Electrical circuits – 2021/20 GCSE 21st Physics B

1. Nov 2021/Paper_J259/01/No.2

Nina is a mountain climber.

(a) Calculate the increase in her stored gravitational energy when she climbs a mountain which has a vertical height of 750 m.

Her mass is 70 kg.

Gravitational field strength = 10 N / kg.

Use the equation: gravitational potential energy = mass × gravitational field strength × height

Gravitational potential energy = ...J **[2]**

(b) **(i)** What is the useful energy store in Nina's muscles **before** she climbs the mountain?

Tick (✓) **one** box.

- Chemical energy store ☐
- Elastic energy store ☐
- Electromagnetic energy store ☐
- Gravitational energy store ☐

[1]

(ii) Nina returns to her starting point at the bottom of the mountain and stops.

Which **two** energy stores have increased when Nina reaches the bottom of the mountain and stops?

Tick (✓) **two** boxes.

- Gravitational energy store in Nina's body ☐
- Elastic energy store in the surroundings ☐
- Nuclear energy store in the surroundings ☐
- Thermal energy stored in Nina's body ☐
- Thermal energy stored in the surroundings ☐

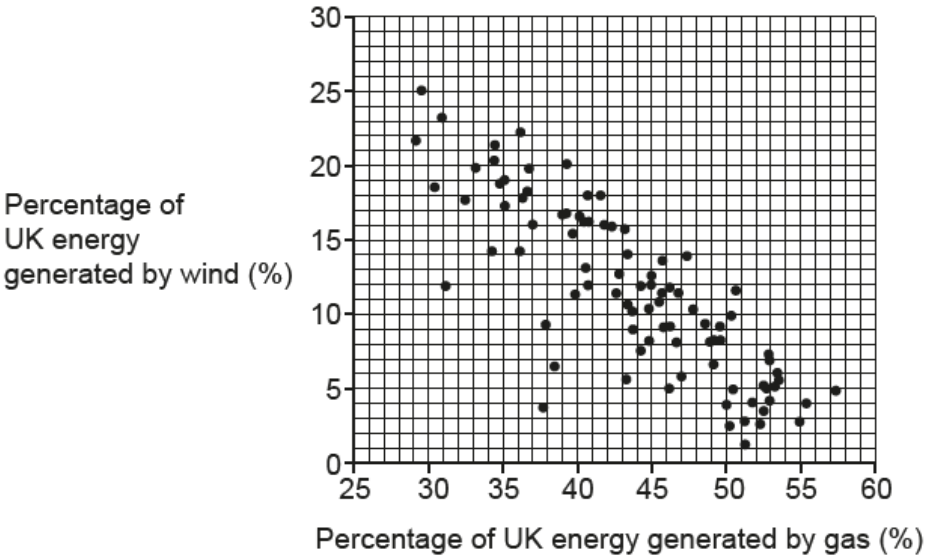
[2]

2. Nov 2021/Paper_J259/01/No.13

A large percentage of electricity in the UK is generated using wind turbines and gas-fired power stations.

The graph compares the percentage of UK energy generated by wind and gas from January to March 2017.

Each plot point shows the energy generated in one day.



(a) Describe and explain the relationship shown in the graph.

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

3. Nov 2021/Paper_J259/02/No.4

Jane has a dimmer switch in her bedroom that allows her to change the brightness of a lamp.

She investigates how the dimmer switch changes the brightness of the lamp. She builds the circuit in **Fig. 4.1**.

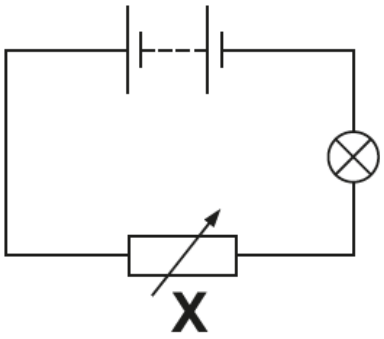

Fig. 4.1

(a) (i) What is the name of the component labelled **X** in **Fig. 4.1**?

Tick (✓) **one** box.

Thermistor ☐

Variable Resistor ☐

Fixed Resistor ☐

[1]

(ii) The potential difference across the lamp is 3.6 V. The current in the circuit is 0.75 A.

Calculate the resistance of the lamp.

Resistance = ... Ω **[3]**

(b) Jane has an electric clock with an illuminated display. The display is designed to be dimmer when the room is dark.

She replaces component **X** in **Fig. 4.1** with a Light Dependent Resistor (LDR) to investigate her electric clock.

The new circuit is shown in **Fig. 4.2**.

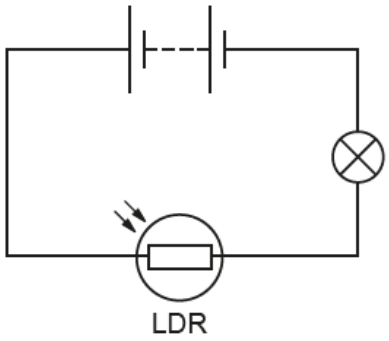

Fig. 4.2

(i) Jane wants to make measurements to calculate the resistance of the LDR in the circuit in **Fig. 4.2**.

What **two** components does Jane need to add to the circuit in **Fig. 4.2**?

Component 1 .....

Component 2 .....

[2]

4. Nov 2021/Paper_J259/02/No.9(a)

Electromagnets are used in scrap metal yards to pick up and move scrap metal.

(a) Amaya builds an electromagnet in the school lab, as shown in **Fig. 9.1**.

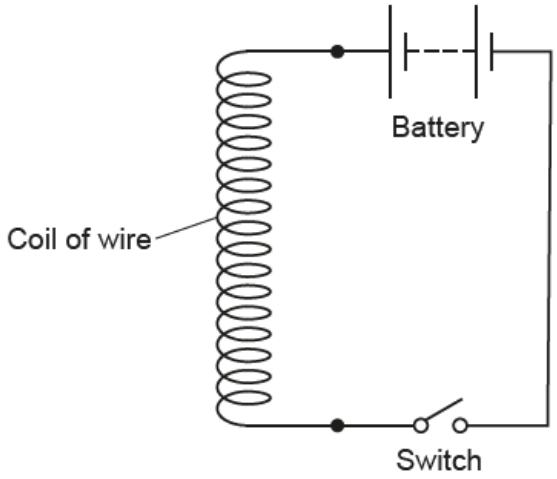

Fig. 9.1

(i) When the switch is closed a current flows in the circuit and creates a magnetic field around the coil of wire.

Describe how to investigate the pattern of the magnetic field.

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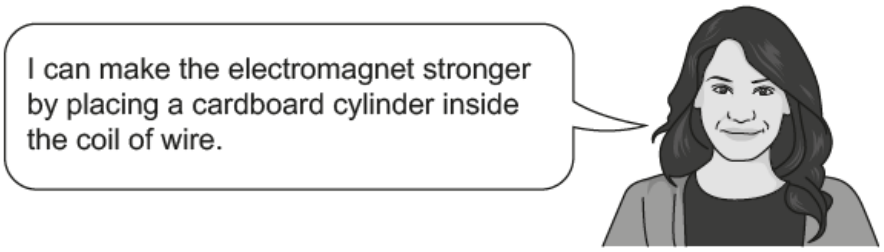
..... **[2]**

(ii) Amaya makes the following suggestion about the electromagnet.



Explain why Amaya is wrong.

Include **one** correct way of making the electromagnet stronger in your answer.

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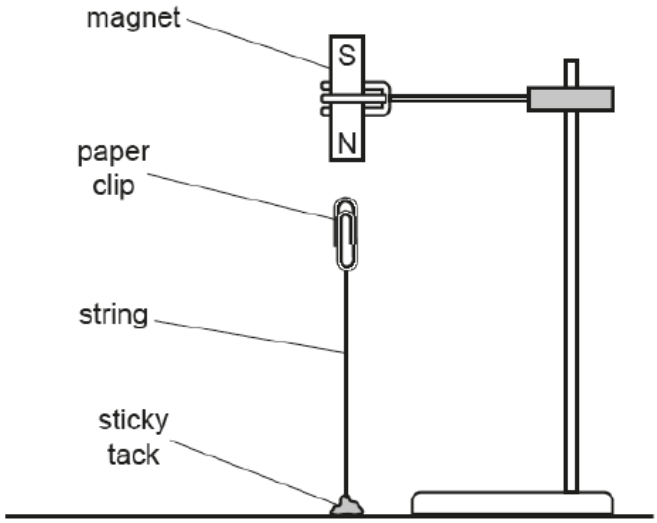
..... **[2]**

5. Nov 2020/Paper_J259/01/No.7

Sarah's teacher demonstrates some examples of forces.

She sets up the equipment shown below.



(a) One of the forces acting on the paper clip is the attractive force of the magnet.

Name **two** other forces acting on the paper clip.

1 .....

2 .....

[2]

(b) Sarah's teacher says that forces always act in pairs.

The magnet provides a force of attraction which acts upwards on the paper clip.

Describe the other force in this pair.

.....

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

(c) The teacher cuts the thread.

(i) Predict what will happen to the paper clip.

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

(ii) Give **one** reason for your answer to **(c)(i)**.

.....

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

6. Nov 2020/Paper_J259/02/No.2

Jamal does an investigation to see how two bar magnets behave when they are brought close to each other.

Fig. 2.1 shows how the two bar magnets are arranged.

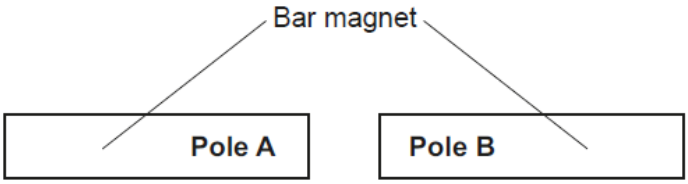


Fig. 2.1

(a) The table shows the possible positions of the north and south poles for the two bar magnets.

Complete the table to show the expected results for the investigation.

Use words from the list.

You may use each word once, more than once or not at all.

Attract **No effect** **Repel**

The first one has been done for you.

Pole A	Pole B	Expected Result
N	S	Attract
N	N	.....
S	S	.....
S	N	.....

[2]

(b) **Fig. 2.2** shows the magnetic field around a bar magnet.

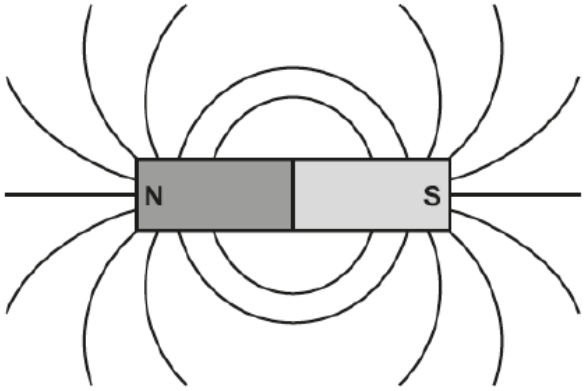


Fig. 2.2

(i) Draw **four** arrows on **Fig. 2.2** to show the direction of the magnetic field around the bar magnet. **[1]**

(ii) Complete the sentence about Jamal's observations.

Use words from the list.

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

stronger **weaker** **closer together** **further apart**

Jamal observes that when the two bar magnets are attracted to one another, the magnetic force of attraction near the poles is ....., because this is where the magnetic field lines are ..... . **[2]**

(c) Which statement about magnetism is correct?

Tick (✓) **one** box.

An induced magnet loses its magnetism when removed from a magnetic field.	☐
A permanent magnet loses its magnetism when removed from a magnetic field.	☐
Induced magnets produce their own magnetic field.	☐
Permanent magnets do **not** produce their own magnetic field.	☐

[1]

7. Nov 2020/Paper_J259/02/No.6

Amaya builds an electrical circuit to investigate the relationship between current and potential difference for a fixed resistor.

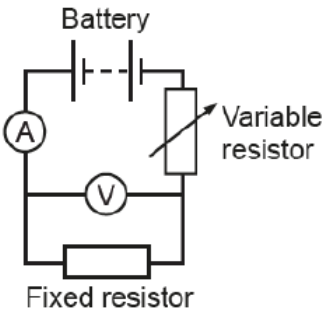


Fig. 6.1 shows Amaya's results for the fixed resistor.

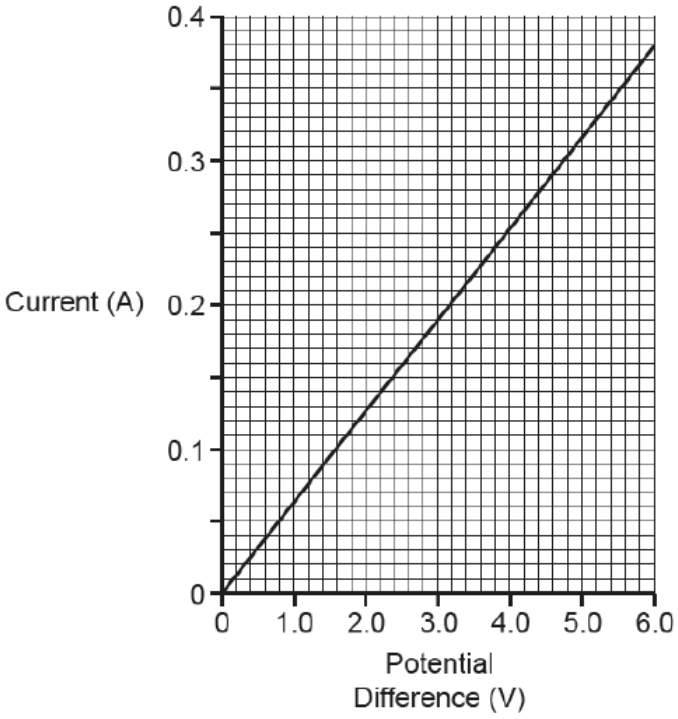


Fig. 6.1

(a) Calculate the resistance of the fixed resistor.

Use the equation: resistance = potential difference ÷ current

Show your working on **Fig. 6.1**.

Give your answer to **1** decimal place and the **unit** for resistance.

Resistance = ... Unit ..... **[4]**

(b) Amaya repeats the investigation, but replaces the fixed resistor with a filament lamp.

Her results are shown in **Fig. 6.2**.

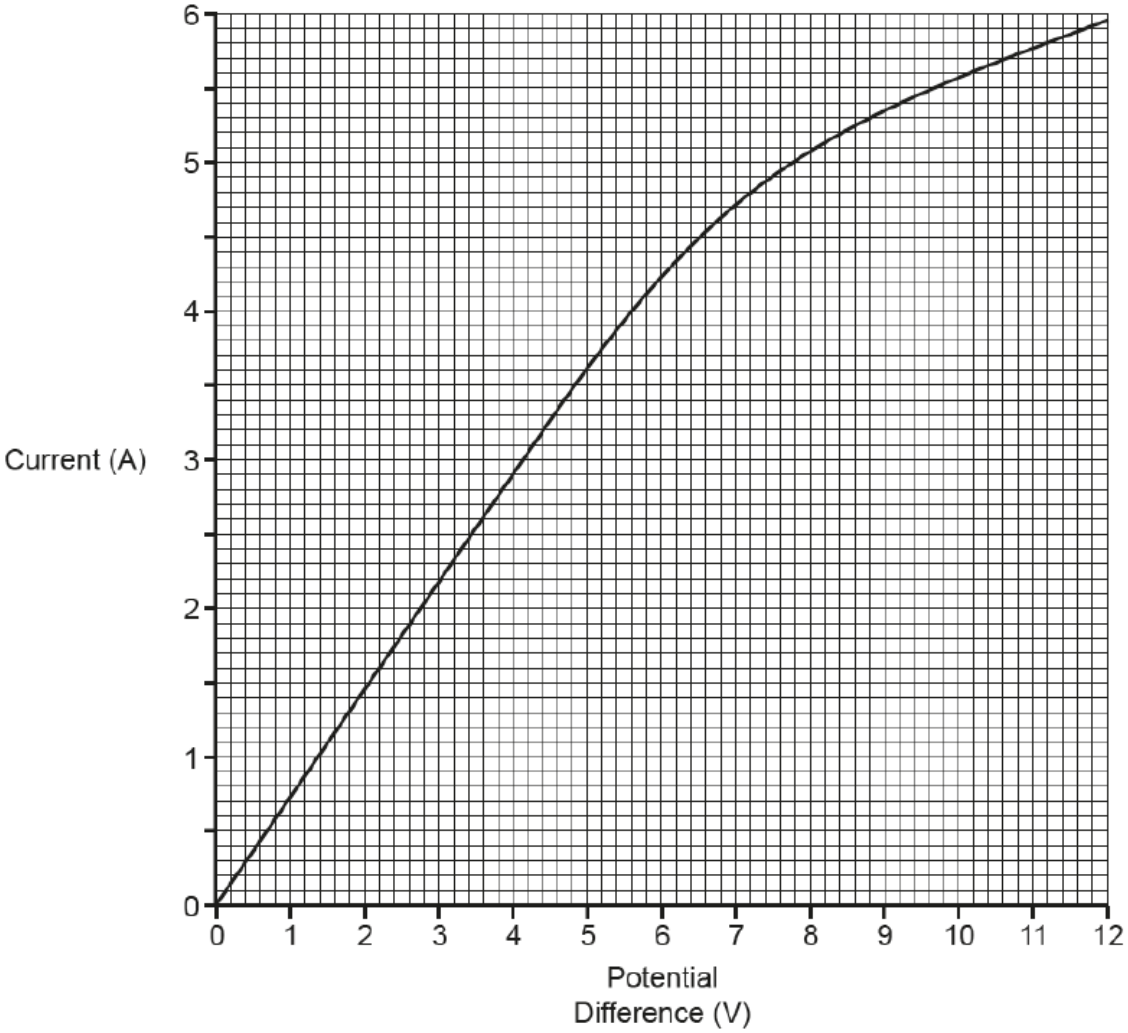
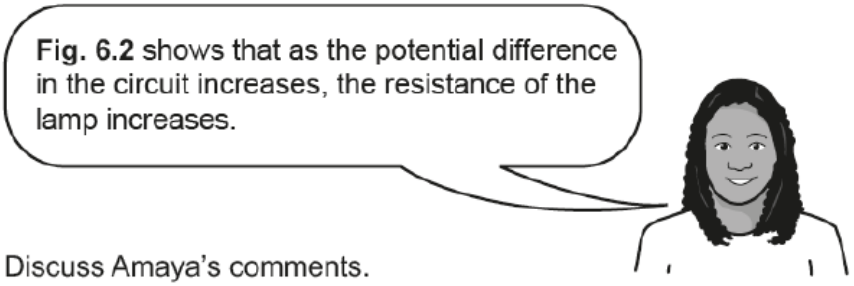


Fig. 6.2

Amaya says:



Discuss Amaya's comments.

Use **Fig. 6.2** to support your answer.

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

8. Nov 2021/Paper_J259/03/No.6

This question is about X-rays.

(a) Give **two** examples of practical uses of X-rays

1. .....

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2. .....

.....

[2]

(b) X-rays are produced by firing electrons at a metal target in a high-voltage electrical circuit.

When the electrons hit the metal target, their kinetic energy is converted into X-rays.

(i) Calculate the work done on an electron when it moves across a potential difference of 50 000 V.

The charge on an electron is 1.6×10^{-19} C.

Work done = ... J **[3]**

(ii) Suggest how the energy of the X-rays could be increased.

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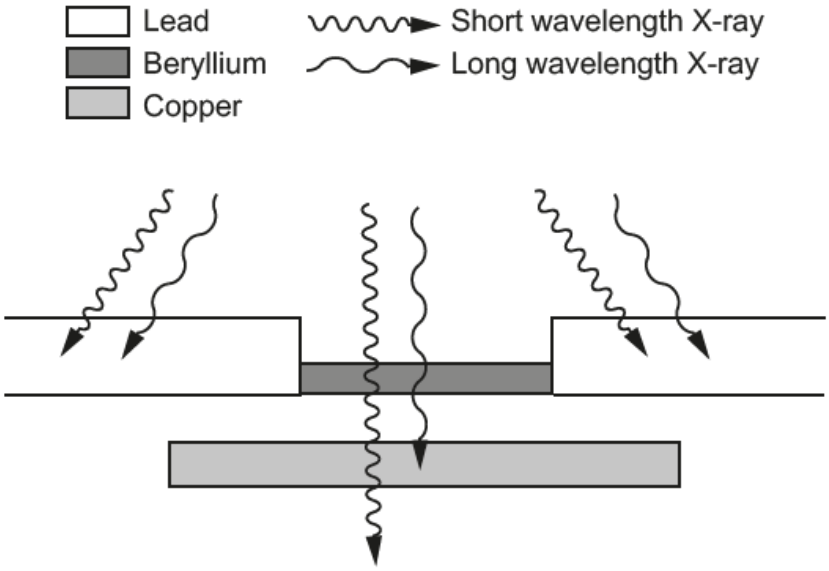
..... **[1]**

(c) An X-ray machine contains lead, beryllium, and copper, as shown in the diagram.



Describe how X-rays of different wavelengths are affected by the three different materials.

Use the diagram to support your answer.

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

9. Nov 2021/Paper_J259/04/No.3

Ling does an experiment to determine the I-V characteristics of an NTC thermistor. She builds the circuit in **Fig. 3.1**.

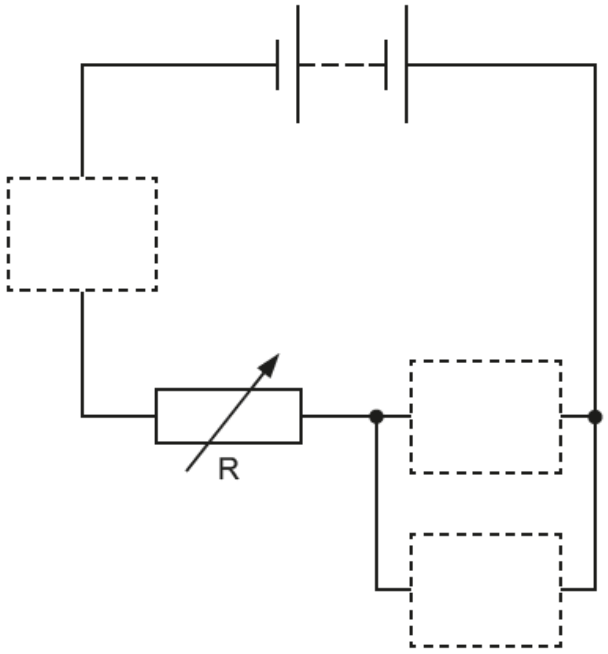

Fig. 3.1

(a) (i) Draw the correct circuit symbols inside the dotted boxes in **Fig. 3.1** to complete the circuit. **[2]**

(ii) Explain how the current changes when the temperature of the thermistor increases.

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

(b) Ling plots a graph of her results, as shown in **Fig. 3.2**.

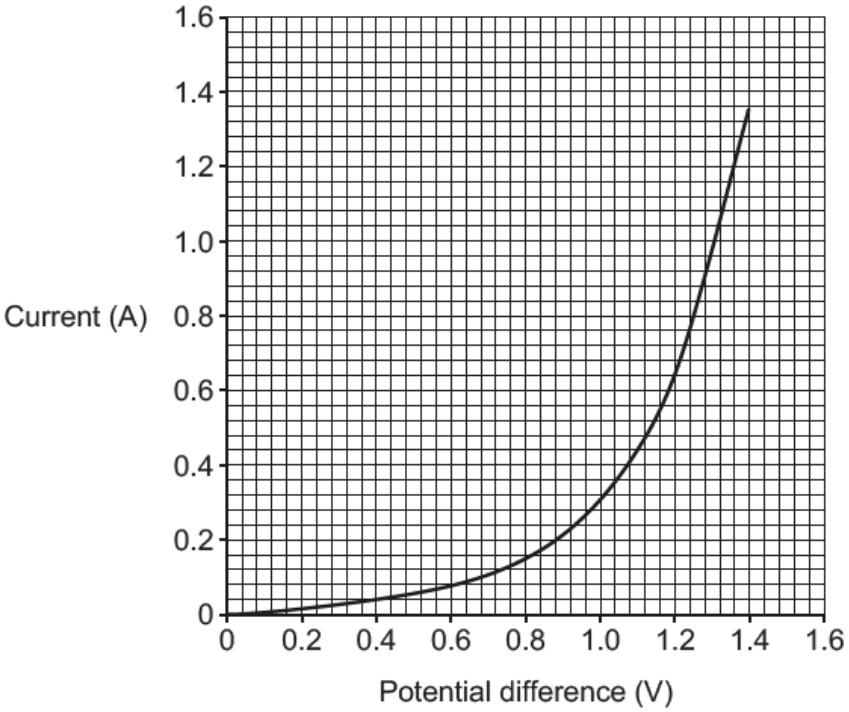


Fig. 3.2

Calculate the difference in the resistance of the thermistor when the potential difference is increased from 0.4 V to 1.2 V, using **Fig. 3.2**.

Give the **unit** of resistance.

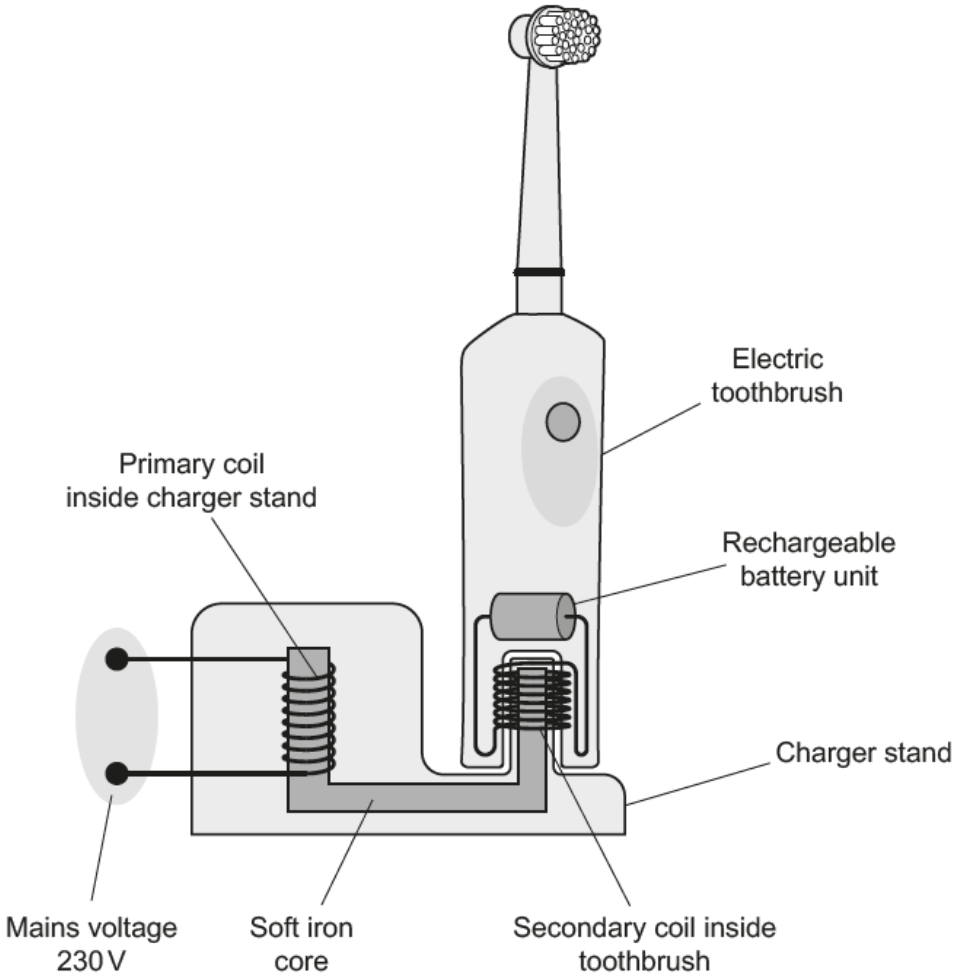
Use the equation: potential difference = current × resistance

Difference in resistance = ... unit ..... **[4]**

10. Nov 2021/Paper_J259/04/No.4

Sam has an electric toothbrush.

The diagram shows the inside of the charger stand and electric toothbrush.
There is a transformer in the charger stand that charges a rechargeable battery unit inside the toothbrush.



(a) When the charger stand is plugged in, the primary coil is connected directly to the mains voltage of 230 V.

The secondary coil inside the toothbrush sits over the iron core when the battery is charging.

(i) Explain how the battery inside the toothbrush can charge on the charger stand.

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

(ii) When the battery is charging the current in the primary coil is 0.25A and the potential difference across the battery is 20 V.

Calculate the current in the secondary coil.

Use the Data Sheet.

Current = ... A **[3]**

(b) Calculate the ratio of the number of turns in the primary coil to the number of turns in the secondary coil.

Use the Data Sheet.

Ratio = ... **[3]**

11. Nov 2021/Paper_J259/04/No.9

Fig. 9.1 shows an alternating current (a.c.) generator being used to power a bulb.

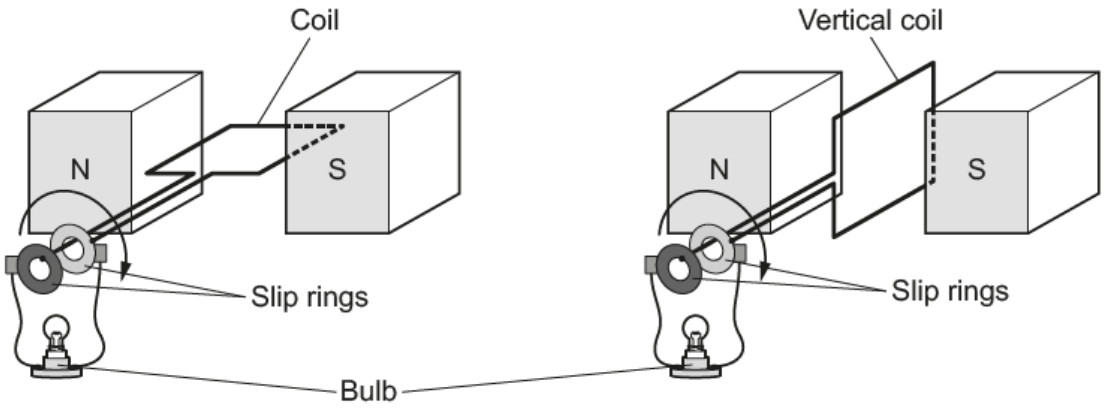

Fig. 9.1

When the coil rotates an alternating potential difference is induced across the ends of the coil as shown in **Fig. 9.2**.

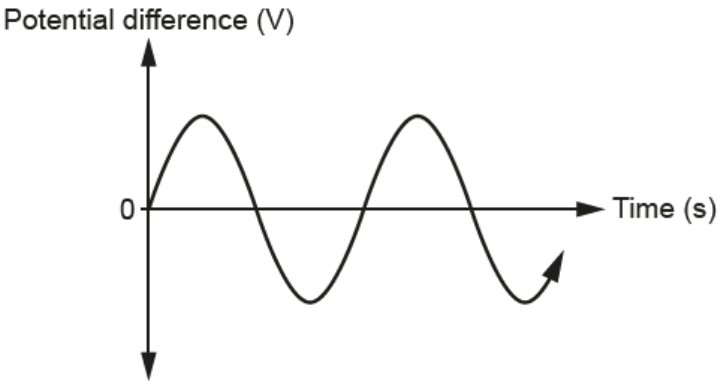

Fig. 9.2

(a) The bulb flashes on and off.
As the coil passes through the vertical position the bulb is off.

Explain why.

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.....

.....

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

(b) The coil is rotated at a faster speed.

Suggest **two** changes this will have on the bulb.

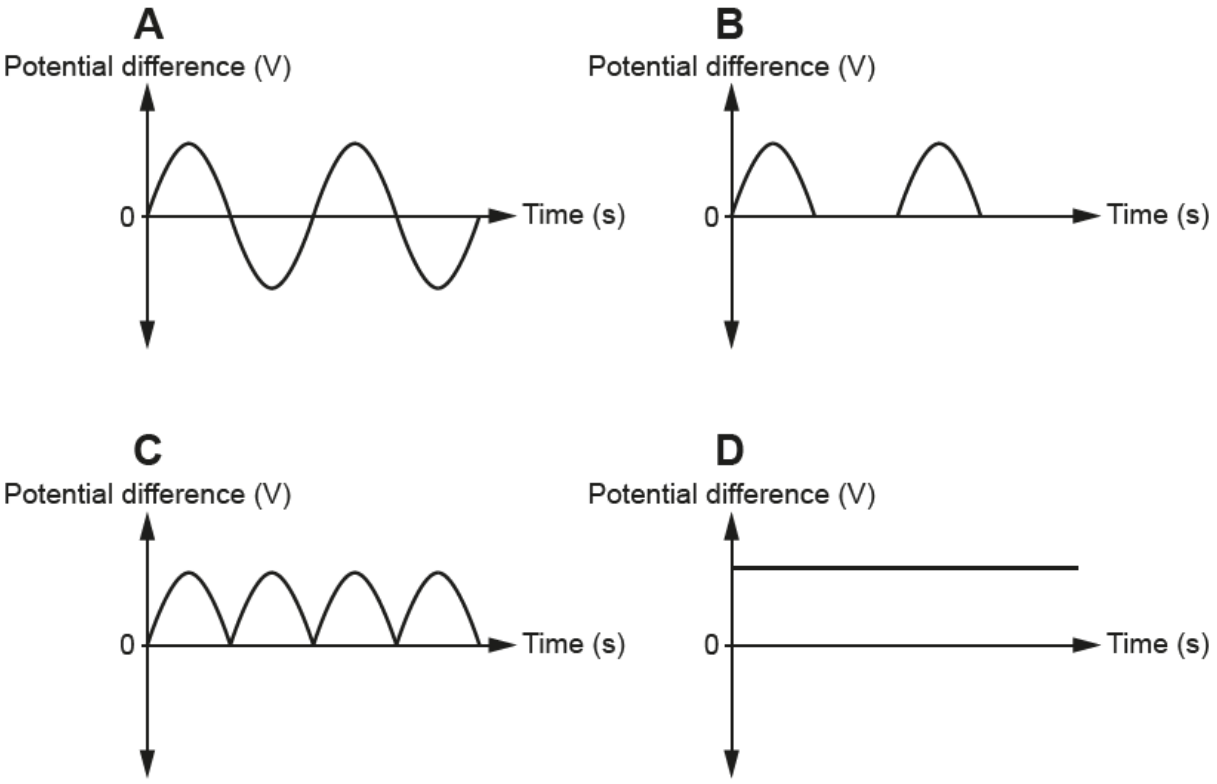
1. .....

2. .....

[2]

(c) The slip rings shown in **Fig. 9.1** are replaced by a split-ring commutator.

Which graph **A**, **B**, **C** or **D** shows the potential difference that will now be generated across the bulb?



Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

(d) A moving coil microphone can be made by attaching a diaphragm to a coil which is in the field of a permanent magnet, as shown in **Fig. 9.3**.

The microphone produces a changing current when a soundwave is incident on the diaphragm.

The coil is connected to a zero centre ammeter, which can show zero, positive, or negative current flowing.

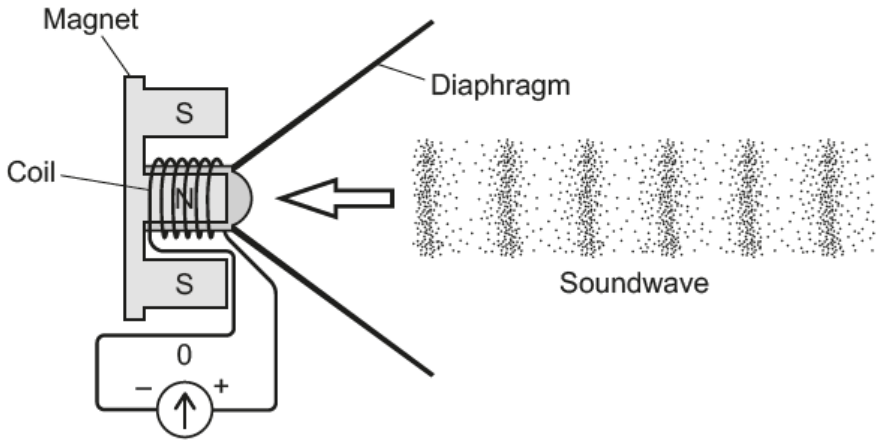


Fig. 9.3

(i) Describe the motion of the particles in a soundwave.

.....

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

(ii) When the soundwave has a high frequency the changing current that is produced also has a high frequency.

Explain how the microphone produces a current from a soundwave with a high frequency.

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

12. Nov 2020/Paper_J259/04/No.5

Amaya sets up the circuit in **Fig. 5.1** to investigate an electrical scent burner.

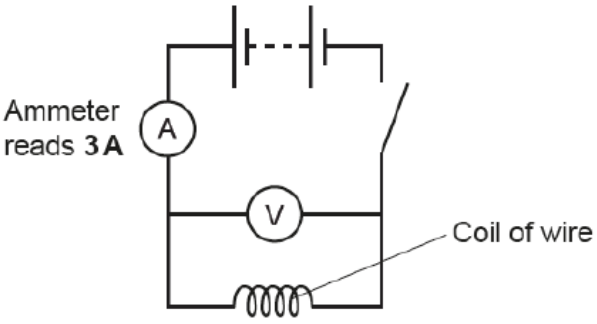


Fig. 5.1

(a) What is needed for a current to flow in any circuit?

Tick (✓) **two** boxes.

Ammeter	☐
Closed Circuit	☐
Filament Lamp	☐
Potential Difference	☐
Switch	☐
Voltmeter	☐

[1]

(b) **(i)** Calculate the charge flowing through the ammeter when the switch is closed for 2 minutes, using **Fig. 5.1**.

Give the correct **unit**.

Charge = ... Unit ..... **[4]**

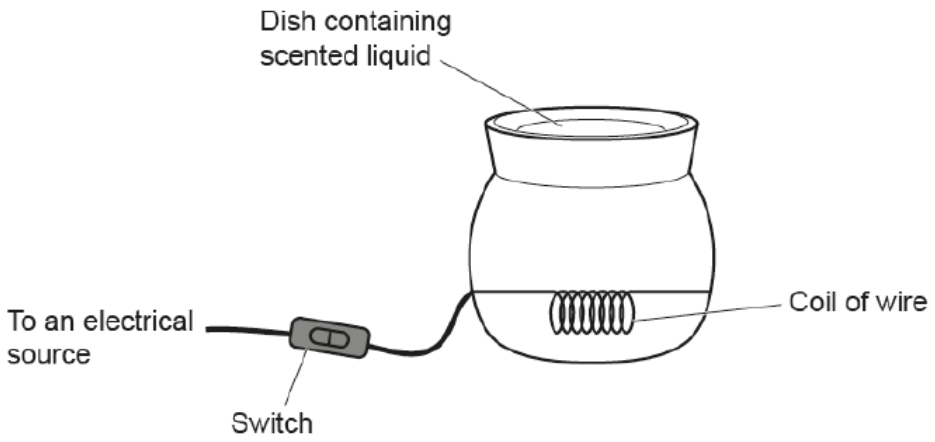
(ii) When the switch is closed for 2 minutes, the work done by the battery on the electrons in the circuit is 2160 J.

Calculate the potential difference across the battery.

Use your answer to **(b)(i)**.

Potential difference = ... V **[3]**

(c) In an electrical scent burner the coil of wire in the circuit heats liquid so it turns into a vapour.



Amaya calculates the resistance for three different lengths of the same wire, using her circuit from **Fig. 5.1**.

Wire	Length (mm)	Resistance (Ω)
A	20	0.18
B	10	0.14
C	5	0.11

Explain which wire, **A**, **B**, or **C**, will have the greatest heating effect in the electrical scent burner.

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.....

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

(d) Amaya wants to investigate the effect of adding another coil of wire connected in parallel.

She sets up the circuit in **Fig. 5.2**.

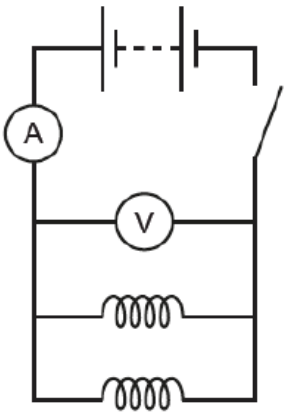
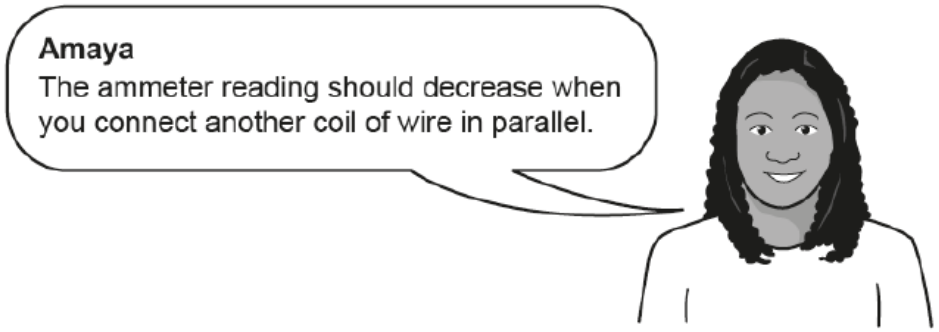


Fig. 5.2



Do you agree with Amaya?

Yes ☐

No ☐

Explain your answer.

.....

.....

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.....

.....

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

13. Nov 2020/Paper_J259/04/No.10(b)

(b) Ben removes the battery shown in **Fig. 10.2** from his mobile phone, and connects the battery directly to the coil of wire.

No sound is produced.

Fig. 10.2

Explain why the direct current supplied by the mobile phone battery does **not** generate a sound from the loudspeaker.

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

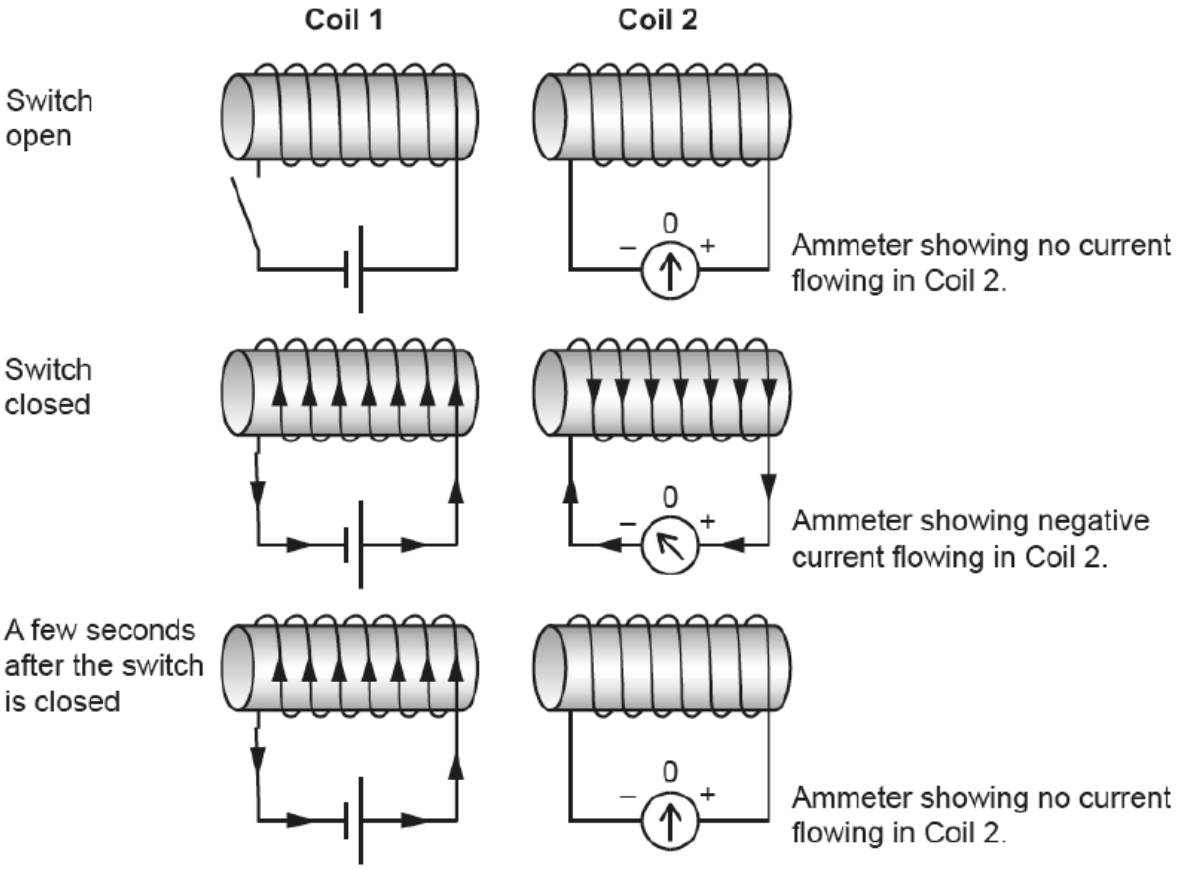
14. Nov 2020/Paper_J259/04/No.11

Eve is investigating electromagnetic induction using two coils of wire that are placed close together.

Coil 1 is connected to a cell and a switch.

Coil 2 is connected to a zero-centre ammeter, which can show zero, positive or negative current flowing.

Eve's observations are shown in the diagrams below.



(a) Explain why negative current flows in Coil 2 when the switch is closed.

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

(b) Explain why no current flows in Coil 2, a few seconds after the switch is closed.

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