

Circuit fault finding and meter readings

AQA GCSE Combined Science Trilogy 8464 and Separate Physics 8463 | Paper 1 | Both tiers

Worked answers and marking guidance | 30 parts | 50 marks

Specification points covered

8463 4.2.1.1 / 8464 6.2.1.1: standard symbols and circuit interpretation
8463 4.2.1.2 / 8464 6.2.1.2: electrical current, charge flow and $Q = It$
8463 4.2.1.3 / 8464 6.2.1.3: potential difference, current and resistance ($V = IR$)
8463 4.2.2 / 8464 6.2.2: series and parallel circuits and meter readings

A technician repairs a model-railway lighting panel. Use circuit diagrams and measurements to locate faults, check meter connections and decide whether repairs have worked.

Original PhysicsUK practice, not an official AQA resource. Credit equivalent methods and consistent error carried forward (ECF). Model modules as fixed resistances. Ideal ammeters have negligible resistance; ideal voltmeters draw no current. Faults are independent unless a repair is specified.

1 Bench checks before reconnecting the panel

The technician tests modules X and Y separately. For these checks, current is measured through the module and potential difference is measured across it.

1(a) A meter symbol is a circle containing A. Name the quantity it measures. **[1 mark]**

Answer / mark points: Electrical current. [1] "Amps" is a unit, not the requested quantity.

1(b) How should a voltmeter be connected to measure the potential difference across module X? **[1 mark]**

Answer / mark points: In parallel across X, with one lead at each terminal. [1] Not in series with X.

1(c) X carries 100 mA when 6.0 V is measured across it on the bench. Calculate its resistance to check its label. **[2 marks]**

Answer / mark points: 100 mA = 0.100 A. [1]
 $R = V / I = 6.0 / 0.100 = 60 \Omega$. [1]

1(d) Y carries 50 mA when 6.0 V is measured across it on the bench. Calculate its resistance. **[2 marks]**

Answer / mark points: 50 mA = 0.050 A. [1]
 $R = 6.0 / 0.050 = 120 \Omega$. [1]



2 Expected readings on the healthy panel

Figure 1 shows the normal circuit. X models the platform lighting; Y models the signal-box lighting. The supply maintains 6.0 V between P and Q. All leads have negligible resistance. Both modules are working.

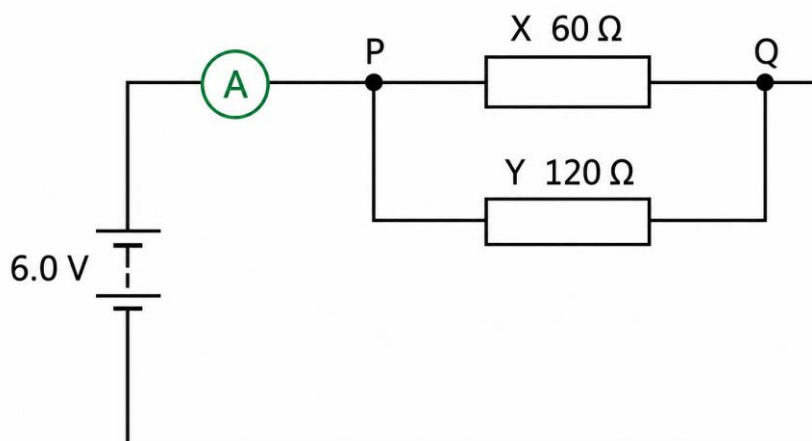


Figure 1

2(a) State the potential difference across X and across Y in Figure 1. Give a circuit reason for your answers. **[2 marks]**

Answer / mark points: X = 6.0 V and Y = 6.0 V. [1 for both]

Both branches connect across the same two supply junctions P and Q, so they have the same potential difference. [1]

2(b) Calculate the current through X in amperes. **[1 mark]**

Answer / mark points: $I = V / R = 6.0 / 60 = 0.100$ A. [1]

2(c) Calculate the current through Y in amperes. **[1 mark]**

Answer / mark points: $I = 6.0 / 120 = 0.050$ A. [1]

2(d) Calculate the reading of the ammeter in Figure 1. Give your answer in mA. **[2 marks]**

Answer / mark points: Supply current = $0.100 + 0.050 = 0.150$ A. [1]

0.150 A = 150 mA. [1] The ammeter is before the split; apply ECF from 2(b)–2(c).

2(e) The healthy panel runs for 2.0 minutes. Calculate the charge that passes through the supply ammeter. **[2 marks]**

Answer / mark points: $t = 2.0 \times 60 = 120$ s. [1]

$Q = It = 0.150 \times 120 = 18$ C. [1] Apply ECF from 2(d), using current in amperes.



3 Which fault fits the evidence

Return to Figure 1 before each independent test in Table 1. Only one fault is present per test. Possible faults are an internal break in Y, a broken lead in Y's branch outside the module, or reduced supply voltage. Module X remains $60\ \Omega$; an intact Y remains $120\ \Omega$. The last column is measured directly across Y's own terminals.

Table 1

Test	P to Q / V	Supply current / mA	Y current / mA	Across Y / V
A	6.0	100	0	6.0
B	3.0	75	25	3.0
C	6.0	100	0	0

3(a) Use test A to calculate the current through X. Give your answer in mA. **[1 mark]**

Answer / mark points: Current through X = total current – Y current = $100 - 0 = 100$ mA. [1]

3(b) Which listed fault fits test A? Explain why 6.0 V across Y does not mean that current must flow through it. **[2 marks]**

Answer / mark points: Y has an internal break / is open circuit. [1] Its terminals can still be connected across the supply, giving 6.0 V, but the broken conducting path prevents charge flow. [1] Do not infer zero resistance from zero current.

3(c) Which listed fault fits test C? Explain why the 0 V reading across Y distinguishes it from test A. **[2 marks]**

Answer / mark points: A lead in Y's branch is broken outside Y. [1] Y itself is intact but has zero current, so its own voltage is $V = IR = 0$ V; in A the supply voltage appears across the internal break. [1] A voltage across the external break would be 6.0 V.

3(d) For test B, calculate the expected current through X and through Y. Give both answers in mA. **[2 marks]**

Answer / mark points: X: $I = 3.0 / 60 = 0.050$ A = 50 mA. [1]

Y: $I = 3.0 / 120 = 0.025$ A = 25 mA. [1]

3(e) A trainee says test B proves that both modules have developed higher resistance. Evaluate this claim using the voltage and current readings. **[2 marks]**

Answer / mark points: The claim is not supported: the supply voltage is half normal, 3.0 V rather than 6.0 V. [1] Both branch currents are also half normal, so V / I remains $60\ \Omega$ for X and $120\ \Omega$ for Y; reduced supply voltage explains the readings. [1] Accept explicit resistance calculations using the two currents from 3(d).

3(f) The internal break in Y from test A is repaired, restoring Y to $120\ \Omega$. The supply remains 6.0 V. Predict the Y-branch current and total supply current in mA. **[2 marks]**

Answer / mark points: Y current = $6.0 / 120 = 0.050$ A = 50 mA. [1]

Total current = $100 + 50 = 150$ mA. [1]



4 A high-resistance contact

For this separate test, Y is disconnected. Figure 2 contains a corroded contact C in series with X. The supply is 6.0 V, the ammeter reads 75 mA and the voltmeter across X reads 4.5 V. X should be 60 Ω . C is the only additional resistance.

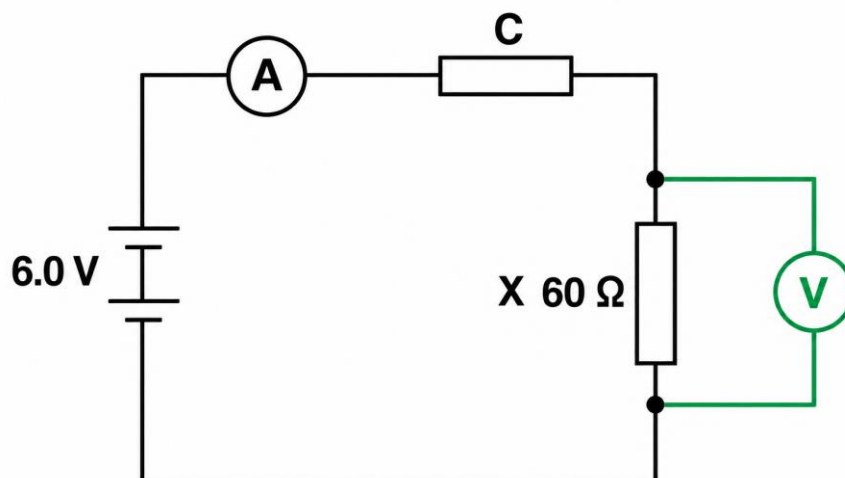


Figure 2

4(a) State the current through C in Figure 2 and explain how you know. [1 mark]

Answer / mark points: 75 mA: C and X are in the same series loop, and the ideal voltmeter draws no current. [1 for current with valid reason]

4(b) Use the two meter readings to calculate the resistance of X. Does it agree with the 60 Ω label? [2 marks]

Answer / mark points: 75 mA = 0.075 A. [1]
 $R = 4.5 / 0.075 = 60 \Omega$, agreeing with the label. [1]

4(c) Calculate the potential difference across C. [1 mark]

Answer / mark points: Voltage across C = $6.0 - 4.5 = 1.5$ V. [1] The supply voltage is shared between C and X.

4(d) Calculate the resistance of C. [1 mark]

Answer / mark points: $R = 1.5 / 0.075 = 20 \Omega$. [1] Use the current already converted in 4(b); apply ECF from 4(c).

4(e) X works normally only when it receives at least 5.0 V. Is replacing X justified by these readings? Explain using the evidence. [1 mark]

Answer / mark points: No: X has the correct 60 Ω resistance, but the contact leaves only 4.5 V across it, below 5.0 V. [1] The evidence identifies the contact, not a wrong-resistance X.



5 A meter creates a new fault

The contact fault has been removed and both healthy modules are reconnected. A trainee then connects the voltmeter as shown in Figure 3. The supply still maintains 6.0 V between P and Q. Use the ideal-meter model stated on page 1.

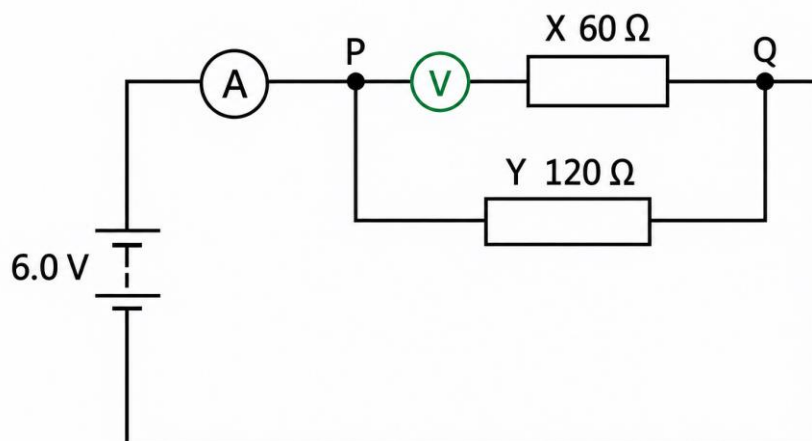


Figure 3

5(a) Identify the voltmeter connection error in Figure 3 and explain its effect on current through X. [2 marks]

Answer / mark points: The voltmeter is in series with X, instead of across it. [1] The ideal voltmeter draws no current, so the current in X's branch is zero. [1] For a real high-resistance voltmeter, accept a negligibly small current rather than exactly zero.

5(b) Calculate the supply ammeter reading in Figure 3. Give your answer in mA. [1 mark]

Answer / mark points: Only Y conducts: $I = 6.0 / 120 = 0.050 \text{ A} = 50 \text{ mA}$. [1] Not zero: Y's complete branch remains across the supply.

5(c) Predict the voltage across X and the reading of the misplaced voltmeter. Explain how these readings fit the zero current through X. [3 marks]

Answer / mark points: Voltage across X = 0 V. [1] The misplaced voltmeter reads 6.0 V. [1] Zero current through the finite 60Ω X gives $V = IR = 0$; the full branch voltage is across the ideal voltmeter. [1] The two voltages still sum to the 6.0 V between P and Q.

5(d) Describe the two wiring changes needed to measure X's potential difference correctly and restore its branch. [2 marks]

Answer / mark points: Remove the voltmeter from the series path and reconnect that path with a wire. [1] Connect the voltmeter in parallel across X, one lead at each terminal. [1] Switch off before moving leads. Merely saying "put it in parallel" does not explain how the broken series path is restored.



6 Checking the repairs

Treat each check below independently. Use the stated circuit, not a fault carried over from an earlier question. The normal modules remain $X = 60\ \Omega$ and $Y = 120\ \Omega$.

6(a) After both wiring changes in 5(d), predict the supply ammeter and voltmeter readings. Give the current in mA. **[2 marks]**

Answer / mark points: Supply ammeter = 150 mA. [1] Voltmeter across X = 6.0 V. [1] The ideal voltmeter does not change the healthy branch currents.

6(b) To measure X's current, a trainee proposes putting an ammeter directly across X. Before switching on, explain why this is unsuitable and state where the ammeter should go instead. **[2 marks]**

Answer / mark points: An ammeter has negligible resistance; across X it makes a low-resistance path across the supply, risking a damaging large current. [1] Insert it in series in X's branch only. [1] Do not switch on the proposed connection. No finite numerical current is required or valid for an ideal zero-resistance short across an ideal voltage supply.

6(c) Return to the Figure 2 contact test with Y still disconnected. The contact is repaired so its resistance is negligible. Calculate the new current through X in mA and state the voltage across X. **[2 marks]**

Answer / mark points: X now has 6.0 V, so $I = 6.0 / 60 = 0.100\ \text{A} = 100\ \text{mA}$. [1]
Voltage across X = 6.0 V. [1]

6(d) Y is now reconnected in parallel with the repaired X branch across the steady 6.0 V supply. Calculate the total current in mA and explain why X's current does not decrease. **[2 marks]**

Answer / mark points: Total = $100 + 50 = 150\ \text{mA}$. [1]
X still has 6.0 V across the same $60\ \Omega$, so its current remains 100 mA; the added parallel branch increases total supply current. [1]

6(e) During a final healthy-panel test, 27 C passes through the supply ammeter at a steady 0.150 A. Calculate the test duration in seconds. **[1 mark]**

Answer / mark points: $Q = It$, so $t = Q / I = 27 / 0.150 = 180\ \text{s}$. [1]

6(f) A spare module carries 75 mA with 4.5 V across it. Calculate its resistance and decide whether it matches type X or type Y. Use only the resistance criterion. **[2 marks]**

Answer / mark points: $I = 0.075\ \text{A}$; $R = 4.5 / 0.075 = 60\ \Omega$. [1 for correct SI calculation]
It matches type X, not Y ($120\ \Omega$). [1] This checks resistance only, not all real-world compatibility or ratings.

Review and improve

Ask pupils to name the branch, measured quantity and supporting evidence. Current is not used up; voltage can exist across an open component. A meter reading is useful only when its position is understood. Timing is estimated, not trialled. No required-practical completion claim.

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