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IGCSE PHYSICS 0625 · TOPICAL PAST PAPERS

Electric Circuits — Paper 2

Worked Solutions (Theory / Structured)

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Electric Circuits — Paper 2 · Worked Solutions

Megalecture worked solutions — model answers with working; please verify before classroom use. These solutions cover the topical **structured (Paper 2)** questions on **Electric Circuits (IGCSE Physics 0625)**. Each part was solved from first principles by the Megalecture team; series and parallel combinations, $V = IR$ and potential-divider results were checked numerically. Final answers are shown in **bold** with units. Keep an eye on the exam reference printed on each card — the part labels (a), (b), (i), (ii)… follow the original paper.

Question 1

M/J 2007 · Paper 2 · Q7

12 V supply. One branch: the 6 Ω and 3 Ω in parallel, in series with ammeter A; the other branch: the 2 Ω and 4 Ω in series. Both branches are connected straight across the 12 V supply.

(a)(i) Combined resistance of 2 Ω and 4 Ω in **series**:

$$\mathrm{R = R_1 + R_2 = 2 + 4 = 6.0\ \Omega}$$

(a)(ii) Combined resistance of 3 Ω and 6 Ω in **parallel**:

$$\mathrm{1/R = 1/3 + 1/6 = 2/6 + 1/6 = 3/6 \ \rightarrow\ R = 2.0\ \Omega}$$

(b) Ammeter reading (current in the parallel-combination branch). This branch has resistance 2.0 Ω across the full 12 V:

$$\mathrm{I = V\ /\ R = 12\ /\ 2.0 = 6.0\ A}$$

(c) p.d. across the 4 Ω resistor. The other branch (2 Ω + 4 Ω = 6 Ω) carries I = 12/6 = 2.0 A:

$$\mathrm{V_4 = I \times R = 2.0 \times 4 = 8.0\ V}$$

Question 2

M/J 2011 · Paper 22 · Q5

Low-voltage lighting circuit, 12 V supply, lamps A, B, C.

(a) Circuit completion (description): connect an **ammeter in series with the supply** (it then reads the total current). Lamp A is wired so it is permanently in the circuit (on all the time). Lamps B and C are joined **in series with each other**, with a **switch** in that B–C branch so they turn on/off together; that B–C branch is in **parallel** with lamp A across the 12 V supply.

(b)(i) Resistance of lamp B (V = 8.0 V, I = 50 mA = 0.050 A):

$$\mathrm{R = V\ /\ I = 8.0\ /\ 0.050 = 160\ \Omega}$$

(b)(ii) B and C are in series, so the same current flows through both:

$$\mathrm{I_C = I_B = 50\ mA = 0.050\ A\ (50\ mA)}$$

Question 3

M/J 2014 · Paper 22 · Q11

18 V supply; fixed resistor R in series with a 50 Ω potentiometer (rheostat/divider) feeding a filament lamp rated 12 V, 0.25 A.

(a) Ammeter (A) is placed in series in the main line carrying the lamp current; voltmeter (V) is connected in parallel across the filament lamp.

(b) Including R limits the current and lets a p.d. be dropped across it, so the voltage across the lamp can be varied down from 18 V to 0 (and R protects the lamp from excessive current near the top of the range). **R acts as a protective/limiting series resistor and shares the supply voltage.**

(c)(i) Graph for the filament lamp: a curve through the origin that **bends towards the voltage axis** as V rises (current rises less steeply at higher voltage), reaching 0.25 A at 12 V — resistance increases as the filament heats up.

(c)(ii) The fixed resistor gives a **straight line through the origin** (constant resistance, obeys Ohm's law at constant temperature), whereas the filament-lamp line **curves** (resistance increases with temperature). **Fixed resistor: linear; lamp: curved.**

(d)(i) Current in the 50 Ω resistor. The lamp (12 V) is connected across the lower part of the divider, so the full 50 Ω element has 12 V across it:

$$I_{50} = V \ / \ R = 12 \ / \ 50 = 0.24 \text{ A}$$

(d)(ii) Current in R = current from the supply = current in 50 Ω element + lamp current:

$$I_R = 0.24 + 0.25 = 0.49 \text{ A}$$

(d)(iii) p.d. across R = supply − lamp voltage:

$$V_R = 18 - 12 = 6.0 \text{ V}$$

(d)(iv) Resistance of R:

$$R = V_R \ / \ I_R = 6.0 \ / \ 0.49 = 12 \ \Omega \ (12.2 \ \Omega)$$

Question 4

M/J 2015 · Paper 21 · Q6

6.0 V supply with a 60 Ω resistor and lamp L (rated 6.0 V, 0.90 W) connected in ***parallel****, so each has the full 6.0 V across it.*

(a)(i) Current in the 60 Ω resistor:

$$I = V / R = 6.0 / 60 = 0.10 \text{ A}$$

(a)(ii) Current in the power supply = resistor current + lamp current. Lamp current = P / V = 0.90 / 6.0 = 0.15 A:

$$I_{supply} = 0.10 + 0.15 = 0.25 \text{ A}$$

(b)(i) New circuit: the second lamp is in **series with the 60 Ω resistor**, and this series combination is connected **in parallel with lamp L** across the supply. (Battery — then two parallel branches: branch 1 = lamp L; branch 2 = 60 Ω in series with the second lamp.)

(b)(ii) The second lamp is in series with the 60 Ω resistor, so the resistor drops part of the 6.0 V; the second lamp therefore gets **less voltage and a smaller current** than lamp L (which has the full 6.0 V), so it dissipates less power and is **dimmer**.

Question 5

M/J 2016 · Paper 21 · Q8

Battery with a 1000 Ω fixed resistor in series with a variable resistor R (single loop / series circuit).

(a)(i) In a series circuit the current is the same everywhere:

$$I_B = I_1 = I_2$$

(a)(ii) The supply p.d. is shared between the two series resistors:

$$V_B = V_1 + V_2$$

(b) Current in R, with V_B = 9.0 V and total resistance = 1000 + 500 = 1500 Ω:

$$I = V / R_{total} = 9.0 / 1500 = 6.0 \times 10^{-3} \text{ A } (6.0 \text{ mA})$$

Question 6

M/J 2017 · Paper 21 · Q5

A 20 Ω resistor in series with a parallel pair (20 Ω and 40 Ω).

(a) Total resistance. First the parallel pair:

$$1/R_P = 1/20 + 1/40 = 2/40 + 1/40 = 3/40 \;\rightarrow\; R_P = 40/3 = 13.3\ \Omega$$

$$R_{total} = 20 + 13.3 = 33\ \Omega\ (33.3\ \Omega)$$

(b) Comparing the voltmeter readings: the same current flows through the single 20 Ω resistor (V_1) and into the parallel section. The two parallel resistors have the **same p.d.** across them, so $\mathbf{V_2 = V_3}$. Since the parallel combination (13.3 Ω) is smaller than 20 Ω, it drops less voltage, so:

$$V_1 \text{ is the largest; } V_2 = V_3 \text{ (both smaller and equal).}$$

Question 7

M/J 2018 · Paper 22 · Q10

Battery with a 10 Ω resistor in series with a 40 Ω resistor (single loop). p.d. across the 40 Ω resistor = 9.6 V.

(a) Potential difference across a resistor is the **work done (energy transferred) per unit charge** as charge passes through the resistor (electrical energy converted to other forms per coulomb).

(b)(i) Current in the 40 Ω resistor:

$$I = V\ /\ R = 9.6\ /\ 40 = 0.24\ A$$

(b)(ii) Series circuit, so I = 0.24 A everywhere. p.d. across 10 Ω = 0.24 × 10 = 2.4 V. e.m.f. = sum of p.d.s:

$$\text{e.m.f.} = 9.6 + 2.4 = 12\ V$$

(c) Best voltmeter for measuring 9.6 V: the **0–20 V** meter. The 0–2 V range is too small (9.6 V is off-scale); the 0–200 V range would put the reading near the bottom of the scale, giving poor precision. 9.6 V sits well across the 0–20 V scale. **Choose the 0–20 V voltmeter.**

(d)(i) Power produced in the 10 Ω resistor:

$$P = I^2R = (0.24)^2 \times 10 = 0.58\ W\ (0.576\ W)$$

(d)(ii) A resistor rated ½P (about 0.29 W) is **not suitable** because the actual power dissipated (0.58 W) exceeds its rating, so it would **overheat / be damaged**. **Power dissipated > rating, so it overheats.**

(e) When resistor R is added in **parallel** with the 40 Ω resistor:

- Current in 10 Ω resistor — increases: the parallel pair (40 Ω || R) has a smaller resistance than 40 Ω alone, so the total resistance of the circuit falls and the supply current rises.
- p.d. across 10 Ω resistor — increases: larger current through the unchanged 10 Ω gives a larger $V = IR$ across it.
- p.d. across 40 Ω resistor — decreases: the supply e.m.f. is fixed, so as the 10 Ω takes more voltage, less is left across the parallel section.

Question 8

O/N 2008 · Paper 2 · Q7

Motorcycle battery = six 2.0 V cells in series. Headlight has two identical filament lamps F and G in ***parallel****; F always lit, G switched by D. With D open the battery supplies 4.6 A.*

(a) Total e.m.f. of six 2.0 V cells in series:

$\text{e.m.f.} = 6 \times 2.0 = 12 \text{ V}$

(b) Completing the table (Fig. 7.2):

- Switch D open: only F is on. Battery current = current in F = 4.6 A; current in G = 0 A.
- Switch D closed: G (identical, in parallel) now carries the same current as F. Current in F = 4.6 A; current in G = 4.6 A; battery current = 4.6 + 4.6 = 9.2 A.

(c) Energy supplied when charge Q = 200 C moves through the circuit (E = QV, with V = e.m.f. = 12 V):

$E = Q \times V = 200 \times 12 = 2400 \text{ J}$

Question 9

O/N 2012 · Paper 21 · Q8

A 600 Ω resistor in series with a thermistor, an ammeter and a 20 V d.c. supply; a voltmeter is in parallel with the 600 Ω resistor. Ammeter reads 0.025 A.

(a)(i) Voltmeter reading = p.d. across the 600 Ω resistor:

$V = I \times R = 0.025 \times 600 = 15 \text{ V}$

(a)(ii) p.d. across the thermistor = 20 − 15 = 5.0 V (series), so:

$R_{\text{thermistor}} = V / I = 5.0 / 0.025 = 200\ \Omega$

(b)(i) As temperature rises, the resistance of the thermistor **decreases**.

(b)(ii) Lower total resistance → larger current, so the **ammeter reading increases**; the larger current through the fixed 600 Ω gives a larger V = IR, so the **voltmeter reading increases**. **Both readings increase.**

Question 10

O/N 2014 · Paper 21 · Q11

A 2.0 V battery is made from two 2.0 V cells in parallel. The battery, an ammeter, a 2.0 Ω resistor and a parallel pair (3.0 Ω and X) form a series loop. The 3.0 Ω resistor and X have a combined (parallel) resistance of 2.0 Ω.

(a)(i) Electromotive force (e.m.f.) is the **energy converted from other forms to electrical energy per unit charge** driven round the circuit by the source (electrical work done per coulomb by the cell).

(a)(ii) Two cells in parallel can supply a **larger current** / last longer (lower internal resistance) than a single cell, while keeping the same 2.0 V. **Larger maximum current / longer life.**

(b)(i) Total resistance = 2.0 Ω (single) + 2.0 Ω (parallel combination):

$$\mathrm{R_{total}} = 2.0 + 2.0 = 4.0\ \Omega$$

(b)(ii) Resistance of X, from the parallel pair (3.0 Ω ∥ X = 2.0 Ω):

$$1/\mathrm{X} = 1/2.0 - 1/3.0 = 3/6 - 2/6 = 1/6 \ \rightarrow\ \mathrm{X} = 6.0\ \Omega$$

(c)(i) Ammeter reading (current from the 2.0 V battery):

$$\mathrm{I} = \mathrm{V}\ /\ \mathrm{R_{total}} = 2.0\ /\ 4.0 = 0.50\ \mathrm{A}$$

(c)(ii) The current is 0.50 A, so a suitable meter range is **0–1 A** (gives a near mid-scale reading).

(d) X is in parallel with the 3.0 Ω resistor, so the main current splits between them and recombines:

$$\mathrm{I_X} = \mathrm{I_2} - \mathrm{I_3}\ \ (\text{equivalently } \mathrm{I_2} = \mathrm{I_3} + \mathrm{I_X}, \text{ where } \mathrm{I_2} \text{ is the current in the 2.0 } \Omega\ /\ \text{main line})$$

(e)(i) p.d. across the 2.0 Ω resistor (I = 0.50 A):

$$\mathrm{V} = \mathrm{I} \times \mathrm{R} = 0.50 \times 2.0 = 1.0\ \mathrm{V}$$

(e)(ii) p.d. across the 3.0 Ω resistor = p.d. across the parallel combination = total − 2.0 Ω drop:

$$\mathrm{V} = 2.0 - 1.0 = 1.0\ \mathrm{V}\ \ (= \mathrm{I} \times \mathrm{R_{parallel}} = 0.50 \times 2.0)$$

(f)(i) Reducing the supply from 12 V to 6.0 V dims the metal-filament lamp, so the filament is **cooler**; for a metal filament a lower temperature means a **lower resistance**. **Resistance decreases (filament cooler).**

(f)(ii) If resistance stayed constant the current would halve to 0.75 A; but the resistance actually falls, so the current does not drop as far. The new reading is therefore **greater than 0.75 A**.

Note from Megalecture. These are original Megalecture worked solutions prepared for revision use. Numerical answers were verified for series/parallel combinations, *V* = *IR* and potential-divider relations. Where an answer depends on circuit interpretation (for example the potential-divider current in Question 3, taken here as the full-element current 12 V / 50 Ω = 0.24 A), an alternative reading may change the figure slightly — please verify against the official mark scheme before classroom use.