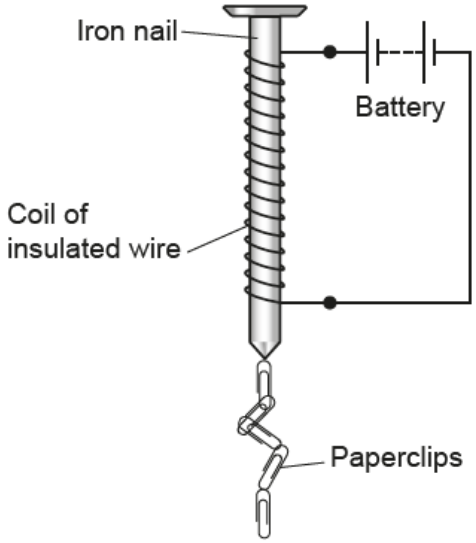
Electrical circuits – 2021/20 GCSE 21st Physics Combined Science B

1. Nov 2021/Paper_J260/03/No.2

James makes an electromagnet.

The diagram shows the electromagnet picking up some paperclips.



(a) (i) Why has James used a nail that is made of **iron**?

.....

..... **[1]**

(ii) How can James make the electromagnet stronger, so that it will pick up more paperclips?

Tick (✓) **two** boxes.

Increase the current in the coil. ☐

Increase the number of turns of wire in the coil. ☐

Increase the resistance of the coil. ☐

Remove the iron nail. ☐

Use an aluminium nail. ☐

[2]

(b) The current in the coil of insulated wire is 1.9A and the potential difference across it is 0.95V.

(i) Calculate the resistance of the coil of insulated wire.

Use the equation: resistance = potential difference ÷ current

Resistance = ... Ω **[2]**

(ii) The current passes through the coil for 30s.

Calculate the charge that flows through the coil.

Use the equation: charge = current × time

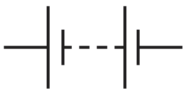
Charge = ... C **[2]**

2. Nov 2020/Paper_J260/03/No.2

Ben is investigating electric circuits.

(a) Complete the table by filling in the blank spaces.

One has been done for you.

Circuit component	Name of circuit component
	
	
	battery
	
	

[2]

(b) Ben wants to investigate the brightness of bulbs in series and parallel.

(i) Draw a series circuit diagram with **one** bulb that Ben can use to start his investigation.

Use **all** of the circuit components from the table.

[2]

(ii) Describe how Ben can investigate if the brightness of the first bulb changes when a second bulb is added in **parallel**.

.....

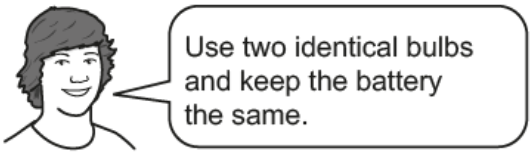
.....

.....

..... **[2]**

(iii) Ben compares the brightness of two bulbs in series, and two bulbs in parallel.

Alex says:



Why is it important for Ben to follow Alex's advice?

..... **[1]**

(iv) Complete the sentences to describe the changes to the bulb brightness when more of the same bulbs are added to the circuit.

Use words from the list.

You can use each choice once, more than once, or not at all.

increase **decrease** **stay the same**

1. When more of the same bulbs are added in **parallel**, the brightness of all of the bulbs will .....

2. When more of the same bulbs are added in **series**, the brightness of all of the bulbs will .....

[2]

(c) (i) Suggest **one** hazard associated with adding more bulbs in series to the circuit.

.....

..... **[1]**

(ii) Suggest **one** way of making the experiment safer when more bulbs are added in series to the circuit.

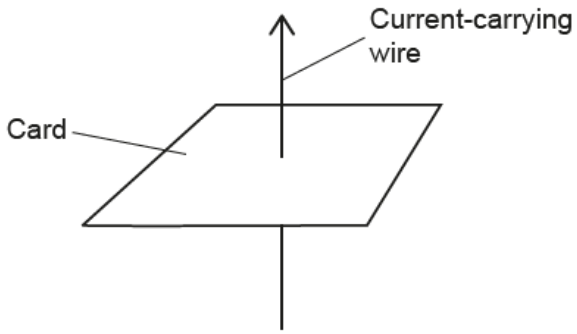
.....

..... **[1]**

3. Nov 2020/Paper_J260/03/No.3

The diagram shows a vertical wire passing through a horizontal piece of card.

There is a current flowing through the wire in the direction of the arrow.



(a) Sundip plots the magnetic field around the current-carrying wire, on the card.

Describe the pattern and direction of the magnetic field.

Your description can be shown on the diagram.

.....

.....

..... **[3]**

(b) Sundip places an iron pin on the card.

The iron pin experiences a magnetic force, which is caused by the magnetic field around the current-carrying wire.

How can Sundip increase the effect of the magnetic field on the pin?

Tick (✓) **two** boxes.

Heat the wire. ☐

Increase the current in the wire. ☐

Increase the resistance of the wire. ☐

Move the card higher up the wire. ☐

Move the pin closer to the wire. ☐

[2]

4. Nov 2020/Paper_J260/03/No.12

Sarah is investigating two circuit components.

She changes the potential difference across each component and measures the current through each component.

The table shows her results for **component A**.

Component A	
Potential difference (V)	**Current (mA)**
–2.0	–12
–1.5	–9
–0.8	–5
0	0
0.5	3
0.9	5
1.4	8
1.8	11

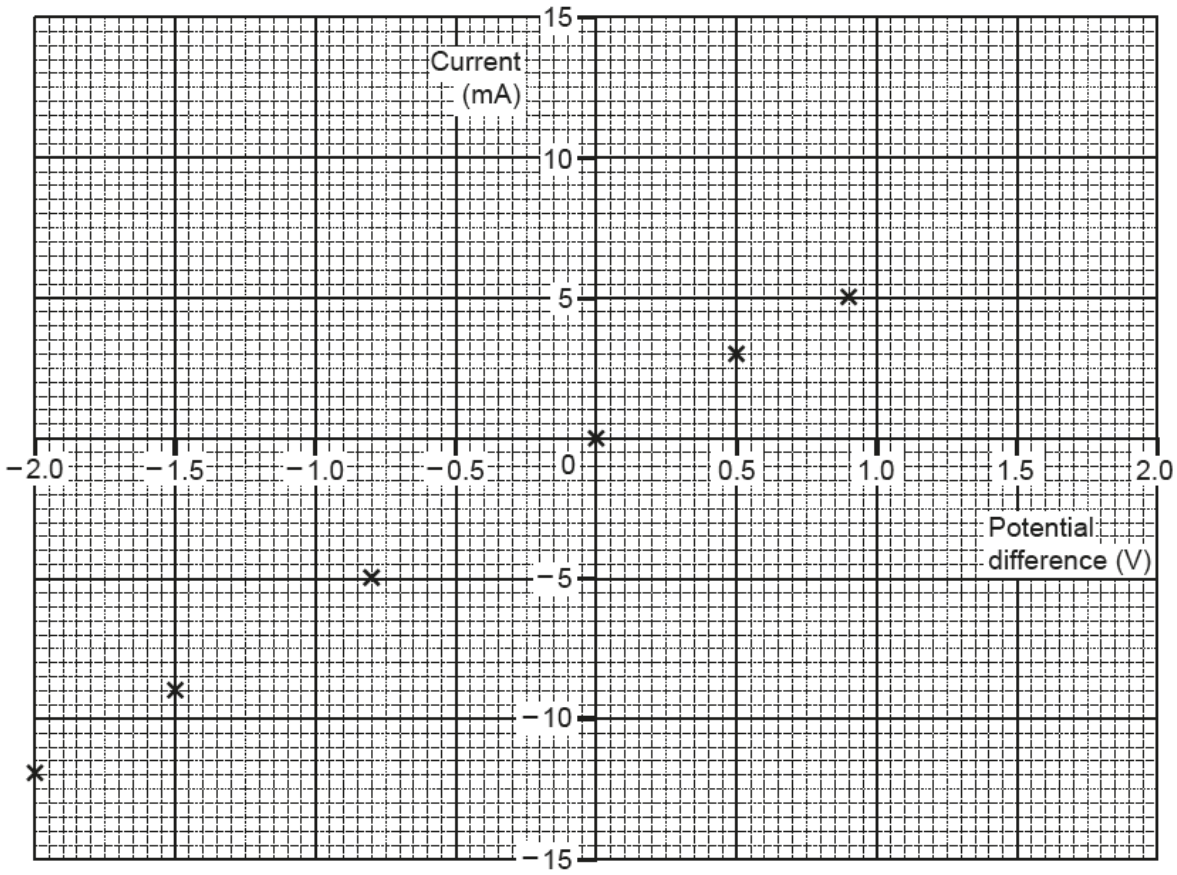


Fig. 12.1

(a) (i) Complete the graph in **Fig. 12.1** by plotting the remaining **two** points from the table. **[1]**

(ii) Draw a line of best fit on the graph in **Fig. 12.1**. **[1]**

(iii) Describe the relationship between current and potential difference for **component A**.

.....

..... **[1]**

(iv) Suggest what **component A** could be.

..... **[1]**

(v) Calculate the resistance of **component A** when the potential difference across it is 2.0 V.

Use data from the graph in **Fig. 12.1**.

Use the equation: potential difference = current × resistance

Resistance = ... Ω **[4]**

(b) **Fig. 12.2** shows the graph of Sarah's results for **component B**.

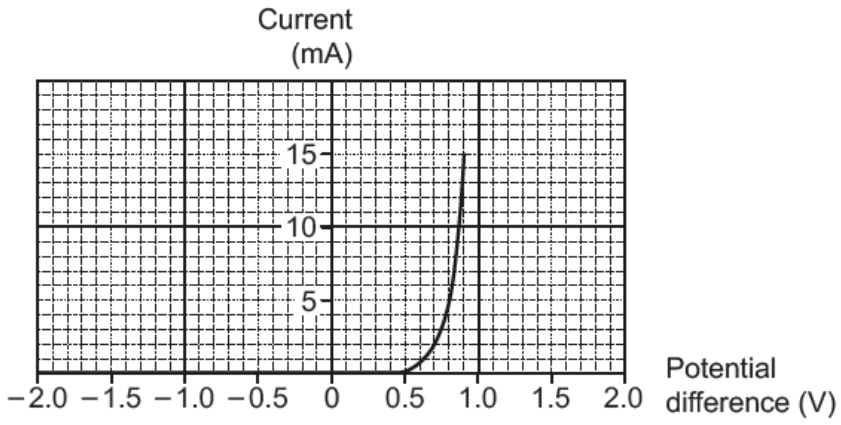


Fig. 12.2

(i) Describe what happens to the current as the potential difference changes for **component B**.

.....

..... **[1]**

(ii) Suggest what **component B** can be used for in a circuit.

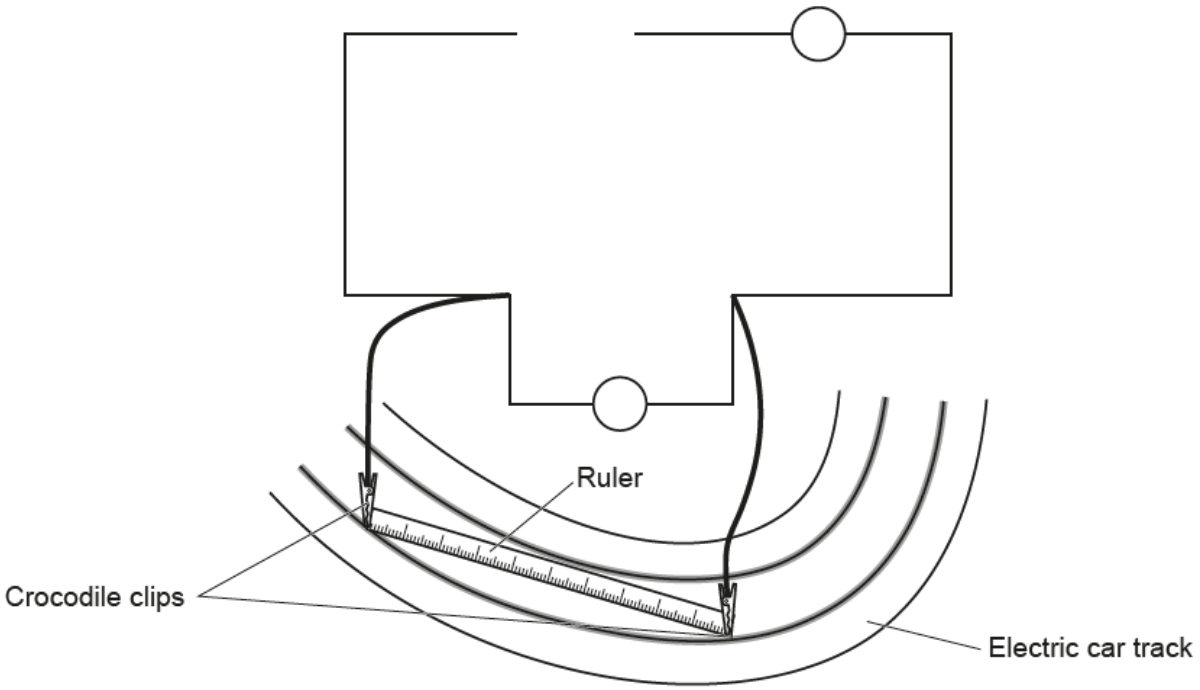
.....

..... **[1]**

5. Nov 2020/Paper_J260/04/No.5

(a) Beth is investigating how changing the length of a wire affects its resistance.

(i) Complete the circuit diagram to show how Beth can investigate the resistance of a wire inside a section of an electric car track.



[3]

(ii) Beth calculates the resistance of different lengths of the section of track, and her results are shown in the table.

Length of section of track (cm)	Resistance (Ω)
10	2.5
20	5.0
30	7.5
40	10.0
50	12.5

What can be concluded from Beth's results?

Use the data in the table to support your answer.

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.....

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..... **[2]**

(iii) Calculate the current in the circuit when there is a potential difference of 3.0 V across 50 cm of track.

Use the equation: potential difference = current × resistance

Current = ... A **[2]**

(b) Beth makes three changes to the investigation to improve it.

Draw lines to connect each change in the investigation with its correct improvement.

Change in investigation	Improvement
Adding a switch to the circuit	Greater accuracy of measurement
Only using straight sections of track	Increases the precision
Taking several readings at each track length	Reduces the risk of overheating

[2]

6. Nov 2021/Paper_J260/07/No.4

Ben does an experiment to investigate the I-V characteristics of a thermistor.

(a) Draw a circuit diagram in the box that can be used for this experiment.

[4]

(b) Describe a method Ben can use to collect the data for his investigation.

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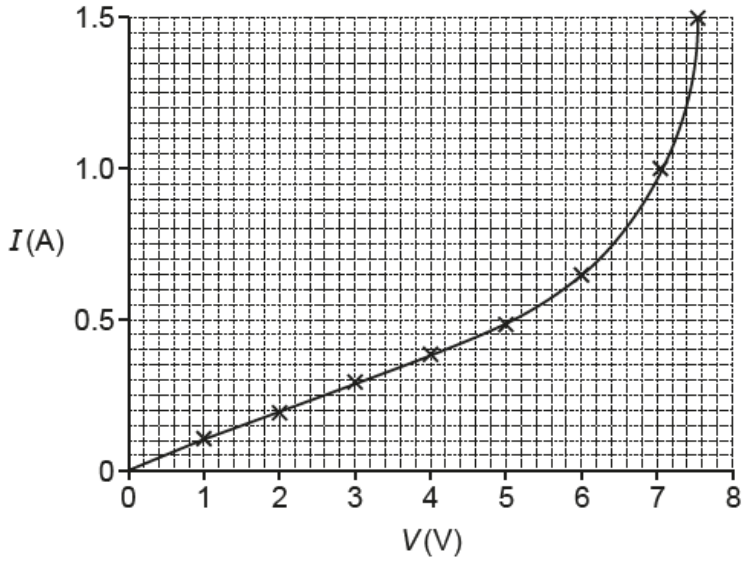
..... **[3]**

(c) Ben plots a graph of his results, as shown.



Explain what the graph shows about the **resistance** of the thermistor as the potential difference changes.

You do **not** need to do any calculations.

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..... **[4]**

7. Nov 2021/Paper_J260/07/No.7(b, c)

(b) A motor makes the mirror ball rotate. Motors use magnets and current-carrying conductors.

Fig. 7.2 shows a current-carrying conductor between the poles of a magnet.

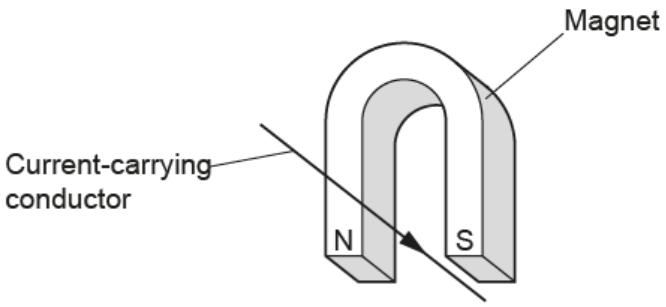

Fig. 7.2

(i) Add an arrow to **Fig. 7.2** showing the direction of the force on the current-carrying conductor. **[1]**

(ii) Describe how you worked out the direction. You may use a diagram.

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.....

.....

..... **[2]**

(c) **Fig. 7.3** shows part of an electric motor.

It has a rectangular coil of current-carrying wire between two magnetic poles.

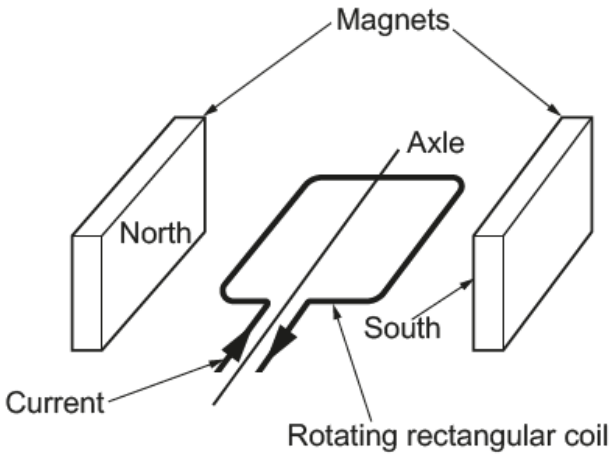

Fig. 7.3

Forces acting on the rectangular coil cause it to rotate around the axle.

Explain how the forces on the rectangular coil cause the coil to rotate until it is vertical.

You can add to the diagram.

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.....

..... **[2]**

8. Nov 2020/Paper_J260/07/No.2

Sarah is investigating two circuit components.

She changes the potential difference across each component and measures the current through each component.

The table shows her results for **component A**.

Component A	
Potential difference (V)	**Current (mA)**
–2.0	–12
–1.5	–9
–0.8	–5
0	0
0.5	3
0.9	5
1.4	8
1.8	11

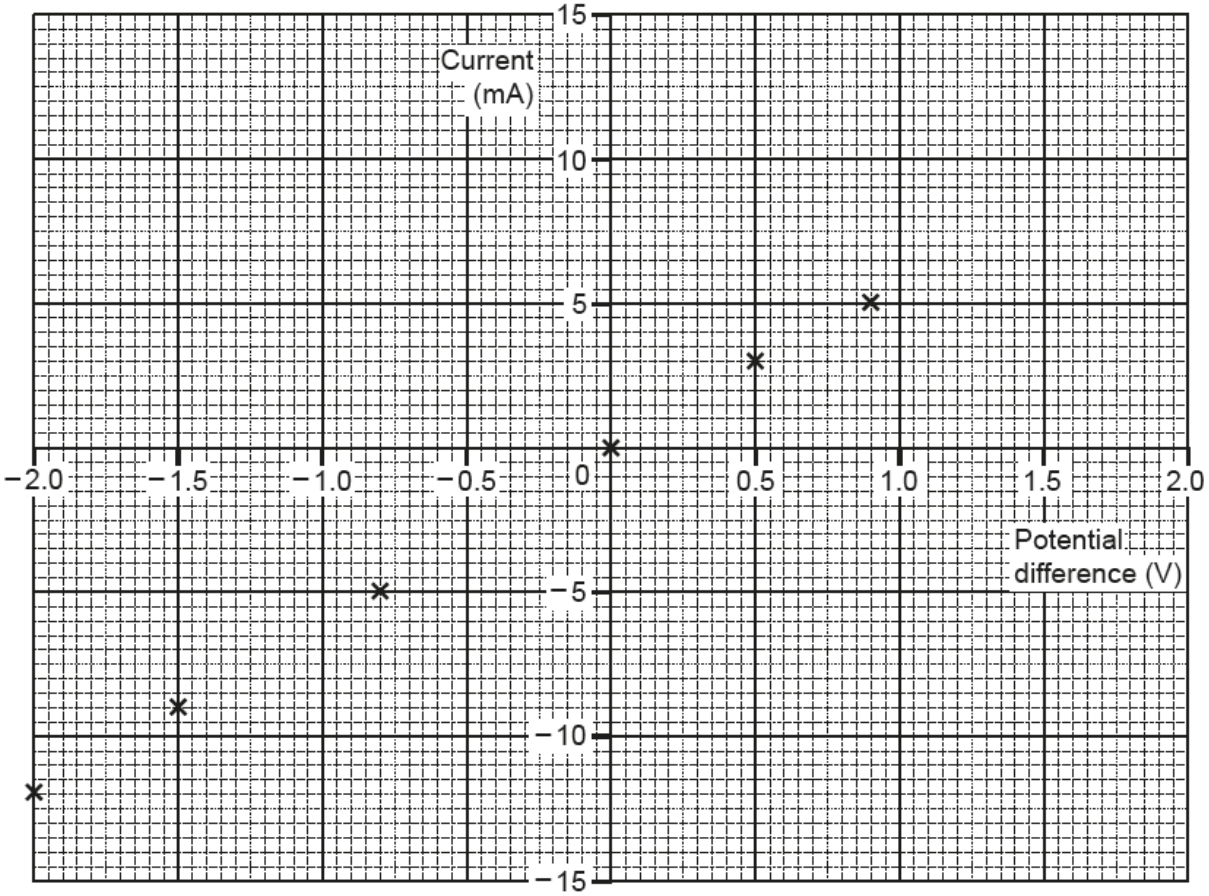

Fig. 2.1

(a) (i) Complete the graph in **Fig. 2.1** by plotting the remaining **two** points from the table. **[1]**

(ii) Draw a line of best fit on the graph in **Fig. 2.1**. **[1]**

(iii) Describe the relationship between current and potential difference for **component A**.

.....

..... **[1]**

(iv) Suggest what **component A** could be.

..... **[1]**

(v) Calculate the resistance of **component A** when the potential difference across it is 2.0 V.

Use data from the graph in **Fig. 2.1**.

Use the equation: potential difference = current × resistance

Resistance = ... Ω **[4]**

(b) **Fig. 2.2** shows the graph of Sarah's results for **component B**.

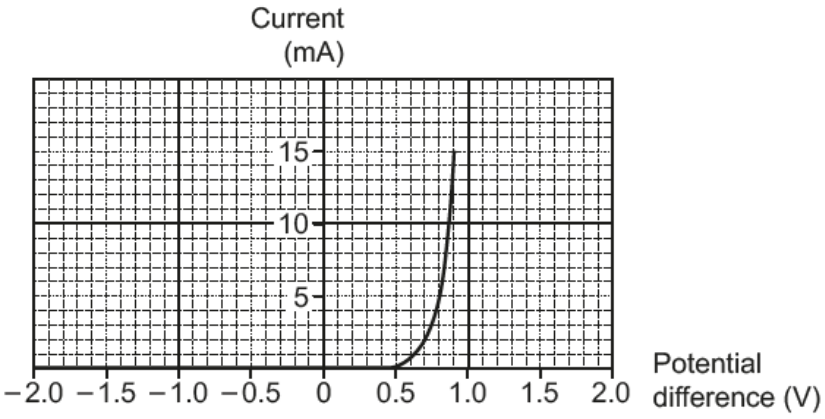

Fig. 2.2

(i) Describe what happens to the current as the potential difference changes for **component B**.

.....

..... **[1]**

(ii) Suggest what **component B** can be used for in a circuit.

.....

..... **[1]**

9. Nov 2020/Paper_J260/07/No.6

Kai investigates series and parallel circuits.

(a) Kai makes two different circuits, as shown in **Fig. 6.1**. He uses identical resistors, ammeters, voltmeters and batteries.

The resistance of all 4 resistors is the same: $R_A = R_B = R_C = R_D$

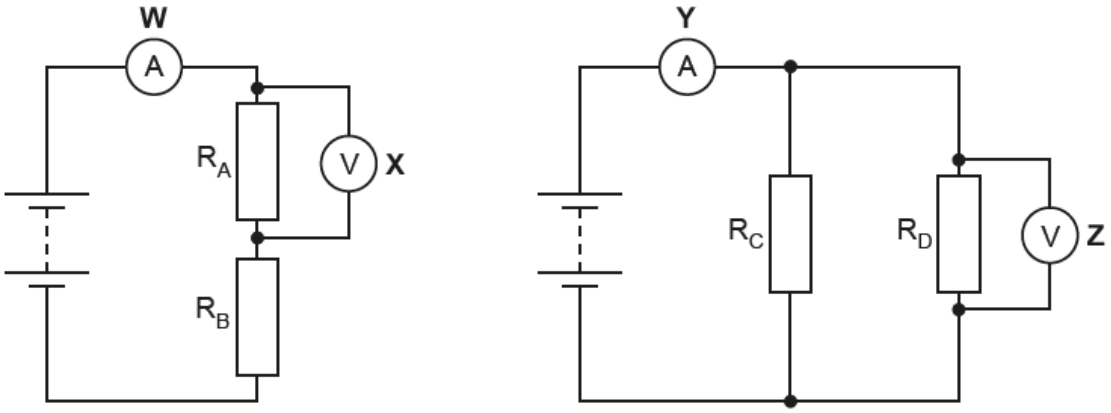

Fig. 6.1

(i) Complete the sentences below about the two circuits.

Put a (ring) around the correct choice to complete each sentence.

The current at **W** is **equal to** / **higher** / **lower** than the current at **Y**.

The potential difference measured by voltmeter **X** is **equal to** / **higher** / **lower** than the potential difference measured by voltmeter **Z**. **[2]**

(ii) Kai replaces resistor $\mathbf{R_A}$ with another resistor that has much **smaller** resistance.

Describe what happens to the current measured by ammeter **W** and the potential difference measured by voltmeter **X**.

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.....

.....

..... **[2]**

(b) **Fig. 6.2** shows the circuit diagram for an LED torch.

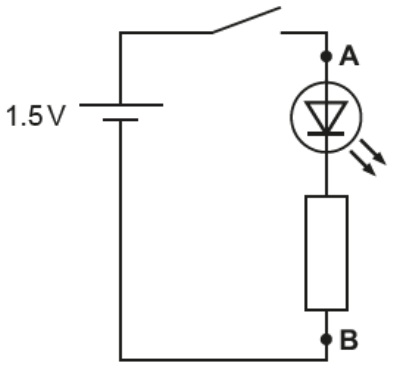


Fig. 6.2

The potential difference between points **A** and **B** is 1.5 V.

How much work is done moving 300 mC of charge from **A** to **B**?

Work done = ... J **[4]**

10. Nov 2020/Paper_J260/07/No.11

Beth investigates forces and magnetic fields.

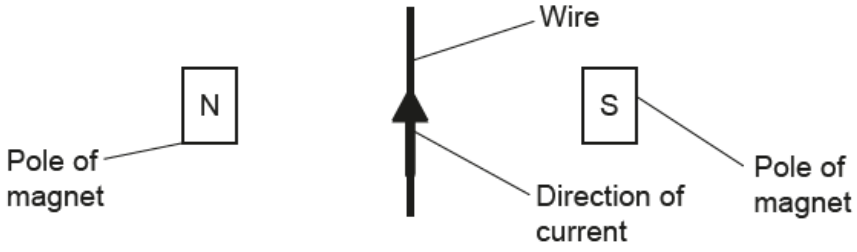
(a) State Newton's third law.

.....

..... **[1]**

(b) Beth places a wire between the poles of a magnet.

The diagram shows a view of the poles of the magnet and the wire from above.



Explain what happens to the wire when a current flows through it.

Use ideas about magnetic fields and forces in your answer.

You may draw on the diagram to support your answer.

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.....

.....

..... **[3]**

(c) When Beth sets the current in the wire to 5.6 A there is a force of 0.072 N on the wire. The wire has a length of 0.45 m.

Calculate the magnetic flux density.

Use the Data Sheet.

Give your answer in **standard form** and to **2** significant figures.

Magnetic flux density = ... T **[4]**

11. Nov 2020/Paper_J260/08/No.3

(a) Layla is investigating **two** fixed resistors.

She sets up an electrical circuit with a 9 V battery to calculate the resistance of each resistor **separately**.

Draw a circuit diagram of this electrical circuit in the box.

[3]

(b) Layla says that placing the two resistors in parallel should give the same total resistance in the circuit as placing them in series.

Is Layla correct?

Yes ☐ No ☐

Explain your answer.

.....

.....

.....

..... **[2]**

(c) Layla calculates that the resistance of each resistor is 100 Ω.

(i) Calculate the total resistance in Layla's circuit when the two resistors are connected in series.

Total resistance in series = ...Ω **[1]**

(ii) Estimate the total resistance in Layla's circuit when the two resistors are connected in parallel.

Estimated total resistance in parallel = ...Ω **[1]**

(d) Layla replaces the old motor in a 12 V electric toy car with a new motor, as shown in the diagram.

She also has access to four different resistors, 10 Ω, 12 Ω, 16 Ω, and 20 Ω.

What is the minimum size resistor that Layla needs to put into the series circuit of the electric toy car to avoid the new motor overheating and breaking?

Resistor = ... Ω **[3]**