

Current, charge, potential difference and resistance

AQA GCSE Physics 8463 and Combined Science Trilogy 8464 | Foundation and Higher | Paper 1

Worked solutions and teaching prompts | 44 practice marks

Specification points covered

8463 4.2.1.1 / 8464 6.2.1.1: circuit symbols and meter positions
8463 4.2.1.2 / 8464 6.2.1.2: charge flow, current and time
8463 4.2.1.3 / 8464 6.2.1.3: current, resistance and potential difference
8463 4.2.1.4 / 8464 6.2.1.4: constant resistance (selected content)
8463 4.2.4.2 / 8464 6.2.4.2: electrical energy and charge (selected content)

A repair cafe restores small battery-powered devices. You will check measurements, choose replacement resistors and decide which light can finish a repair job. Each test is separate. Use only the values given for that test.

Award equivalent correct methods and sensible rounding. Practice marks are deliberately tight. Allow consistent follow-through in linked parts; do not award a conversion twice. This is an original PhysicsUK resource, not an official AQA mark scheme.

1 Meaning of the quantities

1(a) Define electric current. [1 mark]

Answer / mark points: Electric current is the rate of flow of electric charge. [1]

Teacher prompt: Require charge per unit time, not a flow of energy.

1(b) Define potential difference in terms of energy and charge. [1 mark]

Answer / mark points: Potential difference is the energy transferred per unit charge between two points. [1]

Teacher prompt: Energy alone is not a potential difference.

2 Charge passing through devices

Use $Q = It$. Convert current to A and time to s before substituting.

2(a) A lamp carries a steady current of 0.20 A for 40 s. Calculate the charge that passes through it. [1 mark]

Answer / mark points: $Q = It = 0.20 \times 40 = 8.0$ C. [1]

2(b) The lamp now carries 0.20 A for 150 s. Calculate the charge that passes through it. [1 mark]

Answer / mark points: $Q = It = 0.20 \times 150 = 30$ C. [1]



2 Charge passing through devices continued

2(c) During a fan test, 36 C passes a point in 120 s. Calculate the mean current. [1 mark]

Answer / mark points: $I = Q / t = 36 / 120 = 0.30 \text{ A}$. [1]

2(d) A buzzer carries 0.15 A and transfers 108 C of charge. Calculate its operating time in seconds. [1 mark]

Answer / mark points: $t = Q / I = 108 / 0.15 = 720 \text{ s}$. [1]

2(e) A small motor carries a steady current of 250 mA for 2.0 minutes. Calculate the charge that passes through it. [2 marks]

Answer / mark points: $I = 250 / 1000 = 0.250 \text{ A}$; $t = 2.0 \times 60 = 120 \text{ s}$. [1 for both conversions]
 $Q = It = 0.250 \times 120 = 30 \text{ C}$. [1]

Teacher prompt: Divide mA by 1000. Do not substitute a time in minutes into $Q = It$ when current is in A.

2(f) A trainee claims that test (b) had a larger current than test (a) because more charge passed. Explain why this claim is wrong. [2 marks]

Answer / mark points: Both currents are 0.20 A. [1] More charge passes in (b) because the time is longer; current is charge per unit time, not total charge. [1]

3 Potential difference and energy

The cafe tests several devices. Use $E = QV$ for energy transferred.

3(a) A device has a potential difference of 9.0 V across it. State the energy transferred when 1.0 C passes through it. [1 mark]

Answer / mark points: 9.0 J is transferred. [1] One volt means one joule per coulomb.

3(b) A radio transfers energy at 9.0 V while 20 C passes through it. Calculate the energy transferred. [1 mark]

Answer / mark points: $E = QV = 20 \times 9.0 = 180 \text{ J}$. [1]

3(c) A device transfers 72 J when 12 C passes through it. Calculate the potential difference across it. [1 mark]

Answer / mark points: $V = E / Q = 72 / 12 = 6.0 \text{ V}$. [1]

3(d) An indicator has a potential difference of 5.0 V across it and transfers 60 J of energy. Calculate the charge that passes through it. [1 mark]

Answer / mark points: $Q = E / V = 60 / 5.0 = 12 \text{ C}$. [1]

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3 Potential difference and energy continued

3(e) A motor carries a steady current of 0.30 A for 50 s at a potential difference of 4.0 V. Calculate the electrical energy transferred to the motor. **[2 marks]**

Answer / mark points: $Q = It = 0.30 \times 50 = 15 \text{ C}$. [1]

$E = QV = 15 \times 4.0 = 60 \text{ J}$. [1] Accept a correct combined calculation $E = VIt$.

3(f) In a second test, the same 12 C passes through a device at 3.0 V. Compare the energy transferred with the 72 J in part (c). Explain your comparison. **[2 marks]**

Answer / mark points: $E = 12 \times 3.0 = 36 \text{ J}$, half the energy in (c). [1] The charge is the same but the potential difference, and therefore the energy transferred per coulomb, is halved. [1]

Teacher prompt: Potential difference is an energy-per-charge quantity. Do not say that voltage is an amount of charge.

4 Connecting the meters

Figure 1 shows a cell, a resistor and two empty meter positions, P and Q.

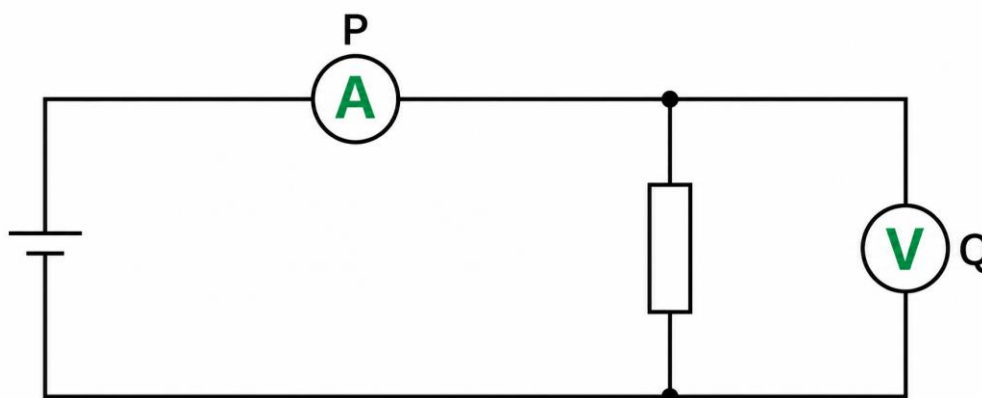


Figure 1

4(a) Identify the meter required at P and the meter required at Q. **[2 marks]**

Answer / mark points: P: ammeter, connected in series. [1] Q: voltmeter, connected in parallel across the resistor. [1] The names alone earn the marks; the connections explain the answers.

Teacher prompt: Trace the current path for P. Q connects to the two ends of the resistor.

4(b) The resistor carries 0.80 A with 4.8 V across it. Calculate its resistance. **[1 mark]**

Answer / mark points: $R = V / I = 4.8 / 0.80 = 6.0 \Omega$. [1]

4(c) The ammeter is moved to the bottom wire without any other change. State its reading and explain why it is not smaller. Assume the meters do not affect the circuit. **[2 marks]**

Answer / mark points: It still reads 0.80 A. [1] Charge is conserved, so the same charge passes each point of the main loop per second; the resistor transfers energy, not charge. [1]

Teacher prompt: Accept same current because charge is not used up. The voltmeter current is negligible under the stated assumption.



5 Choosing a replacement resistor

Two fixed resistors are tested at constant temperature. Table 1 gives the readings.

Table 1

Resistor	Potential difference / V	Current
A	6.0	0.30 A
B	6.0	150 mA

5(a) Use Table 1 to calculate the resistance of resistor A. **[1 mark]**

Answer / mark points: $R = V / I = 6.0 / 0.30 = 20 \Omega$. [1]

5(b) Use Table 1 to calculate the resistance of resistor B. **[2 marks]**

Answer / mark points: $I = 150 / 1000 = 0.150 \text{ A}$. [1]

$R = V / I = 6.0 / 0.150 = 40 \Omega$. [1]

Teacher prompt: 150 mA is 0.150 A, not 0.0150 A or 150 A.

5(c) Resistor B remains at the same temperature. Calculate its current when the potential difference across it is 4.0 V. **[1 mark]**

Answer / mark points: $I = V / R = 4.0 / 40 = 0.10 \text{ A}$ (100 mA). [1] Use the resistance found in (b).

5(d) The potential difference is kept constant. A resistor is replaced by one with twice the resistance. State what happens to the current and to the charge passing in the same time. **[2 marks]**

Answer / mark points: The current is halved. [1] The charge passing in the same time is also halved, because $Q = It$ with unchanged t . [1]

5(e) An alarm circuit must carry between 0.12 A and 0.18 A, inclusive, when 6.0 V is across its resistor. Choose A or B and justify your choice using Table 1. **[2 marks]**

Answer / mark points: Choose B: its current is 0.150 A, inside the permitted range. [1] A carries 0.30 A, above the 0.18 A maximum. [1] Both comparisons are needed.

5(f) At the same temperature, resistor A gives 0.10 A at 2.0 V and 0.20 A at 4.0 V. Do these two measurements support a constant resistance? Use calculated values to justify your answer. **[2 marks]**

Answer / mark points: $R = 2.0 / 0.10 = 20 \Omega$ and $R = 4.0 / 0.20 = 20 \Omega$. [1 for both values]
Yes: V / I is the same at both measured settings. [1] These readings support constant resistance over the measured settings; they do not establish it at every temperature or voltage.

Teacher prompt: Do not claim every real component has a constant resistance. Temperature is controlled in this test.



6 Will the light last for the repair?

A partly used battery pack has 180 C of usable charge remaining at a steady 4.5 V. A repair needs light for 30 minutes. Either unit in Table 2 gives enough light. Assume the current and potential difference remain constant until the usable charge is exhausted.

Table 2

Light unit	Operating potential difference / V	Steady current / mA
L	4.5	80
M	4.5	120

6(a) Calculate the electrical energy that the remaining usable charge can transfer at 4.5 V. [1 mark]

Answer / mark points: $E = QV = 180 \times 4.5 = 810 \text{ J}$. [1]

6(b) Calculate the charge needed to run light unit L for the full 30 minutes. [2 marks]

Answer / mark points: $I = 80 / 1000 = 0.080 \text{ A}$; $t = 30 \times 60 = 1800 \text{ s}$. [1 for both conversions]
 $Q = It = 0.080 \times 1800 = 144 \text{ C}$. [1]

6(c) Calculate the charge needed to run light unit M for the full 30 minutes. [2 marks]

Answer / mark points: $I = 120 / 1000 = 0.120 \text{ A}$; $t = 1800 \text{ s}$. [1 for correct SI substitution]
 $Q = It = 0.120 \times 1800 = 216 \text{ C}$. [1] Use the time already converted in (b).

6(d) Choose the unit that can complete the repair. Justify your choice by comparing both calculated charges with the 180 C available. [2 marks]

Answer / mark points: L can finish: 144 C is less than 180 C. [1] M cannot finish: 216 C is greater than 180 C. [1]

6(e) Calculate the maximum time, in seconds, that unit M can run using the 180 C available. [2 marks]

Answer / mark points: $I = 0.120 \text{ A}$; $t = Q / I = 180 / 0.120$. [1 for correct SI setup]
 $t = 1500 \text{ s}$. [1] This is 25 minutes, shorter than the required 30 minutes.

Teacher prompt: Use the charge available, not the charge needed. Accept consistent follow-through where physically meaningful.

6(f) A different battery also has 180 C of usable charge, but its potential difference is 9.0 V. A trainee says it contains twice as much usable charge as the 4.5 V pack. Explain why this is wrong. Do not connect it to the light units. [2 marks]

Answer / mark points: Both batteries have the same usable charge, 180 C. [1] The 9.0 V battery transfers twice as much energy per coulomb, not twice as much charge (1620 J rather than 810 J in total). [1]

Review and improve

Check charge versus energy, mA versus A, and the reason for your final equipment choice.

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