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IGCSE PHYSICS 0625 · TOPICAL PAST PAPERS

Practical Electricity — Paper 2

Worked Solutions (Theory / Structured)

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Practical Electricity — Paper 2 · Worked Solutions

Megalecture worked solutions — model answers with working; please verify before classroom use. These structured-question solutions for **Practical Electricity (IGCSE Physics 0625, Paper 2)** were solved from first principles by the Megalecture team using the data in each question. Key relations used throughout: **P = VI**, **P = I²R = V²/R**, **E = Pt**, energy in kWh = power(kW) × time(h), cost = energy(kWh) × price per kWh, and fuse rating chosen just above the normal operating current. Bold values are the final answers with units.

Questions 1 – 5

Question 1 — Lamps in a house (parallel)

5054/02/M/J/03 Q6

(a) Each lamp must be drawn with its own switch, and every lamp+switch branch connected **in parallel across the live and neutral lines** (so each lamp gets the full mains voltage and can be switched independently). The single fuse stays in the live wire.

(b) Current in one 240 V, 30 W lamp.

> I = P / V = 30 / 240 = **0.125 A**

(c) Lamps in parallel, so currents add: I_{mains} = 3 × 0.125 = **0.375 A**.

Question 2 — Electric grill

5054/02 M/J/04 Q9

(b) The metal case is connected to **earth** (the earth pin / earth wire of the plug). If a fault makes the live wire touch the case, a large current flows straight to earth through the low-resistance earth wire; this **blows the fuse (or trips the breaker) and disconnects the supply**, so the case cannot stay live and give a shock.

(c)(i) Equation linking current, power and voltage:

> **P = V × I** (power = voltage × current)

(c)(ii) Normal current = 8.3 A, so choose the standard fuse rated **just above** this. The next standard value above 8.3 A is **13 A** (a 13 A fuse carries 8.3 A normally but blows on a fault).

(c)(iii) The student is **wrong**. For a fixed resistance heating element, P = V^2/R, so power depends on the *square* of the voltage.

> Halving V (240 → ~half): P ∝ V^2 → P becomes $(½)^2$ = **¼** of the original, not ½. So at 115 V the power is about **one quarter**, not half.

Question 3 — Two household appliances
5054/02/M/J/05 Q6

(a) Water heater (240 V, 12.6 A, 0.50 h): P = VI = 240 × 12.6 = **3024 W** = **3.024 kW**; energy/day = P × t = 3.024 × 0.50 = **1.51 kW h**.

appliance	power / W	power / kW	energy / kW h
water heater	**3024**	**3.024**	**1.51**

(b) At the same mains voltage the water heater takes a **much larger current** (12.6 A vs 1.20 A); since P = VI, the larger current means more power.

(c) The normal working current of the water heater is **12.6 A**, which is greater than 3 A. A 3 A fuse would **blow immediately** in normal use, so the heater could never operate. **A 3 A fuse is too small (a 13 A fuse is needed).**

Question 4 — Two lamps A and B
5054/02 M/J/06 Q?

(a) Component **C is a (variable) resistor / rheostat** — its purpose is to **control (limit/vary) the current** in the circuit. Component **D is a switch** — its purpose is to **turn the circuit on and off**.

(b) Lamp A is 240 V, 60 W; total current at C = 0.42 A.

(b)(i) Current in lamp A: I = P/V = 60/240 = **0.25 A**.

(b)(ii) A and B are in parallel, so $I_B = I_{total} - I_A$ = 0.42 − 0.25 = **0.17 A**.

(b)(iii) Resistance of lamp A: R = V/I = 240 / 0.25 = **960 Ω**.

(c) Two lamps wired in parallel: each lamp connected directly across the supply on its own branch, so both receive the full 240 V (correct domestic wiring).

(d) Same material and length but **half the cross-sectional area**. Since R ∝ 1/area, halving the area **doubles the resistance**: R_{new} = 2 × 960 = **1920 Ω**.

Question 5 — Mains extension lead
5054/02/M/J/06 Q6

(a)(i) **Live:** the wire that carries the alternating supply voltage (alternates above and below 0 V); it delivers current to the appliance and is the dangerous wire.

(a)(ii) **Neutral:** the return wire that completes the circuit; it stays at (or near) **0 V / earth potential**.

(a)(iii) **Earth:** a safety wire connected to the metal case (and to the ground); it carries current safely away to earth if a fault occurs.

(b)(i) As more lamps are switched on, the total current drawn through the single cable **increases** (so the cable gets hotter).

(b)(ii) A fuse of too high a value will **not blow when the current becomes dangerously large**; the cable/appliance can then overheat and start a fire.

(c) Water conducts electricity, so **wet hands lower the resistance** of the path through the body; if you touch a live part a larger current flows and gives a worse (possibly fatal) shock.

Questions 6 – 10

Question 6 — Lamp power & parallel/series circuits
5054/02 M/J/09 Q9 · M/J/11 Q9

(a) Experiment to check the power of a 24 V, 100 W lamp at 24 V: connect the lamp to a 24 V supply with an **ammeter in series** and a **voltmeter across the lamp**; adjust so the voltmeter reads 24 V; record the current I and voltage V; then **power = V × I** and compare this value with the marked 100 W.

(b)(i) Lamps in parallel across 240 V; lamp A = 190 Ω (branch R), lamp B = 380 Ω (branch Q).

> At R (lamp A): I = V/R = 240/190 = **1.26 A** | At Q (lamp B): I = 240/380 = **0.63 A** | At P (main): I = 1.26 + 0.63 = **1.89 A**

(b)(ii) Total resistance of the parallel combination:

> 1/R = 1/190 + 1/380 → R = (190×380)/(190+380) = **127 Ω** (or 240/1.89 ≈ 127 Ω)

(b)(iv) Drill of power 1000 W on a 240 V supply; choose a fuse from 1 A, 3 A, 4 A, 13 A.

> Normal current I = P/V = 1000/240 = 4.17 A. The fuse must be rated just above this, so a 4 A fuse would blow. The correct choice is the **13 A fuse** (the smallest standard value above 4.17 A).

(c)(i) Same two lamps now in series (190 Ω + 380 Ω) across 240 V; current at S:

> I = V/R = 240 / (190 + 380) = 240/570 = **0.42 A**

(c)(ii) P.d. across lamp B: $V_B = I \times R_B$ = 0.42 × 380 = **160 V**.

(d) The lamps are **brighter in parallel**. In parallel each lamp gets the full 240 V (so each dissipates more power, $P = V^2/R$), whereas in series they share the 240 V and each carries a smaller current, dissipating less power.

Question 7 — Hairdryer & electric heater (mains)
5054/22 M/J/15 Q7

(a) The earth wire provides a **low-resistance path to earth** for the current if a fault makes the live wire touch the metal case, keeping the case safe.

(b) If the live wire touches the metal case, a **large fault current flows through the earth wire to earth**; this large current **blows the fuse**, which breaks the live wire and disconnects the appliance, so the case is no longer live and cannot give a shock.

(c) The hairdryer has a plastic (insulating) case and **double insulation**, so a fault cannot make any touchable metal part live; therefore no earth wire is needed.

(d) A circuit breaker can be **reset (switched back on)** after it trips rather than being replaced — it is reusable, faster to restore, and trips more quickly/accurately than a fuse melts.

Question 8 — Washing machine (earth wire & energy)

5054/22 M/J/11 Q6

(a) If a fault connects the live wire to the metal case, the earth wire gives a **low-resistance route to earth**; a **large current flows and blows the fuse**, disconnecting the supply so the case cannot remain live and shock the user.

(b) Input power 500 W = 0.500 kW; time 45 min = 0.75 h.

> Energy = P × t = 0.500 × 0.75 = **0.375 kW h**

Question 9 — Room heater (two switched elements)

5054/21 M/J/12 Q9

(a)(i) A fuse is drawn as a small **rectangle (box) in the live wire**, in series with switch A (the fuse symbol is a line through a rectangle).

(a)(ii) The earth wire is connected to the **metal case / metal body** of the heater.

(a)(iii)1 A fault could make the **live wire touch the metal case**, so the case becomes live; if a person touches it, current passes through them to earth → electric shock.

(a)(iii)2 The earth connection gives a low-resistance path to earth, so a large current flows and **blows the fuse**, cutting off the supply before a person can receive a dangerous shock.

(c)(i) Both switches give 2100 W; switch A alone gives 600 W. The elements are in parallel so powers add: switch B alone = 2100 − 600 = **1500 W**.

(c)(ii)1 Both switches: 2100 W = 2.1 kW for 2.5 h.

> Energy = 2.1 × 2.5 = **5.25 kW h**

(c)(ii)2 In joules: E = P × t = 2100 × (2.5 × 3600) = 2100 × 9000 = **1.89×10^7 J** (18 900 000 J).

Question 10 — Freezer (kW h and cost)

5054/21 M/J/13 Q10

(a)(i) One **kilowatt-hour** is the energy transferred (used) by a device of power **1 kW operating for 1 hour** (= 3.6×10^6 J). It is the "unit" used for electricity bills.

(a)(ii) Power 80 W = 0.080 kW; one week = 7 × 24 = 168 h.

> Energy = 0.080 × 168 = 13.44 kW h
> Cost = 13.44 × 25 = 336 cents = **$3.36 (336 cents)**

Questions 11 – 16

Question 11 — Heater in a cup of water
5054/22 M/J/13 Q11

(a) Circuit to measure electrical power of the heater: heater connected to the power supply with an **ammeter in series** with the heater and a **voltmeter connected in parallel across the heater** (so V and I can be read together; power = V × I).

(b)(i) Supply 12 V, current 4.2 A.

> P = V × I = 12 × 4.2 = **50.4 W**

(b)(ii) Energy input in 8.0 min (= 480 s), then convert to kW h.

> E = P × t = 50.4 × 480 = 24 192 J
> In kW h: 24 192 ÷ 3 600 000 = **6.72×10^{-3} kW h** (0.00672 kW h)

(Equivalently: 0.0504 kW × (8/60) h = 0.00672 kW h.)

Question 12 — Hairdryer & electric heater (safety)
5054/22 M/J/15 Q7

(a) The neutral wire **completes the circuit**, providing the return path for the current back to the supply (it is at about 0 V).

(b) If a fault makes the **live wire touch the metal case**, the earth wire carries a **large current to earth**; this large current **blows the fuse**, breaking the live connection so the case is no longer live — protecting the user from a shock.

(c) The hairdryer is **double-insulated** with a plastic (non-conducting) case, so no exposed metal part can become live; an earth wire is therefore unnecessary and it is still safe.

(d) A circuit breaker can simply be **reset (switched back on)** after a fault — it is reusable and acts faster, unlike a fuse which must be replaced each time it blows.

Question 13 — Electrical generator supplying a factory
5054/21 M/J/16 Q11

(b)(i)1 Power 500 kW delivered at 33 kV; current in the supply wires.

> I = P / V = (500 000 W) / (33 000 V) = **15.2 A**

(b)(i)2 Electrical energy supplied in 1 hour:

> E = P × t = 500 000 × (1 × 3600) = **1.8×10^{9} J** (= 500 kW h = 1800 MJ)

Question 14 — Television and two lamps
5054/21 M/J/17 Q?

(a)(i) Total power = television + 2 lamps = 120 + 40 + 40 = **200 W**.

(a)(ii) Energy in 3.0 h: E = P × t = 0.200 kW × 3.0 h = **0.60 kW h**.

(a)(iii) Each lamp is 40 W across 240 V (parallel): I = P/V = 40/240 = **0.167 A** (0.17 A).

(b) A switch is placed in the **live wire** so that when it is off the appliance is **disconnected from the dangerous live (high-voltage) supply**. If the switch were in the neutral wire, the appliance would still be connected to the live wire — it could remain live and give a shock even when "switched off".

Question 15 — Three resistors (3.3 Ω, 3 W each)

5054/21 M/J/18 Q5

(a) Method: connect the three resistors in the circuit with a battery, a variable resistor (rheostat), a **voltmeter across one resistor** and an **ammeter in series**; vary the current, record V and I, and find resistance from **R = V / I** (taking several readings / a graph improves accuracy).

(b)(i) P.d. 4.2 V across the resistor, current 1.2 A.

> $R = V / I = 4.2 / 1.2 =$ **3.5 Ω** (close to the marked 3.3 Ω)

(b)(ii) The resistor overheats because the power dissipated exceeds its 3 W rating.

> $P = V \times I = 4.2 \times 1.2 =$ **5.04 W** (> 3 W rating → overheats and smokes)

(b)(iii) With one resistor removed, the other two (3.3 Ω each) are in **series** across 4.2 V.

> $I = 4.2 / (3.3 + 3.3) = 0.64$ A; power in each $= I^2R = 0.64^2 \times 3.3 \approx 1.3$ W

Each resistor now dissipates only ≈ 1.3 W, which is **below the 3 W rating**, so they **do not overheat — they are safe**.

Question 16 — Fuses and a lighting circuit

5054/22 M/J/18 Q8

(a) Two other forms of protection in household circuits: **1. earth wire** (connects metal cases to earth); **2. circuit breaker / trip switch** (cuts the supply on excess current). *(Other accepted: insulation of wires, double insulation.)*

(b)(i) Wire W is the live wire because it is the wire that contains the **fuse and the switches** (protection and switching are always placed in the live wire).

(b)(ii) A switch that controls the lamps must be placed at the position **in the live wire before the lamps branch (point s)**, so that opening it isolates the lamps from the live supply.

(b)(iii) A 5 A fuse means the fuse wire **melts and breaks the circuit if the current exceeds 5 A**, disconnecting the lamps to prevent the wires overheating (the lamps' normal total current is below 5 A).

Note from Megalecture. These are original Megalecture worked solutions prepared for revision use; they were solved independently from the question papers and are *not* copied from any official mark scheme. Final numerical answers are shown in bold with units; please verify before classroom use.