

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 ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Physics B (inside this document)

You can use:

- a scientific or graphical calculator
- an HB pencil



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

Centre number

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Candidate number

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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.

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]

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

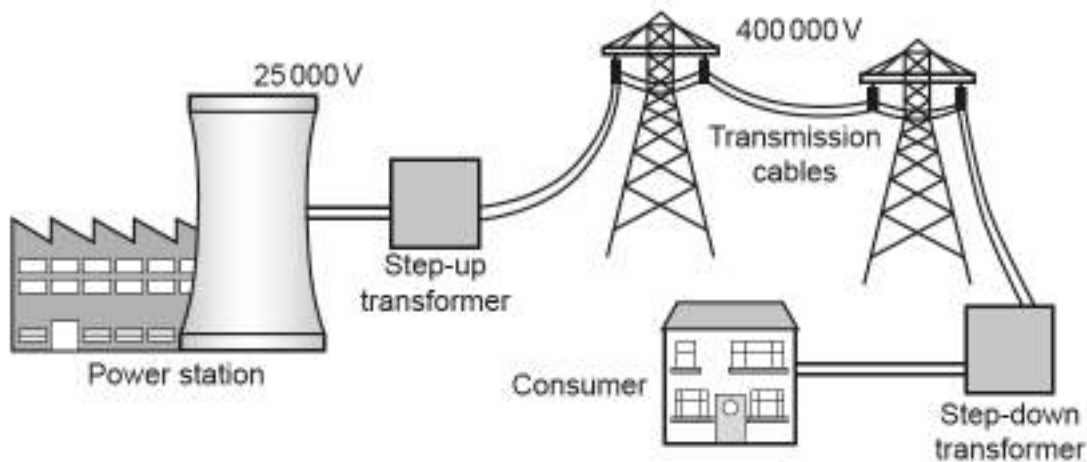


Fig. 2.1

- (a) The National Grid uses a step-up transformer to increase the potential difference from 25000 V to 400000 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]

(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.

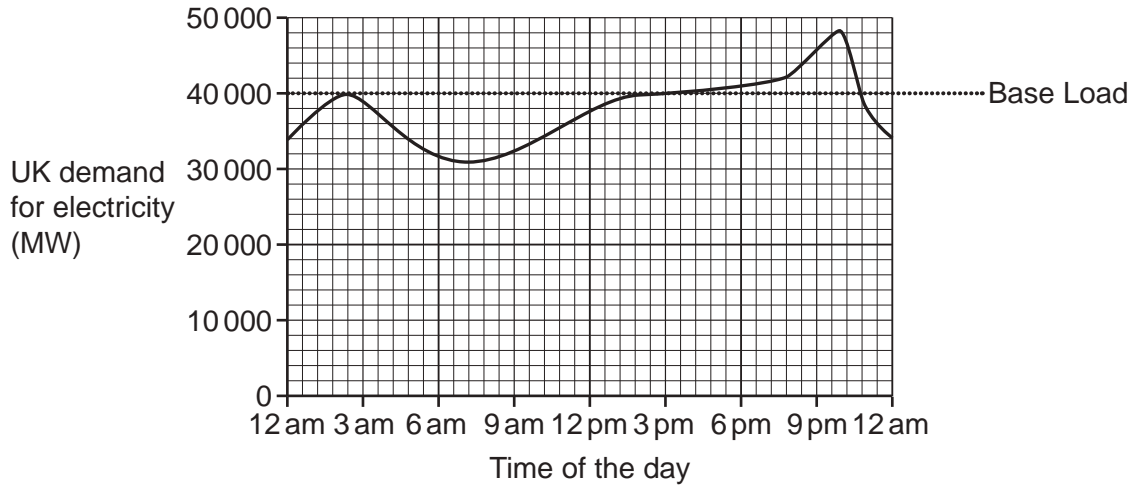


Fig. 2.2

(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**

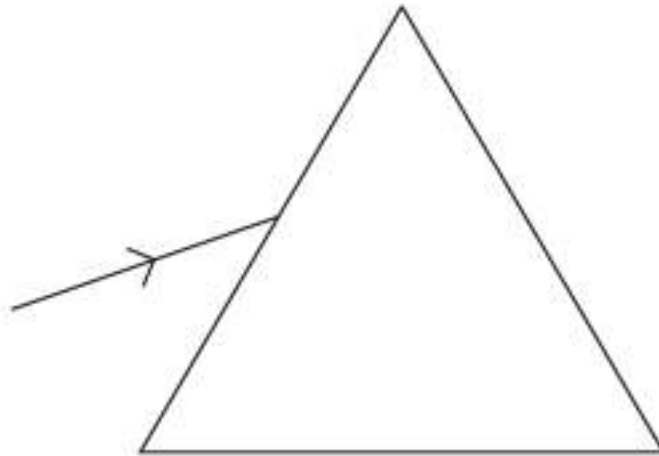
[1]

- 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]

- (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 ($^{\circ}$) | Angle of refraction of violet light emerging from the prism ($^{\circ}$) |
|---------|---|--|
| Glass | 53.5 | 55.2 |
| Crystal | 65.2 | 69.8 |

Nina comes to the following conclusion.

Nina

Crystal is better at producing a rainbow around the room, compared to glass.



Do you agree with Nina's conclusion?

Yes

No

Use data from the table to explain your answer.

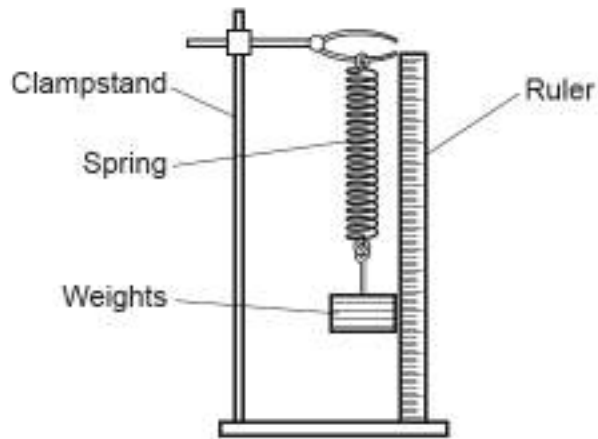
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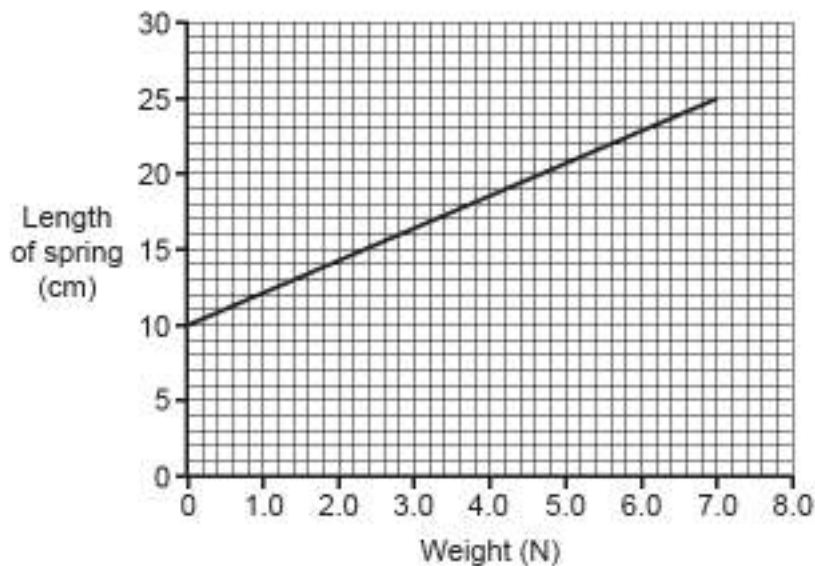
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..... [2]

- 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 $L = mW + c$, 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]

(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 = $\frac{1}{2} \times$ spring constant \times (extension)²

Energy stored = J [4]

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

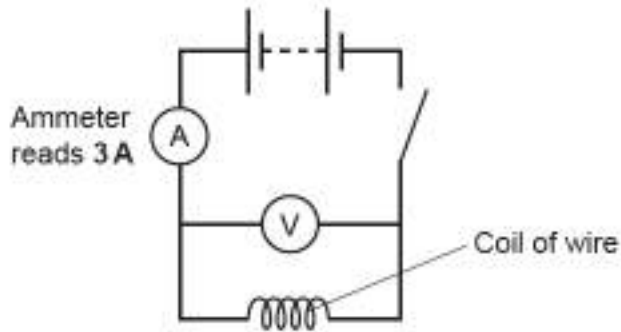


Fig. 5.1

- (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]

- 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.

Jane

I can measure the specific heat capacity of water by timing how long a 1900 W kettle takes to boil 1 kg 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:

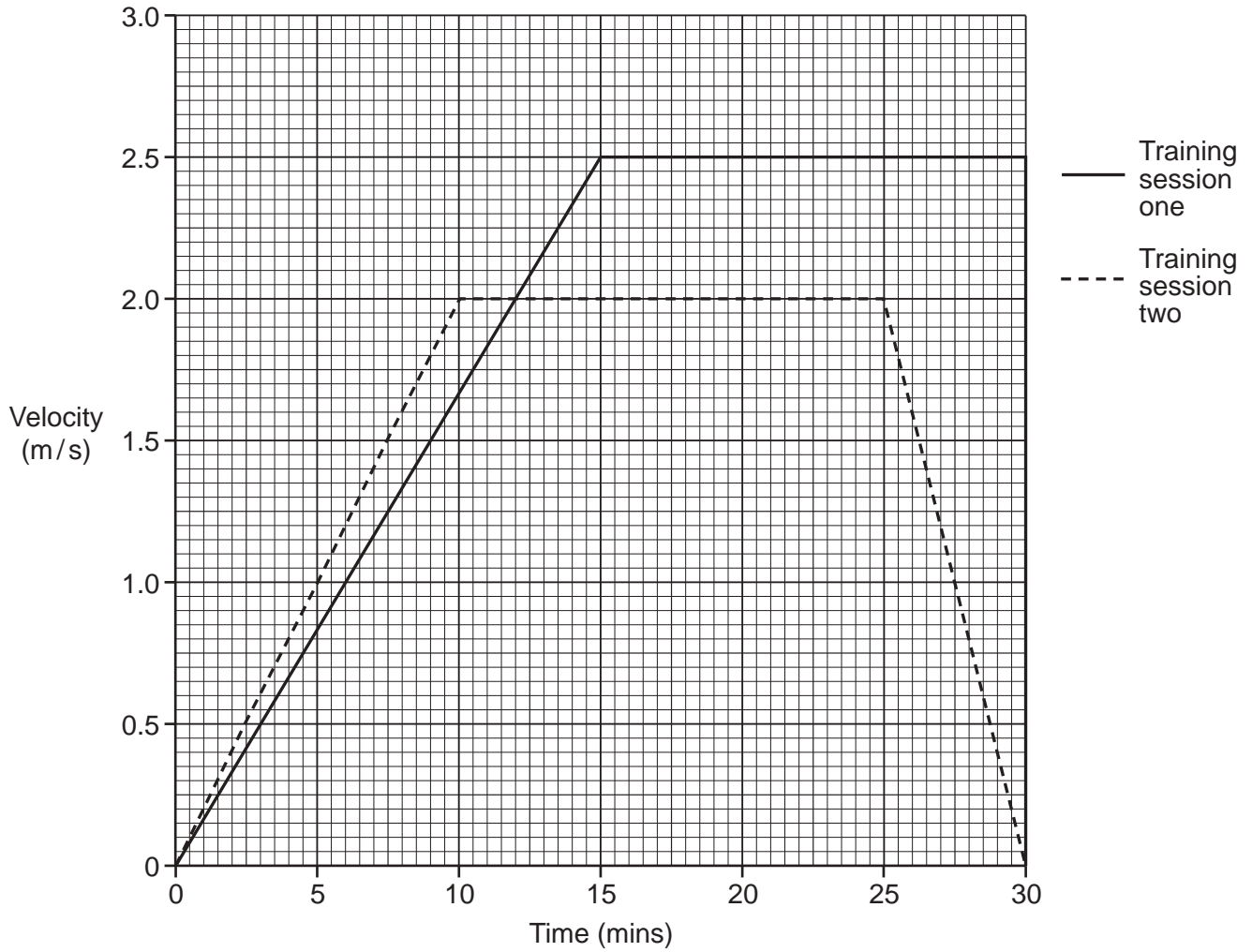
energy transferred = power × time

Specific heat capacity = J/kg°C [4]

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.



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.

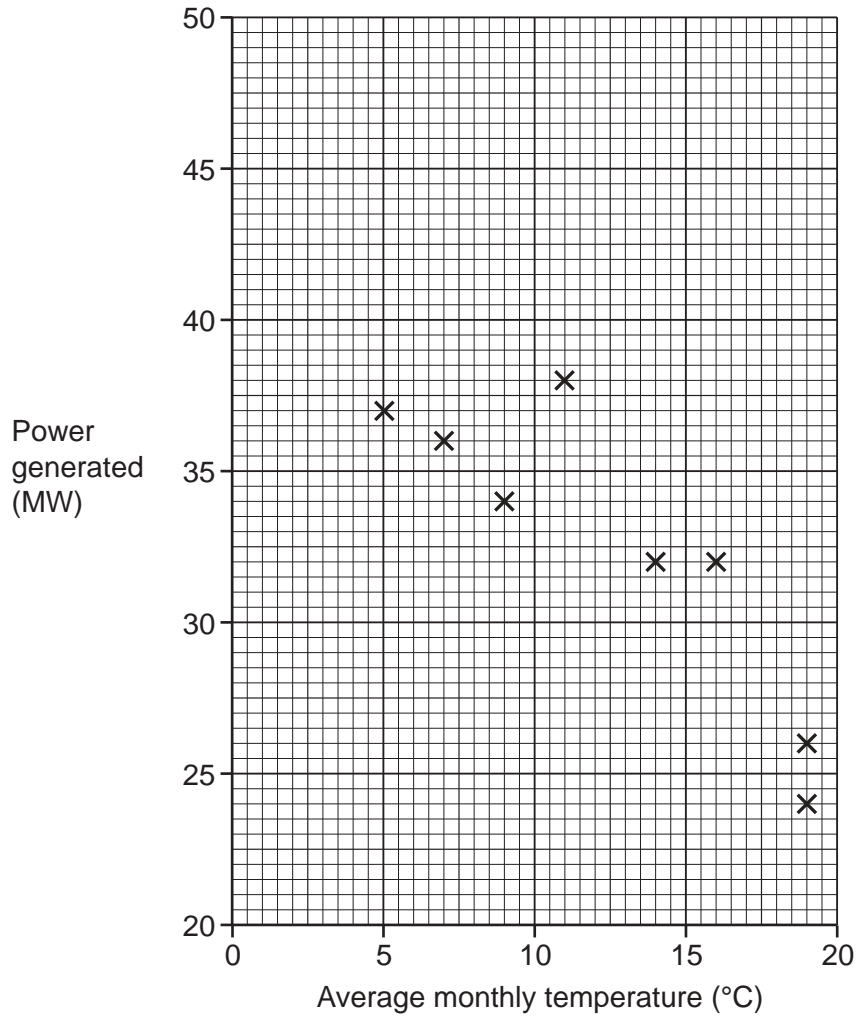


The table shows data for the wind farm over twelve months.

| 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 |

(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]

- 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.

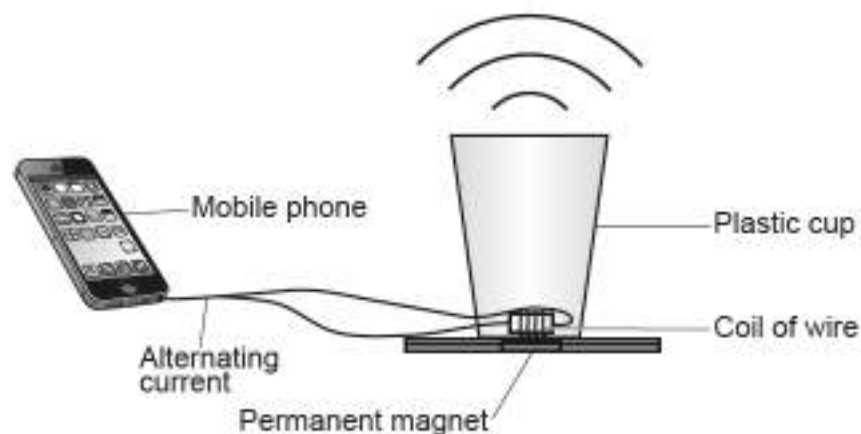
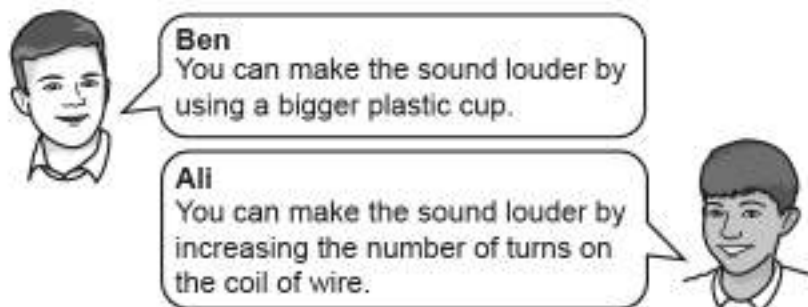


Fig. 10.1

- (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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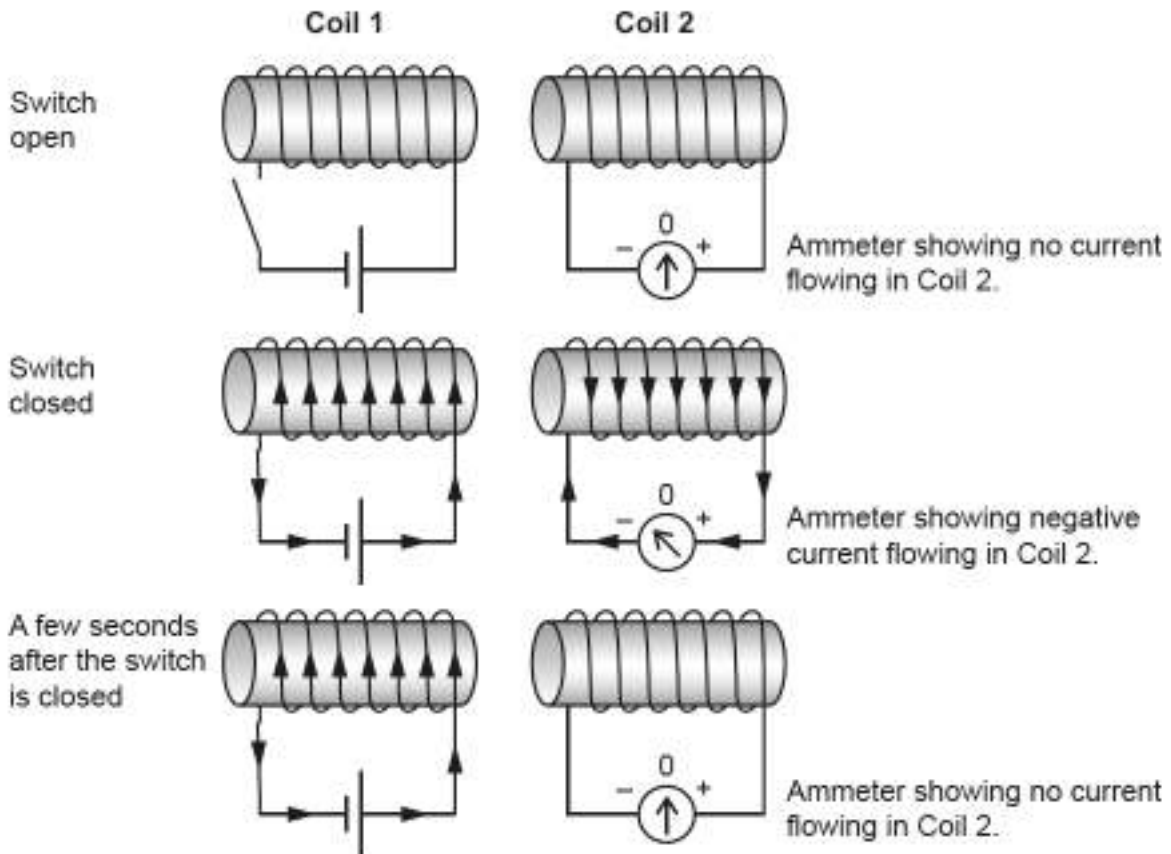
[3]

- 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]

END OF QUESTION PAPER

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).

A large rectangular area with a vertical solid line on the left side and horizontal dotted lines extending across the page, providing space for writing answers.

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