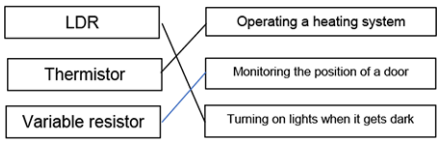
Mark scheme – Simple Circuits (F)

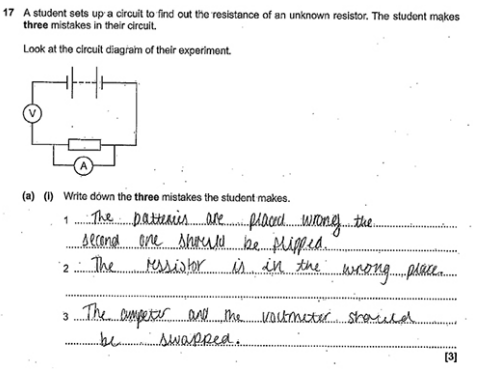
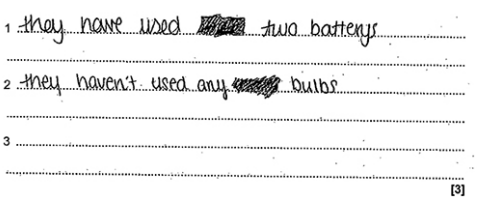
Question			Answer/Indicative content	Marks	Guidance
1			**D** ✓	1 (AO2.2)	
			Total	**1**	
2			**B** ✓	1 (AO2.2)	
			Total	**1**	
3			**B** ✓	1(AO2.2)	**Examiner's Comments** Candidates clearly recalled that the current-voltage graph for a filament lamp was non-linear and they then had to choose between options B and D. Option D, the graph for a thermistor, was chosen by many. Option C is the correct answer as the increased current heats the lamp filament, a hotter filament has an increased resistance and therefore a smaller current is observed than might be expected.
			Total	**1**	
4			**A** ✓	1(AO2.2)	
			Total	**1**	
5			**B** ✓	1 (AO2.1)	
			Total	**1**	
6			D	1 (AO2.2)	
			Total	**1**	
7			C	1 (AO2.2)	
			Total	**1**	
8			D	1 (AO1.1)	
			Total	**1**	
9	a	i	TV ✓	1 (AO3.2b)	**Examiner's Comments** Most candidates multiplied the relevant variables (power and time used) in the data table, and used the units Wh or kWh. This

					was a good approach for questions of this type.
		ii	Light bulb ✓	1 (AO3.2b)	**Examiner's Comments** Here the appliance with the lowest power rating (light bulb) was the right answer **Misconception** The most common misconception was just to compare the power ratings of the appliances and chose the toaster as the answer. Doing some quick calculations of work done and jotting vales next to the table helps answering these types of question. If the power and time for the TV and light bulb had been slightly different it would have given a different answer.
	b			2 (AO 2 × 2.1)	1 mark for each correct link **Examiner's Comments** Most candidates were credited full marks on this question. Virtually no candidates got one mark, perhaps because this required two components to be used for the same purpose. It was encouraging to see how candidates across the ability range were aware of the use of specific electrical components around their homes.
	c		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 10 000 000 (J) award 4 marks** Rearrange to energy = charge × potential difference ✓ 44 000 × 230 ✓ 10 120 000 ✓ 10 000 000 (2 sf) (J) ✓ **OR** Substitute correctly 44 000 (C) = energy ÷ 230 (V)✓ Rearrange to energy = 44 000 (C) × 230 (V) ✓ = 10 120 000 (J) ✓ = 10 000 000 (2 sf) (J) ✓	4 (AO2.1) (AO2.1) (AO2.1) (AO1.2)	Fourth mark is for correct rounding If answer line has 10 120 000 (J) award 3 marks m.p.2 can include m.p.1 if equation not written m.p.2 can include m.p.1 as above **Examiner's Comments** There was an erratum with this question to correct the units to joules. The figures in this question were difficult, and many candidates coped well with the large numbers and also the rearrangement of the equation. Some

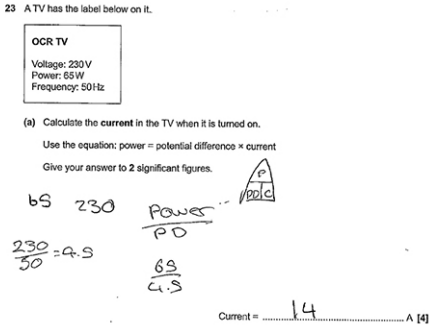
					candidates rearranged the equation before substitution and others after. Fewer candidates were able to round 10 120 000 J to two significant figures (e.g. 10 000 000 J). **OCR support** Mathematical Skills Handbook http:/www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	**8**	
10	a	i	variable resistor ✓	1 (AO1.2)	**ALLOW** rheostat **IGNORE** potentiometer **Examiner's Comments** Q22 is an overlap question with J249/03. Very few candidates recognised that this was a variable resistor. Many thought it was a thermistor.
		ii	Control / change / vary / increase / decrease / AW the resistance / current in the circuit ✓	1 (AO1.2)	**DO NOT ALLOW** merely 'changes the voltage or changes p.d.' **BUT ALLOW**: changes the potential difference or voltage **across** (component) **X** ✓ **Examiner's Comments** Candidates who misidentified the variable resistor in Q22(a)(i) were not able to answer this question.
	b	i	(filament) bulb / lamp ✓	1 (AO3.2a)	**Examiner's Comments** More able candidates were able to recognise the response of a filament lamp.
		ii	gradient / slope (of graph) changes (as potential difference / voltage changes) ✓ idea of increasing resistance (with more p.d.) / ORA ✓ idea of increasing temperature / AW ✓	3 (AO3.1a) (AO1.2) (AO2.2)	**ALLOW** 'graph / line / slope levels off' ✓ } Resistance increases with greater temperature ✓✓ **Examiner's Comments** This overlap question was challenging for most candidates. Most stated 'as p.d. increases, current increases' which does not address the fact that the *V/I* ratio is

					increasing, due to the graph curving downwards, so *R* must be increasing also.
	c	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4 (V) award 2 marks** 0.25 × 16 ✓ 4 (V) ✓	2 (AO2.1) (AO2.1)	**Examiner's Comments** Most candidates were successfully completed the calculation.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1 (W) award 3 marks** P = IV ✓ P = 0.25 × 4 ✓ P = 1 (W) ✓ **OR** $P = I^2R$ ✓ $P = 0.25^2 \times 16$ ✓ P = 1 (W) ✓	3 (AO1.2) (AO2.1) (AO2.1) (AO1.2) (AO2.1) (AO2.1)	**ALLOW e.c.f. from part ci** **Examiner's Comments** A quarter of all candidates calculated the correct answer here. Very few of the other candidates recognised that (c)(i) and (c)(ii) were a developing story and so did not multiply the answer to the first part of the question (4 V) by 0.25 A to calculate the answer to the second part.
			Total	**11**	
11		i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.8 (kW) award 4 marks** (P =) $I^2 \times R$ ✓ 11 × 11 × 23 or 112 × 23 or 121 × 23 ✓ = 2783 ✓ Conversion to kW = 2.8 (kW) ✓	**4** **(AO 1.2)** **(AO 2.1)** **(AO 2.1)** **(AO 2.1)**	**ALLOW** 2.78 kW or 2.783 kW ✓✓✓✓ **ALLOW** equation in any form **ALLOW** ecf candidates answer to 3rd marking point converted to kW **Examiner's Comments** Q23 is an overlap question with J249/04 and candidates found it very challenging with only a small number of the most able candidates being credited with any marks. From the stem of the question candidates knew that their answer needed to be between 1.0 kW and 3.0 kW. There were compensatory marks available where candidates wrote down the equation they were using and the different stages of their calculations. The most common workings

					shown were 11 × 23 or 23 ÷ 11, rather than 112 × 23 = 2.78kW. .
		ii	Wind speed varies / AW ✓	**1 (AO 2.1)**	**ALLOW** it depends on the strength of the wind / how windy it is / AW **IGNORE** there might not be any wind / wind changes direction / AW **Examiner's Comments** Many candidates realised that the wind speed would vary, but most responses were vague statements about the 'weather'.
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	**1 (AO 2.1)**	**ALLOW** (it) may not generate enough power / energy / AW **Examiner's Comments** Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household. **AfL** It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house.
			Total	**6**	
12	a	i	The voltmeter is in series ✓ The ammeter is in parallel ✓ One of the cells is connected the wrong way round / AW ✓	3 (AO3.2b) (AO3.2b) (AO3.2b)	**ALLOW** reverse arguments: E.g. voltmeter should be in parallel ✓ E.g. ammeter should be in series ✓ **ALLOW** The cells/batteries are incorrectly connected / facing each other **Examiner's Comments** Many candidates had problems with this circuit that were not relevant to the question. Some expected to see components (such as a filament bulb) which did not feature and others were unfamiliar with the symbol for a battery (two or more cells in series/two cells joined by a dotted line).

					Exemplar 1 shows a candidate who identified the problems with the battery and the voltmeter and ammeter. Although the candidate has stated two separate points were on the same line for the third mistake, as what the candidate wrote made it clear exactly what they intended the second identified mistake was allowed by the examiner to gain full marks. Exemplar 2 is typical of many candidate responses seen by examiners and gained no marks. **Misconception** Remember it is the apparatus and techniques in Topic P9 (Practical skills) that candidates are examined on not the specific practical activity that they experienced in their science classroom. **Exemplar 1**  17 A student sets up a circuit to find out the resistance of an unknown resistor. The student makes **three** mistakes in their circuit. Look at the circuit diagram of their experiment. (a) (i) Write down the **three** mistakes the student makes. 1 The batteries are placed wrong the second one should be flipped 2 The resistor is in the wrong place 3 The ampeter and the voltmeter should be swapped. [3] **Exemplar 2**  1 they have used two batterys 2 they haven't used any bulbs 3 [3]
		ii	**Any one from:** Put the voltmeter in parallel with the resistor	1 (AO3.3b)	**ALLOW** swap the meters over or AW

			✓ Put the ammeter in series ✓ Turn around one of the cells/AW ✓		**Examiner's Comments** Many candidates who had gained some marks in 17(a)(i) also answered this question successfully. Typical responses that were given the mark included 'turn one of the two batteries round' or 'swap the voltmeter and ammeter over'.
	b		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 200 Ω award 4 marks** Unit conversion 20(mA) = 0.02(A)/20x10^{-3} (A) ✓ *R* = 4.0 ÷ 0.02 ✓ *R* = 200 ✓ Ω ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	If final unit is kΩ or V/mA, this unit conversion is not needed so mp1 is subsumed into mp2 **ECF** incorrect or absent conversion of mA to A e.g. a bald answer of 0.2 gains mp2 & mp3 unless the unit is kΩ or V/mA, when all 4 marks are awarded. Mark unit independently **ALLOW** ohm(s) or V/A or V/mA if consistent with working **Examiner's Comments** In this question the unit mark was free-standing and so any valid unit combination was allowed. Both 0.20 kΩ and 0.2 mA/V are examples of responses which gained 4/4. Because of the application of error-carried-forward, candidates losing the first mark by not converting mA to A did not lose subsequent marks, so for example 0.2 Ω with suitable workings could gain three of the four marks.
			Total	**8**	
13	a		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.28 (A) award 4 marks** Rearrange equation current = power ÷ potential difference/ I = P ÷ V ✓ I = 65 ÷ 230 ✓ I = 0.2826086 ✓	4 (A1.2) (A2.1) (A2.1)	**NOTE** If answer not to 2 sig figs max 3

			I = 0.28 (A) ✓	(A1.2)	marks **ALLOW** one mark for any calculated answer to 2sf **Examiner's Comments** In their response to this question candidates earned a marks for the correct rearrangement of the given equation, a mark for substitution of the appropriate values, a mark for evaluation, and a mark for expressing the evaluated result to 2 significant figures. Error-carried-forward applied here, as shown in Exemplar 9. The first mark was earned by the power/p.d. quotient; it would have been cleared if they had included a subject to make it into a clear equation). There was no obvious logic to their other workings, but the final expression written is 65/4.5 = 14.4444 which (expressed to 2 s.f.) is 14, so earned second mark was given. Examiners are expected to mark positively and although the candidate has not set their workings out sensibly the examiner has assumed 65/4.5 and 14 to be the candidate's final decision. **Exemplar 9**  23 A TV has the label below on it. OCR TV Voltage: 230 V Power: 65 W Frequency: 50 Hz (a) Calculate the **current** in the TV when it is turned on. Use the equation: power = potential difference × current Give your answer to 2 significant figures. 65 230 Power / PD 230/50 = 4.5 65/4.5 Current = 14 A [4]
	b		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 117000 (or 116000) (J) award 4 marks**	4	**ALLOW ECF** from **(a)**

			E = P x t ✓ Unit conversion 30 minutes = 1800 seconds ✓ E = 65 x 1800 ✓ E = 117000 (J) ✓	(A1.2) (A1.2) (A2.1) (A2.1)	E = Q x V or I x t x V E = 0.28 x 1800 x 230 **ALLOW ECF for incorrect time conversion** **ALLOW** three marks for 1950 (J) E = 116000 (J) ✓ **Examiner's Comments** This calculation, the last on the paper, required recall of the energy/power/time relationship and conversion of minutes to seconds, resulting in a large value answer. One candidate did calculate 117000 J correctly and then wrote 'Wrong!' next to it: However, the examiner ignored this comment and the candidate was credited with full marks for the question.
			Total	**8**	
14			As speed increases, (thinking) distance increases / ORA ✓ **BUT** (thinking) distance is (directly) proportional to speed / as speed doubles, (thinking) distance doubles / linear relationship through the origin ✓	2 (AO 3.1a) (AO 3.2b)	**ALLOW** numerical values from graph, e.g. at 15 (m/s), td = 10m but at 30 (m/s) td = 20(m). **ALLOW** numerical values from graph, e.g. at 15 (m/s), td = 10 (m) but at 30 (m/s) td = 2×10 = 20 (m) for 2 marks **Examiner's Comments** Most candidates stated that the thinking distance increased with increasing speed. Few candidates stated that the thinking distance was directly proportional to the speed. The question does indicate that candidates should use data from the graph. In this case, candidates could easily see that the thinking distance line is a straight line through the origin. Alternatively, they could have read the thinking distance at a speed of 15 m / s and 30 m / s to see that the thinking distances are 10 m and 20 m. This means that as the speed doubles the thinking distance doubles.  **AfL**

					Understand how to test from a graph whether two quantities are directly proportional. 1. Take a quantity on the x-axis and double it and read off the y-axis values and see whether they double as well 2. See whether there is a straight line through the origin.
			Total	**2**	
15	a	i	Correct symbol for a voltmeter ✓ Voltmeter is in parallel with the lamp ✓	2 (AO1.1) (AO2.2)	**ALLOW** voltmeter in parallel with lamp and ammeter
		ii	Mistake: Units for current are missing ✓ Correction: Add A/amps/amperes/mA (for the unit) ✓ Mistake: Current is not recorded to correct number of decimal places / 1d.p. Correction: Current should be recorded to 1 d.p./1.0A ✓	4 (AO3.2a) (AO3.2b) (AO3.2a) (AO3.2b)	**ALLOW** Current at 1.0 V is recorded to 4 significant figures **ALLOW** current should be recorded to 2 sig figs
		iii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.25 (Ω) award 3 marks** Rearrange to give resistance = potential difference ÷ current ✓ 4(.0) ÷ 3.2 ✓ = 1.25 (Ω) ✓	3 (AO1.2) (AO2.1) (AO2.1)	**ALLOW** 1.3 (Ω) ✓✓✓ (**ALLOW** *R*) = *V* ÷ *I* Choice of *V*, I for wrong data point loses this mark but can get mp1 for equation and mp3 for evaluation ecf. Mp3 may depend on units chosen for current in (ii).
	b	i	Point 1,1 correctly plotted within ½ small square ✓ Suitable curved line of best-fit drawn ✓	2 (AO2.2 x 2)	Should be within 1 small square of each point. May not be extrapolated to (0,0,)
		ii	Current increases as potential difference increases/AW ✓ Rate of increase reduces/current increases more slowly with potential difference/AW ✓	2 (AO3.1a) (AO3.1a)	**IGNORE** it is a straight line **ALLOW** (they are) not proportional / not linear **ALLOW** resistance increases as current goes up/filament gets hotter

		iii	Change lamp for a (fixed) resistor ✓ Measure current for different potential differences/AW ✓	2 (AO1.2 x 2)	**ALLOW** repeat the experiment
		iv	Straight line (through the origin)/ current is (directly) proportional to voltage ✓ Resistance is constant./not changing/ fixed✓	2 (AO1.2 x 2)	**ALLOW** obeys Ohm's Law
			Total	**17**	
16			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Circuit A identified as a parallel circuit and having the brightest lamps **AND** Detailed explanation of why A has the brightest lamps **AND** Identification of control variables *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Circuit A identified as a parallel circuit and having the brightest lamps **AND** An explanation of why A has the brightest lamps **OR** Identification of control variables *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Circuit A identified as having the brightest lamps. **OR** Identification that circuit A is in parallel. **OR** Identification of control variables *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.	6 (AO1.2 x 2) (AO2.2 x 2) (AO3.2b x 1) (AO3.3a x 1)	**AO1.2 Demonstrate knowledge and understanding of series and parallel circuits** For example: • circuit A is parallel • circuit B is series • both circuits have one cell **AO2.2 Apply knowledge and understanding of series and parallel circuits** For example: • resistance is lower in circuit A / ORA • more current flows in circuit A / ORA **AO3.2b Analyse information and ideas to draw conclusions** For example: • lamps in circuit A are brighter / ORA **AO3.3a Analyse information to develop experimental procedure by identifying control variables** • same (number of) lamps • same (number of) cells

			Total	**6**	
17			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5(.00) (C) award 3 marks** (Rearrange equation) Charge = energy transferred / potential difference ✓ (charge =) 200 / 40 ✓ = 5 (C) ✓	3 (AO1.2) (AO2.1) (AO2.1)	
			Total	**3**	