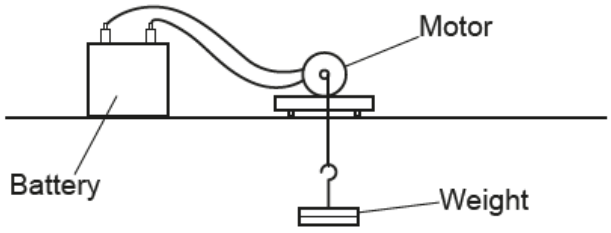
Sustainable energy – 2022 GCSE 21st Physics B

1. June/2022/Paper_ J259/01/No.1

Layla uses a motor to lift a weight, as shown in the diagram. The motor is powered by a battery.



(a) (i) What is the energy store of the battery?

Tick (✓) **one** box.

- Chemical ☐
- Electrical ☐
- Nuclear ☐
- Thermal ☐

[1]

(ii) How is energy transferred from the battery to the motor?

Tick (✓) **one** box.

- By heating ☐
- By radiation ☐
- Electrically ☐
- Mechanically ☐

[1]

(b) (i) Layla measures the power of the motor as 13 W.

It takes 3.0 s to lift the weight.

Calculate the energy transferred by the motor.

Use the equation: energy transferred = power × time

Energy = ... J **[2]**

(ii) Layla repeats the experiment.

She measures the power three times in total.

Her three measurements are: 13 W 17 W 12 W

Calculate the mean (average) power.

Mean power = ... W **[2]**

(c) Layla's teacher says that the motor transfers too much energy to thermal energy.

How could Layla reduce this unwanted energy transfer?

Tick (✓) **one** box.

Use a higher voltage battery. ☐

Use foam to insulate the motor. ☐

Use longer wires. ☐

Use oil to lubricate the motor. ☐

[1]

2. June/2022/Paper_ J259/02/No.3

Kareem wants to use solar energy to provide electricity for his house.

He fits photo-voltaic solar panels to his roof. These solar panels use energy from the Sun to generate electricity.

(a) Which **two** statements are correct about solar panels?

Tick (✓) **two** boxes.

Solar panels generate more electricity when it's sunny. ☐

Solar panels generate more electricity at night than in the day. ☐

Solar panels generate all the electricity needed for the National Grid. ☐

Solar panels release carbon dioxide gas when producing electricity. ☐

Solar panels use a renewable source of energy to generate electricity. ☐

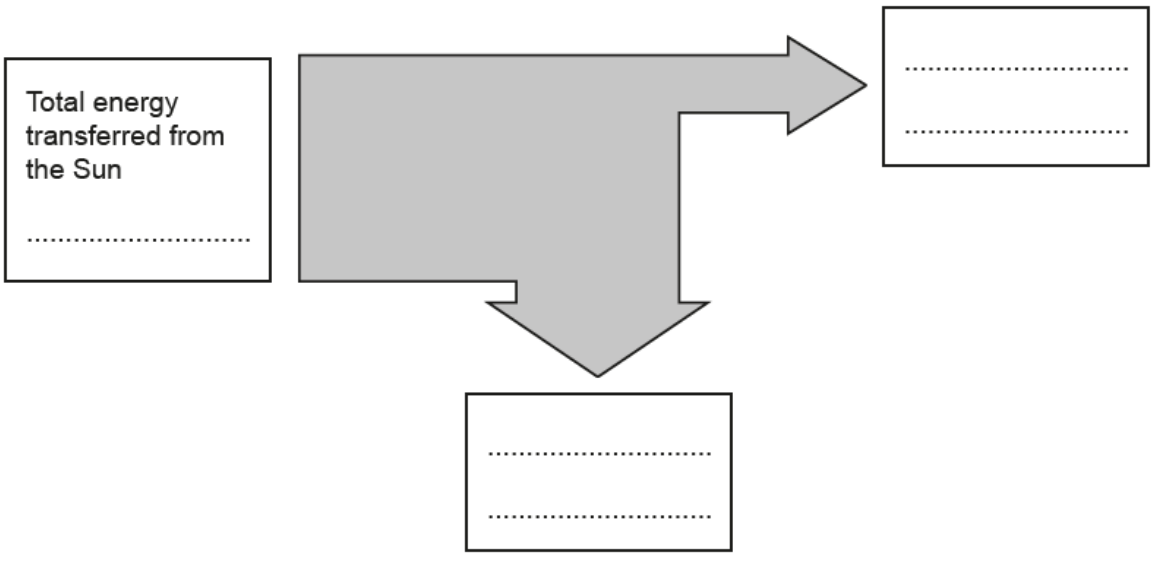
[2]

(b) The total energy transferred from the Sun to one of Kareem's solar panels is 200 J.
The useful energy transferred is 32 J.
The rest of the energy is transferred to the surroundings as thermal energy.

(i) Calculate how much energy the solar panel transfers to the surroundings.

Energy transferred to surroundings = ... J **[1]**

(ii) Kareem draws an outline of a Sankey diagram for this solar panel.



Complete the Sankey diagram for this solar panel. **[1]**

(iii) Calculate the efficiency of the solar panel.

Use the equation: efficiency = useful energy transferred ÷ total energy transferred

Efficiency = ... **[2]**

(c) Complete the sentences about the energy transfers of the solar panels.

Put a (ring) around each correct option.

(i) The total energy transferred from the Sun is carried by

electromagnetic / sound / mechanical waves. **[1]**

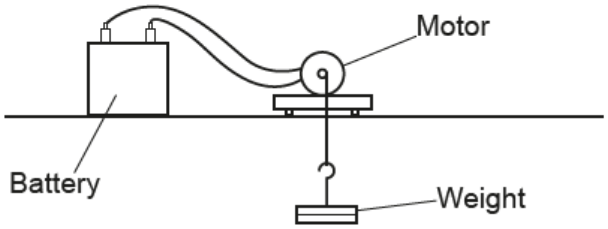
(ii) The energy transferred to the surroundings are in the form of

infrared / gamma / radio waves. **[1]**

3. June/2022/Paper_ J259/03/No.5

Alex investigates the efficiency of a motor.

He uses the motor to lift a weight as shown in the diagram.



He takes measurements and calculates the energy transfers.

(a) The electrical energy input to the motor is 5.6 J.

The work done lifting the weight is 3.5 J.

The motor is switched on for 20 seconds.

(i) Calculate the electrical power input to the motor.

Use the Data Sheet.

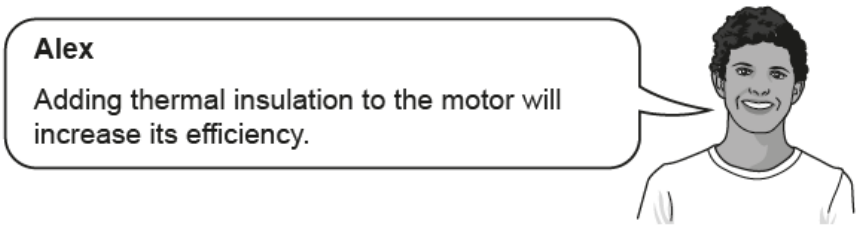
Power input = ... W **[3]**

(ii) Calculate the efficiency of the motor when lifting the weight.

Use the Data Sheet.

Efficiency = ... % **[3]**

(b) Alex researches how to improve the efficiency of the energy transfer.



(i) Explain why Alex is wrong.

.....

.....

.....

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

(ii) Suggest a better method to increase the efficiency of the energy transfer.

.....

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

4. June/2022/Paper_ J259/03/No.6

Mia's teacher uses a Van de Graaff generator to demonstrate static electricity shown in **Fig. 6.1**.

Electrons are transferred to the metal dome, giving it a negative charge.

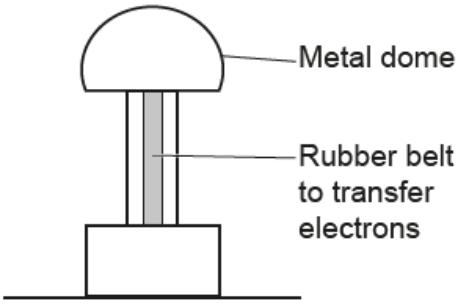


Fig. 6.1

(a) In **Fig. 6.2** a doll's head is attached to the top of the dome. When the dome is charged, the doll's hair also becomes negatively charged. The hair stands on end.

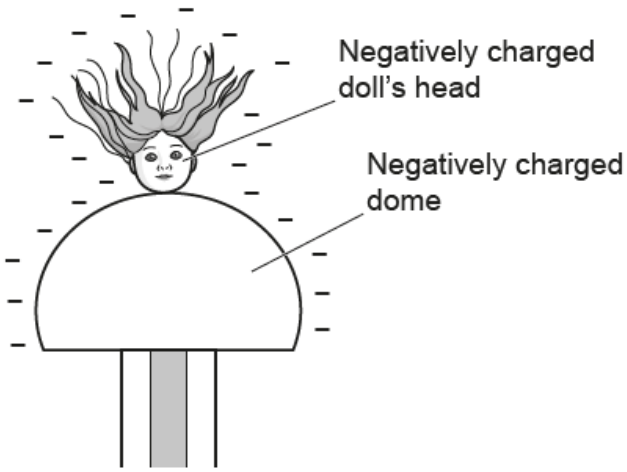
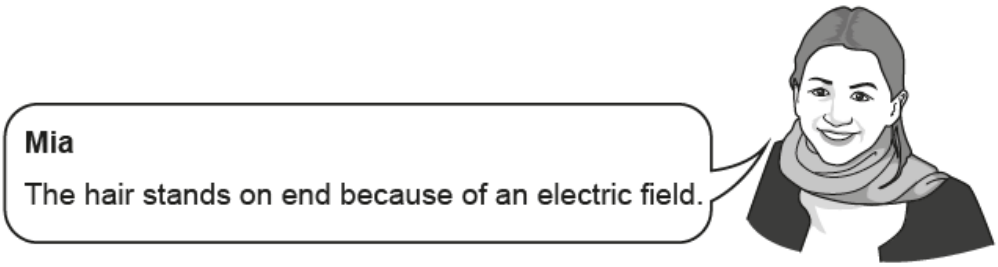


Fig. 6.2

Mia discusses the experiment with her teacher.



Explain why.

.....

.....

.....

..... [2]

(b) Mia's teacher switches off the Van de Graaff generator. He then uses a wooden metre rule to discharge the dome shown in **Fig. 6.3**.

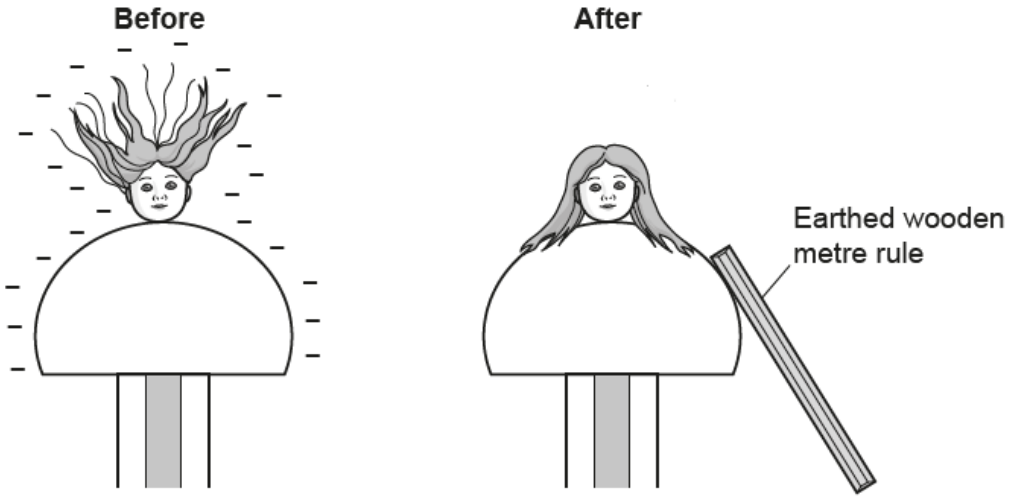


Fig. 6.3

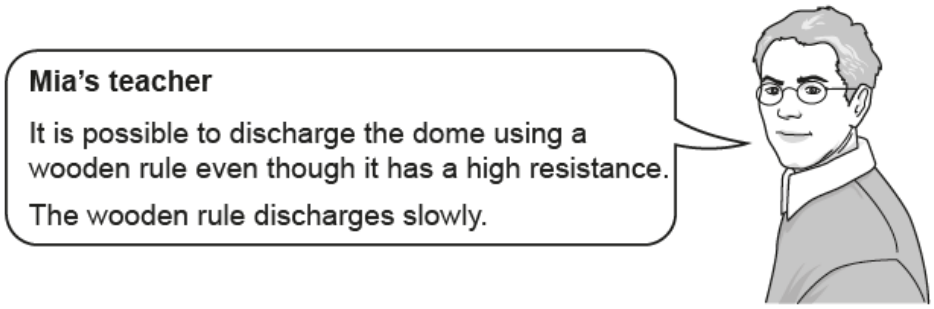
The initial voltage of the charged dome is 120 000 V. The initial charge on the dome is 1.5 μC. The resistance of the wooden rule is $5.0 \times 10^{11}\,\Omega$.

(i) Calculate the initial current that flowed through the wooden rule.

Use the Data Sheet.

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

(ii) Mia's teacher talks about how he discharged the dome.



Use the information given in part **(b)** to explain why it was possible to discharge the dome using the wooden metre rule. You may include a calculation in your answer.

.....

.....

.....

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

5. June/2022/Paper_ J259/04/No.8

Fig. 8.1 shows an alternating current (a.c.) generator.

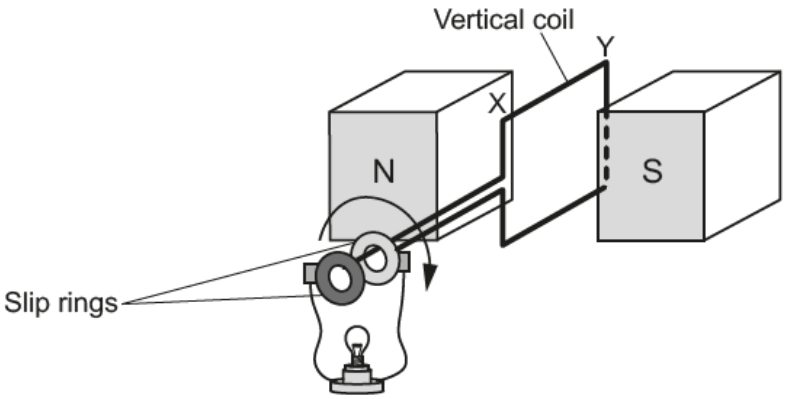


Fig. 8.1

Fig. 8.2 shows the potential difference generated across the bulb as the coil rotates.

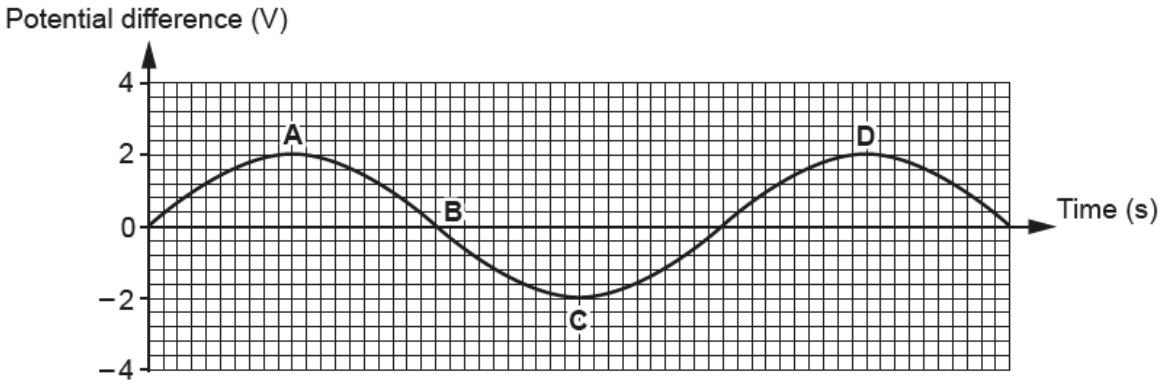


Fig. 8.2

(a) Which letter in **Fig. 8.2**, **A**, **B**, **C**, or **D**, shows the potential difference when the coil is in the vertical position shown in **Fig. 8.1**?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

(b) Explain the change in potential difference during one complete revolution of the coil, using **Fig. 8.2**.

Include the side of the coil labelled XY **in Fig. 8.1** in your answer.

.....

.....

.....

.....

.....

.....

.....

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

(c) **(i)** What change could be made to the generator in **Fig. 8.1** to change it into a direct current (d.c) generator?

.....

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

(ii) Draw the potential difference output for a **direct** current generator rotated at the same speed, on **Fig. 8.3**.

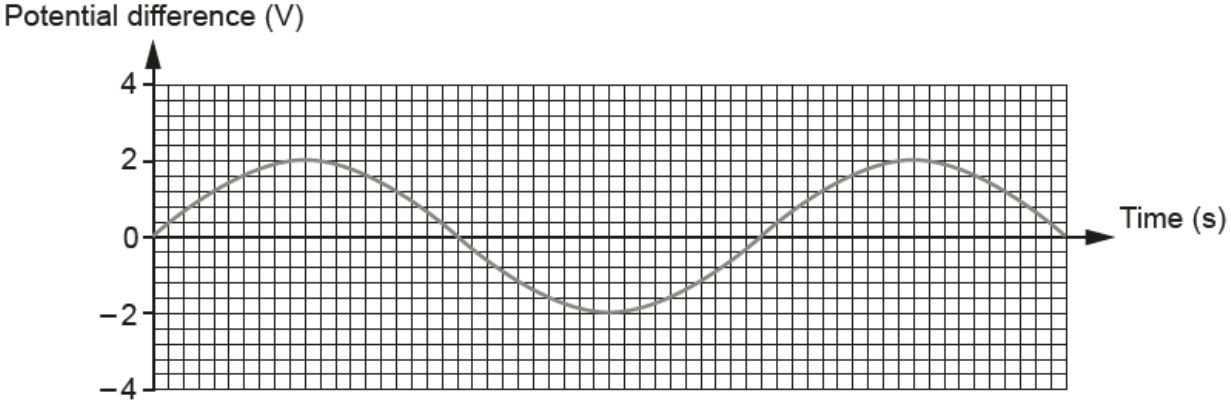
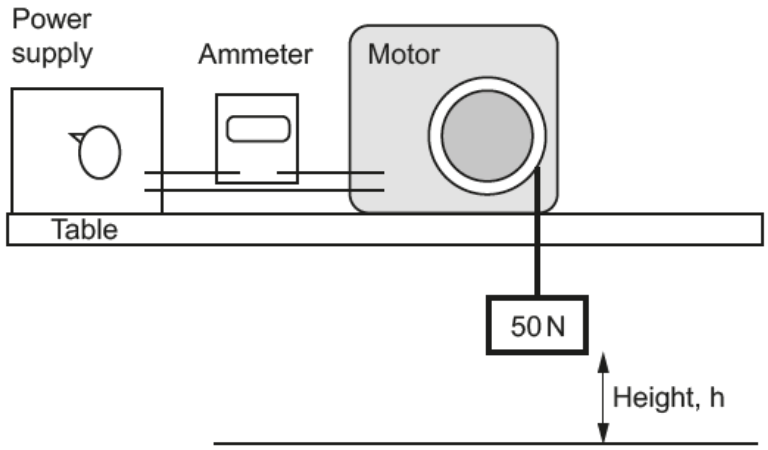


Fig. 8.3

[2]

6. June/2022/Paper_ J259/04/No.9

Kai uses the apparatus shown in the diagram to investigate the efficiency of an electric motor.



When Kai switches on the power supply the motor lifts the 50 N weight. He records the current on the ammeter and measures the height reached by the weight in 10 s.

Kai adjusts the power supply and repeats his measurements. He records his results in the table.

Current (A)	Height reached by 50 N weight (m)	Power output (W)
0.0	0.0	0.0
0.5	1.24	6.2
1.0	1.90	9.5
1.5	2.24	11.2
2.0	2.30	

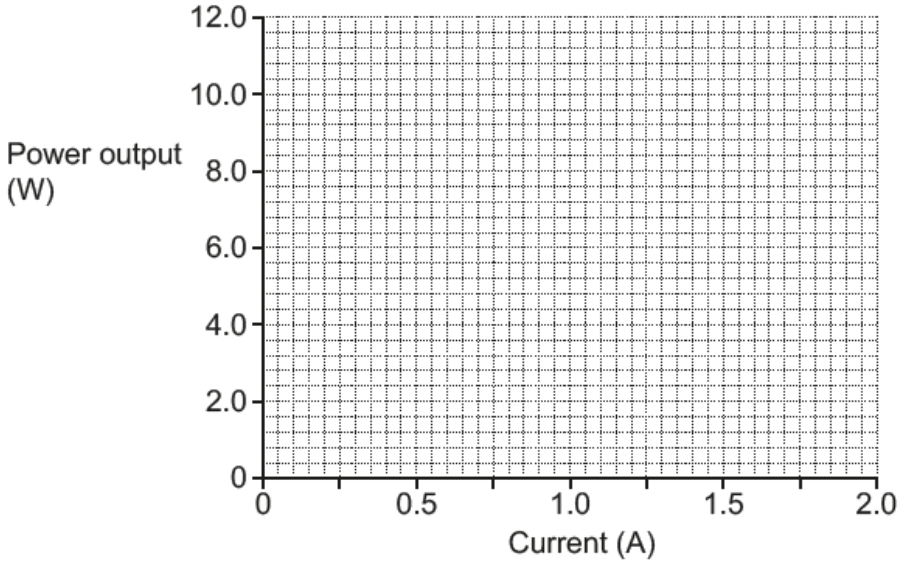
(a) (i) Calculate the power output when the current is 2.0 A.

Use the equation: power = work done ÷ time

Use the Data Sheet.

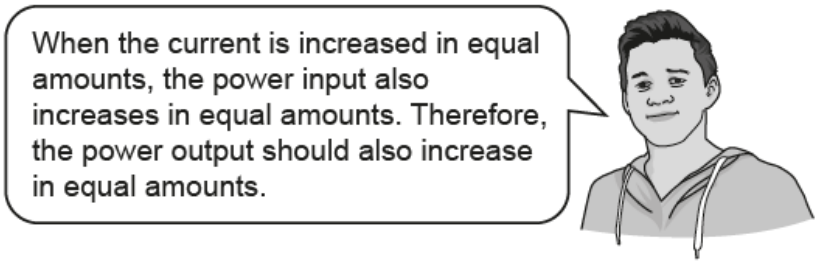
Power output = ... W **[3]**

(ii) Plot the power output against the current on the graph.



[2]

(b) Kai made a hypothesis before recording his results.



What other quantity would need to be measured to confirm this hypothesis?

Explain your answer.

Quantity .....

Explanation .....

.....

.....

[2]

(c) Write a conclusion that Kai can make about the electric motor.

Use data from the graph to support your answer.

.....

.....

.....

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