

Answer **all** the questions.

- 1 (a) State the difference between the directions of conventional current and electron flow in a circuit.

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.....[1]

- (b) Define *potential difference*.

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.....[1]

- (c) (i) Define the *kilowatt-hour* (kWh).

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.....[2]

- (ii) An electric kettle of power rating 1800W can be operated for a total time of 1500 hours during its life. Calculate the total cost of operating this kettle given that the cost of each kWh is 9.0 p.

cost = £ [2]

[Total: 6]

2822 Electrons and Photons

Question	Expected Answers	Marks	Additional Guidance
1 a	Opposite (direction)	B1	Allow 'positive to negative for one and negative to positive for other' even if physics is incorrect (1) Not 'different' direction(s) - because this is stated in question
b	(p.d =) energy (transfer)/charge	B1	Allow $(V =) \frac{W}{Q}$ or $(V =) \frac{E}{Q}$ where W (or E) = energy / work (done) and Q = charge. (1) For mark above, there is no need to define V . Not energy lost by unit charge / by coulomb
c	i (The kilowatt-hour is) the <u>energy</u> (transferred) / <u>work</u> (done) when a <u>1 kW</u> device is operated for <u>1 hour</u>	M1 A1	For a mark the idea of 'division' or 'per' is important The first mark is for realising that kW h is an <u>energy</u> or <u>work</u> (done) unit. The second mark is for referring to 1kW (or 1000 W), <u>and</u> 1 hour (or 3600 s). The second mark can only be awarded if the first mark has been scored.
	ii (Number of kW h =) 1.8×1500 (= 2700) (cost =) 2700×9.0 cost = (£) 243 or 240	C1 A1	Not 'power transferred by a 1 kW device working for 1 hour'. Special cases: Allow 1 mark for bald 2700 Allow 2 marks for bald 243 or 240 Allow 1 mark for $\text{£}2.43 \times 10^5$ (only one error made for not converting the power into kilowatts) Allow 1 mark for $\text{£}2.43 \times 10^4$ (only one error made for not converting pence into pounds) Not $\text{£}2.43 \times 10^7$ or $\text{£}24300000$ because two errors have been made (working in pence and watts) Reject bald 2.7×10^6 for multiplying 1800 and 1500
Total		6	

Question	Expected Answers	Marks	Additional Guidance
5 a	<p>Kirchhoff's first law:</p> <ul style="list-style-type: none"> Charge is conserved Sum of currents into a point = sum of currents out from (the same) point <p>Kirchhoff's second law:</p> <ul style="list-style-type: none"> Energy is conserved Sum of e.m.f.s in a loop = sum p.d.s in the (same) loop <p>Photoelectric effect:</p> <ul style="list-style-type: none"> Energy is conserved <p>Any <u>two</u> further marks from:</p> <ul style="list-style-type: none"> A single photon interacts with an electron $hf = \phi + KE_{\text{(max)}}$ Electron removed when photon energy $\geq \phi$ frequency \geq threshold frequency (wtte) 	<p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p>	<p>Must show ticks on the script to indicate where marks are being awarded</p> <p>Must see "sum of/total" wtte, on both sides of equals.</p>
	QWC		For QWC marks, the answer must involve physics, which attempts to answer the question – otherwise the mark for QWC is zero.
	Structure and organisation mark	B1	Award this mark if the whole answer is well structured (Bulleted answers are allowed)
	Spelling and Grammar mark	B1	More than two spelling mistakes <u>or</u> more than two grammatical errors mean that this mark is lost
	Total	9	

5 (a) Kirchhoff's first and second laws can be used to analyse any electrical circuit. They are a consequence of the conservation of physical quantities in the circuit.

(i) State Kirchhoff's **first** law and the physical quantity conserved.

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(ii) State Kirchhoff's **second** law and the physical quantity conserved.

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(b) A physical quantity is also conserved in the photoelectric effect. Describe and explain the photoelectric effect.



In your answer you should link the description to the conservation of this quantity.

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[Total: 10]

Question			Expected Answers	M	Additional Guidance
5					
	a	i	(sum of/total) current into a junction equals the (sum of/total) current out conservation of charge	B1 B1	total vector sum of currents is zero
		ii	(sum of) e.m.f.s = (sum /total of) p.d.s/sum of voltages in/around a (closed) loop (in a circuit) energy is conserved	B1 B1	
	b		a photon is absorbed by an electron (in a metal surface); causing electron to be emitted (from surface). Energy is conserved (in the interaction).	B1 B1 B1	not hits QWC mark
			Only photons with energy/frequency above the work function energy/threshold frequency will cause emission Reference to Einstein's photoelectric energy equation (energy of photon) = (work function of metal) + (maximum possible kinetic energy of emitted electron) work function energy is the <u>minimum</u> energy to release an electron from the surface Number of electrons emitted also depends on light intensity Emission is instantaneous	B1 B2 B1 B1 B1	3 marks from 6 marking points in symbols only scores 1 mark out of 2, i.e. selects from formula sheet
			Total question 5	10	