

I V graphs resistance and component choice

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

Worked answers | Foundation and Higher | 28 parts | 51 marks

Specification points covered

8463 4.2.1.3 / 8464 6.2.1.3: current, potential difference and resistance; $V = IR$
8463 4.2.1.4 / 8464 6.2.1.4: interpreting resistor, filament-lamp and diode graphs

A mobile repair bench restores portable lights used by a park's evening events team. You will compare measured component characteristics, reject unsuitable replacements and explain what the test results show.

Original PhysicsUK practice, not an official AQA resource. All content is shared Foundation/Higher and Combined/Separate. Accept appropriate graph-reading tolerance and correct follow-through. Calculate operating-point resistance using V / I , not a nonlinear tangent. This is a graph-analysis follow-up, not a complete practical pack. Timing is estimated and untrials.

1 Checking the repair bench readings

Each component is tested separately using a low-voltage supply. Component A has a potential difference of 3.0 V and a current of 150 mA.

1(a) State the unit of electrical resistance. **[1 mark]**

Answer / mark points: Ohm / Ω . [1] A is the unit of current; V is the unit of potential difference.

1(b) Calculate the resistance of Component A. Show the current conversion. **[2 marks]**

Answer / mark points: 150 mA = 0.150 A. [1]
 $R = V / I = 3.0 / 0.150 = 20 \Omega$. [1] Do not divide 3.0 by 150 without converting the unit.

1(c) A spare resistor Z carries 0.060 A when the potential difference across it is 3.0 V. Calculate its resistance and decide whether it is greater or smaller than A's. **[2 marks]**

Answer / mark points: $R = 3.0 / 0.060 = 50 \Omega$. [1]
Z has greater resistance than A's 20 Ω . [1] Compare currents at the same potential difference.



2 Reading the resistor graph

Figure 1 shows Component A at constant temperature. Potential difference is on the vertical axis and current is on the horizontal axis. The plotted line includes reversed connections.

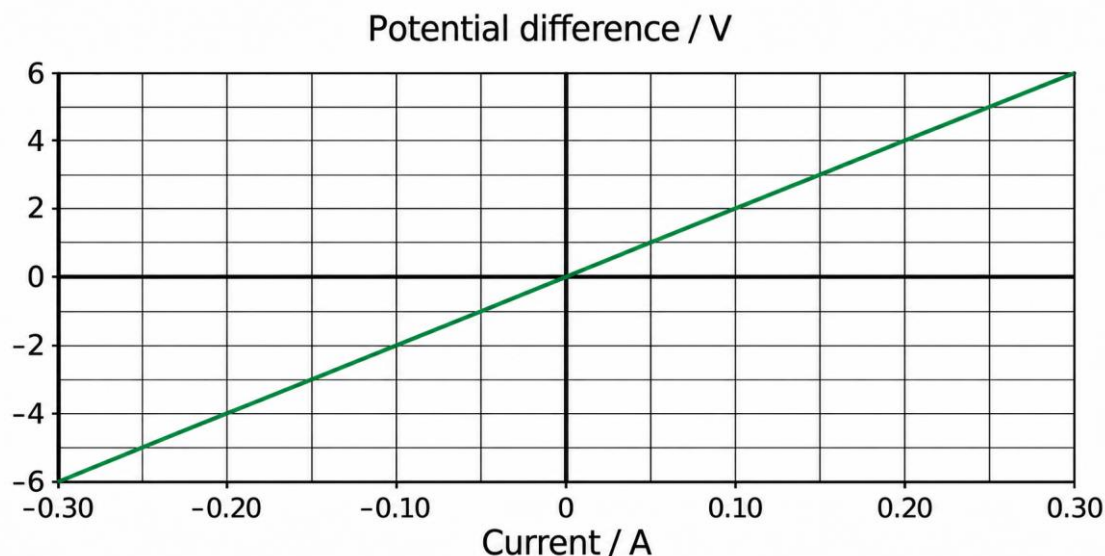


Figure 1

2(a) Read the current in A when the potential difference across it is 4.0 V. **[1 mark]**

Answer / mark points: 0.20 A. [1] Allow 0.195–0.205 A. Read horizontally from 4.0 V to the line, then down to the current axis.

2(b) Calculate A's resistance using that operating point. **[1 mark]**

Answer / mark points: $R = 4.0 / 0.20 = 20 \, \Omega$. [1] Allow correct follow-through from (a).

2(c) Use the graph to find the current at 2.0 V, then check A's resistance at this second operating point. **[2 marks]**

Answer / mark points: At 2.0 V, $I = 0.10$ A. [1] Allow 0.095–0.105 A.
 $R = 2.0 / 0.10 = 20 \, \Omega$. [1] The second point gives the same resistance.

2(d) Explain how Figure 1 shows that A is ohmic over the tested range. **[2 marks]**

Answer / mark points: The graph is a straight line through the origin. [1]
 V and I are directly proportional, so V / I is constant at the stated constant temperature. [1] A straight line that does not pass through the origin would not show direct proportionality.

2(e) The connections are reversed and the potential difference is –4.0 V. Read the current and explain the meaning of its sign. **[2 marks]**

Answer / mark points: $I = -0.20$ A. [1] Allow –0.205 to –0.195 A.
 The minus sign means the current flows in the opposite direction to the chosen positive direction. [1]
 It does not mean the resistor has negative resistance.



3 Checking the filament lamp

Component B is a filament lamp. Figure 2 gives steady readings after the filament temperature has settled at each setting. The axes are now current vertically and potential difference horizontally.

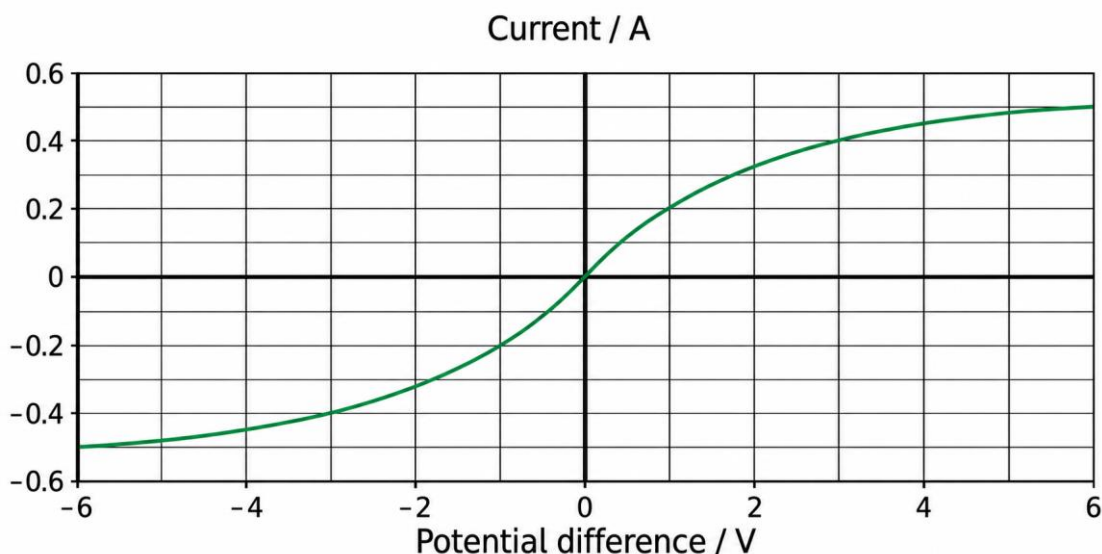


Figure 2

3(a) Read the steady current in B at 3.0 V. **[1 mark]**

Answer / mark points: About 0.40 A. [1] Allow 0.39–0.41 A.

3(b) Calculate B's resistance at 3.0 V. **[1 mark]**

Answer / mark points: $R = 3.0 / 0.40 = 7.5 \, \Omega$. [1] Allow correct follow-through from (a).

3(c) Read the current at 6.0 V and calculate B's resistance at this setting. **[2 marks]**

Answer / mark points: $I \approx 0.50$ A. [1] Allow 0.49–0.51 A.

$R = 6.0 / 0.50 = 12 \, \Omega$. [1] This is greater than its resistance at 3.0 V.

3(d) A trainee predicts that doubling the potential difference from 3.0 V to 6.0 V doubles the steady current. Use Figure 2 to evaluate the prediction. **[2 marks]**

Answer / mark points: Doubling 0.40 A would give 0.80 A, but the graph gives only about 0.50 A. [1]

The prediction is not supported: current is not directly proportional to potential difference for this lamp. [1] Current still increases; it does not decrease.

3(e) Explain why B's resistance changes when its positive potential difference is increased from 3.0 V to 6.0 V. **[3 marks]**

Answer / mark points: The current increases, transferring energy electrically to the filament. [1]

The filament temperature increases. [1]

Its resistance increases. [1] A microscopic explanation may add that stronger lattice vibrations impede electron flow, but it is not needed for these three marks. Do not say that current levels off because resistance stops increasing.



4 Testing the diode

Component C is a diode. In Figure 3, positive potential difference means forward connection. Read currents to the nearest 10 mA for the calculations. Reverse current is too small to distinguish from zero at this graph's resolution.

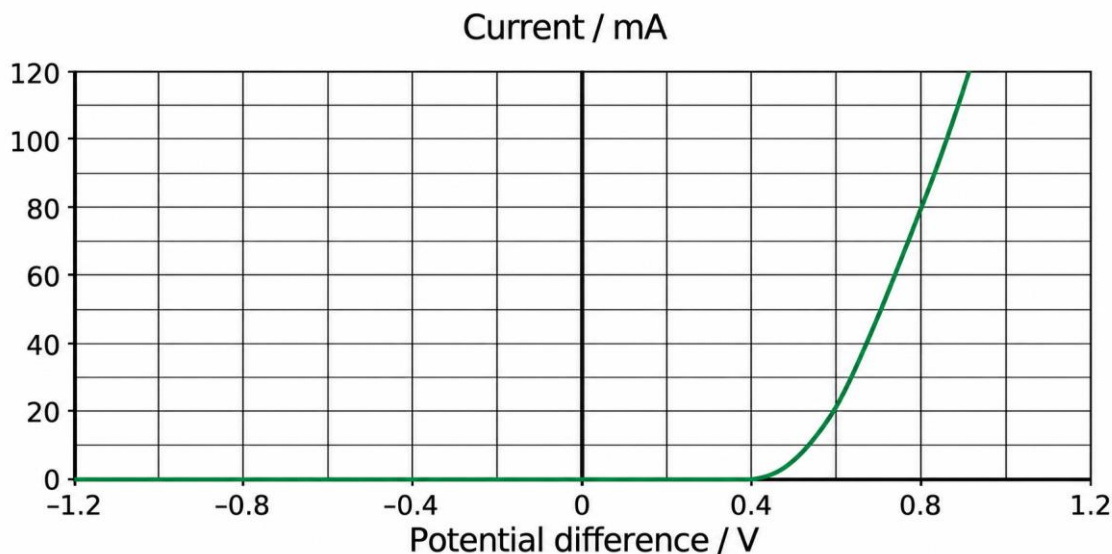


Figure 3

4(a) Read the current in C at 0.60 V, to the nearest 10 mA. [1 mark]

Answer / mark points: 20 mA. [1] This is 0.020 A, not 20 A.

4(b) Calculate C's resistance at 0.60 V. Show the current conversion. [2 marks]

Answer / mark points: 20 mA = 0.020 A. [1]
 $R = 0.60 / 0.020 = 30 \, \Omega$. [1] Allow consistent follow-through from their graph reading.

4(c) Use Figure 3 to calculate C's resistance at 0.80 V. Show the current conversion. [2 marks]

Answer / mark points: $I = 80 \, \text{mA} = 0.080 \, \text{A}$. [1]
 $R = 0.80 / 0.080 = 10 \, \Omega$. [1] The forward resistance is not constant.

4(d) At $-0.80 \, \text{V}$ the displayed current is indistinguishable from zero. Explain this behaviour of C. [2 marks]

Answer / mark points: C is connected in the reverse direction / reverse biased. [1]
 A diode has very high resistance in that direction, so the reverse current is negligible at the stated resolution. [1] No reverse-breakdown model is required.

4(e) A trainee uses the zero-current part of Figure 3 to claim that C has zero resistance in reverse. Explain why that conclusion is wrong. [2 marks]

Answer / mark points: At a non-zero potential difference, a very small current indicates very high resistance, not zero resistance. [1]
 An indistinguishable-from-zero reading does not give a finite numerical resistance by dividing V by zero. [1] It is not evidence of exactly zero physical leakage current at every possible resolution.



5 Choosing components for the lights

Use Component A from Figure 1, filament lamp B from Figure 2 and diode C from Figure 3. Each requirement below is a separate repair decision. Use only the stated operating range; do not design a whole circuit.

5(a) A test unit needs current directly proportional to potential difference in both directions. Choose A, B or C and justify using its graph. **[2 marks]**

Answer / mark points: A. Its graph is a straight line through the origin in both directions. [1]
At constant temperature it has constant resistance, so current is directly proportional to potential difference. [1] B is nonlinear; C conducts readily in only one direction.

5(b) A test channel must carry no more than 0.40 A at either 3.0 V or 6.0 V. Decide which of A and B meets this requirement. Justify using their currents at the two settings. **[2 marks]**

Answer / mark points: A meets the requirement: $I = V / R$ gives 0.15 A at 3.0 V and 0.30 A at 6.0 V, both below 0.40 A. [1]
B fails at 6.0 V because it takes about 0.50 A, even though it meets the limit at 3.0 V. [1] A conclusion based only on the lower setting is insufficient.

5(c) A different unit needs a component that conducts readily with one connection direction but has negligible current when the connections are reversed. Choose A, B or C and explain. **[2 marks]**

Answer / mark points: C, the diode, allows a substantial forward current under the tested conditions. [1]
Its very high reverse resistance makes current negligible when reversed. [1] A and B can carry current in both directions.

5(d) Calculate the current in A at 3.0 V and compare it with B's current at the same potential difference. Use your values to state which component has greater resistance at that setting. **[2 marks]**

Answer / mark points: For A, $I = 3.0 / 20 = 0.15$ A, smaller than B's approximately 0.40 A. [1]
A has greater resistance because it passes less current at the same potential difference. [1] The comparison must hold potential difference constant.

5(e) A trainee says that resistance always increases when potential difference increases for any nonlinear component. Use the lamp and diode results to challenge this claim. **[2 marks]**

Answer / mark points: B's resistance increases from 7.5 Ω to 12 Ω as V increases from 3.0 V to 6.0 V. [1]
C's forward resistance decreases from 30 Ω to 10 Ω as V increases from 0.60 V to 0.80 V. [1]
Nonlinear means the ratio V / I is not constant, not that it must change in one particular direction.



6 Checking the evidence and the axes

The team reviews two trainees' graph reports and repeats a lamp reading. Give reasons as well as conclusions when asked.

6(a) A trainee replots A with current vertically and potential difference horizontally. Using (2.0 V, 0.10 A) and (4.0 V, 0.20 A), calculate the gradient. Explain why that value is not A's resistance. **[2 marks]**

Answer / mark points: Gradient = change in I / change in V = $(0.20 - 0.10) / (4.0 - 2.0) = 0.050 \text{ A / V}$. [1]

These axes give I / V, not V / I; A's resistance is still 20 Ω . [1] No conductance terminology or reciprocal formula is required.

6(b) The lamp curve passes through the origin. A trainee divides 0 V by 0 A and calls its resistance zero. Explain how resistance at a chosen non-zero operating point should be found instead. **[2 marks]**

Answer / mark points: 0 / 0 does not define a resistance. [1]

Read V and I at the chosen non-zero point and use $R = V / I$; for example $3.0 / 0.40 = 7.5 \Omega$. [1] Do not replace this with the gradient of a tangent to the nonlinear lamp curve.

6(c) At 3.0 V, three repeat currents for B are 0.38 A, 0.40 A and 0.42 A. Calculate the mean current and use it to estimate the resistance. **[2 marks]**

Answer / mark points: Mean I = $(0.38 + 0.40 + 0.42) / 3 = 0.40 \text{ A}$. [1]

$R = 3.0 / 0.40 = 7.5 \Omega$. [1] Retain the same operating conditions when averaging.

6(d) A resistor's current falls while the potential difference across it stays at 4.0 V. Explain what has happened to its resistance, and suggest a temperature control before repeating the test. **[2 marks]**

Answer / mark points: $R = V / I$ increases when I falls at fixed V. [1]

Allow the resistor to return to the same starting temperature / keep temperature constant before comparison. [1] Heating is a possible explanation, not proved by these two readings alone.

6(e) A spare component gives one reading of 4.0 V and 0.20 A. Explain why this alone does not show that it is ohmic across the repair unit's full operating range, and describe the further evidence needed. **[2 marks]**

Answer / mark points: One pair gives its resistance at just one operating point, not whether that resistance stays constant. [1]

Measure several current–potential-difference pairs over the full range at constant temperature and check for a straight line through the origin / constant V / I. [1] The same single pair could lie on a nonlinear curve.

Review and improve

Model precise language: current increases, the filament temperature increases, and its resistance increases. A diode's negligible reverse current indicates very high resistance, not zero resistance. A graph through the origin is not necessarily directly proportional.

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