I.D. Number: ____________

Teachers: Mr Coombes, Mr Pitt, Mr Robson

Task Weighting: 30% **Time Allowed: 1.5 hours**

This task is marked out of 50 marks ____ / 50

INSTRUCTIONS: There are **two** parts **A** and **B** in this task. There are two questions in part A, each of which requires you to carry out a first-hand investigation. You will need to go to where the apparatus is set up in the lab to conduct these investigations. Several stations have been set up for each investigation. You must watch for when the apparatus is free and quietly move to the vacant station to conduct the investigation.

Part B requires you to apply some knowledge and skills to answer the questions without carrying out any first-hand gathering of data. There are four questions in part B.

Read the whole of each question before commencing it, and then record your answers in the spaces provided.

Part A

1. Examine the apparatus set up at Station A in the lab. The copper wire is connected to the DC terminals of a TR unit. For the purpose of this task, the direction of the current through the wire has been concealed.

   Rest the wire across the top of the magnet taped to the desk with the side one which the insulation tape is placed on the right of the magnet. Press the switch "S" and observe the response of the wire.

(a) Describe the **initial** response of the wire when the current is turned on. (1 mark)

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(b) Account for the response of the wire. (1 mark)

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(c) Deduce the direction of the force on the magnet when the current is first turned on. (1 mark)

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(d) Propose a method of increasing the force on the wire. (1 mark)

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2. In this task, the equipment for which is set up for you at station B, you are to **experimentally** determine the **period** of a pendulum of a fixed length, and then use this data and the equation below to calculate the **acceleration due to gravity**.

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

T = period of pendulum (time for one complete backwards and forwards swing)

l = length of pendulum

g = acceleration due to gravity

You have been provided with a pendulum consisting of a mass suspended beneath a light string that is attached to a clamp.

(a) Using the ruler provided, measure the length of the pendulum in metres and record the value. (1 mark)

Length of pendulum: ______________________

(b) Using the stopwatch provided, collect measurements that can be used to calculate the period (Do not spend more than 5 minutes collecting your data). Present these measurements in an appropriate format in the space below and perform any calculations necessary to establish the period. (5 marks)

[space for answer continues on the next page]

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(c) Calculate the acceleration due to gravity. (2 marks)

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(d) To be able to make a valid conclusion from any experiment, the measurements recorded need to be as **reliable** as possible. Outline **one procedure** you used to ensure that your results were **reliable.** **(1 mark)**

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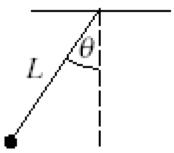
[this question continues on the next page]

Two students, Dion and James, performed a similar experiment using a pendulum to calculate a value of g. Their procedure and results are shown below:



1. Adjust the length of the string (L) to measure 0.08 m.
2. Hold the mass to the side to give a small angular displacement, θ.
3. Release the mass and measure the time for one period (T).
4. Record the result in a table.
5. Repeat using a string length (L) of 0.09 m and continue until the string length is 0.19 m (going up in 0.01 m increments, using the same initial angular displacement each time).
6. Calculate g using the relationship $T = 2\pi\sqrt{\frac{L}{g}}$.

Results:

L (m)	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19
T (s)	0.57	0.62	0.65	0.67	0.70	0.73	0.76	0.80	0.81	0.84	0.86	0.89

The students analysed the results and used a **graph** and the **formula** to calculate g.

[this question continues on the next page]

(e) On the grid provided, plot an **appropriate** graph that could be used in the calculation the acceleration due to gravity. Put the **independent variable** on the **horizontal axis** **(4 marks)**

(f) **Calculate** the value of the acceleration due to gravity **using the graph**. Show **ALL** your **working** and clearly **indicate** how the graph was **used**. **(3 marks)**

[this question continues on the next page]

(g) **Assess** the two methods used to calculate the acceleration due to gravity in this activity *in terms of both their **procedure** and **results analysis*** to **deduce** which technique produced the most valid value of g. (5 marks)

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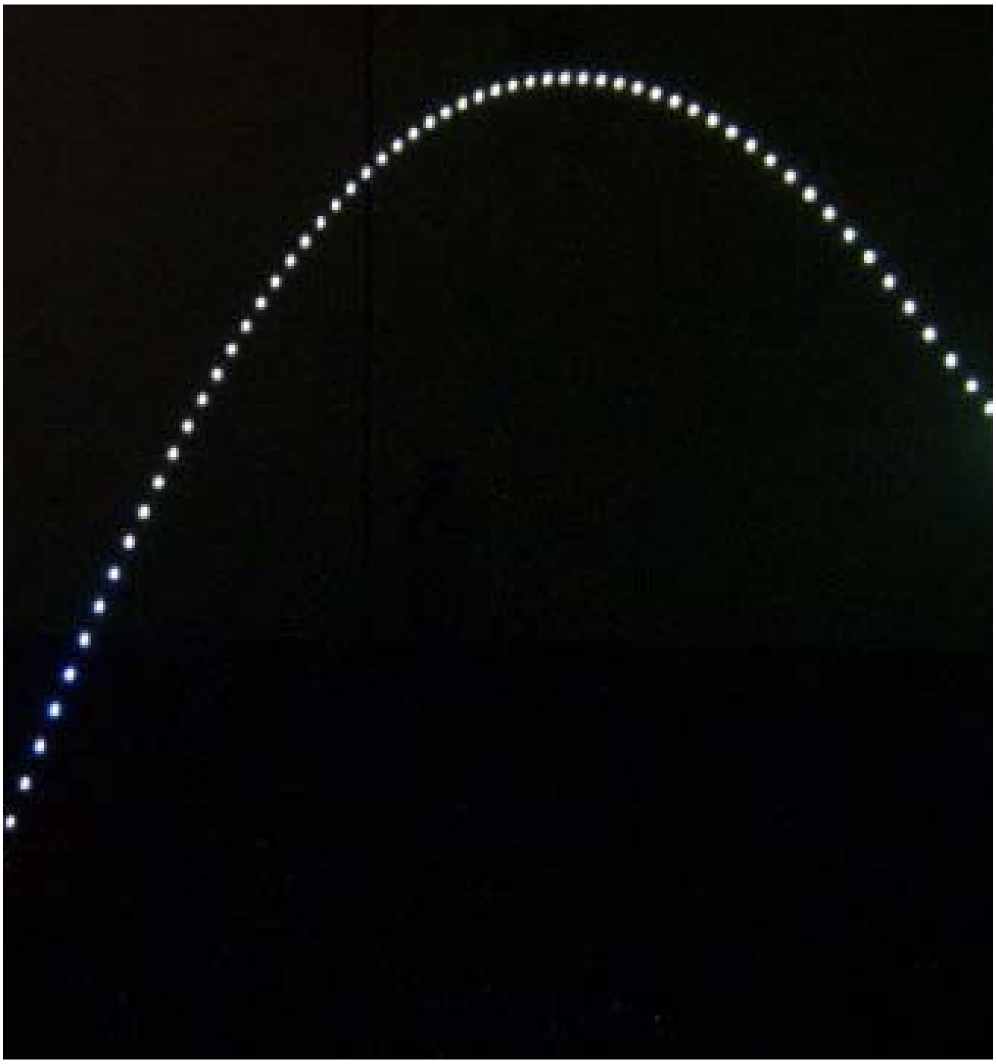
Part B

3. The following image was created using a small electronic device that caused a light emitting diode (LED) to produce flashes of light at a constant frequency of 100 Hz. The device was thrown through the air, from right to left in the photograph, in a darkened room with the LED pointing towards a digital camera, which was set to take a long-exposure photograph, which captured the motion of the device.



(a) Analyse the photograph to determine how long the projectile took to travel the entire trajectory shown in the photograph. Outline your analysis. (1 mark)

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(b) Calculate the vertical distance moved by the projectile from its highest point to the final position shown on the left of the diagram. Assume $g = 9.8\ ms^{-2}$ (3 marks)

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(c) Describe quantitatively the horizontal motion of the projectile, supporting your description with appropriate evidence from the photograph. (2 marks)

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(d) Calculate the final velocity of the projectile. (3 marks)

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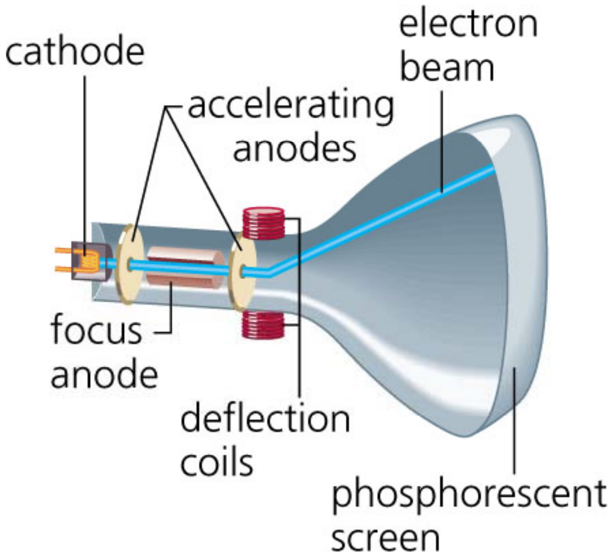
I.D. Number: ____________

4. The following diagram shows a simplified cross-section of a television picture tube. Electrons are produced at the cathode and they are accelerated by a pair of anodes. The electron beam is deflected by magnetic deflection coils as shown.



(a) Account for the deflection of the electron beam by describing the direction of the magnetic field produced by the deflection coils. (1 mark)

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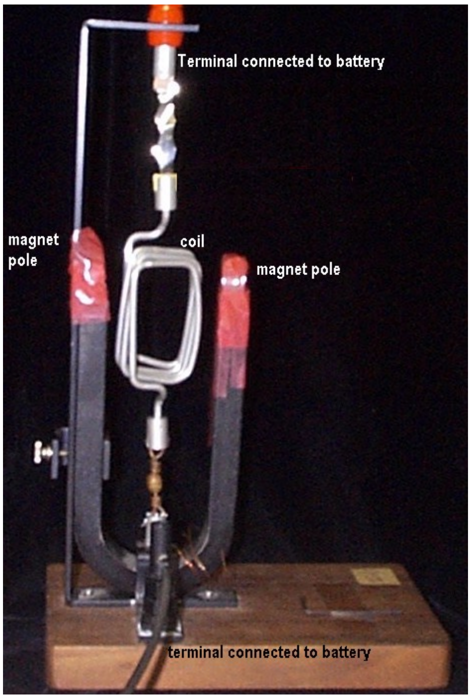
(b) The following photograph shows a model electric motor with a coil suspended between the poles of a magnet so that it is free to rotate around a vertical axis. The magnetic field can be considered to be uniform across the region between the labelled poles. The north pole is on the right and the top terminal is connected to the positive battery terminal.



The current was turned on through the coil when it was at rest in this position. Predict whether the coil would rotate and justify your prediction with careful reference to the photograph. Use the space to the right of the photograph to draw a simplified diagram to support your argument. (3 marks)

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5. A person was travelling in a vehicle accelerating horizontally at a uniform rate at 2 ms^{-2} in a straight line. When the vehicle was travelling at 5 ms^{-1}, the person dropped a heavy mass which fell 2 m to the floor.

(a) Compare the time taken for the mass to fall to the floor with the time that it would take if the vehicle was stationary. (1 mark)

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(b) Describe the motion of the mass as seen by a observer stationary on the ground outside the vehicle. (2 marks)

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(c) Describe the motion of the falling object as seen by the observer in the vehicle. (2 marks)

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(d) If the person in the vehicle had no other frame of reference other than the interior of the vehicle, how would they account for the behaviour of the falling mass? (2 marks)

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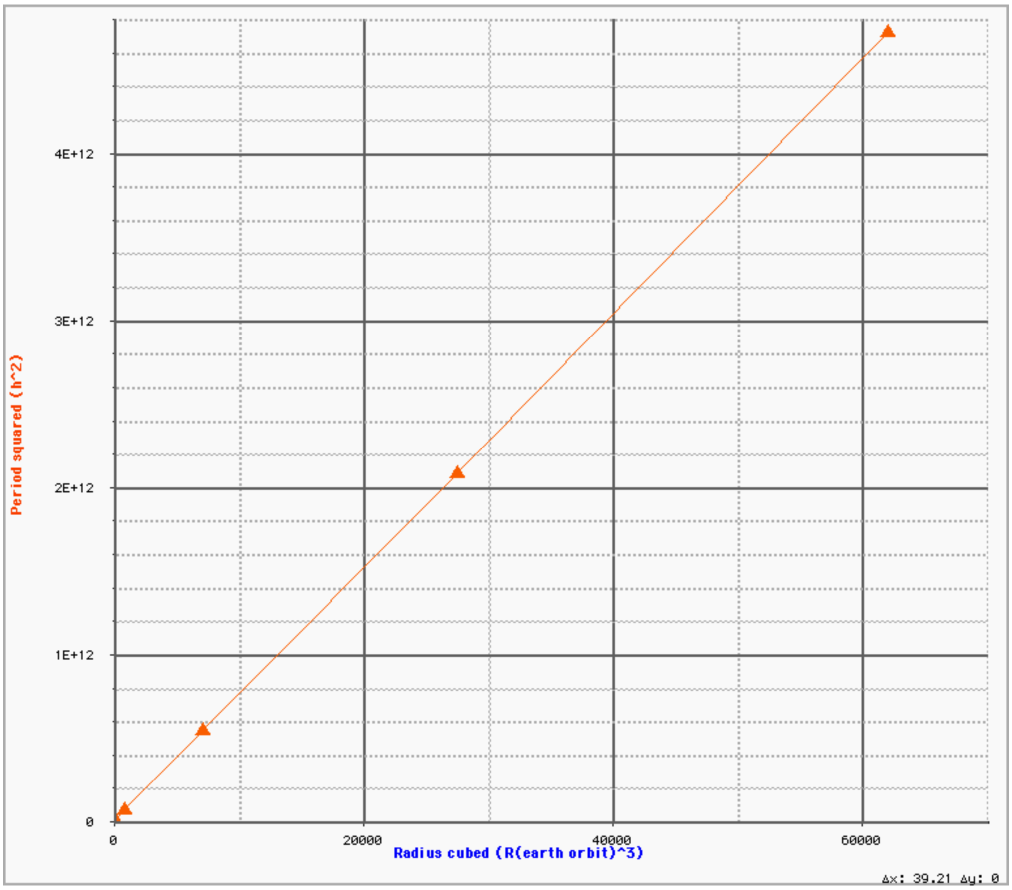
6. The following table of data shows the orbital radii and corresponding periods of the planets in the solar system. The period of Venus has been omitted from the table.

The following equations are provided: $E_p = -G\frac{m_1 m_2}{r}$ $F = \frac{mv^2}{r}$ $\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$

The universal gravitational constant has a magnitude equal to 6.67 x 10^{-11}.

Planet	Orbital radius Earth = 1	Period Hours
Mercury	0.38859	2111.111
Venus	0.72483	
Earth	1	8777.778
Mars	1.5302	16500
Jupiter	5.22147	103888.88
Saturn	9.59731	258333.33
Uranus	19.2617	738888.89
Neptune	30.2013	1444444.4
Pluto	39.5973	2172222.2

The following graph has been derived using this data.



(a) Use this graph and any other information necessary to determine the mass of the Sun. (Show your working.) (3 marks)

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(b) Calculate the period of Venus. (2 marks)

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End of Task

Marking Criteria for Year 12 Prac/Process Half yearly 2005

1 (a) Criteria	Marks
Clear description of wire movement using appropriate reference point and/or diagram	1

1 (b) Criteria	Marks
Clearly states that the response is due to the force which acts on a current-carrying wire when placed in a magnetic field (the motor effect)	1

1 (c) Criteria	Marks
Clearly states that the force on the magnet is in the opposite direction to the force on the wire. (Newton's 3rd law)	1

1 (d) Criteria	Marks
Clearly outlines one method that produces a larger force (use a stronger magnet, pass a larger current through the wire)	1

2 (a) Criteria	Marks
Records length of pendulum in metres	1

2 (b) Criteria	Marks
Table used to display results Appropriate headings/units used for columns. Evidence that more than one oscillation has been used in method. Shows repetition At least one sample calculation (eg of period)	5
Missing one of above or one incorrect	4
Missing two of above	3
Missing 3 of above	2
Missing 4 of above	1

2 (c) Criteria	Marks
Substitutes experimental values of length and period into the appropriate formula and correctly calculates final answer including units	2
Substitutes experimental values of length and period into the appropriate formula but does not correctly calculate final answer.	1

2 (d) Criteria	Marks
States that repetition is used to establish reliability	1

2 (e) Criteria	Marks
Graph of period squared versus length plotted Length plotted on horizontal axis Axes correctly labeled Points plotted correctly and a reasonable straight line of best fit drawn	4
Any 3 of above	3
Any 2 of above	2
Any 1 of above	1

2 (f) Criteria	Marks
Gradient of graph calculated using points shown on the line of best fit Clearly links the appropriate formula to the gradient Correctly calculates a value of g	3
Gradient of graph calculated using points shown on the line of best fit Clearly links the appropriate formula to the gradient but does not correctly calculate a value of g OR Gradient of graph not calculated using points shown on the line of best fit but Clearly links the appropriate formula to the gradient Correctly calculates a value of g OR Gradient of graph calculated using points shown on the graph but does not clearly link the appropriate formula to the gradient Correctly calculates a value of g	2
Gradient of graph calculated using points shown on the line of best fit but does not clearly link the appropriate formula to the gradient or correctly calculate a value of g OR Clearly links the appropriate formula to the gradient but does not calculate the gradient of graph appropriately or correctly calculate a value of g OR Uses one point only from the data and substitutes into the formula.	1

2 (g) Criteria	Marks
Refers to BOTH procedure and results analysis Identifies and discusses at least 3 relevant features of the methods that can be used to compare them. Identifies which method is superior/inferior	5
Refers to BOTH procedure and results analysis Identifies and discusses at least 3 relevant features of the methods that can be used to compare them but does not identify which method is superior/inferior OR Does not refer to BOTH procedure and results analysis but identifies and discusses at least 3 relevant features of the methods that can be used to compare them and identifies which method is superior/inferior OR Refers to BOTH procedure and results analysis Identifies and discusses 2 relevant features of the methods that can be used to compare them and identifies which method is superior/inferior	4
Refers to BOTH procedure and results analysis Identifies and discusses 2 relevant features of the methods that can be used to compare them OR Identifies and discusses at least 2 relevant features of the methods that can be used to compare them and identifies which method is superior/inferior OR Identifies and discusses at least 3 relevant features of the methods that can be used to compare them.	3
Identifies and discusses at least 2 relevant features of the methods that can be used to compare them OR Identifies and discusses 1 relevant feature of the methods that can be used to compare them and identifies which method is superior/inferior	2 marks
Identifies and discusses 1 relevant feature of the methods that can be used to compare them OR identifies which method is superior/inferior	1 mark
	1 mark
6 (a) Criteria	Marks
Chooses correct equation for determination of mass Calculates and uses gradient or substitutes single point on line into equation Completes calculation to determine a “reasonable” value	3 marks
Chooses correct equation for determination of mass and calculates and uses gradient or substitutes single point on line into equation but final calculation does not result in a “reasonable” value	2 marks
Chooses correct equation for determination of mass OR Calculates gradient	1 mark
6 (b) Criteria	Marks
Chooses an appropriate formula and correctly substitutes values to obtain the period of Venus (substituting an “incorrect” value from part a is not penalised)	2 marks
Chooses an appropriate formula but does not correctly substitute values or incorrectly calculates the period of Venus	1 mark

Sample Answers

2 (b)

(b) Using the stopwatch provided, collect measurements that can be used to calculate the period (Do not spend more than 5 minutes collecting your data). Present these measurements in an appropriate format in the space below and perform any calculations necessary to establish the period. (5 marks)

Results in Calculating Period

Time taken for 10 swings	Period (T) (seconds)	T^2 (s^2)	$g = \frac{4\pi^2 L}{T^2}$ ($m s^{-2}$)
13.74	1.374	1.888	9.61
13.86	1.386	1.920	9.46
13.53	1.353	1.831	9.92
13.87	1.387	1.924	9.44
13.95	1.395	1.947	9.32

Average g = 9.55

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$T = \frac{\text{Time taken for 10 swings}}{\text{Number of swings}}$.

✓

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The above equation was used to calculate the period

The table drawn on the previous page calculates the period by averaging the time taken for a set number of swings

2 (c)

(c) Calculate the acceleration due to gravity. (2 marks)

As $g = \frac{4\pi^2 L}{T^2}$

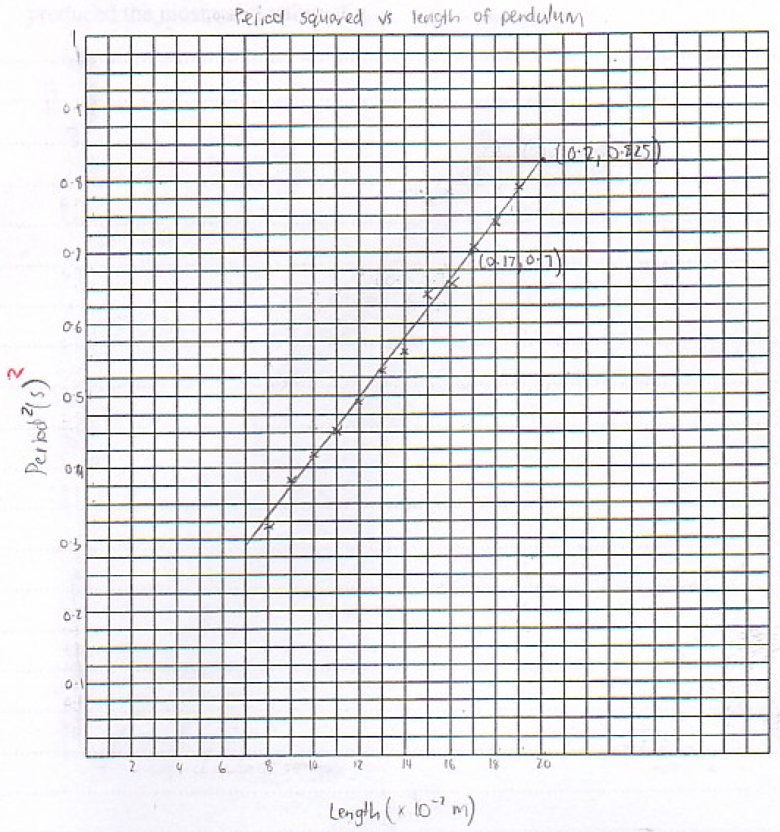
Using the tabulated values

Average $g = 9.55 \, m s^{-2}$ ✓✓

2

2 (e)

(e) On the grid provided, plot an **appropriate** graph that could be used in the calculation the acceleration due to gravity. Put the **independent variable** on the **horizontal axis** **(4 marks)**



4

$T^2 = 4\pi \frac{l}{g}$

$gT^2 = 4\pi l$

$\frac{T^2}{l} = \frac{4\pi}{g}$

2 (g)

(g) Assess the two methods used to calculate the acceleration due to gravity in this activity *in terms of both their procedure and results analysis* to **deduce** which technique produced the most valid value of g. (5 marks)

• The procedure used in 2b. involved timing 10 swings, whereas in 2e. only involved 1. Thus the significance of reaction time in 2b. was less than in 2e. In this regard 2b. is more valid.
• Experiment 2b was also ~~repeated~~ performed three times and results were no more than 6% different, making 2b. more reliable in this regard.
• Experiment 2e was performed over a range of values for l, whereas 2b was performed for only one value.
• This allowed a graph to be plotted in 2e. of l vs T^2, and since $g = \frac{4\pi^2 l}{T^2}$, a result for g could be found using $\frac{1}{m}$ $(m = \frac{4T^2}{4\ell})$.
The value of m was constant due to the directly proportional relationship between l and T^2, as shown by the same line. Thus in this regard, since 2e. allowes 'g' to be shown as constant over a range of values of 'l' and thus T^2, it is more valid.
• However, the procedure of 2e, timing only one period, was seriously flawed as reaction time had a major impact. For this reason 2b. is more valid - as demonstrated by a result of $g = 9.41 ms^{-2}$, closer to the accepted value of $9.8 ms^{-2}$ than 2e.s result of $8.77 ms^{-2}$.

5

The value you get does not tell you how valid the technique is.

4 (b)

The current was turned on through the coil when it was at rest in this position. Predict whether the coil would rotate and justify your prediction with careful reference to the photograph. Use the space to the right of the photograph to draw a simplified diagram to support your argument. (3 marks)

The coil would rotate as the currents on either side of the coil are flowing perpendicular to the magnetic field and would therefore experience the necessary force required for the rotation to occur. The coil is clearly free to rotate as seen in the photo, and is in the correct position to do so.

3

The above answer could be further improved by stating that the force on opposite sides of the coil acts in opposite directions, producing a torque on the coil about the axis of rotation. This is illustrated in the following response.

The current was turned on through the coil when it was at rest in this position. Predict whether the coil would rotate and justify your prediction with careful reference to the photograph. Use the space to the right of the photograph to draw a simplified diagram to support your argument. (3 marks)

The coil would rotate as the plane of the loop is parallel to the magnetic field. This makes the left and right loop sections perpendicular to the field, producing a force into the page on the left and out on the right, producing a torque.

3

5d

(d) If the person in the vehicle had no other frame of reference other than the interior of the vehicle, how would they account for the behaviour of the falling mass? (2 marks)

If the person in the vehicle had no other frame of reference than the interior of the car, they would assume that the falling mass was experiencing a force that was causing it to move backwards. The person would likely feel the acceleration of the vehicle however and therefore would be aware that the vehicle is moving. In which case they would account for it using normal projectile motion.

2