is the time taken for the electron to travel from **A** to **D**? (3 marks)

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(c) Calculate the distance between **A** and **D**. (2 marks)

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Question 14 **(17 marks)**

(a) **Figure 1** shows two magnets, supported on a yoke, placed on an electronic balance.

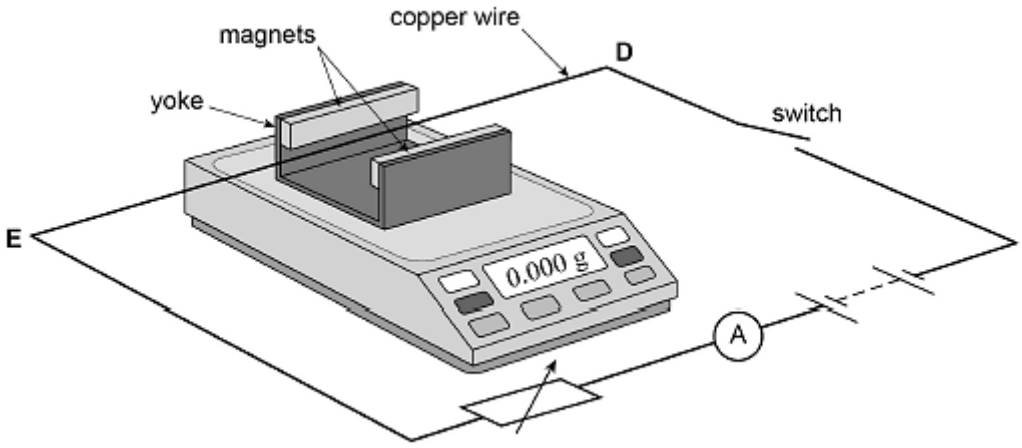
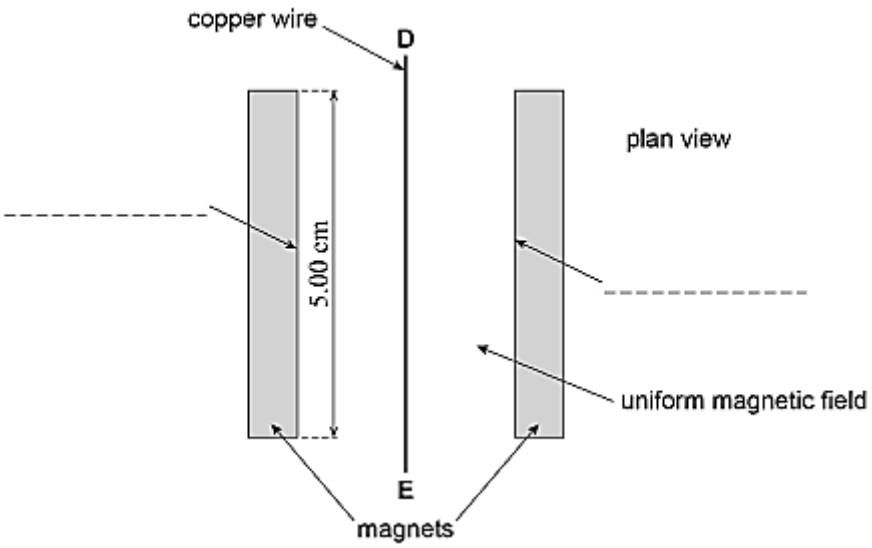


Figure 1

The magnets produce a uniform horizontal magnetic field in the region between them. A copper wire **DE** is connected in the circuit shown in **Figure 1** and is clamped horizontally at right angles to the magnetic field.

Figure 2 shows a simplified plan view of the copper wire and magnets.

Figure 2



When the apparatus is assembled with the switch open, the reading on the electronic balance is set to 0.000 g. This reading changes to a positive value when the switch is closed.

(i) Which of the following correctly describes the direction of the force acting on the wire **DE** due to the magnetic field when the switch is closed?

Tick (✓) the correct box. (1 mark)

towards the left magnet in Figure 2	
towards the right magnet in Figure 2	
vertically up	
vertically down	

(ii) Label the poles of the magnets by putting **N** or **S** on each of the two dashed lines in **Figure 2**. Draw the magnetic field between the magnets. [Use a minimum of 6 lines of flux.] (2 marks)

(iii) Define the tesla. (2 marks)

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(iv) The magnets are 5.00 cm long. When the current in the wire is 3.43 A the reading on the electronic balance is 0.620 g. Assume the field is uniform and is zero beyond the length of the magnets.

Calculate the magnetic flux density between the magnets. (2 marks)

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(b) A cyclotron has two D-shaped regions where the magnetic flux density is constant. The D-shaped regions are separated by a small gap.

An alternating electric field between the D-shaped regions accelerates charged particles. The magnetic field causes the charged particles to follow a circular path.

Figure 3 shows the path followed by **a proton** that starts from **O**.

Magnetic field: 0.44 T ΔV between "D"s: 186000 V

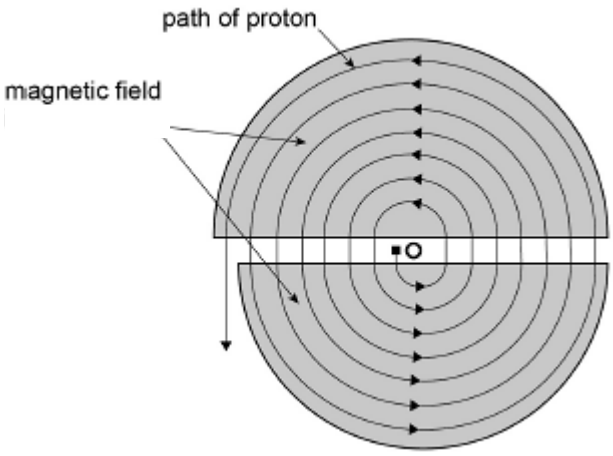

Figure 3

(i) Show clearly on Figure 3 the direction of the magnetic fields in the D-shaped regions. (1 mark)

(ii) Explain why it is **not** possible for the magnetic field to alter the speed of a proton while it is in one of the D-shaped regions. (2 marks)

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(iii) When the proton crosses the gap between the "D"s, how much energy does it gain? (2 marks)

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(iv) The maximum radius of the path followed by the proton is 0.85 m and the magnetic flux density of the uniform field is 0.44 T.

Ignore any relativistic effects.

Calculate the maximum speed of a proton when it leaves the cyclotron. (2 marks)

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Is the assumption: "*Ignore any relativistic effects*." reasonable? Explain briefly. (1 mark)

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Sq. if declaring which way to rearrange the information?

Use formulae on the Data Sheet to derive following expression for the cyclotron frequency OR

The following expression for the cyclotron frequency is independent of the radius of the path

$$f = \frac{q\,B}{2\,\pi\,m}$$

A synchrocyclotron is a cyclotron in which the frequency of the driving electric field is varied to compensate for relativistic effects as the particles' velocity begins to approach the speed of light. This is in contrast to the classical cyclotron, where the frequency was held constant, thus leading to the synchrocyclotron operation frequency being

$$f = \frac{f_0}{\gamma}$$

where γ is the Lorentz factor.

Assuming that the correction is necessary, calculate the cyclotron frequency. (2 marks)

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Question 15 **(15 marks)**

(a) The following makeshift device, **Figure 1**, was made to provide lighting for a stranded astronaut on Mars.

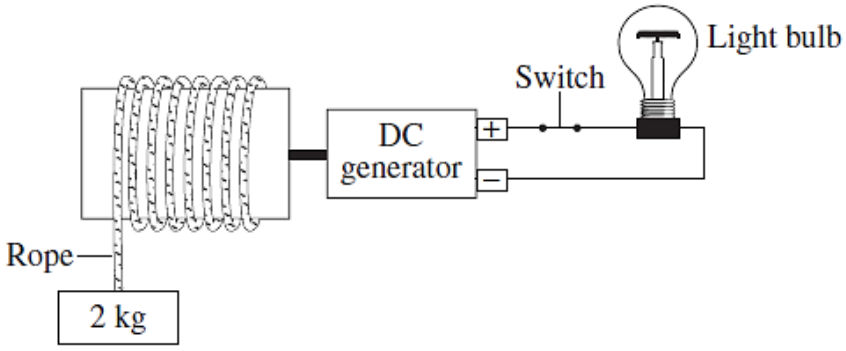

Figure 1

Explain the difference in the behaviour of the falling mass when the switch is open. (3 marks)

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(b) The alternator in **Figure 3** has a rectangular coil with sides of 0.30 m x 0.40 m and 10 turns. The coil rotates four times a second in a uniform magnetic field. The magnetic flux through the coil in the position shown is 0.20 Wb.

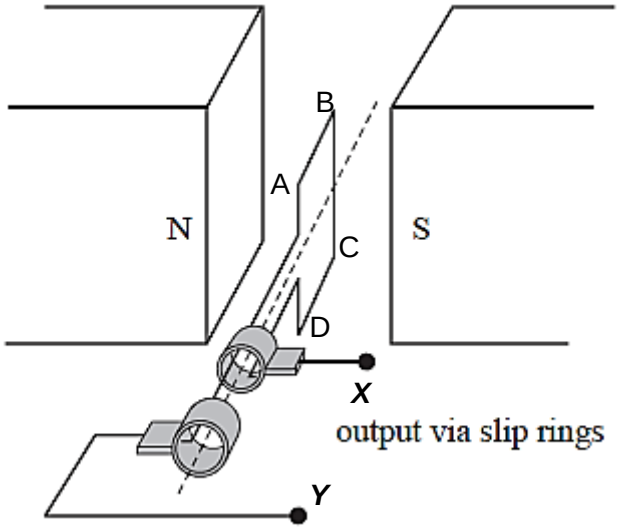

Figure 3

(i) Calculate the magnitude of the peak EMF (ε) generated. (2 marks)

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Figure 4 shows the output EMF (ε) versus time graph of the alternator for two complete cycles.

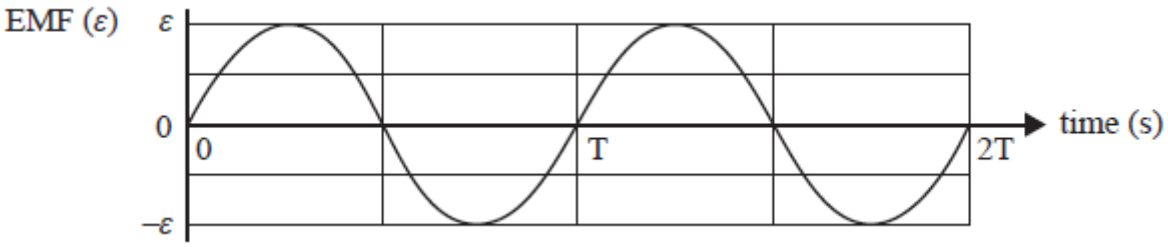
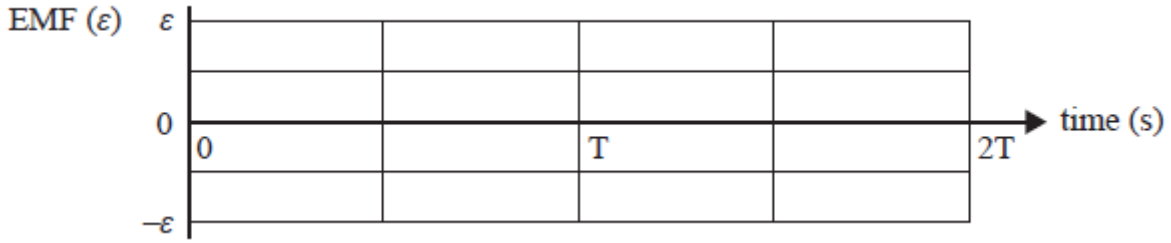


Figure 4

(ii) On **Figure 4** show a point that corresponds to the EMF at the point of rotation shown in **Figure 3.** (1 mark)

The two slip rings in **Figure 3** are now replaced with a split-ring commutator.

(iii) On the axes provided below, sketch the EMF (ε) versus time graph of this new arrangement for two complete cycles. (2 marks)



Again refer to **Figure 3.**

(iv) Describe the orientation of the coil ABCD so that the output slip ring ***X*** is + (positive) and the output slip ring ***Y*** is – (negative). (2 marks)

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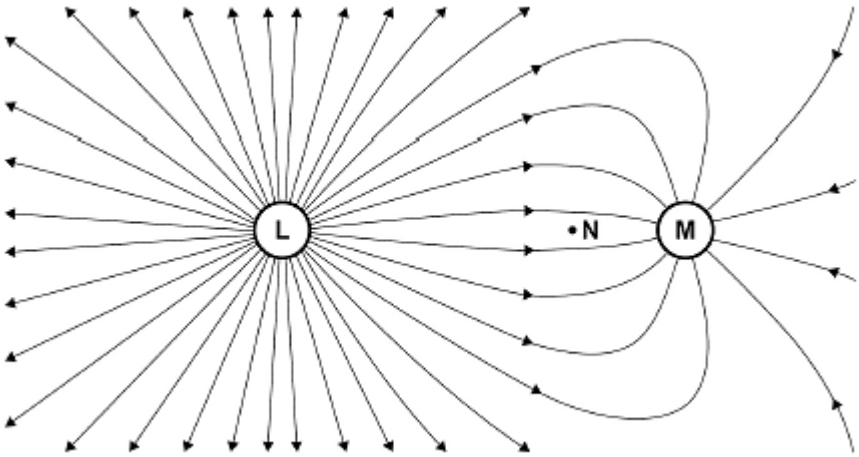
(c) (i) **Figure 5** shows lines of force for the electric field surrounding two charged objects **L** and **M**.



2 marks?

State which object **L** or **M** has a charge with the greater magnitude. ……

State which object **L** or **M** has a positive charge. ……
(1mark)

Explain why the lines of force shown in **Figure 5** cannot represent a gravitational field.
(1 mark)

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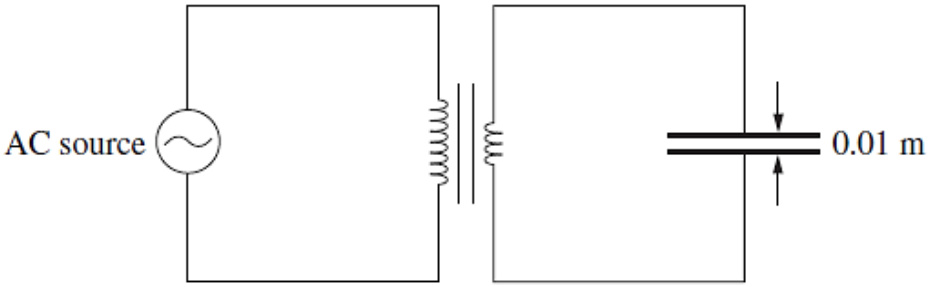
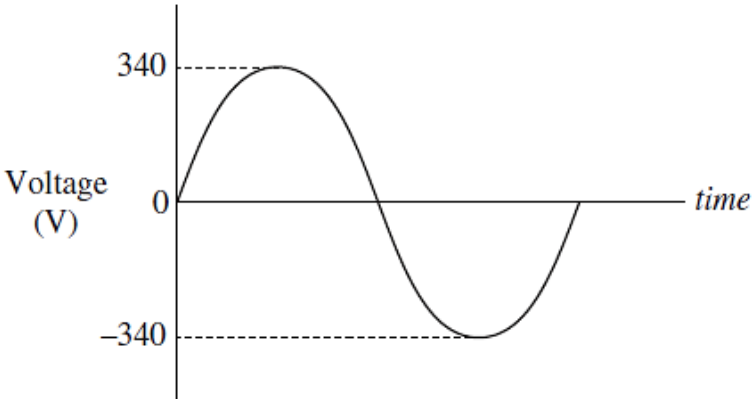
(ii) An AC source is connected to a transformer having a primary winding of 900 turns. Connected to the secondary winding of 450 turns is a pair of parallel plates 0.010 m apart.



The AC input is shown in the graph.



What is the maximum field strength (in V m^{-1}) produced between the plates?

(2 marks)

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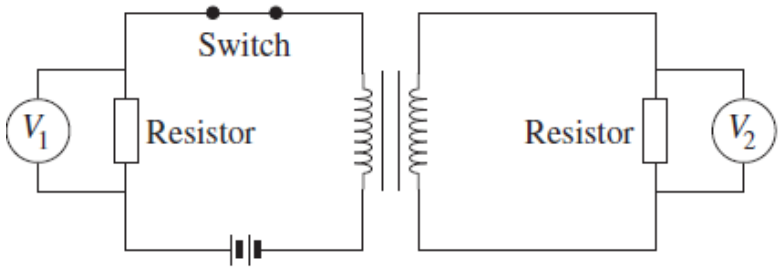
(iii) The diagram shows a DC circuit containing a transformer.

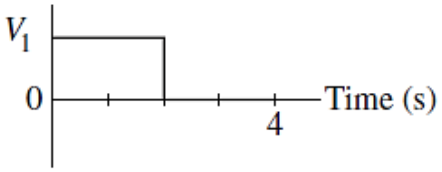


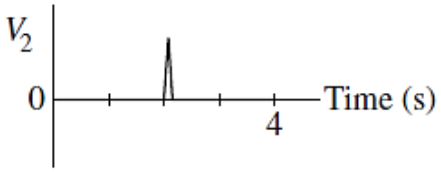
The potential differences V_1 and V_2 are measured continuously for 4 s.

The switch is initially closed. At t = 2 s, the switch is opened.

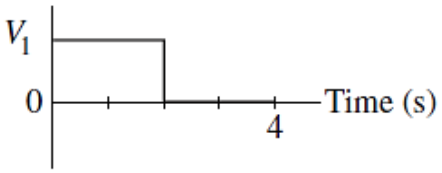
Which pair of graphs shows how the potential differences V_1 and V_2 vary with time over the 4-second interval? (1 mark)

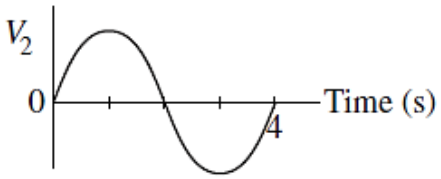
A.



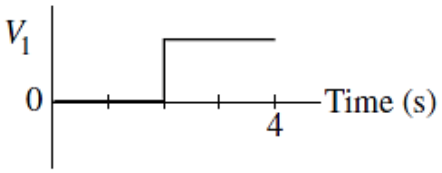


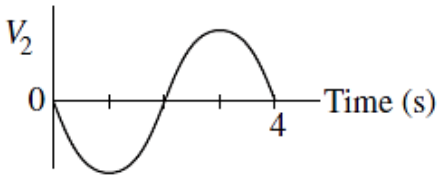
B.



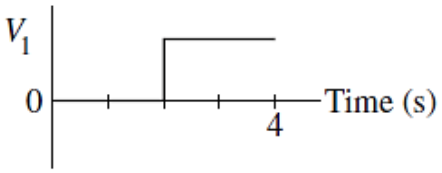


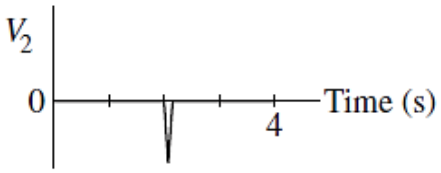
C.





D.





Question 16 **(14 marks)**

(a) An aurora is the appearance of brilliant coloured 'curtains' of light in the sky near the north and south poles.

Particles discharged from the sun, known as the Solar Wind, travel toward Earth before they are drawn irresistibly toward the magnetic north and south poles. As the particles pass through the Earth's magnetic shield, they mingle with atoms and molecules of oxygen, nitrogen and other elements that result in the dazzling display of lights in the sky.

Typically, when the particles collide with oxygen, yellow and green are produced. Interactions with nitrogen produce red, violet, and occasionally blue colours.

Carefully explain, using physics principles, how and why auroras occur and the reason for the different colours. (4 marks)

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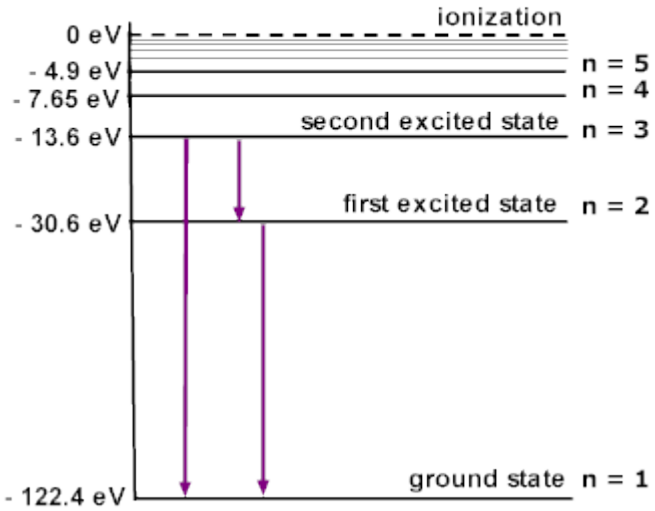
(b) Consider some of the energy levels for Neon given below.



(i) Consider the 3 transitions shown.

Would these transitions shown be part of an *absorption* or *emission* spectrum?
Circle the correct answer. (1 mark)

Indicate on the diagram the transition with the longest wavelength.

Calculate this wavelength.

Is this a photon of visible light? (4 marks)

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(ii) State what would emerge from a sample of neon gas when it is bombarded by the following particles. (5 marks)

Bombarding particles	Emerging particles (eV)
Photons of 114.75 eV	
Electrons of 110 eV	

Question 17 **(10 marks)**

In an experiment, blue light of frequency 6.25 x 10^{14} Hz is shone onto the sodium cathode of a photocell. The apparatus is shown in Figure 1 below.

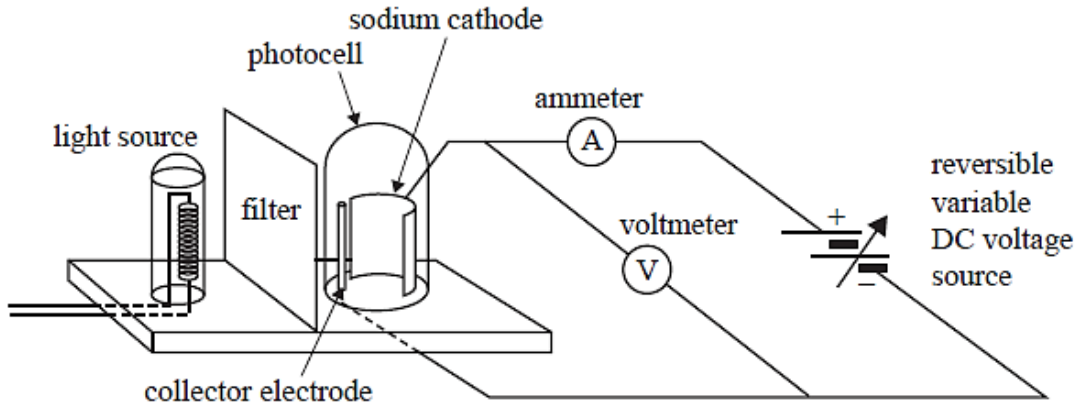

Figure 1

The graph of photoelectric current versus potential difference across the photocell is shown in Figure 2.

Figure 2

The threshold frequency for sodium is 5.50 x 10^{14} Hz.

(i) Determine the speed of the ejected electrons. (3 marks)

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(ii) What is the cut-off potential, Vo, when blue light of frequency 6.25 x 10^{14} Hz is shone onto the sodium cathode of the photocell referred to in Figures 1 and 2? (2 marks)

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(c) On the graph of photoelectric current versus potential difference shown in Figure 2, sketch the curve expected if the light is changed to **ultraviolet** with a **higher intensity** than the original blue light. (2 marks)

(d) The results of photoelectric effect experiments in general provide strong evidence for the particle-like nature of light.

Outline **two** aspects of these results that provide the strong evidence that is not explained by the wave model of light, and explain why. (3 marks)

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Question 18 **(15 marks)**

(a) Tests of relativistic time dilation have been made by observing the decay of short-lived particles. A muon, travelling from the edge of the atmosphere to the surface of Earth, is an example of such a particle.

To model this in the laboratory, another elementary particle with a shorter half-life is produced in a particle accelerator. It is travelling at 0.99875c (γ = 20). Scientists observe that this particle travels 9.14×10^{-5} m in a straight line from the point where it is made to the point where it decays into other particles. It is not accelerating.

(i) Calculate the lifetime of the particle in the scientists' frame of reference. (2 marks)

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(ii) Calculate the distance that the particle travels in the laboratory, as measured in the particle's frame of reference. (2 marks)

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(iii) Explain why the scientists would observe more particles at the end of the laboratory measuring range than classical physics would expect. (2 marks)

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(b) A space probe speeding towards the nearest star moves at 0.250c and sends radio information at a broadcast frequency of 1.00 GHz.

(i) At what speed is the radio signal received on the Earth? Explain briefly. (2 marks)

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(ii) What frequency is received on the Earth? (2 marks)

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(c) If two spaceships A and B are heading directly towards each other at 0.800c. A canister is shot from the first ship A at 0.25c, as measured in A's frame of reference.

(i) How fast will an external observer see the projectile travelling? (2 marks)

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(ii) How fast will B see the projectile approaching? (2 marks)

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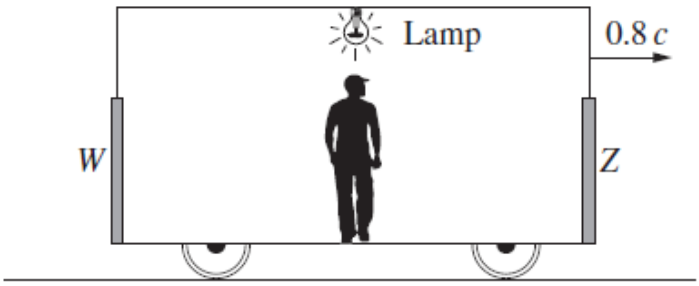
(d) In a thought experiment, a train is moving at a constant speed of 0.8 *c*. A lamp is located at the midpoint of a carriage. There are doors *W* and *Z* at each end of the carriage which open automatically when light from the lamp reaches them.



The passenger standing at the midpoint of the carriage switches on the lamp.

Which statement best explains what the passenger observes about the doors? (1 mark)

(A) *Z* opens before *W* because the lamp is moving towards *Z.*

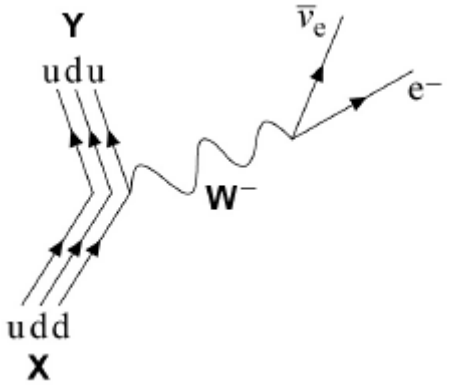
(B) *W* opens before *Z* because *W* is moving towards the lamp.

(C) *W* and *Z* open simultaneously because the lamp is placed at an equal distance from both.

(D) *W* and *Z* open simultaneously because the distance from the lamp to each door has contracted by the same amount.

Question 19 **(8 marks)**

The Figure below represents the decay of a particle **X** into a particle **Y** and two other particles. The quark structure of particles **X** and **Y** are shown in the diagram.



(a) Deduce the name of particle **X**. …… (1 mark)

(b) State the type of interaction that occurs in this decay. (1 mark)

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(c) State the class of particles to which the **W**⁻ belongs. …… (1 mark)

(d) Show clearly how charge and baryon number are conserved in this interaction.
You should include reference to all the particles, including the quarks, in your answer. (2 marks)

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(e) State the quark constituents of $\bar{Y}$. …… (1 mark)

(f) Name the only stable baryon. …… (1 mark)

(g) A muon is an unstable particle. The incomplete decay equation is shown below.

$$\mu^- \rightarrow \nu_\mu + e^- + ...$$

State the name of the missing particle. …… (1 mark)

Section Three: Comprehension **20% (31 Marks)**

This section has two (2) questions. Write your answers in the spaces provided.

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.

Suggested working time: 40 minutes.

Question 20 **(19 marks)**

An experiment is set up to investigate how the motion of a sphere on a track depends on the radius of curvature of the track.

The apparatus is set up as shown in **Figure 1**.

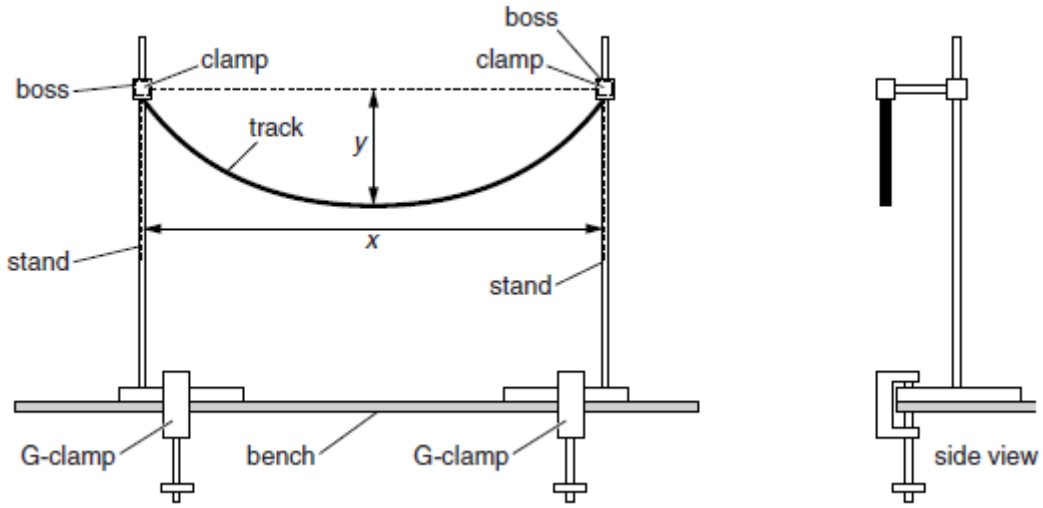

Figure 1

(a) The radius of curvature R of the track is calculated by

$$R = \frac{x^2}{8y} + \frac{y}{2}.$$

One set of data has x = 91.5 cm and y = 18 cm. Calculate the radius of curvature R, *in cm,* of the track, including the standard error. Express your answer to the appropriate number of significant figures (4 marks)

absolute error?

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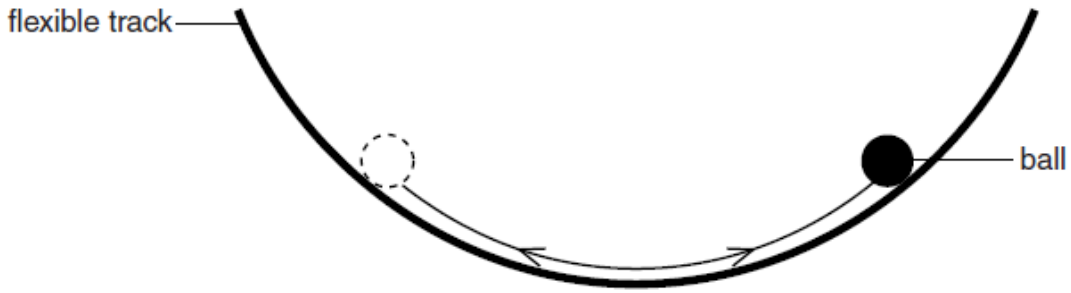
A ball rolls forwards and backwards on a curved track as shown in **Figure 2**.



It is suggested that the period ***T*** of the oscillations is related to the radius ***r*** of the ball and the radius of curvature ***R*** of the track by the relationship:

$$T^2 = \frac{28\,\pi^2}{5\,g}\,(R - r)$$

where *g* is the acceleration of free fall.

(b) The period ***T*** of the oscillations was calculated by timing 5 oscillations of the ball, repeating the trial, and averaging the results. What is the reason for each of the underlined steps? (2 marks)

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The Table of Results is as follows:

T (s)	***R*** (cm)	T^2
1.28 ± 10%	42	
1.55 ± 10%	53	
1.61 ± 10%	58	
2.09 ± 10%	83	

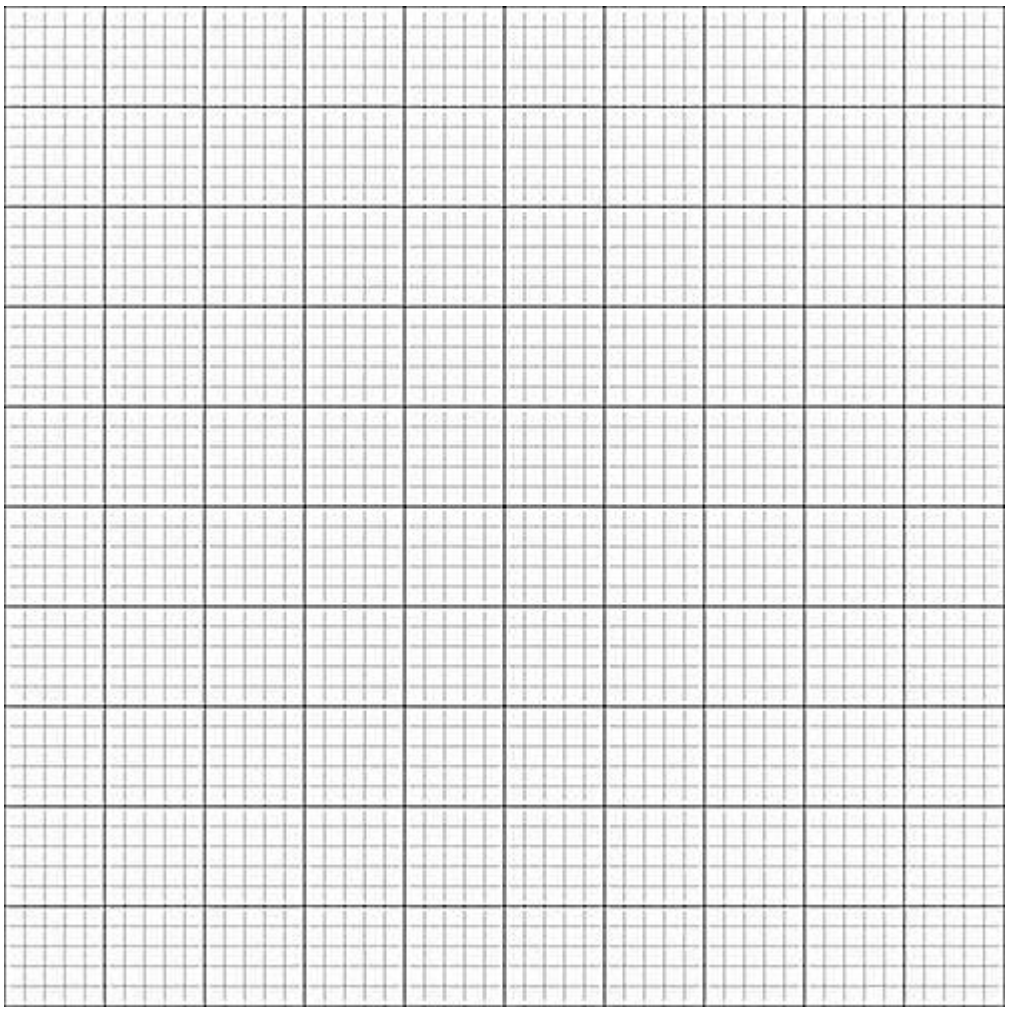
(c) Calculate the values of T^2, including the absolute error. Record them in the table. (4 marks)

(d) Graph T^2, including the error bars, on the y-axis and ***R*** on the x-axis on the graph paper on the next page. Additional graph paper is supplied at the end of this question if required. (4 marks)

(e) Draw the line of best fit. (2 marks)

Just draw the error bars for 1 point, e.g. for R = 53 cm. Otherwise time for the exam may

become an issue.



(f) Determine the radius ***r*** of the ball. Show your working clearly. (3 marks)

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(g) ? More to come?

Extras

The length of a spaceship is measured by an observer to be 3.57 m as the spaceship passes with a velocity of 0.7*c*.At what velocity would the spaceship

(c) NASA uses a robotic spacecraft to map the Moon. The Lunar Reconnaissance Orbiter having a mass of 1020 kg, orbits the Moon at an average altitude of 50.0×10^3 m with a period of 6.78×10^3 s.

Determine the approximate mass of the Moon. (3 marks)

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The LRO Instruments

(b) Name the force that is keeping the satellite in this circular orbit, and state the direction in which this force is acting. (2 marks)

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Jami is doing a workout. He is using a barbell with weights on it. The total mass of the bar with the weights on it is 120 kg.

(a) Calculate the work done on the bar if Jamie lifts it 0.55 m vertically at constant speed. (2 marks)

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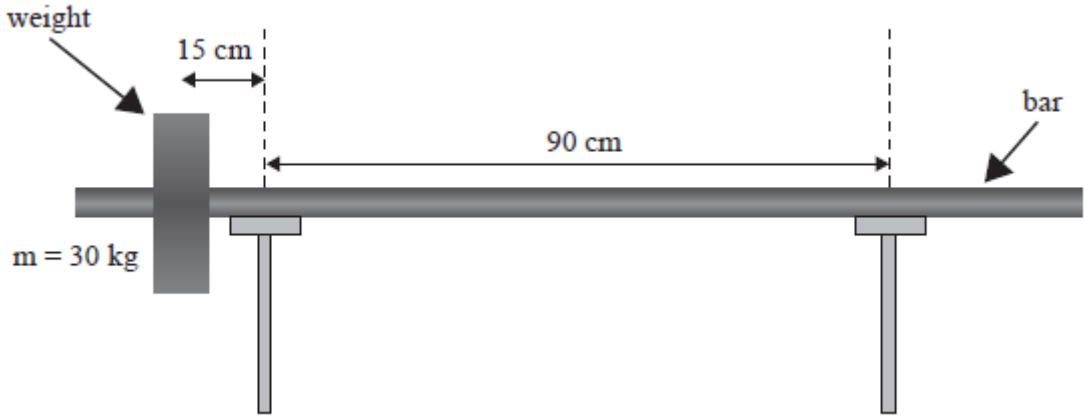
(b) Jamie puts the barbell on two supports and changes the weights on the bar. With no weights on one end and a 30.0 kg weight on the other end, the support force provided by the right-hand support is 10.0% of the weight of the bar alone.



(i) Draw labelled arrows on the diagram showing the forces on the bar. (2 marks)

(ii) Use the concept of torque to calculate the weight of the bar. Assume it is a uniform bar. (4 marks)

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(a) Would an alien observer on the spacecraft measure the same time interval for the searchlight blinks that we measure on Earth? (1 mark)

11 The diagram shows a DC motor with a constant current flowing to the rotor.

14 Blue light is found to cause photoelectric emission from a sodium surface but not from a platinum surface.

Q17 Rel +18

(ii) Two stars in a visual binary system have an orbital period of 2.1 × 108 s and are determined to be 7.2 × 108 km apart.
Calculate the combined mass of the stars.

(iii) The spectra below show absorption lines for a variable pair of

spectroscopic binary stars at two different times, Time 1 and Time 2.
Each spectrum contains the absorption lines from both stars.

(b)
(i) Describe de Broglie's proposal that a particle can exhibit both wave and particle properties.
(ii) Explain how Davisson and Germer were able to confirm de Broglie's proposal.
(iii) Calculate the velocity of an electron that has a wavelength of 3.33 × 10–10 m.

A spring is used to construct a device to launch a projectile.

VIC 2017 pg 7
A model car is on a track and moving to the right.

(a) The diagrams show features of the hydrogen emission spectrum.

A student sits inside a windowless box that has been placed on a smooth-riding train carriage. He conducts a series of motion experiments to investigate frames of reference.

Lee listens while a police car with a loud siren comes towards her, travels past her and then continues on away from her.
Compared with the sound she would hear from the siren if the police car were stationary, the sound has

Quantised energy levels within atoms can best be explained by
A. electrons behaving as individual particles with varying energies.

Figure 5 shows a generator at an electrical power station that generates 100 MW RMS of power at 10 kV RMS AC.

The energy-level diagram for sodium is shown in Figure 17. Part of the emission spectrum of sodium vapour includes a photon of energy 1.65 eV.

A teacher demonstrated the principles of Young's Double Slit experiment using a microwave source and detector as shown in the diagram below.