Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
	substitution into P = V × I (1) 2600 = 230 × I rearrangement (1) I = P ÷ V evaluation (1) 11 (A)	Substitution and re-arrangement in either order I = 2600 ÷ 230 for 2 marks allow answers that round to 11 award full marks for correct answer without working allow I = 2.6 ÷ 230 for 1 mark allow 0.011 (A) for 2 marks max if no other marks scored, award 1 mark for 2.6 kW = 2600 W	**(3)**

Q2.

Question number	Answer	Additional guidance	Mark
i	substitution (1) $(I = \frac{P}{V})$ = 1.9 (x 10^3) / 230 (1) evaluation (1) 8.3 (A)	 8.3 / 8.26 (A) award full marks for correct answer without working award one mark for 8.26 x 10^{-3} / 0.0083	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
ii	choice and substitution (1) $E = I \times V \times t$ = 7.4 x 230 x 120 evaluation (1) 200000 (J)	 accept 204000 / 204240 award full marks for correct answer without working award 1 mark for 3400 / 3404 (J) (using 2 minutes as time)	**(2)** **AO2**

Q3.

Question number	Answer	Additional guidance	Mark
	conversion of time (1) 1 x 60 (s) substitution (1) (I =) $\frac{9000}{230 \text{ (x } 60)}$ evaluation (1) (I =) 0.65 (A)	 any value that rounds to 0.65; e.g. 0.65217 0.7 0.6 award full marks for the correct answer without working allow 2 marks for answer of 39(.130)	**(3)** **AO2**

Q4.

Question Number	Answer	Additional guidance	Mark
	2.5(A)	Accept $2\frac{1}{2}$ (A)	**(1)**

Q5.

Question Number	Answer	Additional guidance	Mark
(i)	substitution (1) (ΔQ) = 1.5 x 4200 x 50 evaluation (1) 320 000 (J)	 accept 315 000 (J) 310 000 (J) award full marks for the correct answer without working 320 000 000 315 000 000 310 000 000 score 1 mark (mass in grams)	**(2)**

Question Number	Answer	Additional guidance	Mark
(ii)	substitution (1) $3500 = \frac{670\,000}{t}$ rearrangement (1) $(t=) \frac{670\,000}{3500}$ evaluation (1) 190(s)	accept substitution and rearrangement in either order accept any answer that round to 190(s) power of ten error award 2 marks maximum award full marks for the correct answer without working	**(3)**

Q6.

Question Number	Answer	Additional guidance	Mark
	substitution (1) (Q=)0.9 x 50 evaluation (1) 45 unit (1) coulomb	 award 2 marks for the correct answer without working If no substitution seen 4.5 or 450 scores 1 mark only independent mark C, c, As Accept recognisable spellings of coulomb	**(3)**

Q7.

	Answer	Acceptable answers	Mark
	substitution (1) 10/0.44 or 250/11 evaluation (1) 23 (ohms)	give full marks for correct answer, no working 22.7(ohms),22.73 (ohms), 22.72(ohms) Ignore excessive decimal places.	**(2)**

Q8.

Question number	Answer	Additional guidance	Mark
(i)	Substitution and evaluation (1) 15 (Ω)		**(1)** **AO2**

Question number	Answer	Additional guidance	Mark
(ii)	select / recall (1) (power =) V x I or (power =) I^2 x R or (power =) $\frac{V^2}{R}$ substitution and evaluation (1) (power =) 1.4 (W)	 (power =) 4.5 x 0.3 0.3^2 x 15 $\frac{4.5^2}{15}$ allow 1.3(5) (W) award full marks for the correct answer without working	**(2)** **AO2**

Q9.

Question Number	Answer	Additional guidance	Mark
(i)	recall and substitution into V = IR (1) 5.0 = 0.26 x R rearrangement (1) (R =) $\frac{5.0}{0.26}$ evaluation (1) 19 (Ω)	accept substitution and rearrangement in either order (R =) $\frac{V}{I}$ $\frac{5.0}{0.26}$ scores 2 marks accept answers that round to 19 (Ω) (e.g. 19.23) accept answer written in table if not written on answer line. award full marks for the correct answer without working	**(3)**

Question Number:	Answer	Additional guidance	Mark
(ii)	a comment that includes the following points idea that resistance increases with potential difference (1) idea that doubling the potential difference does not result in doubling of resistance (1) **OR** V = constant x R is not supported by this data (1) correct processing of data from the table to support either of the above mark points (1)	idea that equal increments of potential difference do not cause equal increments of resistance reverse argument e.g. if student was correct then equal increments of p.d. would cause equal increment of resistance if student was correct then current would be constant ignore simple quoting of data for this mark	**(3)**

Q10.

Question number	Answer	Additional guidance	Mark
	substitution (1) 0.15 x 40 evaluation (1) 6(.0) (V)	award full marks for correct answer without working	**(2)** **AO2**

Q11.

	Answer	Acceptable answers	Mark
	substitute (1) 3 = I × 12 transformation (1) I = 3 ÷ 12 evaluation (1) 0 .25 (A) Ignore any unit given by candidate	Subst. and transform. either order 1 mark only can be scored for correct substitution after incorrect transposition. Accept any number of sig. figs. that rounds to 0.25 (A) 250 mA gains 3 marks give full marks for correct answer, no working 2.5 × any other power of ten = 2 marks eg 25 (A) gains 2 marks	**(3)**

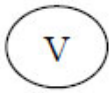
Q12.

Question Number:	Answer	Additional guidance	Mark
(i)	substitution (1) (P)= 0.12 x 0.24 evaluation (1) 0.029 (W)	 accept 0.03 (W), 0.0288(W) 0.028 (W) power of ten error is awarded 1 mark award full marks for the correct answer without working	**(2)** AO 2 1

Question Number:	Answer	Additional guidance	Mark
(ii)	chooses /uses (1) E= V x I x t evaluation (1) 1.4 (J)	E =0.3 x0.13 x35 accept an answer that rounds to 1.4 (J) e.g. 1.365(J) a maximum of 1 mark is awarded in the case of a power of ten error award full marks for the correct answer without working	**(2)** AO 2 1

Question Number:	Answer	Additional guidance	Mark
(iii)	substitution (1) (Q)=0.13 x 35 evaluation (1) 4.6 (C)	 accept an answer that rounds to 4.6 e.g. 4.55 or in this context allow 4.5 power of ten error is awarded 1 mark award full marks for the correct answer without working	**(2)** AO 2 1

Q13.

	Answer	Acceptable answers	Mark
(i)	 connected in parallel with lamp (1)	recognisable symbol such as a box with letter V inside or box with the word voltmeter inside it accept voltmeter across both lamp and ammeter	**(1)**
(ii)	Substitution R = 6.0 / 0.26 (1) Evaluation = 23 (1)	An answer which rounds to 23 Give full marks for correct answer no working	**(2)**

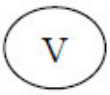
Q14.

Question number	Answer	Additional guidance	Mark
	<table><tr><th>part of plug</th><th>safety feature</th></tr><tr><td>cable grip</td><td>✓</td></tr><tr><td>earth wire</td><td>✓</td></tr><tr><td>fuse</td><td>✓</td></tr><tr><td>live wire</td><td></td></tr><tr><td>neutral wire</td><td></td></tr></table>	Note that the tick next to cable grip is already in the grid more than two additional ticks deduct one mark for each incorrect tick.	**(2)**

Q15.

	Answer	Acceptable answers	Mark
	☒ D a variable resistor		**(1)**

Q16.

	Answer	Acceptable answers	Mark
(a)	☒ D a variable resistor		**(1)**
(b)(i)	 connected in parallel with lamp (1)	recognisable symbol such as a box with letter V inside or box with the word voltmeter inside it accept voltmeter across both lamp and ammeter	**(1)**
(b(ii)	Substitution R = 6.0 / 0.26 (1) Evaluation = 23 (1)	An answer which rounds to 23 Give full marks for correct answer no working	**(2)**
(c)(i)	point correctly plotted at 2.0, 0.14 to within half a small square (1) smooth curve of best fit connecting all given points within half a small square (1)	Judge curve by eye. If more than one line present then ignore any that appear to be erased or deleted. Ignore any part of line which goes beyond given points. If plotted point is incorrect then allow ecf for line	**(2)**

(c)(ii)	a description including**two** of the following: • current increases as voltage increases (1) • current is not proportional to the pd (1) • gradient gets less (1)	Allow reverse argument positive correlation (between them) graph is not a straight line not in equal steps current does not increase as much (as it gets higher) accept resistance has increased with increase in current for two marks	**(2)**
(c)(iii)	a suggestion to include: there is still a current (when control is at min position) (1) make the battery last longer (1)	to break the circuit to switch **the current**off accept flow of electricity/charge/electrons for current {battery / energy} would be {drained /used up/ wasted} otherwise accept reverse arguments ignore reference to power / volts	**(2)**

Q17.

Question Number:	Answer	Additional guidance	Mark
	a comment that makes reference to any three of the following points: • idea that the current increases with the p.d. /voltage (1) • until (current) reaches a constant value (1) • the current is not directly proportional to p.d. (1) • uses idea that the values do not go up in equal steps / does not show doubling	(staying) at 0.13(A)	**(3)** AO 3 2a AO 3 2b

Q18.

	Answer	Acceptable answers	Mark
	substitution (1) 3.7 x 13 evaluation (1) 48 (C)	48.1 Correct answer with no calculation scores 2 marks	**(2)**

Q19.

	Answer	Acceptable answers	Mark
(i)	point correctly plotted at 2.0, 0.14 to within half a small square (1) smooth curve of best fit connecting all given points within half a small square	Judge curve by eye. If more than one line present then ignore any that appear to be erased or deleted. Ignore any part of line which goes	**(2)**

	(1)	beyond given points. If plotted point is incorrect then allow ecf for line	
(ii)	a description including**two** of the following: • current increases as voltage increases (1) • current is not proportional to the pd (1) • gradient gets less (1)	Allow reverse argument positive correlation (between them) graph is not a straight line not in equal steps current does not increase as much (as it gets higher) accept resistance has increased with increase in current for two marks	**(2)**
(iii)	a suggestion to include: there is still a current (when control is at min position) (1) make the battery last longer (1)	to break the circuit to switch **the current**off accept flow of electricity/charge/electrons for current {battery / energy} would be {drained /used up/ wasted} otherwise accept reverse arguments ignore reference to power / volts	**(2)**

Q20.

Question number	Answer	Additional guidance	Mark
(i)	A description including as the potential difference (voltage) increases so does the current (1) idea of gradient of graph decreasing as V increases (1)	 positive correlation at a decreasing rate non-linear not directly proportional	**(2)** **AO3**

Question number	Answer	Additional guidance	Mark
(ii)	Award one mark for each row of the table voltage / V | current in mA point P | 1(.00) | 20 point Q | 3.4 ±0.1 | 43 ±1	ignore any units added in the boxes	(2) AO2

Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) $(R=)\frac{4.5}{51(\times 10^{-3})}$ evaluation (1) 88.(2) (Ω)	0.088(2) or 8.8(2) or 0.88(2) or 0.09 seen scores 1 mark 0.088(2) kΩ or 0.09 kΩ scores 2 marks award full marks for correct answer without working	(2) AO2

Question number	Answer	Additional guidance	Mark
(iv)	an explanation linking any three of: identification of resistance increasing (1) heating (of the filament) (1) because of more collisions (1) of electrons (with ions / atoms / other electrons) (1)	temperature increases	(3) AO1

Q21.

Question number	Answer	Additional guidance	Mark
	a description including two from: put the coil in the water (1) (electric) current in the wire/coil (1) thermal energy transferred (in the wire) (1)	 allow electricity for electric current heat(energy) in wire / temperature of wire increases/ produces heat/ gives energy/ to heat the water	**(2)**

Q22.

Question number	Answer	Additional guidance	Mark
	voltmeter should be moved (1) (to be) in parallel with the resistor X (1)	voltmeter is in wrong place / (re)connect the voltmeter allow 'voltage' for 'voltmeter' in this context allow across X or equivalent statement answers may be seen on the diagram	**(2)**

Q23.

Question number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • Chemical energy stored in battery • Transferred to KE in motors • Transferred to GPE as it rises • Thermal energy wasted (at each stage) • Energy transferred to surroundings (at each stage)	(6)

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Summary for guidance			
Level	**Mark**	**Additional Guidance**	**General additional guidance – the decision within levels** e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Isolated fact e.g. a description of least one energy store **or** interpretation of diagram without mentioning energy stores or types	Possible candidate responses Chemical energy stored in the battery **or** energy transferred from the battery to the motors and then to the blades. Some energy is lost at each stage.
Level 2	3–4	Additional guidance Description of at least one energy transfer	Possible candidate responses KE (of blades) is transferred to GPE (as the drone rises) **or** (thermal) energy is transferred to the surroundings
Level 3	5–6	Additional guidance Description of two or more energy transfers	Possible candidate responses Chemical energy in the battery is transferred to KE of the blades **AND** Thermal energy is wasted in the motors when they turn.

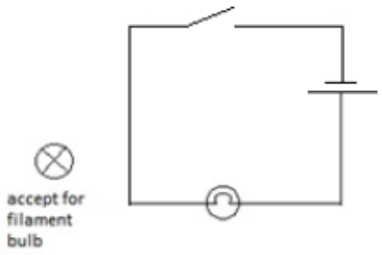
Q24.

Question number	Answer	Additional guidance	Mark
	d.c. - (current) in one direction only (1) a.c. - (current) changes direction (1)	one way both ways	**(2)** **AO1**

Q25.

	Answer	Acceptable answers	Mark
(i)	C		**(1)**
(ii)	B		**(1)**

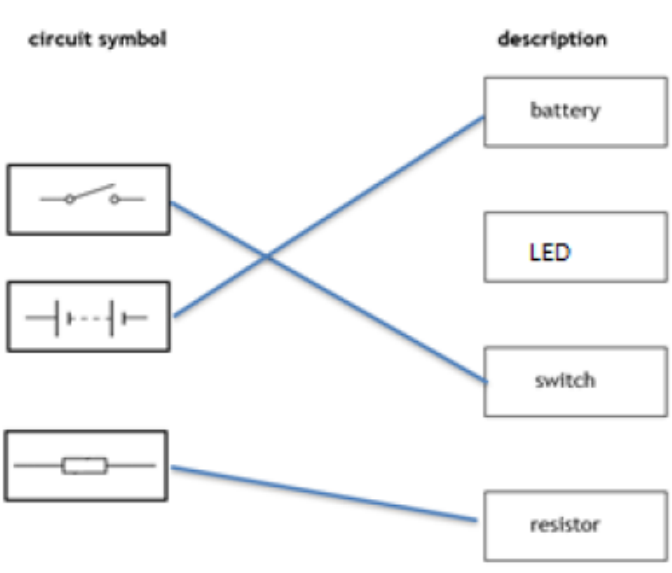
Q26.

Question number	Answer	Additional guidance	Mark
	 battery/cell symbol (1) lamp symbol (1) switch symbol (1) then complete series circuit shown (1)	ignore polarity of battery	**(4)** **AO3**

Q27.

Question number	Answer	Additional guidance	Mark
	a diagram of a circuit including **all** of the following: power supply / cell(s) / battery, identifiable resistance wire an ammeter a voltmeter (1) plus any **two** from ammeter in series (1) voltmeter in parallel (1) indication of tapping off / using 50cm of resistance wire (1)	accept symbols accept ohmmeter with resistance wire only ignore lamp(s) / additional resistors allow ohmmeter (across wire) instead of ammeter and voltmeter for 1 mark e.g. (crocodile) clips	**(3)** **AO2**

Q28.

Question number	Answer	Additional guidance	Mark
		1 mark for each correct line. more than one line to or from any box loses the mark for that symbol.	**(3)** **AO1**

Q29.

	Answer	Acceptable answers	Mark
(a)(i)	11x 0.4 (substitution) (1) 4.4 (V) (1)	Full marks for correct answer with no calculation	**(2)**
(a)(ii)	0.6 - 0.4 (A) (1)	0.2 or 1/5 (A)	**(1)**
(a)(iii)	B		**(1)**
(b)	An explanation linking: electrons (1) {colliding with / bumping into} ions in the lattice /atoms in the metal (1)	colliding with other electrons If no other marks scored, allow for 1 mark for "electrical energy {transferred/changed} into thermal/heat energy" <u>do not allow</u> energy being created or produced	**(2)**

		Indicative Content	
QWC	***(c)**	A explanation including some of the following points Light dependent resistors (LDR) • Resistance changes with light intensity • Bright light , low resistance • No light (dark), high resistance • Low resistance gives high current.(RA) Thermistor • Resistance changes with temperature • Negative temperature coefficient • High temperature, low resistance • Low temperature, high resistance • Low resistance gives high current (RA)	
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited explanation linking light affecting LDR AND heat affecting thermistor OR a correct relationship for one device, e.g. thermistors change resistance when the temperature changes and LDRs change resistance when it gets dark OR the {resistance decreases/ current increases} of a LDR when the light gets brighter • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple explanation correctly linking the temperature and light with resistance or current for both devices	

		OR a correct relationship for one device with a link to the way this affects the current and resistance. e.g. the resistance of a LDR increases when the light gets dimmer and when the temperature lowers the resistance of a thermistor increases OR the resistance of a LDR decreases when the light gets brighter and this increases the current • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed explanation including the qualitative relationships for both devices and a link to the way resistance change affects the current in BOTH of them, e.g. the resistance of a LDR is less when the light gets brighter which increases the current. When the temperature lowers the resistance of a thermistor increases. This means that the current will decrease as the thermistor cools down. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Total for question = 12 marks

Q30.

	Answer	**Acceptable answers**	**Mark**
(i)	11x 0.4 (substitution) (1) 4.4 (V) (1)	Full marks for correct answer with no calculation	**(2)**
(ii)	0.6 - 0.4 (A) (1)	0.2 or 1/5 (A)	**(1)**
(iii)	B		**(1)**

Q31.

	Answer	**Acceptable answers**	**Mark**
(a)(i)	Correctly plotted point (1)	+/- ½ a small square	**(1)**
(a)(ii)	Smooth line through most (at least 5) crosses / points (1)	Do not accept clearly dot-to-dot or excessive tramlining Ignore any part of line after 45	**(1)**
(a) (iii)	Substitution: (1)	transposition and substitution in either	**(3)**

	12 = 0.047 × R Transposition: (1) R = 12/0.047 Evaluation: (1) R = 260	order substitution mark can be scored when incorrectly transposed word/symbol equation is given 255.3, 255 give full marks for correct answer no working power of 10 errors with no working score max 1 mark	
(a) (iv)	An explanation linking • current increases with temperature (1) with • (so) resistance decreases(1) or • the voltage is constant (1) with • (so) resistance decreases (with temperature increase)(1)	(for this first MP) ignore faster/slower (charge/current) ignore references to heat, current flows more can score both marks by quoting two suitable pairs of values from graph For full marks, there must be a reference to change of either I or R with temperature	**(2)**
(b)(i)	An explanation linking • {electrons / negative charges} (1) • collide with {ions/lattice/electrons} (1)	atoms / nuclei allow for 1 mark,electrical energy transferred to {thermal/heat} energy if no other scored	**(2)**
(b) (ii)	A suggestion including energy transfer in {the thermistor/ any component part of the electrical circuit} causes a rise in temperature of thermistor (above surroundings)(1)	thermistor/resistor {gets hot/is heated}	**(1)**

Q32.

	Answer	**Acceptable answers**	**Mark**

	☒ **B** charge		**(1)**

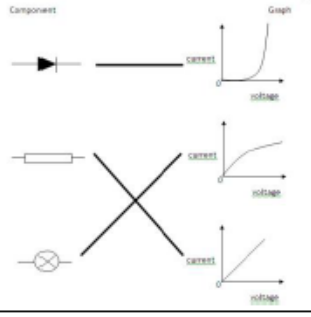
Q33.

Question number	Answer	Additional guidance	Mark
(i)	Any two from: • remove one or two of the cells (1) • put a resistor in (series with lamp) (1) • leave on for a long time (1)	reverse a cell	**(2)**

Question number	Answer	Additional guidance	Mark
(ii)	recall $P = \frac{E}{t}$ (1) substitution (1) $\frac{18}{20}$ evaluation (1) 0.9 W (1)	allow 1 mark for a correct substitution of values into an incorrect equation independent mark watt(s) award full marks for correct answer without working	**(4)**

Question number	Answer	Additional guidance	Mark
(iii)	substitution into V = IR (1) $4.2 = 0.19 \times R$ rearrangement (1) $\frac{4.2}{0.19}$ evaluation (1) 22 (Ω)	award full marks for correct answer without working 22.1(Ω)	**(3)**

Q34.

Question Number	Answer	Acceptable answers	Mark
	Connecting lines as shown  (2)	all 3 for 2 marks allow one mark if one or two lines correct more than one line from any component or to any graph is incorrect, so a maximum of 1 mark is possible	**(2)**

Q35.

Question Number	Answer	Acceptable answers	Mark
(i)	(correct) voltmeter symbol seen anywhere (1) voltmeter symbol connected in parallel / across heater (1)	accept symbols that are attempts at circles. accept line through symbol accept for second mark: any symbol or diagram of meter or box provided it is just from one side of the heater to the other	**(2)**

Question Number	Answer	Acceptable answers	Mark
(ii)	Substitution (into V = I x R) V = 0.56 x 15 (1) Evaluation = 8.4 (V) (1)	Allow full marks for correct answer with no working shown accept any power of 10 error for 1 mark e.g. 84 (V) or 0.84 (V) scores 1 mark accept rounding to 8 (V) for both marks	**(2)**

Question Number	Answer	Acceptable answers	Mark
(iii)	Substitution Energy = 6.0 x 0.40 x 30 (1) Evaluation 72(J) (1)	accept any power of 10 error for 1 mark e.g. 720 or 7200 (J) scores 1 mark Allow full marks for correct answer with no working shown	**(2)**

Question Number	Answer	Acceptable answers	Mark
(iv)	An explanation linking any two from: (there is the same) current in the (variable) resistor/ wires (1) (so) energy is {transferred/used/goes to/ lost/ wasted} in the {(variable) resistor/wires} (1) (so) {(variable) resistor / wires} gains/loses thermal energy (1)	 accept there is a p.d. across the (variable) resistor or {p.d./voltage} across heater is different to battery {p.d./voltage} ignore references to voltmeter and heater ignore 'energy wasted as heat' without qualification accept {resistor/wires} {heats/warms} (up) gains 1 mark energy lost in (variable) {resistor/ wires} as heat gains both marks	**(2)**

Q36.

	Answer	**Acceptable answers**	**Mark**
(i)	D variable resistor		**(1)**
(ii)	B in parallel with the lamp		**(1)**
(iii)	A description including • resistance changed (1) • reduced/decreased/lowered (1) **OR** • voltage/p.d /EMF (of supply) changed (1) • increased /turned up/higher(1)	 remove (variable) resistor /component X (2) number of batteries/number of cells add another cell/battery/battery pack/power pack/power supply (2)	**(2)**

Q37.

Question Number	Answer	Acceptable answers	Mark
	Conversion to correct units: 120 seen anywhere (1) Substitution: 0.08 x 120 (1) Evaluation: 9.6 (C) (1) accept 10 C	Allow full marks for correct answer with no working seen. 0.08 x 2 gains 1 mark for sub of their time into correct eq'n 0.16 (C) gains 2 marks (only mistake is not converting time to seconds) accept any power of 10 error for 2 marks e.g. 960 (C)	**(3)**

Q38.

Question Number	**Answer**	**Mark**
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.	**(6)**
	The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • the batteries store energy as chemical energy • the energy is transferred to electrons to make them flow/move • the current is a flow of electrons • the electrons flow through the metal/filament • the electrons collide with the ions in the lattice • the collisions make the ions vibrate more • the increased vibrations makes the lattice/filament hotter • the heat energy is dissipated to the surroundings • the ions give out/emit light	

Mark	Descriptor
0	• No rewardable material.
1–2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
3–4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
5–6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

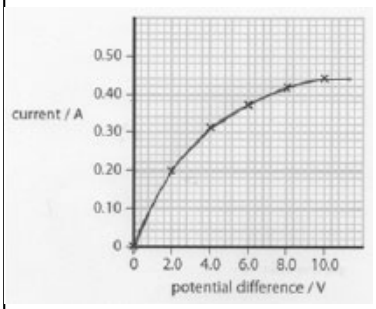
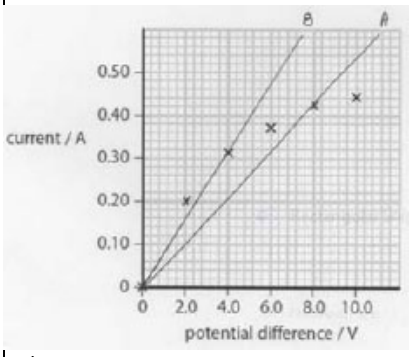
Level	**Mark**	**Additional Guidance**	**General additional guidance** Eg - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance unlinked statements	Possible candidate responses Particles move through the wire Batteries store energy Lamp gives off heat

Level 2	3–4	Additional guidance Limited explanation **linking** facts about particles OR **linking** facts about energy transfers	Possible candidate responses Electrons move through the wire/lamp OR The particles moving in the wire are electrons OR Particles collide in the wire OR Chemical energy (stored) in battery OR Energy dissipated / {released as light or thermal} energy in surroundings OR Energy is transferred electrically (from battery to lamp)
Level 3	5–6	Additional guidance Detailed explanation about particles AND energy transfers. (one may be stronger than the other but both should feature for level 3)	Possible candidate responses one from electrons move through the wire/lamp OR the charged particles are electrons OR particles collide in the wire AND one from chemical energy (stored) in battery OR energy dissipated / {released as light or thermal} energy in surroundings

Q39.

	Answer	**Acceptable answers**	**Mark**
(i)	An explanation linking • {electrons / negative charges} (1) • collide with {ions/lattice/electrons} (1)	 atoms / nuclei allow for 1 mark,electrical energy transferred to {thermal/heat} energy if no other scored	**(2)**
(ii)	A suggestion including energy transfer in {the thermistor/ any component part of the electrical circuit} causes a rise in temperature of thermistor (above surroundings)(1)	 thermistor/resistor {gets hot/is heated}	**(1)**

Q40.

	Answer	Acceptable answers	Mark
(a)(i)	D variable resistor		**(1)**
(a)(ii)	B in parallel with the lamp		**(1)**
(a)(iii)	A description including • resistance changed (1) • reduced/decreased/lowered (1) **OR** • voltage/p.d /EMF (of supply) changed (1) • increased /turned up/higher(1)	remove (variable) resistor /component X (2) number of batteries/number of cells add another cell/battery/battery pack/power pack/power supply (2)	**(2)**
(b)(i)	both points correct (1)	allow + / - half square	**(1)**
(b)(ii)	curve of best fit judged by eye (1)  	Must pass through zero and two other points. 5th point can be either (8.0,0.42) or (8.0, 0.44) straight line of best fit through origin tolerance between lines A and B shown on the diagram  5th point can be either (8.0,0.42) or (8.0, 0.44)	**(1)**

(c)	substitution (1) 10/0.44 or 250/11 evaluation (1) 23 (ohms)	give full marks for correct answer, no working 22.7(ohms),22.73 (ohms), 22.72(ohms) Ignore excessive decimal places.	**(2)**
(d)(i)	an explanation linking two of the following points • electric(al)(energy) (1) • (is converted) to heat / thermal (energy) (1) • (is converted) to light (1)	electricity	**(2)**

Total marks for question =10

Q41.

Question number	Answer	Additional guidance	Mark
i	Wire X .....earth.....(1) Wire Y .....live..... (1)	accept 'life'	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
ii	Component Z ....fuse..... (1)		**(1)** **AO1**

Q42.

Question number	Answer	Mark
	C ammeter in series with component, voltmeter in parallel Only option C is correct for both the ammeter and the voltmeter	**(1)** **AO1**

Q43.

Question number	Answer	Mark
	A electrons	**(1)**

Q44.

Question number	Answer	Mark
	D protons and neutrons	**(1)**

Q45.

Question number	Answer	Additional guidance	Mark
(i)	**B** electrons A C and D are incorrect because they do not move through a conductor to create an electric current.		**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
(ii)	substitution (1) (charge =) 0.21 x 300 evaluation (1) (charge =) 63 unit (1) coulombs	 award full marks for the correct answer without working independent mark C(oulombs) c As	**(3)** **AO2** **AO1**

Q46.

Question number	Answer	Additional guidance	Mark
i	A an ammeter B, C and D are incorrect because they do not show current		**(1)**

Question number	Answer	Additional guidance	Mark
ii	substitution (1) (Q) = 2.5 x 8 (x60) evaluation (1) 1200 (C)	 allow 20 (C) for 1 mark award full marks for the correct answer without working	**(2)**

Q47.

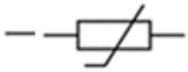
Question number	Answer	Mark
	D variable resistor Options A, B and C are all wrong identifications with both the circuit components shown	**(1)** **AO1**

Q48.

Question number	Answer	Additional guidance	Mark
(i)	B live and neutral A , C and D are incorrect because the terms positive and negative are not used in the context of wires in a mains cable.		**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
(ii)	a description that incudes any **two** from melts (1) if there is a fault (1) breaks the circuit (1) stops current (1) safety (1)	 blows / breaks if current too large prevents overheating / fire if no other marks scored allow 1 mark for identifying the fuse.	**(2)** **AO1**

Q49.

Question Number	Answer	Mark
	 **The only correct answer is D** **A is incorrect** because that is the symbol for a diode **B is incorrect** because that is the symbol for a light dependent resistor **C is incorrect** because that is a symbol for a motor	**(1)**

Q50.

Question Number:	Answer	Mark
	D diode **The only correct answer is D** ***A*** *is not correct as for a thermistor, current would increase with potential difference from the origin* ***B*** *is not correct as current against p.d for a resistor gives a straight line from the origin* ***C*** *is not correct as current against p.d for a resistor gives a straight line from the origin*	**(1)** AO 1 1

Q51.

Question number	Answer	Additional guidance	Mark
(a)(i)	Any one reason from: • the thermistor and the water are at the same temperature (1) • large volume of water gives a steady temperature rise (1)	accept idea that only small part of thermometer would be in contact with a thermistor in air accept difficult to control change in temperature of thermistor when heated in air	**(1)**

Question number	Answer	Additional guidance	Mark
(a)(ii)	Any one of the following developments to the procedure: • add ice to increase lower limit of temperature range (1) • use liquid with higher boiling point to increase upper limit of temperature range (1)	accept named liquid with higher boiling point, e.g. oil	(1)

Question number	Answer	Additional guidance	Mark
(b)	A comparison and contrast that must include at least **one** similarity and **one** difference from the following points to a maximum of three marks: Similarities • resistance of both changes with temperature (1) • both graphs show a non-linear relationship (1) • data comparison, e.g. both have the same resistance at 80 °C (1) Differences • resistance of A decreases with temperature but resistance of B increases with temperature (1) • for A, (largest slope/rate of change) is at lower temperature but for B, (largest slope/rate of change) is at higher temperature(s) (1) • for B, resistance is constant below 50 °C but for A resistance is roughly constant above 60 °C (1)	accept (smallest slope/rate of change) for A is at higher temperature but (smallest slope/rate of change) for B is at lower temperature	(3)

Q52.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all of the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **A01 (6 marks)** • measure the resistance of the thermistor • use ammeter and voltmeter/ use multimeter set on R • in a circuit • measure temperature of thermistor • using thermometer • use water bath • heater or method of heating • use cool water / room temperature water to start • raise temperature • measure new resistance • etc	**(6)**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Q53.

Question number	Answer	Mark
(a)	B	**(1)**

Question number	Answer	Mark
(b)	substitution into correct equation (1) = 1.9 × 10.0 × 9.0 answer (1) 171 (J) (which is about 170 J) Answer must be shown to 3 significant figures	(2)

Question number	Answer	Mark
(c)	B	(1)

Question number	Answer	Mark
(d)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • the coil contains wires which have a resistance (1) • and current in the wire is due to movement of electrons through (close-packed) lattice of positive ions (1) • hence collisions between electrons and ions in the lattice transfer energy from electrons to the lattice (causing the temperature of the wires/coil to rise) (1)	(3)

Q54.

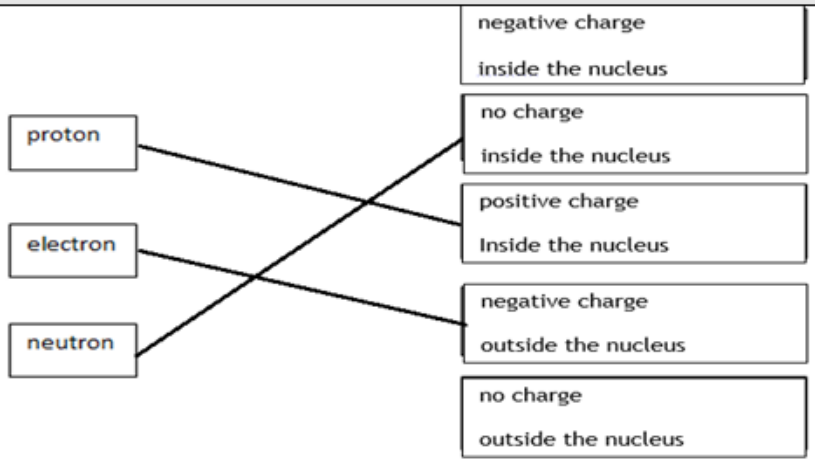
		Indicative Content	
		A explanation including some of the following points Light dependent resistors (LDR) • Resistance changes with light intensity • Bright light , low resistance • No light (dark), high resistance • Low resistance gives high current.(RA) Thermistor • Resistance changes with temperature • Negative temperature coefficient • High temperature, low resistance • Low temperature, high resistance • Low resistance gives high current (RA)	
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited explanation linking light affecting LDR AND heat affecting thermistor OR a correct relationship for one device, e.g. thermistors change	

		resistance when the temperature changes and LDRs change resistance when it gets dark OR the {resistance decreases/ current increases} of a LDR when the light gets brighter • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple explanation correctly linking the temperature and light with resistance or current for both devices OR a correct relationship for one device with a link to the way this affects the current and resistance. e.g. the resistance of a LDR increases when the light gets dimmer and when the temperature lowers the resistance of a thermistor increases OR the resistance of a LDR decreases when the light gets brighter and this increases the current • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed explanation including the qualitative relationships for both devices and a link to the way resistance change affects the current in BOTH of them, e.g. the resistance of a LDR is less when the light gets brighter which increases the current. When the temperature lowers the resistance of a thermistor increases. This means that the current will decrease as the thermistor cools down. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Q55.

	Answer	**Acceptable answers**	**Mark**
	A suggestion to include any 2 of the following • (LED) turns on and off • as voltage/current {changes direction/from +ve to –ve/ twice each second } (1) • (LED) on for (+ve) part of cycle (1) • (LED) off for (-ve) part of cycle (1)	Flash(es) / flicker(s) (on and off) current changes every 0.25 s /4 times each second Turns on twice each second = 2 marks Only on when voltage/current is +ve gains both marks	**(2)**

Q56.

Question Number	Answer	Mark
	 One mark for each correct line. More than one line from a box on the left loses the mark for that box.	(3)

Q57.

	Answer	Acceptable answers	Mark
(i)	Correctly plotted point (1)	+/- ½ a small square	**(1)**
(ii)	Smooth line through most (at least 5) crosses / points (1)	Do not accept clearly dot-to-dot or excessive tramlining Ignore any part of line after 45	**(1)**
(iii)	Substitution: (1) 12 = 0.047 × R Transposition: (1) R = 12/0.047 Evaluation: (1) R = 260	transposition and substitution in either order substitution mark can be scored when incorrectly transposed word/symbol equation is given 255.3, 255 give full marks for correct answer no working power of 10 errors with no working score max 1 mark	**(3)**
(iv)	An explanation linking • current increases with	(for this first MP)	**(2)**

	temperature (1) with • (so) resistance decreases(1) or • the voltage is constant (1) with • (so) resistance decreases (with temperature increase)(1)	ignore faster/slower (charge/current) ignore references to heat, current flows more can score both marks by quoting two suitable pairs of values from graph For full marks, there must be a reference to change of either I or R with temperature	

Q58.

Question number	Answer	Additional guidance	Mark
	an explanation linking any **three** from: lamp in second circuit is dimmer (than lamp in first circuit) (1) current in second circuit is less (than in first circuit) (1) potential difference / voltage across each lamp (in second circuit is) less / shared (1) idea that power of each lamp (in second circuit) is less / shared (1) the (total) resistance of the second circuit is more (than in first circuit) (1)	accept reverse arguments throughout	**(3)** **AO1**

Q59.

Question number	Answer	Mark
(i)	either power = (current)^2 × resistance or $P = I^2 \times R$	(1)

Question number	Answer	Additional guidance	Mark
(ii)	substitution into $P = I^2 \times R$ (1) $55 = 4.4^2 \times R$ rearrangement (1) $R = P \div I^2$ evaluation (1) 2.8 (Ω)	Substitution and re-arrangement in either order $R = 55 \div 4.4^2$ for 2 marks allow answers that round to 2.8 award full marks for correct answer without working allow alternative route $V = P \div I = 55 \div 4.4$ then $R = V \div I = 12.5 \div 4.4$	(3)

Q60.

Question number	Answer	Mark
	1.4 (A)	(1) AO2

Q61.

Question number	Answer	Additional guidance	Mark
(i)	0.9 (v)	0.90 ignore units ignore calculations	(1)

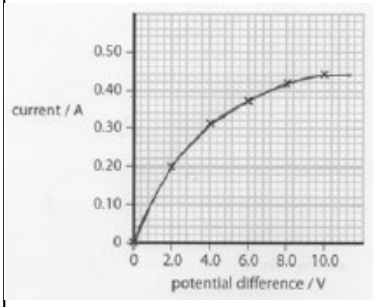
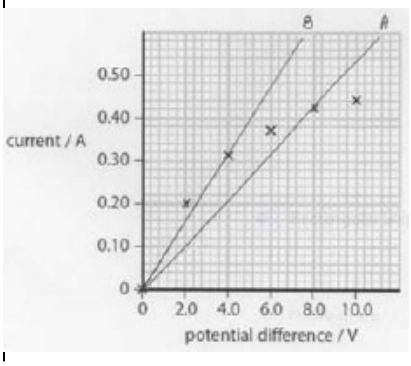
Question number	Answer	Additional guidance	Mark
(ii)	substitution (1) $R = \frac{2.1}{0.041}$ evaluation (1) R = 51(.2) (Ω) (which is approx. 50 (Ω))	allow (V) = 0.041 × 50 V = 2.05 (v) **(which is approx. 2.1)** allow R = 51(.2) (Ω) with no working for 2 marks	**(2)**

Question number	Answer	Additional guidance	Mark
(iii)	recall and substitution (1) (P) = 2.1 × 0.041 evaluation (1) (P =) 0.086 (W)	 allow any value that rounds to 0.086; e.g. 0.0861 (W) 0.09 (W) award full marks for the correct answer without working allow POT error for 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
(iv)	recall that effective resistance = sum of individual resistances (1) (resistance =) 50 + 22 evaluation (1) 72 (Ω)	 51 + 22 73 (Ω) award full marks for the correct answer without working	**(2)**

Question number	Answer	Additional guidance	Mark
(v)	substitution (1) (E =) 3.0 x 0.041 x 2 (x60) evaluation (1) 15 (J)	 accept values that round to 15; e.g. 14.76 award full marks for the correct answer without working award 1 mark for answer of 0.246 (J) or 0.25 (J) without working	**(2)**

Q62.

	Answer	Acceptable answers	Mark
(i)	both points correct (1)	allow + / - half square	**(1)**
(ii)	curve of best fit judged by eye (1)  	Must pass through zero and two other points. 5th point can be either (8.0,0.42) or (8.0, 0.44) straight line of best fit through origin tolerance between lines A and B shown on the diagram  	**(1)**

		5th point can be either (8.0,0.42) or (8.0, 0.44)	

Q63.

	Answer	Acceptable answers	Mark
	An explanation linking: electrons (1) {colliding with / bumping into} ions in the lattice /atoms in the metal (1)	 colliding with other electrons If no other marks scored, allow for 1 mark for "electrical energy {transferred/changed} into thermal/heat energy" do not allow energy being created or produced	**(2)**

Q64.

	Answer	Acceptable answers	Mark
	Substitution 12 × 230 (1) evaluation 2800 (W) (1)	 2760 (W) give full marks for correct answer, no working Power of 10 error max. 1 mark.	**(2)**

Q65.

Question Number	Answer	Acceptable answers	Mark
(a)	**A** - 1 joule per coulomb		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)(i)	Substitution (1) 1800 = 230 x I Transformation (1) I = 1800 / 230 Evaluation (1) 7.8 (A) substitution and transposition can be in either order	 current = power / pd Any value which rounds to 7.8 such as 7.8261 Allow full marks for correct answer with no working shown	 **(3)**

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	Using E = I x V x T: Substitution (1) 7.8 x 230 x 2 (x 60) Evaluation(1) 220 000 (J) (note: incorrect conversion of time loses the evaluation mark)	Allow ecf from 2(b)(i) Using energy = power x time 1800 x 2 (x 60) (1) Values which round to 220 000 such as 216 000 (J) 215 280 (J) Allow correct conversion to MJ or kJ Allow full marks for correct answer with no working shown	 **(2)**

Question Number	Answer	Acceptable answers	Mark
(b)(iii)	An explanation linking two from Energy is transferred (1) (as a result of) collisions of electrons (1) with ions/atoms / lattice (1)	electrons collide with each other for 2 marks	**(2)**

(Total for Question = 8 marks)