Teacher Resource Bank

GCE Physics

Sample AS EMPA:

- Question Paper

AQA Physics Sample AS EMPA

Centre Instructions

Section A Task 1

Candidates are to measure the potential difference between different points in a circuit and make deductions about the identity of the components in the circuit.

Apparatus required for each candidate:

- ❑ dc power supply consisting of a series arrangement of 4 D-Type 1.5 V cells in a suitable holder (or holders) or a 5 V stabilised supply; the negative terminal of this supply can be hard-wired into the rest of the circuit (see Figure 1) but the positive terminal **must** be a round socket and labelled 'P', any other tappings should be taped over
- ❑ digital voltmeter capable of reading to 0.01 V or better (an inexpensive 3 ½ digit digital multimeter will be satisfactory)
- ❑ circuit to be made up by the supervisor, part of which should be concealed; list of passive components below (see also circuit diagram)

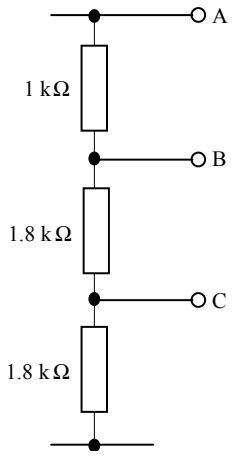
passive components required for concealed circuit for use in Task 1 and in Task 2:

- ❑ one 1 kΩ resistor, carbon or metal film, at least 0.25 W (Rapid 62-0370)
- ❑ two 1.8 kΩ resistors, carbon or metal film, at least 0.25 W (Rapid 62-0376) (component codes given are for Rapid carbon film type, packets of 100)
- ❑ round sockets to be labelled 'A', 'B' and 'C'
- ❑ two 4 mm round plugs, to be labelled 'plug 1' and 'plug 2'; the location of these is explained in **Figure 1** of Task 1
- ❑ concealing box for circuit; see Figure 1 of Section A Task 1 below

additional passive component required for Task 1:

- ❑ one 2.2 kΩ resistor, carbon or metal film, at least 0.25 W (Rapid 62-0378); the resistance of this component should be concealed and short leads terminating at 4 mm round plugs should be connected to each leg of the resistor leg to allow connection between sockets B and C so that it is in parallel with the 1.8 kΩ resistor, as shown in **Figure 2** of Task 1; the label '**resistance = R_4**' should be clearly shown on the concealing enclosure

The arrangement required for the concealed circuit is shown below.



The components should be concealed, e.g. with a suitable box or with insulation tape.

The Examiners require no information for this question.

Section A Task 2

Candidates are to investigate the current-voltage characteristics of a modified version of the circuit used for Task 1.

Apparatus required for each candidate:

- ❑ dc power supply as used in Task 1; the positive terminal **must** be a round socket and labelled 'P' and the negative terminal **must** be a round socket and labelled 'N'; any other tappings should be taped over
- ❑ additional round socket, to be labelled 'S'
- ❑ digital voltmeter capable of reading to 0.01 V or better (an inexpensive 3 ½ digit digital multimeter will be satisfactory), as used in Task 1
- ❑ digital ammeter capable of reading to 2.00 mA or better (as before, a cheap 3 ½ digit digital multimeter will be satisfactory)
- ❑ concealed circuit consisting of three resistors, as used in Task 1; there is no requirement to make up a new circuit from scratch for Task 2

additional passive components required:

- ❑ one 1N4001 rectifier diode (e.g. Rapid 47-3130) with short leads terminating at 4 mm round plugs connected to each leg to allow connection between sockets B and C so that it is in parallel with the 1.8 kΩ resistor, as shown below; the anode should be connected to socket B and the cathode connected to socket C; the identity of this component should be concealed from the candidates; the label 'component X' should be clearly shown on the concealing enclosure
- ❑ one 1.0 kΩ linear potentiometer, 0.2 W, e.g. Rapid 65-0705; short leads terminating at 4 mm round plugs connected to all three legs of this component

The arrangement of the circuit should appear as in Figure 3 of Section A Task 2.

Examiners required no information for the question.

Note that when completing Section B of the test, candidates should be provided with their completed copy of Section A Task 2, whereas candidates' copies of Section A Task 1 should **not** be made available to them.

Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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PHYSICS
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Sample Unit 3 EMPA

Section A Task 1

For Examiner's Use		
		Mark
Section A Task 1		
	1	
	2	
Total (Section A Task 1)		
TOTAL		
Examiner's Initials		

For this paper you must have:
- a calculator
- a pencil and a ruler

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this task is 16.
- The marks for the questions are shown in brackets.

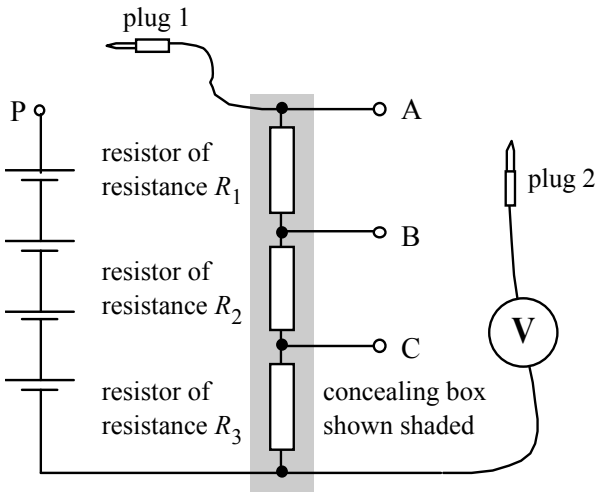
SECTION A TASK 1

- Follow the instructions given below.
- Provide the information required in the spaces provided.
- No description of the experiment is required.

1 You are required to measure the potential difference between different points in a circuit and make deductions about the resistance of the resistors in the circuit.

In this experiment, you are provided with a circuit containing resistors of resistance R_1, resistance R_2 and resistance R_3, connected in series. The circuit is concealed within a box, as shown shaded in **Figure 1**.

Figure 1



1 (a) Connect plug 1 to socket P.

1 (a) (i) Connect plug 2 to socket A and measure the potential difference across the combination of resistors of resistance R_1, R_2 and R_3 together.

1 (a) (ii) Remove plug 2 from socket A and connect plug 2, in turn, to socket B and then to socket C, to measure the potential difference across the combination of resistors of resistance R_2 and R_3 together and then across the resistor of resistance R_3 separately.

Record all your observations in **Table 1** below.
When you have completed your observations, disconnect plug 1 and plug 2 from the circuit.

Table 1

plug 2 connected to	potential difference/V
socket A	
socket B	
socket C	

(1 mark)

1 (b) Use you results from the circuit shown in **Figure 1** to calculate the potential difference across each of the resistors of resistance, R_1, R_2 and R_3, separately. Show the results of your calculation in **Table 2**.

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Table 2

resistance of resistor	potential difference/V across resistor
R_1	
R_2	
R_3	

(2 marks)

1 (c) With reference to your answers in **Table 2**, state and explain, **without calculation**, how the resistances R_1, R_2 and R_3 compare qualitatively.

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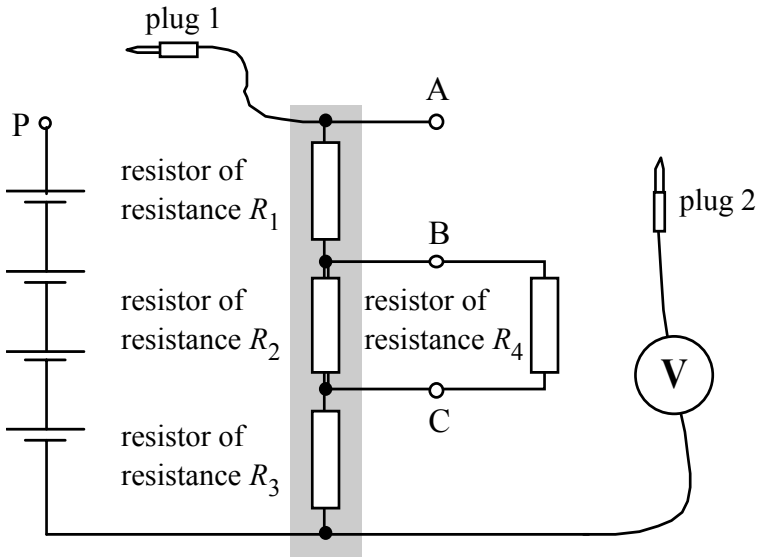
(4 marks)

1 (d) You are provided with an additional resistor of resistance R_4.

Connect this resistor between sockets B and C, so it is parallel with the resistor of resistance R_2, as shown in **Figure 2**.

Figure 2



1 (d) (i) Connect plug 1 to socket P and connect plug to socket B.
Measure the potential difference across the combination of resistors of resistance R_2, R_3 and R_4 together.

1 (d) (ii) Remove plug 2 from socket B and connect plug 2 to socket C to measure the potential difference across the resistor of resistance R_3 separately.

Record all your observations in **Table 3** below.
When you have completed your observations, disconnect plug 1 and plug 2 from the circuit.

Table 3

plug 2 connected to	potential difference/V
socket B	
socket C	

(1 mark)

1 (e) Use your results from **Table 3** and **Table 1** 'socket A' to calculate the potential difference across each of the resistors of resistance, R_1 and R_3, separately, and across the parallel combination of resistors of resistance R_2 and R_4.
Show the results of your calculation in **Table 4**.

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Table 4

resistance of resistor(s)	potential difference/V across resistor(s)
R_1	
parallel combination of R_2 and R_4	
R_3	

(2 marks)

1 (f) It is suggested that $\frac{1}{R_1} \approx \frac{1}{R_2} + \frac{1}{R_4}$.
Explain whether your answers in **Table 4** confirm this suggestion.

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(4 marks)

END OF QUESTIONS

Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

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Sample Unit 3 EMPA

Section A Task 2

For Examiner's Use		
		Mark
Section A Task 2		
	1	
Total (Section A Task 2)		
TOTAL		
Examiner's Initials		

For this paper you must have:
- a calculator
- a pencil and a ruler

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this task is 16.
- The marks for the questions are shown in brackets.

SECTION A TASK 2

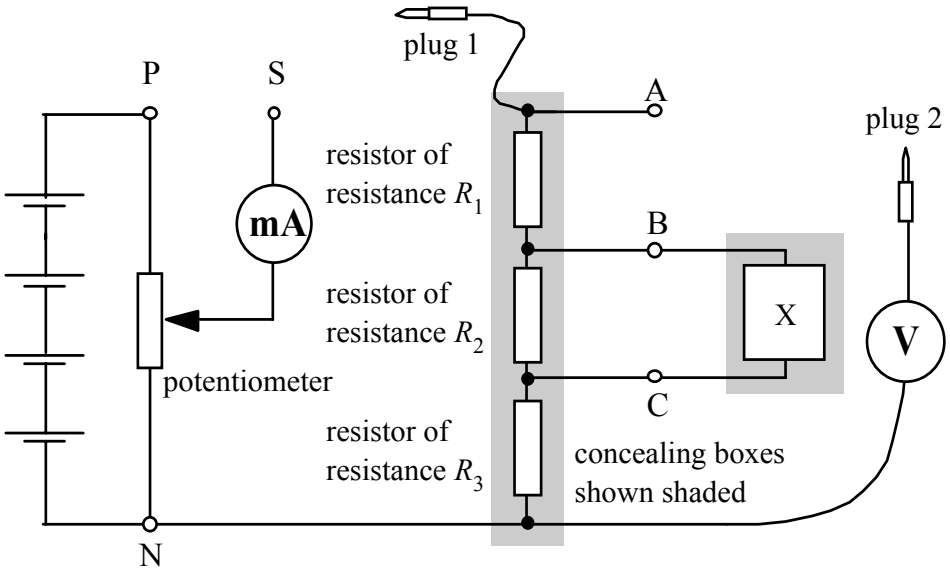
- Follow the instructions given below.
- Provide the information required in the spaces provided.
- No description of the experiment is required.

1 In this experiment you will investigate the current-voltage characteristics of a modified arrangement of the circuit you in Section A Task 1.

The power supply is connected to sockets P and N; these sockets are connected to the ends of a potentiometer.
A milliammeter is connected between the output of the potentiometer and socket S.

This modified arrangement is shown in **Figure 3**.

Figure 3



1 (a) A component, X, has been connected between sockets B and C so that it is parallel with the resistor of resistance R_2.
Component X should remain in this position throughout the experiment.

Check that the **positive** terminal of the power supply is connected to socket P and the negative terminal of the supply is connected to socket N.
Connect plug 1 to socket S and connect plug 2 to socket A.
Check that the voltmeter reading and the milliammeter reading change as the setting of the potentiometer is adjusted.
Measure the milliammeter reading I, and the potential difference, V, shown on the voltmeter, as V, is varied by adjusting the setting of the potentiometer.

Record these data on page 11 with the independent variable in the **left-hand** column of your table.

In both part (a) and part (b) you should collect sufficient readings so that a detailed comparison can be made between I and V.

1 (b) Disconnect the power supply from sockets P and N, then reconnect with the **negative** terminal connected to socket P and the positive terminal connected to socket N.

Measure and recored further values of I and V, by adjusting the setting of the potentiometer.
The readings of I and V taken in part (b) should be recorded **as negative**.

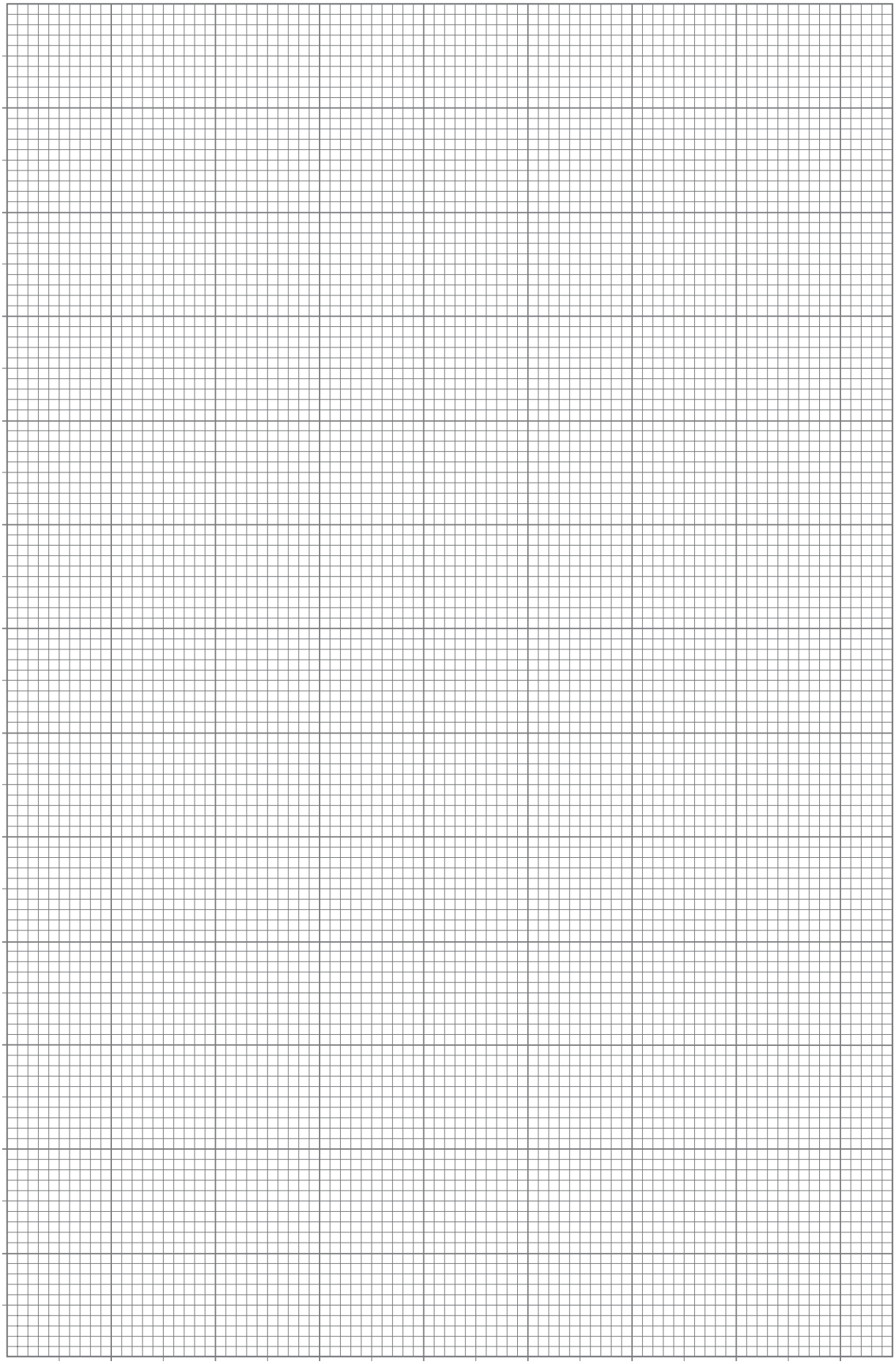
Record below all your observations for parts (a) and (b).

(8 marks)

1 (c) Plot, on the grid opposite, and using a **single set of axes**, a graph of **all** your readings from (a) and (b) with I on the vertical axis and V on the horizontal axis.

(8 marks)

END OF SECTION A TASK 2



Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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Sample Unit 3 EMPA

Section B

Time allowed: 1 hour 15 minutes

For this paper you must have:
- a calculator
- a pencil and a ruler

For Examiner's Use		
		Mark
Section B	1	
	2	
	3	
	4	
Total (Section B)		
TOTAL		
Examiner's Initials		

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this task is 23.
- The marks for the questions are shown in brackets.

SECTION B

- Answer all the questions in the spaces provided.
- Time allowed 1 hour 15 minutes.
- You will need to refer to the work you did in Section A Task 2 when answering these questions.

1 (a) Determine the gradient, G_1, of your graph where $V = +3.0\,\text{V}$.

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$G_1 =$ .....

1 (b) Determine the gradient, G_2, of your graph where $V = -3.0\,\text{V}$.

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$G_2 =$ .....

1 (c) Evaluate $\frac{G_1}{G_2}$.

$\frac{G_1}{G_2} =$ .....

(4 marks)

2 With reference to your experimental results, discuss the extent to which the circuit you investigated in Section A Task 2 obeyed Ohm's law.
Provide a sketch of your graph to provide some quantitative detail with your answer.

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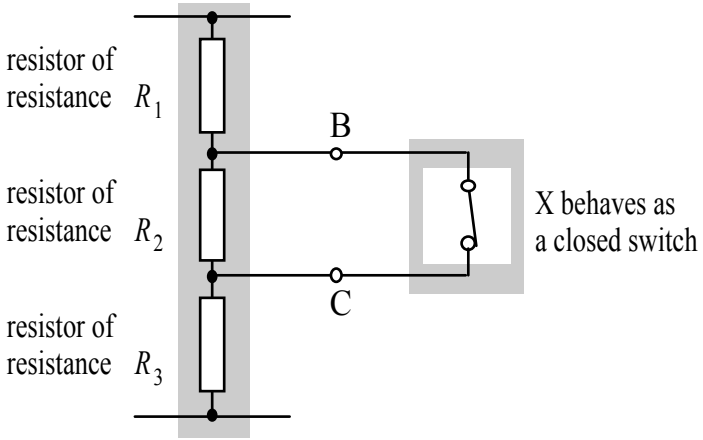
(3 marks)

3 (a) When the gradient of the graph is G_1, component X, which was connected between sockets B and C, behaves like a **closed** switch, i.e. as a resistor of zero resistance. This idea is illustrated in **Figure 4**.

Figure 4



The resistance of the circuit shown in **Figure 4** is equal to $\frac{1}{G_1}$.

3 (a) (i) Use your results for G_1 to calculate the resistance, in ohms, of the circuit shown in Figure 4.

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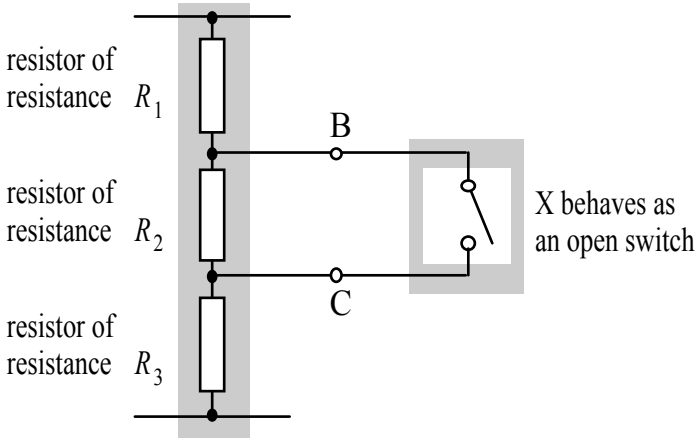
When the gradient of the graph is G_2, component X behaves like an open switch, i.e. as a resistor of infinite resistance.
This is illustrated in **Figure 5**.

Figure 5



The resistance of the circuit shown in **Figure 5** is equal to $\frac{1}{G_2}$.

3 (a) (ii) Use your result for G_2 to calculate the resistance, in ohms, of the circuit shown in **Figure 5**.

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(1 mark)

3 (b) (i) Use your answers to (a) to calculate the resistance R_2.

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3 (b) (ii) Given that $R_2 = R_3$, calculate R_1.

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(4 marks)

4 **Table 5** shows a student's results for the pd across the resistors of resistance R_1 and R_2 during Section A Task 1 when the **same current** was in each resistor.

Table 5

resistance of resistor	potential difference/V across resistor	percentage uncertainty/%
R_1	1.28	
R_2	2.33	

The student estimates the uncertainty in the potential difference readings to be ±0.04 V.

4 (a) Calculate the **percentage** uncertainty in each measurement of pd and record these results in the right-hand column of **Table 5**.

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(2 marks)

4 (b) The student (correctly) calculates the ratio of $\frac{R_2}{R_1}$ as 1.82.

4 (b) (i) Calculate the percentage uncertainty in the student's result for $\frac{R_2}{R_1}$.

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4 (b) (ii) Use your result from (b) (i) to calculate the uncertainty in the student's results for $\frac{R_2}{R_1}$.

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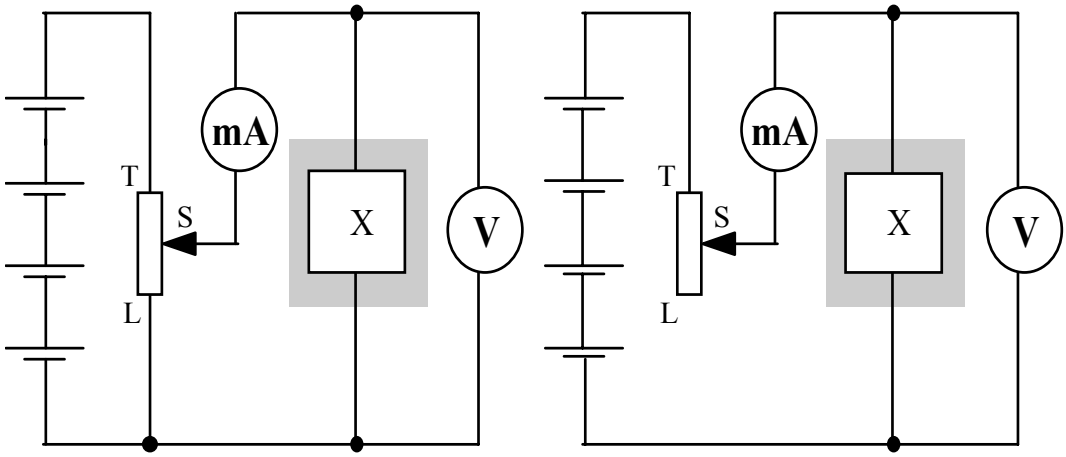
(4 marks)

5 Two students build circuits to generate the current-voltage characteristic of component X and hence confirm its identity.
Each circuit is capable of producing a range of current and voltage readings, but the method each student uses to obtain these values is different.
Student A's circuit use the potentiometer (potential divider) principle and student B's circuit uses a variable resistor (rheostat) principle.
The circuit built by each student are shown in **Figure 6**.

Figure 6



student A's circuit student B's circuit

The power supplies in each circuit have identical emf, *E*, and negligible internal resistance.

5 (a) (i) Explain how the pd across X in student A's circuit varies as the sliding contact, S, is moved between positions T and L.

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5 (a) (ii) Explain how the pd across X in student B's varies as the sliding contact is moved between T and L.

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(4 marks)

5 (b) Each student obtains 10 sets of readings for I and V, moving the sliding contact in **equal steps** between **T** and **L**.

5 (b) (i) State **one** advantage of the method employed by student A compared with that of student B.

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5 (b) (ii) State and explain **one** advantage of the method employed by student B compared with that of student A.

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(3 marks)

END OF QUESTIONS