1. In an experiment to look at work done, Molly uses different electric motors to lift a large mass to find out which motor is the most efficient. She measures the input electrical energy and the work done on the mass.

Look at the table of her results.

Electric motor	Input energy (J)	Output energy (J)
Q	800	760
R	2 000	1 920

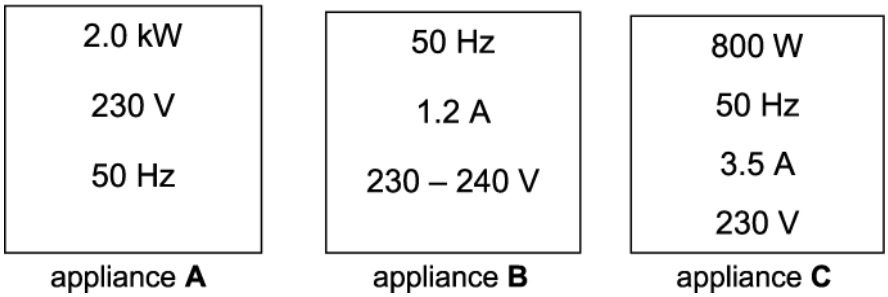
Motor **R** takes 20 seconds to lift the mass.

Calculate the **difference** between the input and output power.

difference = _____ W **[3]**

2. This question is about energy transfers in electrical appliances.

The plates on the back of three electrical appliances are shown below.



(i) Calculate the number of kWh of energy transferred by appliance **A** if it is on for 195 minutes. In your answer use the equation: energy transferred = power × time

_____ kWh **[3]**

(ii) Calculate which appliance (**A, B** or **C**) takes the biggest electric current from the mains power supply.

_____ **[4]**

3(a). A 230 V mains-powered electric drill draws a current of 2.5 A.

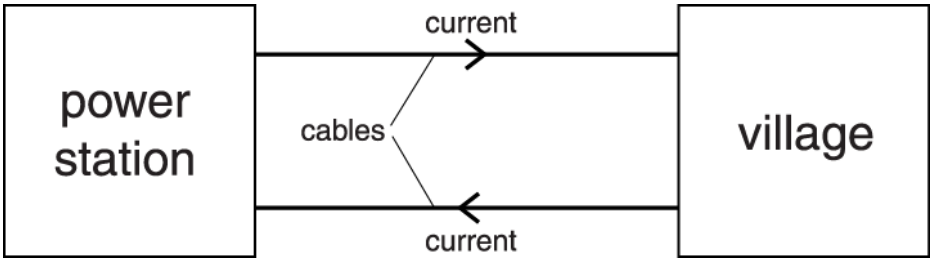
Calculate the power of the drill when it is in use.

power = _____ W **[2]**

(b). Another electric drill has a power rating of 600 W. Calculate the number of joules of energy transferred when this drill is in use for 5 minutes.

energy = _____ J **[2]**

4. The diagram shows a small village being supplied by electricity from a power station.



The power station produces 100 000 W of electrical power.

The power station could transfer the energy at 250 V or at 2500 V.

The table below shows what happens in each case.

Power produced at power station in W	Power station voltage in V	Power wasted in heating cables in W	Power delivered to village in W
100 000	250	32 000	68 000
100 000	2500	320	99 680

Use information from the table to decide which voltage should be used.
Give reasons for your answer.

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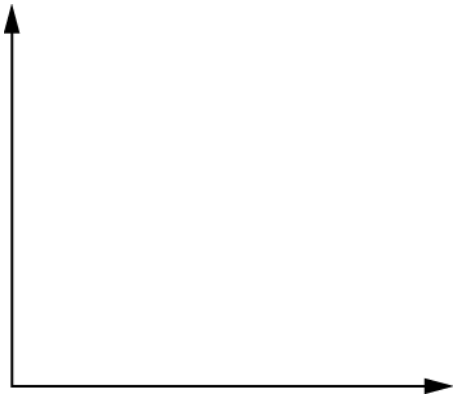
[2]

5(a). This data shows the relationship between the current in a wire and the power lost by the wire.

Current in amps	Power lost in watts
0.5	1
1.0	4
1.5	9
2.0	16

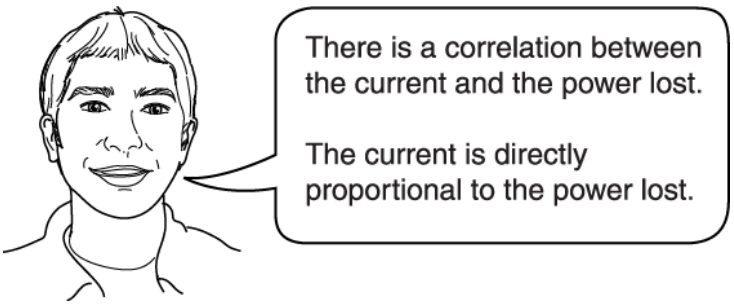
Sketch a graph of these results on the axis below.

You do not need to plot any points.



[3]

(b). Edward looks at the data and draws conclusions.



Is Edward correct?

Justify your answer.

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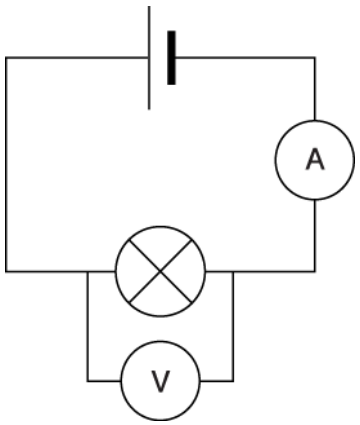
[3]

6. Jason sets up the following circuit.



The voltage is 1.5 V and the current is 0.5 A.

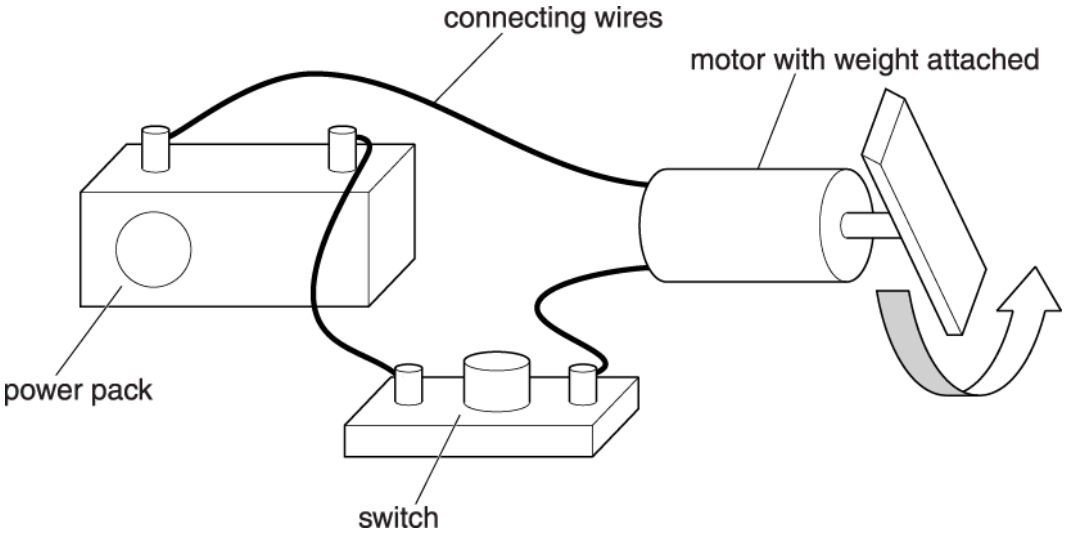
Jason then calculates the power and resistance of the lamp.

Draw a line from each **quantity** to the correct **calculation** for it.

quantity	**calculation**
	$1.5\text{V} \times 0.5\text{A}$
power (W)	$1.5\text{V} + 0.5\text{A}$
	$1.5\text{V} - 0.5\text{A}$
resistance (Ω)	$\frac{1.5\text{V}}{0.5\text{A}}$
	$\frac{0.5\text{A}}{1.5\text{V}}$

[2]

7. Luke sets up an experiment with a motor.



When Luke turns on the circuit, the motor rotates.

He finds out how many times the motor rotates each second.

He measures the power supplied to the motor.

He then repeats the experiment with different values of power.

Here are his results.

Power (W)	4	6	8	10	12
Number of rotations per second	0.50	0.75	1.0	1.2	1.3

Luke says, “The power cannot be related to the number of rotations per second. There is no reason for a correlation”.

Is Luke correct? Explain your answer.

The quality of written communication will be assessed in your answer.

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[6]

8. A toothbrush uses a rechargeable battery.

The potential difference across the battery is 1.2 V.

During a typical use, 360 C of charge moves though the toothbrush motor over a time of 2 minutes.

(i) Calculate the total energy transferred by the toothbrush in one day if it is used **two** times a day.

Energy transferred = ... J **[3]**

(ii) Calculate the current in the toothbrush when used for 2 minutes each time.

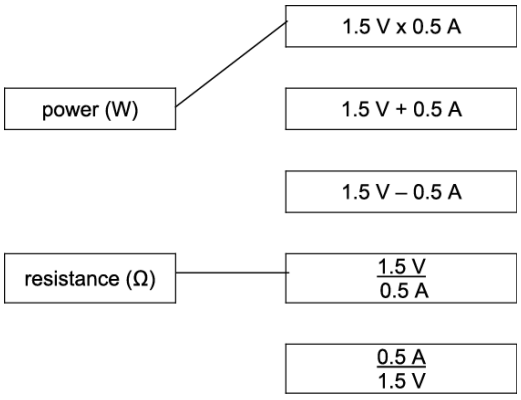
Current = ... A **[4]**

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			FIRST CHECK ANSWER ON ANSWER LINE. If answer = 4 W award 3 marks Use of: power = energy / time: Input power = 2000/20 = 100 W (1) Output power = 1920/20 = 96 W (1) Difference: 100 – 96 = 4W (1)	3	
			Total	3	
2		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 6.5 (kWh) award 3 marks Convert 195 minutes in hours = 3.25 h (1) 2.0 (kW) × 3.25 (h) = 6.5 (kWh) (1)	3	correct substitution gains first 2 marks (if equation is missing)
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8 – 9 (A) and therefore appliance A award 4 marks Recalls Power = Voltage × Current (1) Converts 2 kW to 2000 W (1) Rearranges to I = P/V = 2000 / 230 (1) Gets 8 – 9 A so appliance A has largest current (1)	4	correct substitution gains first 2 marks (if equation is missing) or applies $P = IV$ to appliance B (to find P) which is 276 – 288 W so 2 kW (appliance A) is greatest power and so greatest current
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
3	a		230 V × 2.5 A (1); = 575 (W)(1)	2	575 with no working gets both marks Examiner's Comments This was very well done. A very small number of candidates divided rather than multiplied. Answer 575 W
	b		600 W × (5 × 60 s) (1); = 180 000 (J) (1)	2	3000 J = 1 mark 180 000 / 180 k / 0.18 M with no working gets both marks Examiner's Comments Wrong calculations were common. Very few candidates converted minutes to seconds, the answer 3000 J was very often seen. Answer 180 000 J
			Total	4	
4			EITHER use 2500 V as gives / delivers more power (to the village) OR more efficient (1) and less power wasted OR less power heats the cables(1) OR don't use 250 V as gives / delivers less power (to the village) OR less efficient (1) and more power is wasted OR more power heats the cables (1)	2	Answer must identify or imply the voltage consistent with reasons. Marks are awarded for the reasons given. accept answers in terms of energy (per unit time) accept watts / W for power ignore less heat wasted Examiner's Comments It was pleasing to see that most candidates were able to interpret the table of data correctly and explain why 2500V should be used, referring to the energy or the power in their answers.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
5	a		axes labelled – power (lost), current	1	units not required **not** just scales **allow** units instead of quantity i.e. amps instead of current, and Joules or j/s or watts for power lost **accept** power or current as vertical axis
			line going up to the right	1	**accept** attempt to plot the points without a line line does not have to go through the origin
			curves towards the power axis / away from current axis	1	use scales on axes to identify curvature if no labels a bar chart can earn the first and third marks Examiner's Comments This question also appeared on the Higher Tier paper, so was designed to be accessible to candidates operating at grade C. Not surprisingly, many Foundation Tier candidates struggled to earn half marks for it. Only a minority were able to sketch the graph with clearly labelled axes; many weak candidates assumed that the graph would be a straight line, thereby losing a mark.

Question			Answer/Indicative content	Marks	Guidance
	b		any 3 correlation comment is correct / there is a correlation because as current increases so does power directly proportional is incorrect / it isn't directly proportional because power does not double as current doubles / not a straight line / line is a curve / square relationship	3	not just he is correct accept his first comment is correct not just he is wrong accept his second comment is wrong Examiner's Comments This question also appeared on the Higher Tier paper, so was designed to be accessible to candidates operating at grade C. Not surprisingly, many Foundation Tier candidates struggled to earn half marks for it. Only a minority were able to sketch the graph with clearly labelled axes, required candidates to comment on a pair of statements stated by Edward; too many lost marks because it was not clear which statement they were referring to; simply saying that Edward was right/wrong earned no credit as his first statement was correct and the second one was not.
			Total	6	
6				2	
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
7			**(Level 3)** Candidate describes correlation quantitatively **and** explains mechanism in terms of energy transfer. Quality of written communication does not impede communication of the science at this level. (5–6 marks) **(Level 2)** Candidate describes correlation quantitatively **and / or** makes some attempt to link power to number of turns, with reference to energy. Quality of written communication partly impedes communication of the science at this level. (3–4 marks) **(Level 1)** Candidate recognises and gives a qualitative description of correlation **or** links power and energy. Quality of written communication impedes communication of the science at this level. (1–2 marks) **(Level 0)** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to C** **Indicative scientific points may include:** • discussion of correlation eg clear / no outliers / both increase etc / positive correlation • when power doubles, number of turns doubles / for increase of 2 in power rotations (per second) increase by 0.25 • limit to pattern / up to 8W • power is rate of supply of energy • energy / power supplied turns the motor / weight • more rotations (per second) means more kinetic energy • discussion of variables eg input / independent is power output / outcome / dependent is number of turns. **Use the L1, L2, L3 annotations in Scoris; do not use ticks.** **Examiner's Comments** This Level of Response question was about commenting on a statement about correlation and cause using data from an investigation. Many candidates recognised a positive correlation and were able to describe this qualitatively and thus gained level 1. Few were able to use the data to give a quantitative description as required for levels 2 and 3. Just quoting the data did not achieve these levels; it required some analysis. Some candidates achieved level 2 by linking power to energy supplied. A description of energy transfer in the circuit from electrical to kinetic energy, needed for level 3, was rarely given. Some mistook the readings for repeats rather than a change in the independent variable. Others confused their answers by describing the correlation qualitatively (e.g. rotations increase as power increases) but then said 'there is no correlation', probably by confusing correlation with proportionality, but that was not stated.

Question			Answer/Indicative content	Marks	Guidance
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
8		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 864 (J) award 3 marks	3	
			recall **and** rearrange equation: energy = p.d. × charge ✓	(AO 1.2)	Equations used to calculate energy must have energy as the subject (accept W for E). **ALLOW** E= ItV **and** Q = It / E = Pt **and** P = VI and Q = It / 360 × 1.2 seen
			substitution 2 × 1.2 × 360 ✓	(AO 2.1)	Correct substitutions gain m.p 1 also
			= 864 (J) ✓	(AO 2.1)	**DO NOT ALLOW** bald '86400' or '1728' or '432'. Credit can only be given for working <u>Examiner's Comments</u> Candidates were on the whole unable to recall the equation to use in the question. Some candidates did multiply the potential difference by the charge, but many of them were confused about the time. Some only calculated the amount of energy used each time the toothbrush was used and some multiplied the 2 times per day as well as the 2 minutes each time it is used.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3.0 (A) award 4 marks	4	
			Recall **and** rearrange: current = charge / time ✓	(AO 1.2)	
			Convert 2 minutes = 120 s ✓	(AO 2.1)	
			= 360 / 120 ✓	(AO 2.1)	**ALLOW** 3 marks for 180 (unit conversion omitted)
			= 3.0 (A) ✓	(AO 2.1)	**ALLOW** '3 (A)' <u>Examiner's Comments</u> More candidates were able to recall and rearrange this equation than the previous one, and most of them realised that time had to be converted into seconds for the calculation.
			Total	7	