

AQA AS Current potential difference and resistance worksheet

35–40 minutes independent practice + 15–20 minutes review | 50 marks

Specification points covered

• 3.5.1.1 Basics of electricity: current $I = \Delta Q / \Delta t$; potential difference $V = W / Q$; resistance $R = V / I$.

• 3.5.1.2 Current–voltage characteristics: Ohm's law at constant physical conditions; ohmic conductors, filament lamps and semiconductor diodes; ideal meters; either axis orientation.

Scenario Asteria launch-site anti-icing tests

Before launch, heater H clears frost from a spacecraft's optical window. Engineers separately test H, filament indicator lamp L and protection diode D on a low-voltage bench rig.

Meters are ideal unless stated otherwise. Show working, units and sensible significant figures.

Charge and energy in the heater

1. Define electric current. [1 mark]

2. During a short heater test, 0.480 C of charge passes a point in 1.60 s. Calculate the mean current. [1 mark]

3. The heater then carries a constant current of 0.360 A for 2 min 30 s. Calculate (a) the charge transferred and (b) the number of electrons passing a point. The magnitude of the electron charge is 1.60×10^{-19} C. [3 marks]

4. The potential difference across the heater is 12.0 V. Explain what this means in terms of energy and charge, then calculate the energy transferred when 18.0 C passes through it. [2 marks]

5. A technician says, 'The heater uses up charge, so the steady current leaving it is smaller than the current entering it.' Explain why this statement is incorrect. [2 marks]

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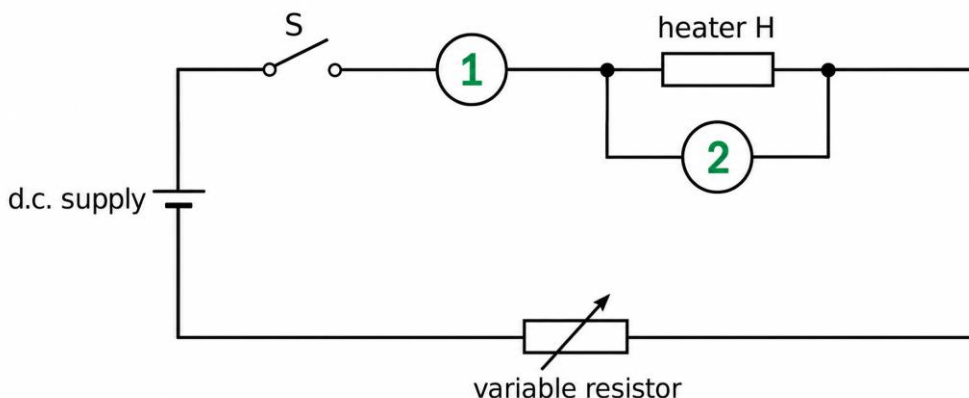
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Measuring the heater resistance

6. Figure 1 shows the test circuit. Identify meters 1 and 2, and explain why each is connected in its shown position. Switch S is closed for all measurements. [2 marks]



7. State the resistance of an ideal ammeter and an ideal voltmeter. Explain why the ideal voltmeter in Figure 1 draws no current. [2 marks]

8. The correctly connected ideal meters give 1.44 A and 8.64 V for the heater. Calculate its resistance. Explain why this single pair of readings cannot establish that the heater obeys Ohm's law. [2 marks]

9. A replacement ammeter has resistance $0.500\ \Omega$ and carries 1.20 A. Calculate the potential difference across this ammeter. Explain how its resistance affects the heater current at a fixed supply voltage and variable-resistor setting. Treat the heater resistance as constant. [2 marks]

10. An ideal voltmeter is mistakenly placed in series with the heater, with no other current path. Predict the current and explain your answer. [2 marks]

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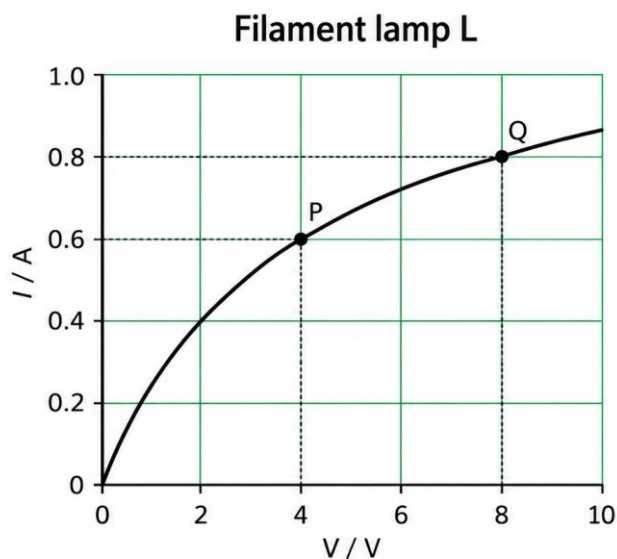
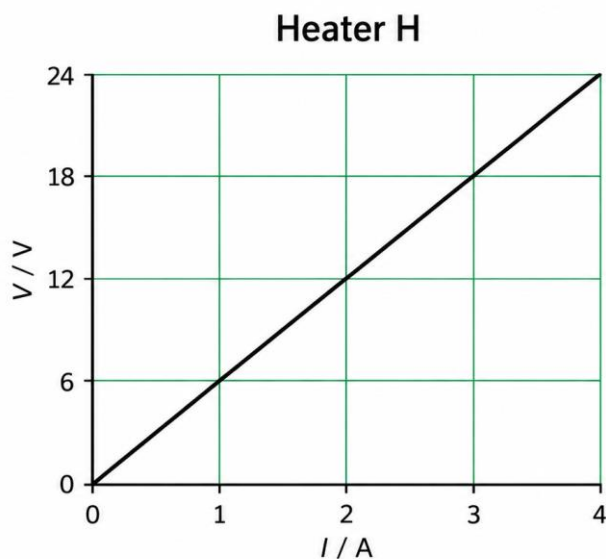
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Interpreting I–V characteristics

11. Figure 2 shows measurements from separate tests of heater H and filament lamp L. Use the gradient of the heater graph to determine its resistance. State the feature of this graph that is consistent with Ohm's law at constant temperature. [2 marks]



12. Using points P and Q on the lamp graph, calculate the resistance at each point. Explain the increase in resistance in terms of temperature, lattice ions and conduction electrons. [4 marks]

13. A technician calculates $\Delta V / \Delta I$ between P and Q as $20 \, \Omega$ and calls this 'the lamp's resistance at Q'. Evaluate this claim, giving the correct resistance at Q. [2 marks]

14. The lamp is operating at Q. The supply polarity is reversed to give $-8.0 \, \text{V}$ under otherwise identical conditions. State (a) the current, including its sign, and (b) the resistance. [2 marks]

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The protection diode and characteristic sketches

Table 1 Diode measurements at constant temperature. Reverse breakdown is not reached. Currents smaller than 0.01 mA in magnitude are recorded as 0.00 mA.

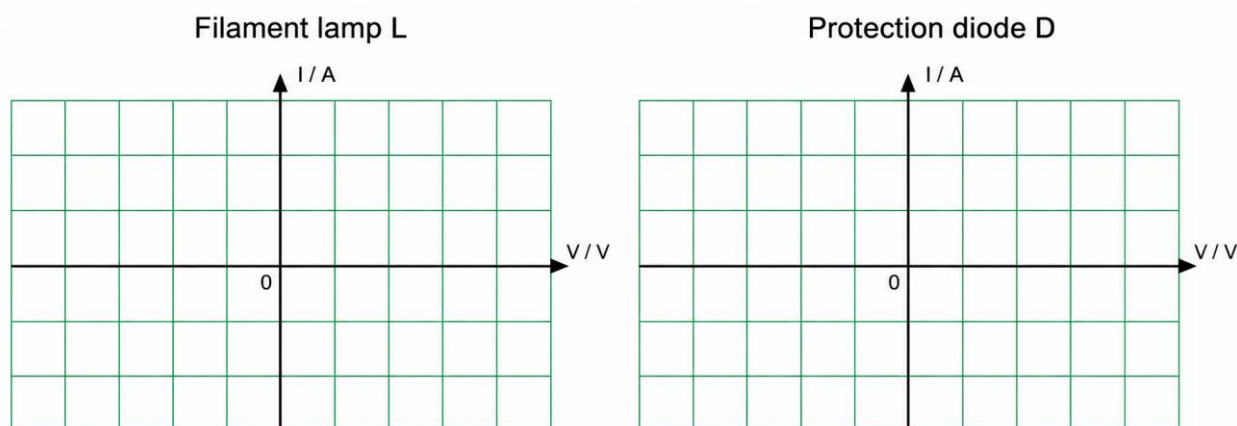
V / V	-1.00	-0.60	0.00	+0.40	+0.60	+0.70
I / mA	0.00	0.00	0.00	0.02	2.00	12.0

15. Table 1 gives results for protection diode D. Calculate its resistance at +0.60 V and at +0.70 V. Use these results to decide whether the diode obeys Ohm's law. [3 marks]

16. The diode is held at +0.70 V for 25.0 s. Use Table 1 to calculate (a) the charge transferred and (b) the energy transferred in the diode. [2 marks]

17. The diode should allow current from the battery to the control panel. It is accidentally installed in reverse, with -0.60 V across it. State the effect on this current, using Table 1. [1 mark]

18. Sketch the complete I-V characteristic of each component on Figure 3, including positive and negative potential differences. The axes have no numerical scale. Diode reverse breakdown is outside the range considered. [4 marks]



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Planning and checking the anti-icing test

19. Describe a method to obtain the filament lamp's full I–V characteristic and test whether the heater obeys Ohm's law. Organise your answer around: circuit and control; range and signs of readings; reliability and safety; analysis and temperature control. [6 marks]

20. In a separate test, the heater gives 2.00 A at 12.0 V and, after becoming hotter, 3.20 A at 24.0 V. A technician claims that this contradicts Ohm's law. Calculate both resistances and evaluate the claim. [2 marks]

21. A window needs at least 3.60 kJ transferred to its heater within 2.00 min. The heater operates steadily at 12.0 V and 2.00 A. Using charge transferred and energy per unit charge, determine whether the target is met and calculate the minimum time required to transfer 3.60 kJ. Assume no change in current or potential difference. [3 marks]

Review and improve

Check one mA conversion and one graph calculation.

Correct any statement that confuses charge with energy, or omits the constant-temperature condition for Ohm's law.

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