

Electrical Calculations

Mark Scheme



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1. Electrical calculations allow us to use standard equations to determine exactly how charge, current, potential difference, resistance, and energy interact within a circuit.

- a) A current of 3.0 A flows through a component for 15 seconds.
How much charge flows through the component?

D – is the only correct answer.	1 mark
	Total: 1 mark

- b) A battery transfers 120 J of energy to 10 C of charge passing through it.
What is the potential difference of the battery?

B – is the only correct answer.	1 mark
	Total: 1 mark

- c) A microwave oven transfers 48,000 J of energy in exactly 1 minute.
What is the power of the microwave oven?

A – is the only correct answer.	1 mark
	Total: 1 mark

- d) An electric motor operates with a potential difference of 9.0 V and draws a current of 2.0 A.
How much energy is transferred by the motor in 30 s?

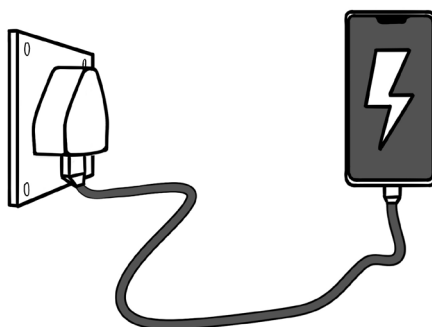
D – is the only correct answer.	1 mark
	Total: 1 mark

- e) A fixed resistor has a resistance of 50 Ω and dissipates a power of 200 W.
What is the current flowing through the resistor?

B – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 5 marks)

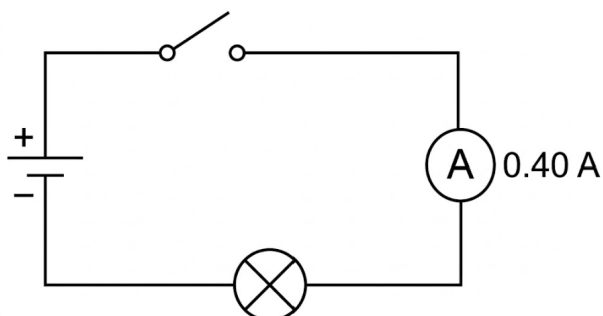
2. A student charges her smartphone.
The charging cable allows a current of 1.5 A to flow into the battery.



- a) Calculate the total charge that flows into the battery when it is plugged in for 2 hours.

$t = 2 \times 60 \times 60 = 7200 \text{ s}$	1 mark
$Q = I \times t$	1 mark
$Q = 1.5 \times 7200$	
$Q = 10\,800 \text{ C}$	1 mark
	Total: 3 marks

- b) A student uses a series circuit in an experiment. The figure below shows the circuit the student used.
The ammeter displays a steady reading of 0.40 A.



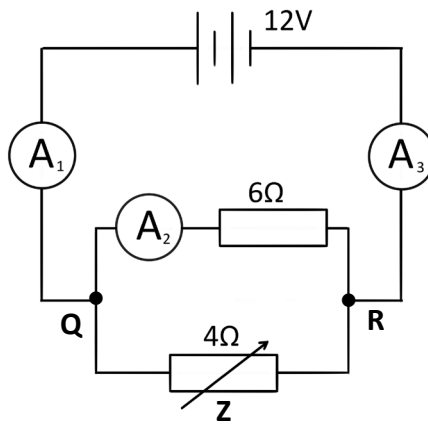
The student closes the switch in the circuit.

Calculate the time it takes for 12 C of charge to flow through the filament lamp.

$Q = I \times t$	1 mark
$12 = 0.40 \times t$	1 mark
$t = 12 \div 0.40 \quad t = 30 \text{ s}$	1 mark
	Total: 3 marks

(Total for Question 2 is 6 marks)

3. The figure below shows a circuit.



a) State the potential difference between points Q and R.

12 V	1 mark
	Total: 1 mark

b) Calculate the current moving through ammeter 2, A_2 .

$I = 12 \div 6$	1 mark
$I = 2 \text{ A}$	1 mark
	Total: 2 marks

c) State how the reading on ammeter A_1 compares to the reading on ammeter A_3 .

They are the same or equal.	1 mark
Allow: they both read the total current.	
	Total: 1 mark

d) Using your answer from part (b), calculate the current at ammeter A_1 .

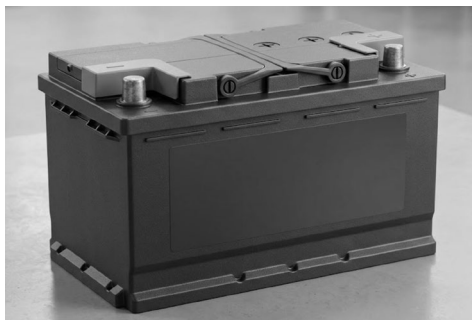
$I = 12 \div 4 = 3 \text{ A}$	1 mark
Total current = $2 + 3 = 5 \text{ A}$	1 mark
	Total: 2 marks

e) The variable resistor Z is adjusted. The new reading on ammeter A_1 is 3.5 A.
Calculate the new resistance of resistor Z.

Determine new current for branch Z: $I_Z = 3.5 - 2.0 = 1.5 \text{ A}$	1 mark
Resistance using Ohm's law: $R = V \div I$	1 mark
$R = 12 \div 1.5$	1 mark
$R = 8 \Omega$	1 mark
	Total: 4 marks

(Total for Question 3 is 9 marks)

4. A 12 V car battery is used to power the starter motor of a car.
The figure below shows a car battery.



During this process, the battery transfers 54 000 J of energy.

- a) Calculate the charge that flows through the starter motor.

$E = Q \times V$ $54\,000 = Q \times 12$	1 mark
$Q = 54\,000 \div 12$	1 mark
$Q = 4500$	1 mark
	Total: 3 marks

- b) The student noticed a fault on the battery.

Using their smart phone they took a picture of the fault to send an image of the fault to an engineer.

When the flash is used, 300 J of energy is transferred as 1.5 C of charge flows through the flash.

Calculate the potential difference across the flashbulb.

$E = Q \times V$ $300 = 1.5 \times V$	1 mark
$V = 300 \div 1.5$	1 mark
$V = 200$	1 mark
	Total: 3 marks

(Total for Question 4 is 6 marks)

5. An electric kettle transfers 120 kJ of energy to its thermal store in 2.0 minutes.



- a) Calculate the power of the kettle.

Energy = 120 000 (J)	1 mark
Time = 120 (s)	1 mark
$P = e \div t$	
$P = 120\,000 \div 120$	1 mark
$P = 1000\text{ W}$	1 mark
	Total: 4 marks

- b) An 800 W microwave transfers 144 000 J of energy to heat a bowl of soup.

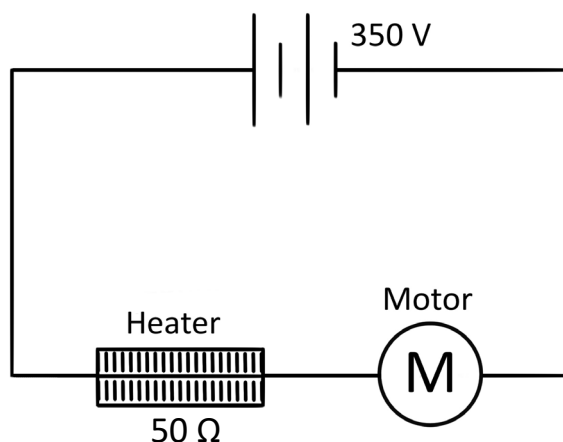


Calculate the time taken to heat the soup. Give your answer in minutes.

$P = e \div t$	
$800 = 144\,000 \div t$	1 mark
$t = 144\,000 \div 800$	1 mark
$t = 180\text{ s}$	1 mark
Time in minutes = $180 \div 60$ Time in minutes = 3	1 mark
	Total: 4 marks

(Total for Question 5 is 8 marks)

6. An industrial machine contains a heating element and a motor connected in series to a 350 V d.c. power supply, as shown in the figure below.



- a) When the machine is operating, the heating element dissipates 1800 W of power.

Calculate the current flowing through the heating element.

$P = I^2 \times R$	1 mark
$I^2 = 1800 \div 50$	1 mark
$I = \sqrt{36} \quad I = 6.0$	1 mark
	Total: 3 marks

- b) The machine is left switched on for 5.0 minutes.

Calculate the total energy transferred by the motor during this time.

You must show your working.

Step 1: Calculate potential difference across the heater. $V = I \times R \quad \text{OR} \quad V = P \div I$ $V = 6.0 \times 50 = 300 \text{ (V)}$	1 mark
Step 2: Calculate potential difference across the motor. $V(\text{motor}) = V(\text{total}) - V(\text{heater})$ $V(\text{motor}) = 350 - 300 = 50 \text{ (V)}$	1 mark
Step 3: Convert time to seconds. $t = 5.0 \times 60 = 300 \text{ (s)}$	1 mark
Step 4: Equation for energy $E = V \times I \times t$	1 mark
$E = 50 \times 6.0 \times 300$	1 mark
$E = 90\,000 \text{ J}$	1 mark
	Total: 6 marks

(Total for Question 6 is 9 marks)