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**School Name**

**Semester 2 Examination, 2010**

**Question/Answer Booklet**

**PHYSICS 2A and 2B**

**Name/Number:** \_\_\_\_\_

**Teacher:** \_\_\_\_\_

***Time allowed for this paper***

Reading time before commencing work: Ten minutes

Working time for paper: Three hours

## ***Material required/recommended for this paper***

### **To be provided by the supervisor**

This Question/Answer Booklet

Physics: Formulae, Constants and Data Sheet (inside front cover of this Question/Answer Booklet)

### **To be provided by the candidate**

Standard Items: Pens, pencil, eraser, correction fluid, ruler, highlighter

Special Items: MATHOMAT and/or Mathaid, drawing compass, protractor, set square and calculators satisfying the conditions set by the Curriculum Council for this subject.

## ***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	Number of questions to be attempted	Marks available
A: Short Answers	13	ALL	50
B: Problem Solving	5	ALL	56
C: Comprehension and Data Analysis	1	ALL	14

## ***Instructions to candidates***

1. Write your answers in the spaces provided in this Question/Answer Booklet.
2. You may remove the enclosed Physics: Formulae, Constants and Data Sheet from the booklet and use as required. This sheet is to be handed in at the end of the examination.
3. Your 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, you may obtain marks for method and working, provided these are clearly and legibly set out.
4. Questions containing the specific instructions “**show working**” should be answered with a complete, logical, clear sequence of reasoning showing how you arrived at your final answer. For these questions, correct answers which do not show full working will not be awarded full marks.
5. Questions containing the instruction “**estimate**” may give insufficient numerical data for their solution. You should provide appropriate figures to enable an approximate solution to be obtained.
6. When descriptive answers are required, you should display your understanding of the context of a question. An answer which does not display an understanding of Physics principles will not attract marks.

**SECTION A: Short Answers**

Marks Allotted: 51 marks out of total of 120 marks (42.5%)

Attempt **ALL** 13 questions in this section. The marks for each question is indicated in brackets.  
Answers are to be written in the space below or next to each question.

Section A

1. Carbon-14 is a radioactive isotope of carbon produced in the upper atmosphere by bombardment of air by cosmic rays. It decays by emitting a  $\beta$  particle.

- a) Explain the difference between normal carbon-12 and carbon-14, which are both forms of element number 6 in the Periodic Table.

[2 marks]

- b) Write a nuclear equation for the decay of carbon-14.

[2 marks]

2. An experiment is carried out to determine the age of a piece of papyrus found in an ancient Egyptian tomb. For this, the Geiger-counter reading from a 0.50 g sample of the ancient papyrus was measured and compared with the reading from a 1.00 g sample of newly-made papyrus.

The background count taken in the laboratory is also recorded and all the Geiger Counter readings are shown below in Table 1.



Ancient Egyptian papyrus

Table 1	1	2	3
Sample	Activity (counts min <sup>-1</sup> )	Corrected count (counts min <sup>-1</sup> )	
0.5 g sample of ancient papyrus	84		
1.0 g sample of new papyrus	196		
Background reading	22		

- a) Fill in column 3 of Table 1 to show the count rate of  $\beta$ -emission from the **samples only**.

[1 mark]

- b) Calculate the ratio of the count rates of the old papyrus to the new papyrus, allowing for the difference in their masses.

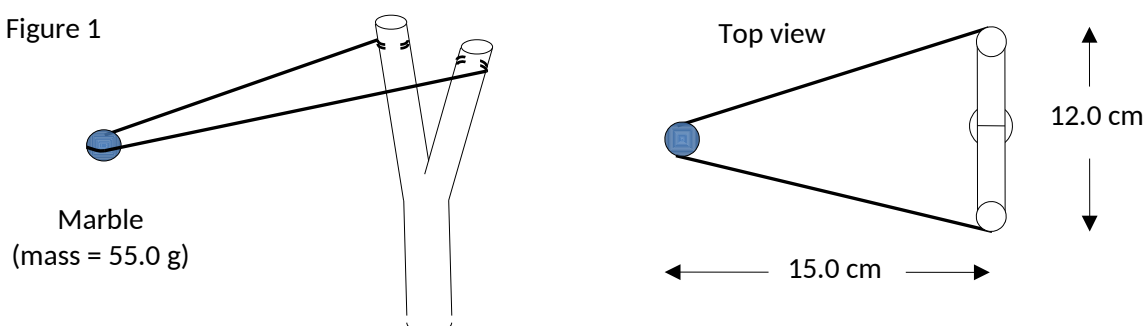
[3 marks]

- c) Using the formula  $A = A_0 \left( \frac{1}{2} \right)^n$ , estimate the age of the ancient papyrus by substituting different values for n into the equation. ( the half-life of carbon-14 is 5730 years)

[3 marks]

3. Anna and Taryn decided to make a slingshot that would fire marbles in their back yard. They found a Y-shaped piece of wood to use and attached some strong elastic to it with Superglue, as shown in Figure 1.

Figure 1



Anna stretched the elastic back by 15.0 cm to fire a marble, as shown in the right-hand diagram so that the tension force in each side of the elastic was 48.0 N.

Calculate the accelerating force acting on the marble as it is released.

[4 marks]

4. (Refer to the slingshot on Fig. 1 above)  
As Anna holds the slingshot and pulls the elastic back for a shot she remarks to Taryn that she is finding it hard to hold onto the handle.

Explain why it is harder to hold the handle of the slingshot when the elastic is being pulled back.

[2 marks]

5. (Refer to the slingshot on Fig. 1 above).

- a) Calculate the acceleration of the 55.0 g marble as it is released (if you were unable to calculate the answer to question 4 take the force acting on the marble as 90.0 N.

[2 marks]

- b) During the marble's acceleration, how fast will it be travelling when it leaves the slingshot at a point 15.0 cm to the right of its starting position?

[2 marks]

6. In Canada a large proportion of the population lives close to the Great Lakes, a very large area of fresh water. This is because the average winter temperature around the Lakes can be about 20 degrees higher than other locations inland at the same latitude.

Explain how this temperature difference occurs.

[2 marks]

7. Alan turns on his 2 kW kettle to make a cup of tea and it starts to boil 1½ minutes later.

Make an estimate of the mass of water Alan had in his kettle.

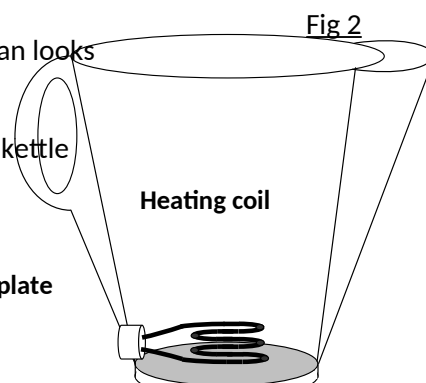
[3 marks]

8. Referring to the kettle in the last question (Fig.2), Alan looks inside it and notices two prominent design features:

- i) The heating coil is located at the **bottom** of the kettle

6

Metal plate



- ii) Directly below the heating coil, inside the kettle, is a **shiny metal plate**.

Explain why these two features are necessary in the design of an efficient kettle.

[4 marks]

9. Coming back from her night shift in the town, Sheila takes a glass of beer from her freezer.

If the glass has 350 g of beer in it and the ice is at exactly zero degrees, calculate the mass of ice Sheila needs to add to achieve this temperature reduction (neglect the heat absorbed by the glass in this calculation).

[5 marks]

- 10.

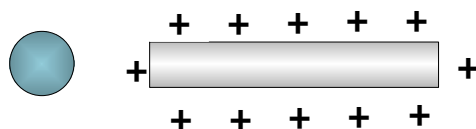


Figure 3

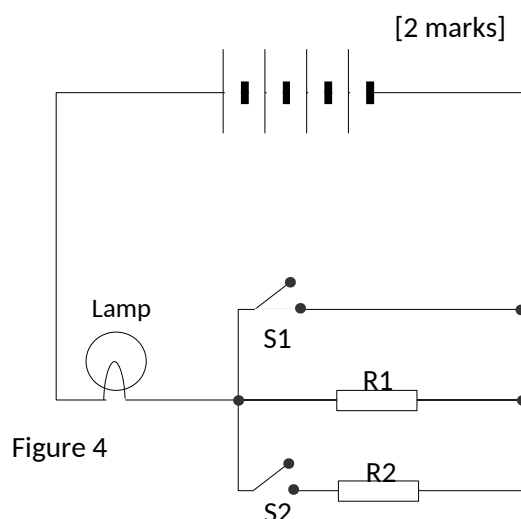
Jordan has learned in school that positive charges attract negative charges but cannot understand why an uncharged object can be attracted to a charged object placed near it.

At school, Jordan's teacher suspends an uncharged plastic table-tennis ball on a cotton thread and then brings a positively charged polythene rod close to it (see Figure 3). The table-tennis ball is attracted and moves towards the rod. How should Jordan explain this?

11. Samantha is trying to make a lamp-dimming circuit to use in her model house as a geography project.

She has two resistors in the circuit ( $R_1$  and  $R_2$ ) and two switches ( $S_1$  and  $S_2$ ), connected as shown in Figure 4.

Complete the table below to indicate the brightness of the lamp when the switches are open and closed in different arrangements.



Place numbers in column 3 below to indicate the relative brightness of the lamp in each case, using the numbering system where number '1' indicates the lamp is at its brightest, '2' indicates the lamp is at its next brightest, and so on.

		Relative Brightness
$S_1$ OPEN	$S_2$ OPEN	
$S_1$ CLOSED	$S_2$ OPEN	
$S_1$ OPEN	$S_2$ CLOSED	
$S_1$ CLOSED	$S_2$ CLOSED	

[4 marks]

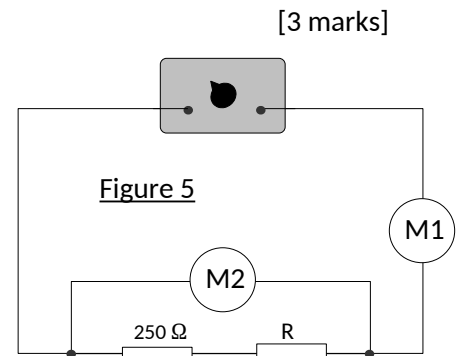
12. In Australia, all metal-clad electrical devices, such as drills and toasters must have a separate yellow/green cable connected to the outer case.



Explain what this cable is and why it is a compulsory feature of mains-powered devices.

13. A physics class is told to set up the circuit shown in Figure 5 with an unknown resistor  $R$  connected in parallel to a standard  $250\ \Omega$  resistor.

Meters  $M_1$  and  $M_2$  are connected to measure current and voltage.



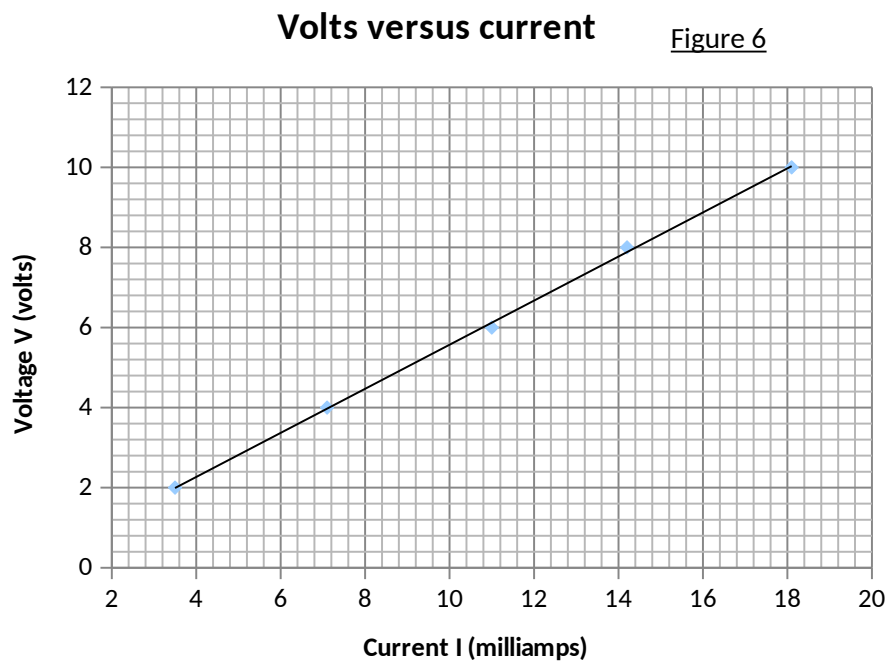
- a) Name the type of meters used in the circuit shown in figure 5.

$M_1$  \_\_\_\_\_

$M_2$  \_\_\_\_\_

[1 mark]

The power supply unit can be switched to give voltages ranging from 2 to 12 volts and for each voltage a value of the current was recorded on the ammeter. A graph of voltage versus current is shown below (Figure 6).



- b) Find the slope of the graph and hence determine the total resistance of the circuit.

[3 marks]

- c) Calculate a value for the unknown resistor R from your previous results.

[2 marks]

**SECTION B: Problem Solving**

Marks Allotted: 56 marks out of total of 120 marks (46.6%)

This section contains 5 questions. You should answer **ALL** of the questions and show full working.

Answer all questions in the spaces provided.

1. [11 marks]

Kenny and Suzie have set up an investigation at home to look at the viscosity of different liquids (viscosity is a measure of liquid friction, or *runniness* of a liquid.)

A diagram of their equipment is shown in Figure 7 and comprises a measuring cylinder containing liquid A, a metre rule and a digital stopwatch.

For the experiment, Kenny drops a 5 mm diameter ball-bearing into the liquid and Suzie measures the time it takes for the ball to fall between two sticky tape markers (X and Y) stuck to the cylinder and records a single result of 1.56 seconds. She also measures the distance between X and Y to be 15.0 cm.

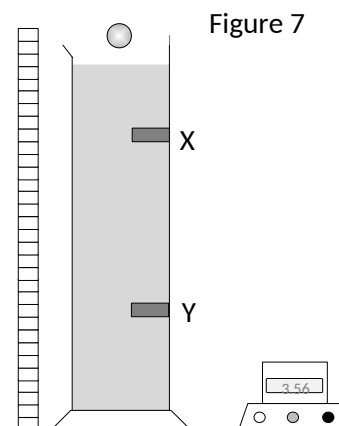


Figure 7

- a) Calculate a value for the speed of the ball in liquid A.

[1 mark]

- b) Suzie maintains that the speed she calculated must be really accurate because of the accuracy of her measuring instruments: The ruler measures to one millimetre and the stopwatch to  $\frac{1}{100}$  of a second. Is she correct? Explain.

[1 mark]

- c) Make an estimate of the percentage uncertainty in the recorded measurement of distance XY from the data supplied.

[2 marks]

- d) The two students want to repeat their experiments at school but they find that the equipment there is different. They want to make a Fair Test and control all the variables in order to obtain the same results that they got at home.

Which of the variables at school **must** be controlled so they get the same results as at home? (Tick the boxes in the table below)

Variable	Must be the same	Doesn't matter
Diameter of the ball		
Distance X-Y		
Type of timer		
Size of measuring cylinder		
Weight of ball		
Type of liquid		

[3 marks]

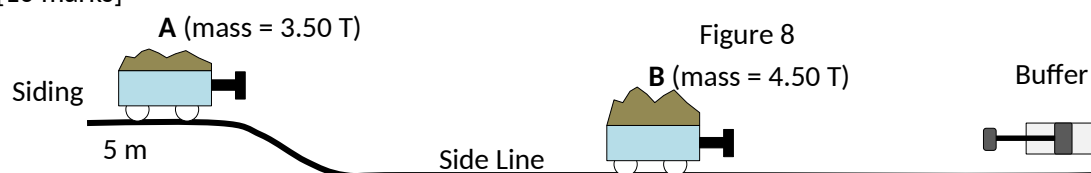
Kenny and Suzie continue with some other experiments at school by dropping the ball bearings from the first floor window of the lab and timing the flight. Their 5 results of time to reach the ground are shown below:

1.75 s; 1.80 s; 1.78 s; 1.73 s; 1.69 s.

- e) Calculate the average time of flight of the balls and hence obtain a value for the drop height from the window.

[4 marks]

2. [10 marks]



Two railway trucks carrying coal need to be linked together for transporting the coal to Derby. Truck A is in a siding which is 5.0 m above the side line, as shown in Figure 8. Truck A has a mass of 3.5 tonne and truck B has a mass of 4.5 tonne.

- a) If truck A runs down to the Side Line from rest to link up with truck B, what will be its speed as it impacts?

[3 marks]

- b) When truck A collides with truck B they both link together and move off at a slower speed. Calculate a value for this final speed.

[3 marks]

- c) Find a value for the total kinetic energy of the two linked trucks after the collision (If you couldn't calculate an answer in part b), take the final velocity as  $4.5 \text{ ms}^{-1}$ ).

[1 mark]

- d) At the end of the Side Line is a device which brings the trucks to a halt, called a Buffer. This contains a piston in oil that absorbs the kinetic energy of moving trucks.

If the force exerted against the moving trucks A and B by the Buffer is 250 kN, in what distance will they be brought to rest by the Buffer?

[3 marks]

3. [16 marks]

When miners were prospecting in the Outback in the 1880s they kept their food cool by using a Coolgardie safe. This consisted of a wooden box covered in sacking material which absorbed water and was kept wet by a water reservoir on top (see Fig. 9).

- a) Explain how the Coolgardie Safe maintained a cool temperature inside when a breeze was blowing.

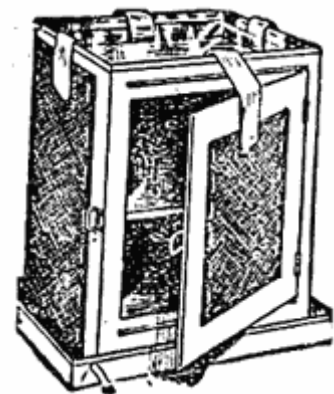


Figure 9. Coolgardie Safe

[3 marks]

- b) Today's modern evaporative air conditioners work in a similar way to the Coolgardie Safe. In one such air conditioner 15.0 g of water evaporates in one minute.
- (i) What amount of heat must be absorbed by this mass of water in order to evaporate?

[2 marks]

- (ii) The heat needed to evaporate the water is absorbed from the air in a living room which has dimensions 3.5 m x 5.2 m x 6.1 m. If 1 m<sup>3</sup> of air has a mass of 1.22 kg, calculate the mass of air in the room.

[2 marks]

- (iii) Given that the specific heat capacity of air is 995 Jkg<sup>-1</sup>K<sup>-1</sup>, calculate the change in temperature of the air in the living room due to the evaporation of this amount of water.

[3 marks]

- (iv) Air conditioners do not work very well in regions of Australia where there is high humidity. Explain why this is so.

[2 marks]

- c) A freezer in a house runs on a power of 155 watts. Assuming the freezer is 100% efficient, calculate how long it would take for an ice tray containing 350 g of water at 20°C to freeze to ice at zero degrees.

[4 marks]

4. [12 marks]

Radon-222 is a radioactive gas produced by the decay of the element Radium-226.

- a) Using the data sheet, write a nuclear equation for the decay of radium to radon and state what kind of radiation would be emitted in the decay?

[2 marks]

Radon gas is commonly found in underground mines and also becomes trapped inside houses. In the USA it is estimated that Radon is the cause of 21,000 deaths a year from cancer.

- b) Why is Radon so hazardous compared with other radioactive sources found in the environment?

[2 marks]

- c) (i) A 95 kg miner in one year is exposed to both  $\alpha$  and  $\beta$  radiation. The  $\alpha$ -rays cause 2.5 mJ of heat to be released in his body per day and the  $\beta$ -rays cause 5.4 mJ to be released per day. From these figures, calculate the **Absorbed Dose** (in grays) received by the miner in one year.

[2 marks]

- (ii) Calculate the miner's Effective Dose caused by each of the separate radiations and hence his total Effective Dose.

[3 marks]

- d) A sample of air from a mine containing Radon has an activity of 240 mBq at the start of an experiment and after 60.8 days the activity reading has dropped to 15.0 mBq.

Use these figures to estimate a value for the half-life of radon-222.

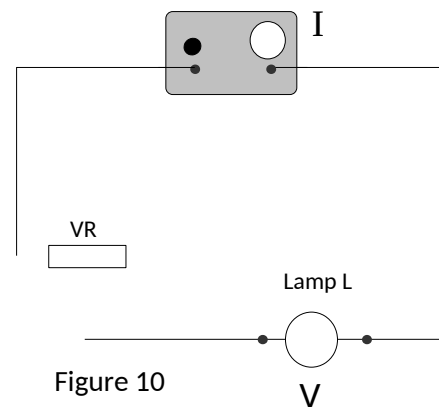
[3 marks]

5. [7 marks]

Lisa connects an electric lamp L into a circuit, as shown in figure 10, in series with a power supply and a variable resistor (VR), which varies the voltage across the lamp.

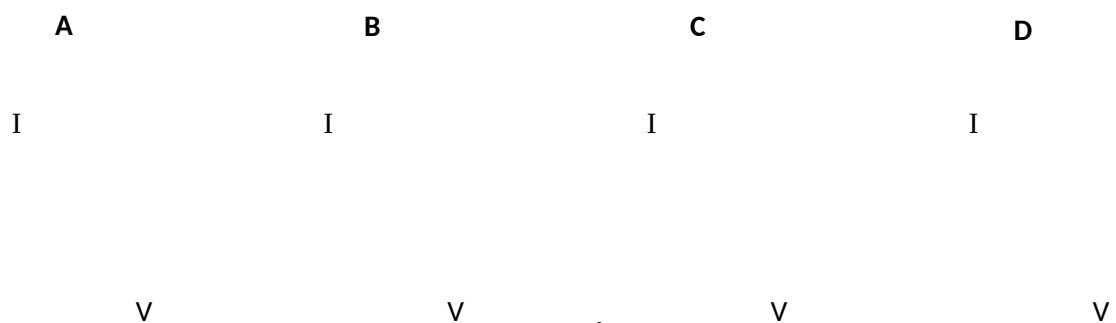
Lisa has learned for school that filament lamps are non-ohmic conductors.

- a) (i) Explain what a non-ohmic conductor is.



[1 mark]

- (ii) Which of the following graphs below would you expect to obtain from this experiment?  
(circle the correct answer)



[1 mark]



- b) The lamp in the circuit has been designed to operate efficiently at exactly 6.0 volts, with a power output of 0.18 W. What is its resistance?

[2 marks]

- c) 3 such lamps are connected as shown in figure 11.

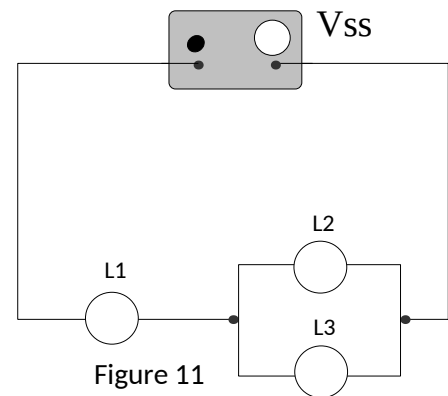


Figure 11

Calculate the maximum value of the supply voltage ( $V_s$ ) so that none of the lamps can have a voltage across it exceeding 6.0 volts.

[3 marks]

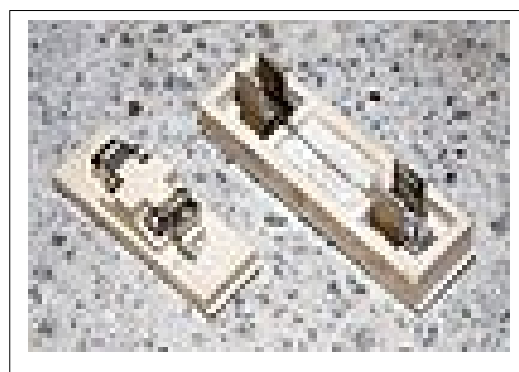
**SECTION C: Comprehension and Data Analysis**

Marks Allotted: 14 marks out of total of 120 marks (11.6%)

This section contains **One** question worth **12 marks**.

Read the following information and answer the questions at the end of each. Candidates are reminded of the need for clear and concise presentation of answers. Diagrams (sketches), equations and/or numerical results should be included as appropriate.

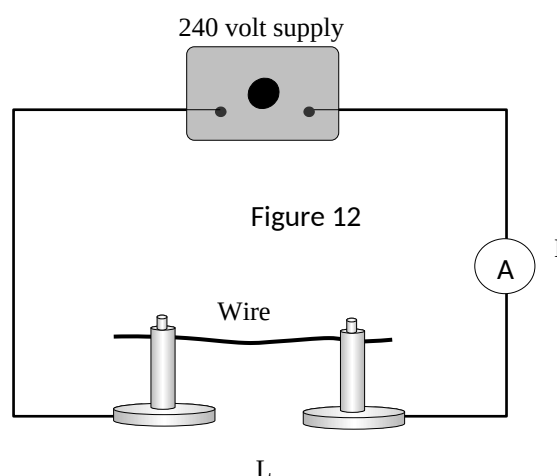
Rewirable thermal fuses are used extensively in households circuits to protect circuits such as Lighting and Power systems. A fuse is simply a piece of zinc/copper alloy wire connected in series with a circuit which will melt if a certain, safe, current is exceeded.



A series of experiments is being carried out by two graduates, Fiona and Minh to investigate the properties of different metal alloys to be used in thermal fuses. An electrical company has supplied a sample of a new alloy wire called Feranium in various diameters to be connected into the test rig circuit shown below in Figure 12.

The 240 V power supply is connected, via an ammeter, to a fixed length of sample wire clamped into position and readings of the current are taken. The length of wire is then changed and the new ammeter reading noted.

Results for the sample of 0.50 mm diameter Feranium wire are shown below in Table 2.



Length L (cm)	Current I (amp)	1/L (cm <sup>-1</sup> )
2	15.5	
3	10.3	
5	3.1	
7	2.2	
10	1.6	

Fiona suggests that the current in the circuit depends directly on the length of the wire, whereas Minh thinks that the current in **inversely** proportional to the length of wire.

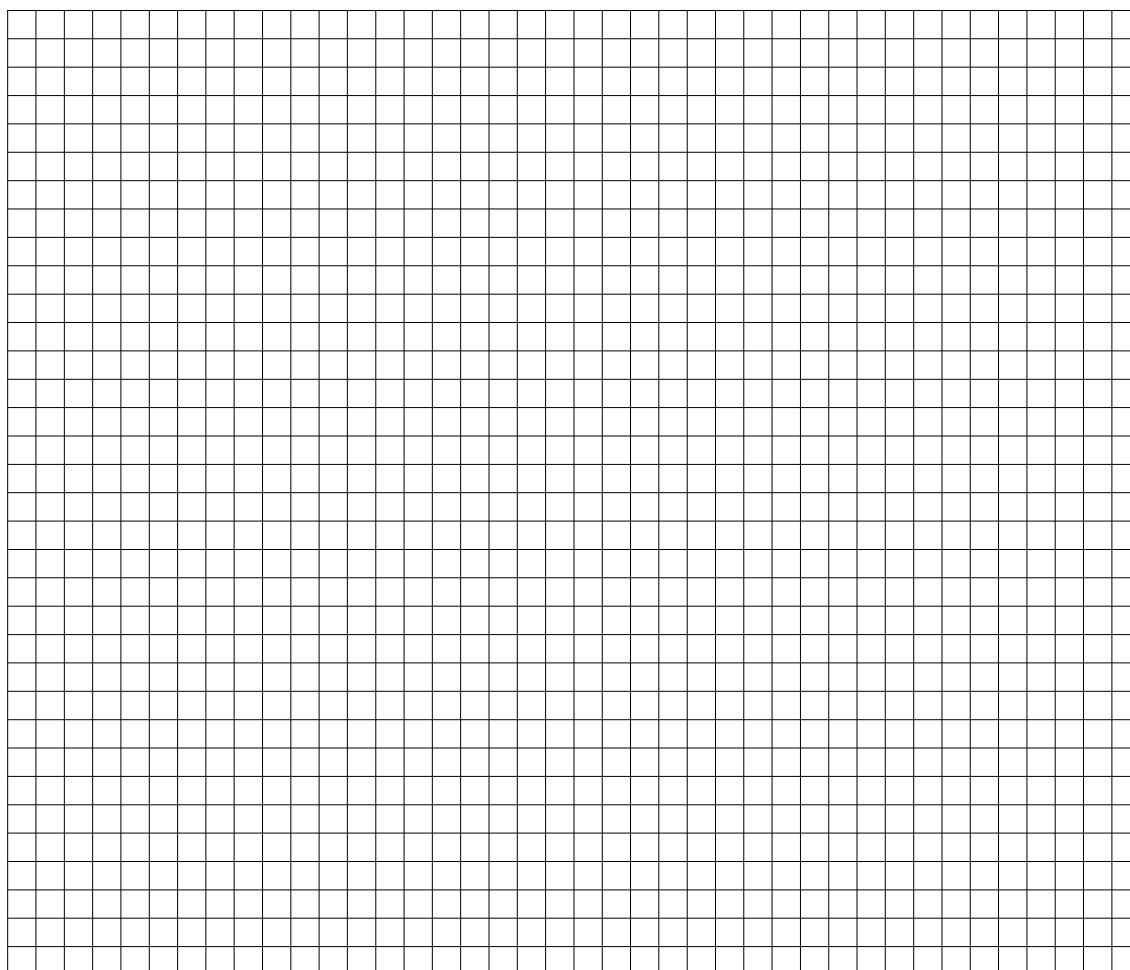
- a) Fill in values of  $1/L$  in the 3<sup>rd</sup> column of Table 2 and compare the data to determine which of the researchers is likely to be correct. Fill the line in below:

*I think* \_\_\_\_\_ *(name) is correct because* \_\_\_\_\_

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[2 marks]

- b) Plot a graph of current  $I$  (up) against  $1/L$  (along) on the axes below and draw in the line of best fit.



[3 marks]

In Fiona's research she derived a formula for the current passing through a fuse wire which is:

$$I = k \left( \frac{1}{l} \right) \quad \text{where } k = \frac{VA}{\sigma}$$

V is the applied voltage

A is the cross-sectional area of the wire

$\sigma$  is the resistivity constant for Feranium

- c) (i) from your line of best fit, find the gradient and hence write a value for k.

[1 mark]

- (ii) calculate the cross-sectional area of the Feranium wire

[2 marks]

- (iii) Using your value for the gradient and other data given in this question, calculate a value for  $\sigma$ .

[2 marks]

- d) Minh looks at Fiona's graph and sees that there are two possible straight lines that could be drawn: 1) a minimum line of best fit through the first 4 points only  
2) a maximum line of best fit drawn through the origin and the last two points only.  
Draw in these two alternative lines (use a different colour) to obtain values for the maximum and minimum gradients.

[2 marks]

**END OF PAPER**