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Monday 23 November 2020 – Morning

GCSE (9–1) Physics B (Twenty First Century Science)

J259/04 Depth in physics (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ru er (cm/mm)
- the Data Sheet for GCSE (9–1) Phys cs B (ns de th s document)

You can use:
- a sc ent f c or graph ca ca cu ator
- an HB penc

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J259/04

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

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1 James is an astronomer and he observes light from distant galaxies.

The diagram shows the spectral lines of hydrogen in the visible part of the electromagnetic spectrum, as seen on Earth, and for two galaxies at different distances away from Earth.

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(a) James makes a conclusion from this data.

Complete the sentences to finish James's conclusion.

Use words from the list.

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

further	**nearer**	**more**	**less**	**red**	**blue**
wavelength	**frequency**	**faster**	**slower**		

The ..... away the galaxies are from Earth, the .....

the spectral lines are shifted towards the ..... end of the spectrum.

This suggests that the ..... of the light coming from galaxies further away is stretched. I can conclude that more distant galaxies must be moving away from the Earth ....., than galaxies that are closer to Earth, which suggests that the universe is expanding.

[4]

(b) James discovers a new galaxy and writes an article about it in a scientific journal.

Before it is published it must be peer reviewed.

Explain why and how the article is **peer reviewed**.

Why .....

.....

How .....

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

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2 Electricity is transferred from power stations to consumers by the National Grid, as shown in **Fig. 2.1**.

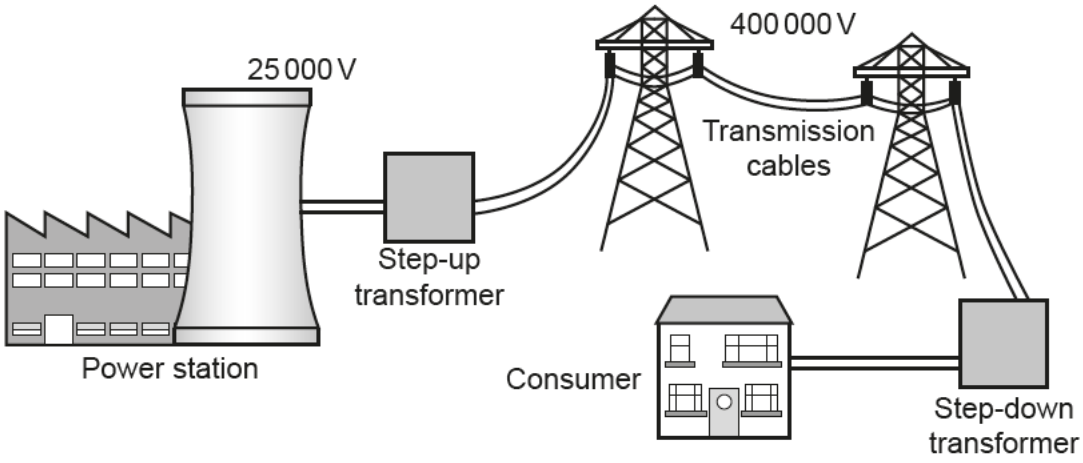


Fig. 2.1

(a) The National Grid uses a step-up transformer to increase the potential difference from 25 000 V to 400 000 V before the current is sent along the transmission cables.

The current in the primary coil of the step-up transformer is 2000 A.

Calculate the current flowing in the secondary coil of the step-up transformer.

Use the Data Sheet.

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

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(b) **Fig. 2.2** shows the UK's demand for electricity during a 24 hour period, and the base load.

The base load is the amount of electricity which is constantly generated.

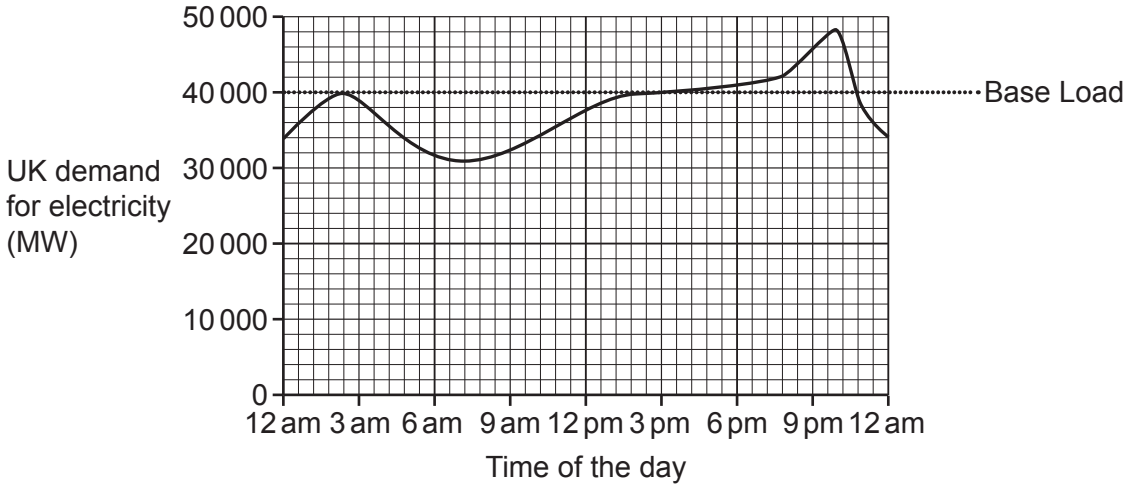


Fig. 2.2

(i) What is the value of the base load?

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

(ii) At which approximate time of the day is the demand for electricity the greatest?

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

(iii) At which approximate time of the day does the demand for electricity become greater than the base load?

Put a (ring) around the correct answer.

2.30am **7am** **4pm** **10.30pm**

[1]

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(c)* The UK uses many types of power stations to meet electrical demand.

The table shows information about four types of power station.

Type of power station	Start-up time	Maximum power generated (MW)
Wind	10 minutes	14 000
Fossil fuel	1 to 2 days	38 000
Solar	Instant	5 000
Hydroelectric	1 minute	5 000

Describe the **advantages** and **disadvantages** of these four types of power station and **conclude** how these four types of power station could be used to meet electrical demand during the 24-hour period **shown** in **Fig. 2.2**.

Use your own knowledge of these four types of power station in your answer.

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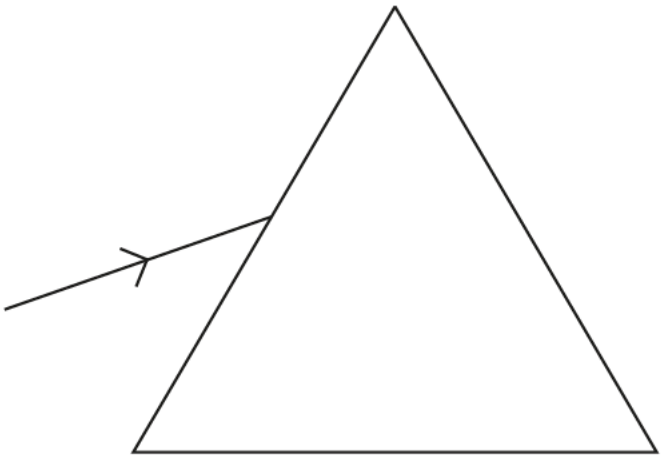
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3 Nina wants to make a rainbow maker for her window.

A rainbow maker is a prism and when sunlight hits the prism it makes a rainbow around the room.

(a) Complete the ray diagram to show what happens when a ray of **white light** enters and leaves a prism.

You should include the normal lines on your diagram.



[2]

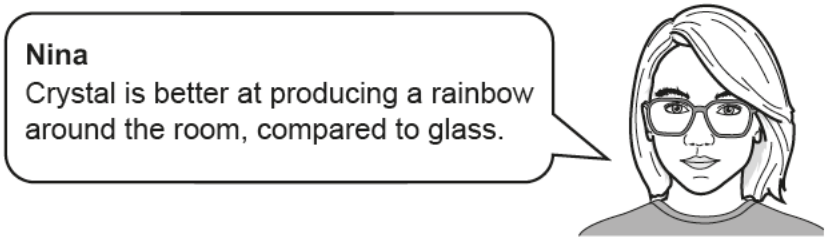
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(b) Nina investigates whether to use a glass prism or a crystal prism for her rainbow maker.

Nina measures the refracted angles of red light and violet light as they emerge from each prism, and records them in the table shown.

Prism	**Angle of refraction of red light emerging from the prism (°)**	**Angle of refraction of violet light emerging from the prism (°)**
Glass	53.5	55.2
Crystal	65.2	69.8

Nina comes to the following conclusion.



Do you agree with Nina's conclusion?

Yes ☐

No ☐

Use data from the table to explain your answer.

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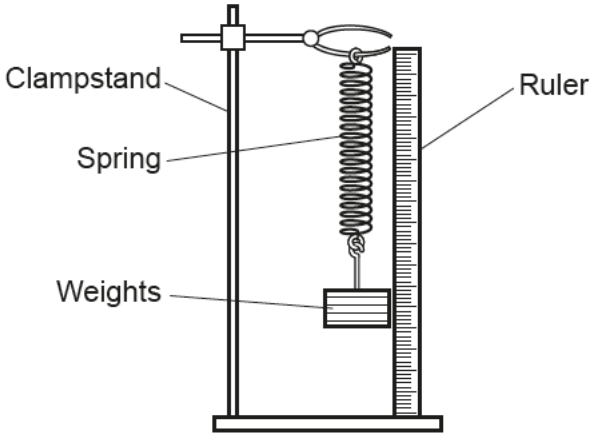
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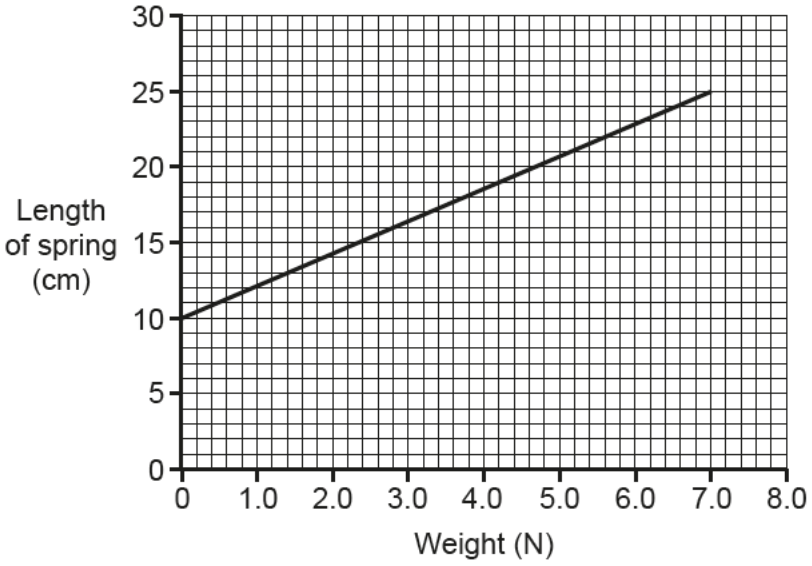
..... **[2]**

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4 Li does an experiment to investigate the stretching of a spring.



Li records the length of the spring for different weights on the spring, and plots the graph, as shown.



(a) (i) The relationship for the spring can be expressed in the form L **= m**W + **c**, where L is the length and W is the weight.

Find out the gradient, **m**, and the y-intercept, **c**, to complete the relationship for this spring.

Relationship for the spring = ... **[3]**

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(ii) The length of the spring is proportional to the weight on the spring.

What physical quantities are represented by the y-intercept, **c** and the gradient, **m**?

Y-intercept, **c** = ...

Gradient, **m** = ... **[2]**

(b) Li tests another spring which has a spring constant of 60 N / m.

The spring has an original length of 6 cm, and stretches to a length of 18 cm when some weights are added.

Calculate the energy stored in this spring when these weights are added.

Use the equation: energy stored in a stretched spring = ½ × spring constant × (extension)^2

Energy stored = ... J **[4]**

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

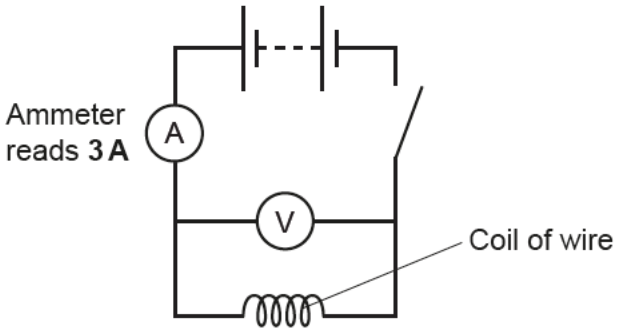


Fig. 5.1

(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.

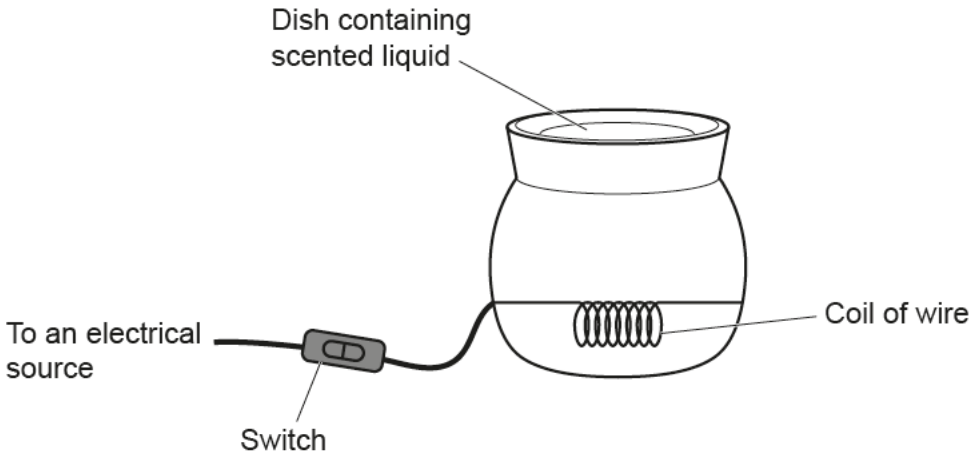
Calculate the potential difference across the battery.

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

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

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(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]**

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(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**.

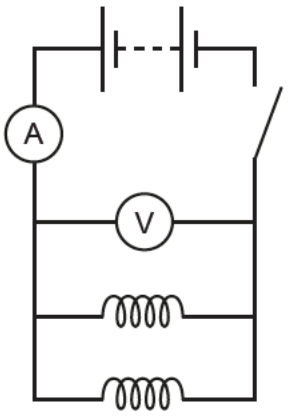
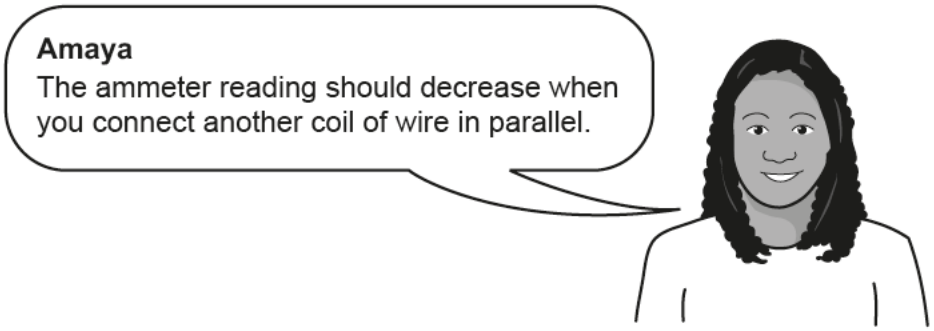


Fig. 5.2



Do you agree with Amaya?

Yes ☐

No ☐

Explain your answer.

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

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6 The wreck of the ship, Titanic, is a few kilometers below the surface of the sea. In order to reach these depths, a mini-submarine capable of resisting large pressure was used.

The mini-submarine contained a ballast tank, which was flooded with water when the mini-submarine wanted to sink, and was emptied of water when it wanted to rise to the surface of the sea.

(a) Explain, using **forces**, how the mini-submarine could sink.

Use ideas about weight and upthrust in your answer.

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

(b) The Titanic is 3.8 km below the surface of the sea.

Calculate the pressure on the submarine from the water, at the depth of the Titanic.

Use the data sheet.

Give your answer in **MPa**.

The density of seawater = 1025 kg / m^3

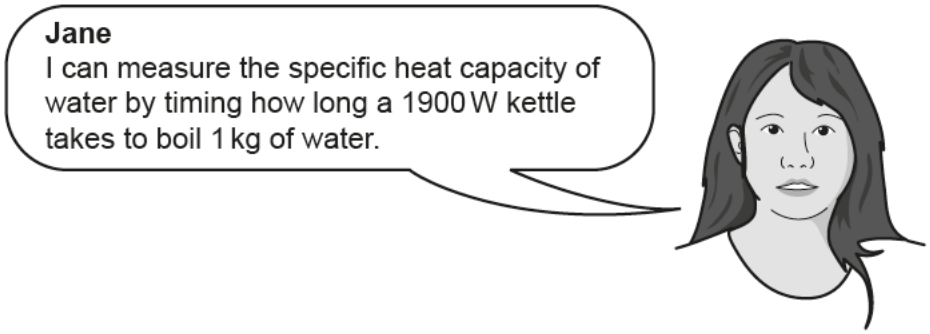
Gravitational field strength = 10 N / kg

Pressure = ... MPa **[4]**

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7 Water can be used as a coolant to stop over-heating in systems such as car engines.

Jane does an experiment to find the specific heat capacity of water.



(a) (i) Give **one** reason why Jane's result for the specific heat capacity of water will be inaccurate.

.....

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

(ii) Suggest **one** improvement to Jane's experiment, to get a more accurate value for the specific heat capacity of water.

.....

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

(b) It takes the kettle 3 minutes to heat 1 kg of water to 100 °C from a starting temperature of 20 °C.

Calculate the specific heat capacity of water.

Use the equation:
change in internal energy = mass × specific heat capacity × temperature change

Use the equation:
energy transferred = power × time

Specific heat capacity = ... J / kg °C **[4]**

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(c) When water is heated in a kettle, the energy stored within the water changes.

Describe how heating water in the kettle to **boiling point** changes the energy stored within the water.

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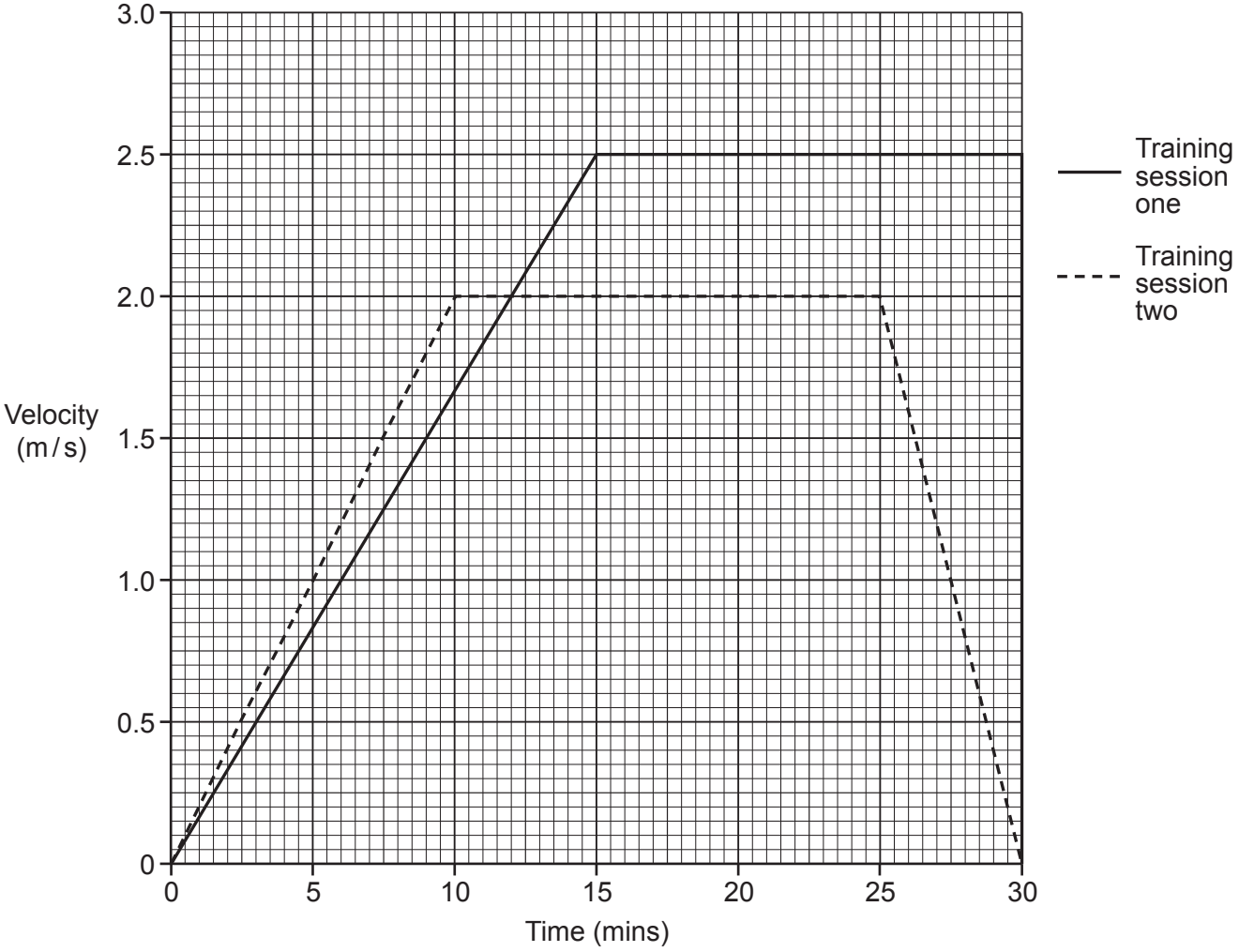
..... **[3]**

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8* Layla is training for a long distance race. She follows two different training sessions in preparation for running the race, and collects some information on her performance in each training session.

Each training session lasts 30 minutes.

The graph shows her motion for both training sessions.



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Give the **similarities** and **differences** between Layla's performance in the two training sessions.

Use calculations from the graph to support your answer.

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..... **[6]**

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9 Kai and Amir live near a wind farm.

They both believe that there is a relationship between average monthly temperature and the power generated by the wind farm.



Kai
I think there is a **strong** correlation between the power generated and average monthly temperature.

Amir
I think there is a **weak** correlation between the power generated and average monthly temperature.



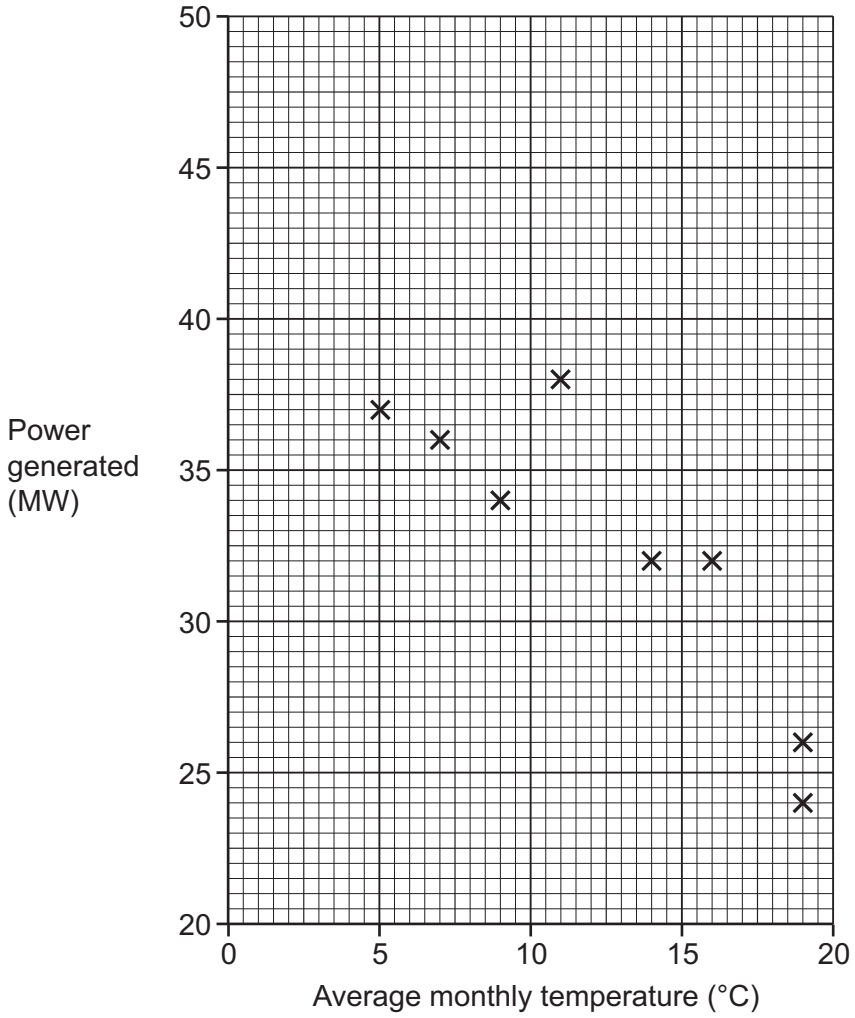
The table shows data for the wind farm over twelve months.

Month	Average monthly temperature (°C)	Power generated (MW)
January	5	37
February	7	36
March	9	34
April	11	38
May	14	32
June	16	32
July	19	24
August	19	26
September	17	32
October	13	40
November	10	35
December	7	41

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(a) (i) Complete the scatter graph by plotting the last four points from the table. **[1]**

(ii) Draw a line of best fit. **[1]**



(b) Discuss Kai and Amir's comments.

Use the graph to support your answer.

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

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10 Ben and Ali want to make a loudspeaker to connect to a mobile phone.

They build a loudspeaker from a plastic cup, permanent magnet and coil of wire as shown in **Fig. 10.1**.

An alternating current flows through the coil of wire when music is played on the mobile phone. This alternating current matches the pattern of the sound waves from the music.

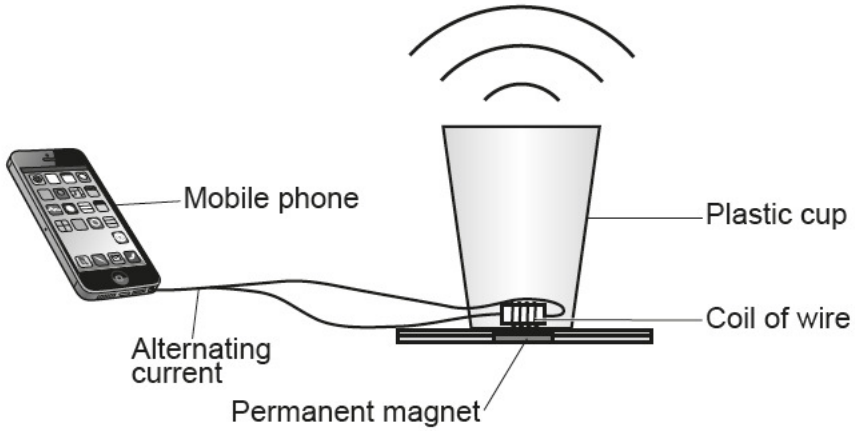
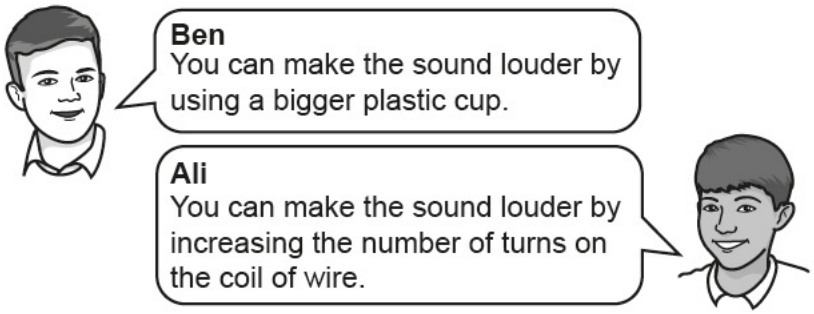


Fig. 10.1

(a) (i) When Ben connects the loudspeaker to his mobile phone and plays music, the sound produced is very quiet, even on the phone's maximum volume.



Who do you agree with?

Ben ☐

Ali ☐

Explain your answer.

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

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(ii) When Ben's mobile phone is connected to the loudspeaker it produces a sound which has a wavelength of 24 cm.

Calculate the frequency of the sound produced.

Give your answer to **2** significant figures.

The speed of sound in air is approximately 340 m / s.

Frequency = ... Hz **[5]**

(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]**

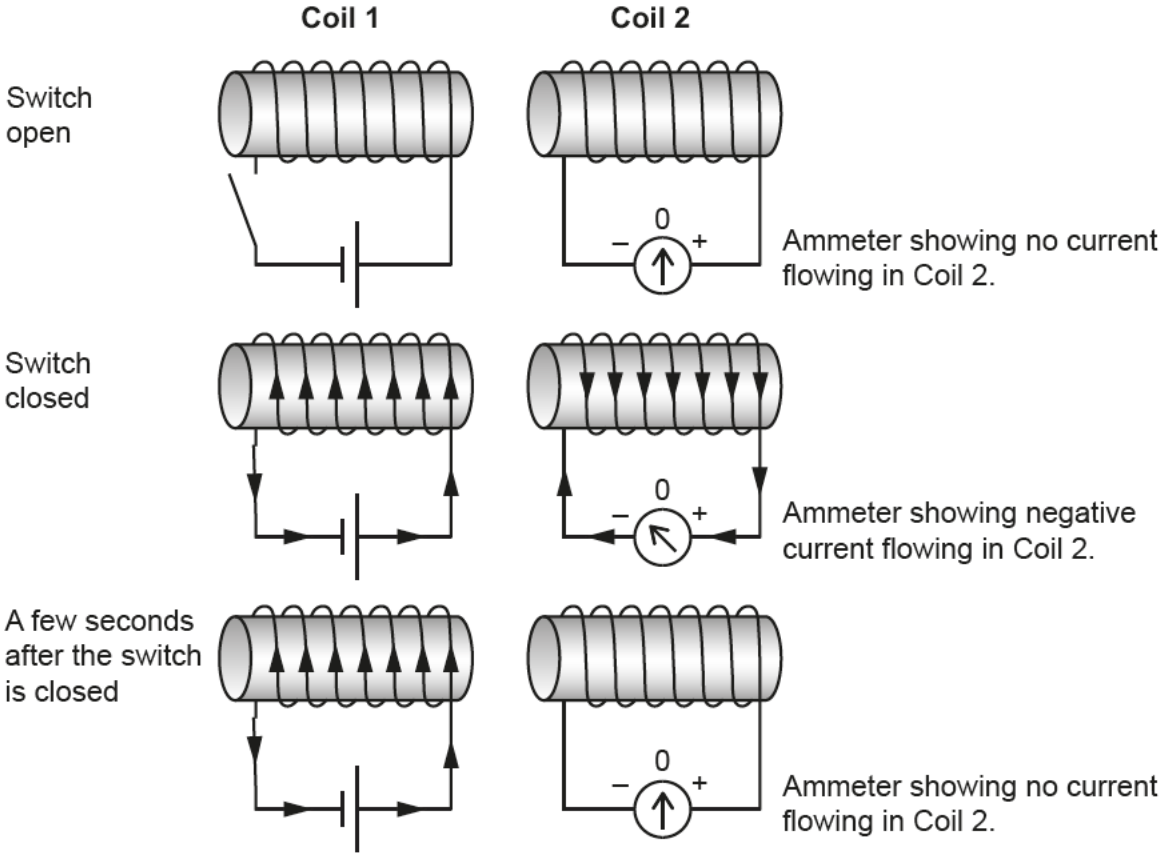
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11 Eve is investigating electromagnetic induction using two coils of wire that are placed close together.

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]**

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

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

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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