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IGCSE PHYSICS 0625 · TOPICAL PAST PAPERS

Electric Current — Paper 2

Worked Solutions (Theory / Structured)

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Electric Current — Paper 2 · Worked Solutions

Megalecture worked solutions — model answers with working; please verify before classroom use. These solutions for the topical structured compilation on **Electric Current (IGCSE Physics 0625, Paper 2)** were prepared from first principles by the Megalecture team. Calculations use the standard relations $Q = It$, $V = IR$, $E = QV$ and the series/parallel rules for cells and resistors, with data taken from each figure as given.

Question 1 · M/J 2005 P2 Q8 — three cells in series with a 15 Ω resistor

(a) The cells are in series, so the e.m.f.s add: total e.m.f. = 1.5 + 1.5 + 1.5 = **4.5 V**.

(b) Equation: $V = I\,R$ (so $I = V\,/\,R$).
$I = 4.5\,/\,15 = 0.30\ A$.

(c) One advantage of connecting cells in parallel: the battery **lasts longer** (larger charge capacity, so it can supply current for a longer time) — note that the e.m.f. of the parallel battery stays at **1.5 V**, the same as one cell.

Question 2 · M/J 2008 P2 Q6 — filament lamp rated 240 V, 0.20 A

(a) $R = V\,/\,I = 240\,/\,0.20 = 1200\ \Omega$.

(b) As the resistance rises from its low cold value to its high hot value (Fig. 6.1), the current does the opposite: at switch-on the current is **large**, then it **falls** rapidly and finally **levels off at a steady (lower) value** once the filament reaches its working temperature.

(c) Two differences that give the second filament a higher resistance: **1** it is **longer**; **2** it is **thinner** (smaller cross-sectional area). (Either a different metal of higher resistivity is also acceptable.)

Question 3 · M/J 2010 P21 Q6 — measuring current against p.d. for a lamp

(a) Component P is a **variable resistor (rheostat)**.

(b) The current–p.d. graph for a filament lamp is an **S-shaped curve through the origin** that **bends towards the p.d. axis** (gradient decreasing) as the p.d. increases — current rises less and less steeply for equal increases in p.d.

(c)(i) The resistance of the lamp **increases** as the p.d. increases.

(c)(ii) On the graph the curve gets **less steep** (the gradient I/V falls), so the ratio $V/I = R$ gets larger — i.e. equal steps in p.d. produce smaller and smaller increases in current, showing the resistance is rising (because the filament gets hotter).

Question 4 · M/J 2013 P21 Q6 — current–p.d. graph for a metal wire

(a) Ohm's law: **the current through a metallic conductor is directly proportional to the potential difference across it, provided the temperature (and other physical conditions) stay constant.**

(b) Read a point on the straight line, e.g. p.d. = 4.0 V gives current = 0.20 A.
$R = V / I = 4.0 / 0.20 = 20\ \Omega$.

(c)(i) Same metal and same length, but half the cross-sectional area. Resistance is inversely proportional to area, so halving the area **doubles** the resistance: $R_{new} = 2 \times 20 = 40\ \Omega$.

(c)(ii) The new wire has twice the resistance, so for any p.d. it carries **half the current**. Draw a straight line through the origin with **half the gradient** of the original — e.g. passing through (5.0 V, 0.125 A) instead of (5.0 V, 0.25 A).

Question 5 · M/J 2014 P21 Q11 — torch lamp, four 1.5 V cells in series

(a)(i) Potential difference across the lamp is the **work done (energy converted) per unit charge** passing through the lamp (1 V = 1 J/C).

(a)(ii).1 The graph is a **curve (not a straight line through the origin)**, so current is not proportional to p.d. — equal increases in p.d. give smaller increases in current.

(a)(ii).2 As the current increases the filament **gets hotter**, so its **resistance increases**, which holds the current back below a proportional value.

(a)(iii).1 From Fig. 11.1 at p.d. = 6.0 V the current ≈ 350 mA = **0.35 A**.

(a)(iii).2 $Q = I\,t = 0.35 \times (2.0 \times 3600) = 0.35 \times 7200 = 2520\ C$ (≈ 2.5 × 10^3 C).

(a)(iii).3 Energy supplied $E = Q\,V = V\,I\,t = 6.0 \times 2520 = 15\ 120\ J$ (≈ 1.5 × 10^4 J).

(a)(iii).4 It is only an estimate because the current is **not constant** over the 2.0 hours (the cells run down, so the p.d. and current fall) — 0.35 A is only an average/initial value.

(b) Two cells in parallel can supply **the same current for a longer time** (more charge stored), while still giving the same e.m.f. of 1.5 V as a single cell.

(c) The LED needs 3.0 V, so use **two cells in series (1.5 + 1.5 = 3.0 V)**, and connect **two such series-pairs in parallel**. Circuit: the two parallel branches, a **switch** and the **LED** all in one series loop, with the LED connected the correct way round (forward-biased).

Question 6 · M/J 2019 P21 Q5 — investigating a resistor R

(a) **Adjust the variable resistor** to change the current; for each setting record the matching ammeter and voltmeter readings, giving a range of values.

(b)(i) Ohm's law: **the current in a metallic conductor is directly proportional to the p.d. across it, provided the temperature stays constant.**

(b)(ii) Work out V/I for each row (convert mA to A):

V / V	I / A	R = V/I / Ω
7.6	0.320	23.8
5.2	0.220	23.6
2.4	0.100	24.0

The ratio V/I is **constant (≈ 24 Ω)**, so R is constant — the resistor obeys Ohm's law.

(b)(iii) The currents are a few hundred mA, so choose the **0–200 mA range for the smaller readings (100 mA)**, but the largest readings (220 mA and 320 mA) exceed 200 mA, so for those use the **0–10 A range**. In each case pick the **smallest range that the reading still fits inside**, for the best precision.

Question 7 · O/N 2011 P22 Q6 — measuring p.d. and current for a metal wire

(a)(i) A correct circuit has a **cell/battery and switch** in the main loop, the **metal wire (R)** with an **ammeter in series** with it, and a **voltmeter connected in parallel** across the wire. (A variable resistor in series lets the current be changed.)

(a)(ii) Close the switch; **vary the current** (adjust the variable resistor / supply). For each setting **read the voltmeter (p.d. across the wire) and the ammeter (current in the wire)** and record the pairs of values.

(a)(iii) Defining equation for resistance: $\mathrm{R} = \mathrm{V} \ / \ \mathrm{I}$.

(b) If V ∝ I then $\mathrm{R} = \mathrm{V}/\mathrm{I}$ is **constant**, independent of the current. So the graph of resistance against current is a **horizontal straight line** (parallel to the current axis), not passing through the origin.

Question 8 · O/N 2014 P22 Q7 — three 1.5 V cells in parallel, 6.0 Ω resistor and a resistance wire

(a)(i) One advantage of cells in parallel: the battery **lasts longer / can supply current for longer** (more charge available), while the e.m.f. stays the same as one cell.

(a)(ii) Cells in parallel give the same e.m.f. as one cell, so the p.d. between P and Q (across the battery) = **1.5 V**.

(b)(i) The 6.0 Ω resistor and the wire are in series across 1.5 V with current 0.075 A.
Total resistance $\mathrm{R}_{\mathrm{total}} = \mathrm{V} \ / \ \mathrm{I} = 1.5 \ / \ 0.075 = 20 \ \Omega$.
Resistance of the wire $= \mathrm{R}_{\mathrm{total}} - 6.0 = 20 - 6.0 = 14 \ \Omega$.

(b)(ii) When the wire gets hotter its **resistance increases**, so the total circuit resistance increases. With the e.m.f. unchanged, $\mathrm{I} = \mathrm{V}/\mathrm{R}$ means the current falls — the **ammeter reading decreases**.

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Note from Megalecture. Graph readings (Q4, Q5) are taken to the nearest sensible scale division, so the answers carry a small reading uncertainty. These are original Megalecture worked solutions prepared for revision use; please verify against the official mark scheme before classroom use.