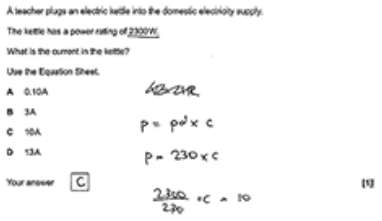
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		Angle of incidence not equal to angle of reflection (at mirror B/second reflection) / **AW** ✓ Normal line is not at 90° (to surface of mirror B) / **AW** ✓	2 (2 x AO 1.1)	**IGNORE** not at correct angle **If no other marks scored:** **ALLOW** (second) reflected ray should be parallel to original ray for 1 mark **Examiner's Comments** A significant number of candidates could not apply their knowledge of reflection in enough detail to this question. Answers were often too vague, e.g. the normal is at the wrong angle, so did not gain credit.
	b		dust on it/retroreflector ✓	1 (AO 3.2a)	**ALLOW** it is dirty/dull/scratched/not smooth
			Total	**3**	
2			A	1 (AO 2.2)	
			Total	**1**	
3			C	1 (AO 2.1)	**Examiner's Comments** In this question, candidates were required to rearrange the equation given to find the input energy. They then had to subtract the useful energy from the input energy to calculate the wasted energy. The most common errors of option A and option B involved rearranging the equation incorrectly.
			Total	**1**	
4	a		Bar for kinetic energy higher than zero ✓ Bar for thermal energy higher than previous bar ✓ Sum of the heights of the bars = 5 ✓	3 (3 × AO 2.2)	**DO NOT ALLOW** this mark if candidate has drawn a kinetic energy bar which is higher in Fig. 22.2 **Examiner's Comments** Nearly all candidates scored at least 1 mark (marking point 1), with the majority of candidates scoring two marks (marking point 1 and either

					marking point 2 or 3). The most common errors included candidates not realising that the total energy in Fig. 22.3 had to add up to 5 J.
	b	i	**Any one from:** Insulate the tube ✓ Repeat (the experiment) **and** take an average (temperature rise) ✓	1 (AO 3.3b)	**ALLOW** use a tube made of a more insulating material
		ii	So pellets do not rub against side of tube / to reduce friction / to reduce thermal energy transfer (to tube)	1 (AO 2.2)	**ALLOW** pellets to fall (more) vertically / to reduce the cooling of the pellets **Examiner's Comments** Fewer than half of candidates scored a mark in part (b) (i). There was a variety of suggestions including repeating the experiment, but this did not score on its own, as candidates also needed to say that they would calculate the mean. Very few candidates answered part (b) (ii) correctly.
		iii	**First check the answer on answer line** **If answer = 0.45 (J) award 2 marks** (GPE =) 0.03 × 10 × 1.5 ✓ (GPE =) 0.45 (J) ✓	2 (AO 2.1) (AO 2.1)	**ALLOW** 0.44 (J) **ALLOW** use of 9.8(1) N / kg **ALLOW** 0.44 (J)
		iv	**First check the answer on answer line** **If answer = 140 J / kg °C award 4 marks** Rearrange to give: c = E / (m × Δθ) ✓ (c =) 21 / (0.03 × 5) ✓ (c =) 140 ✓ J / kg °C ✓	4 (AO 2.1) (AO 2.1) (AO 2.1) (AO 1.1)	**ALLOW** 0.14 J / g °C for 4 marks **ALLOW** K for °C **ALLOW** 1 mark for correct substitution into unrearranged equation, e.g., 21 = 0.03 × c × 5 Unit mark is independent **ALLOW** J / kg / °C **Examiner's Comments** The calculations in both parts (b) (iii) and (b) (iv) were answered very well, with over three quarters of candidates

					giving the correct numerical answers. The unit of specific heat capacity was less well known. Lower scoring candidates sometimes unnecessarily attempted to change kilograms into grams and metres into centimetres. **Assessment for learning** Candidates could benefit from mini-tests on quantities in the specification and their units. **OCR support** Appendix 5e of the specification includes a table of quantities, common symbols, their SI units and their abbreviations. A student friendly printable version is available online and on Teach Cambridge. OCR's Alphabet of physics includes a table that highlights where confusion might otherwise occur. It includes practice questions.
		v	**Any three from:** Student A: A higher SHC would lead to a lower temperature rise/change ✓ (small) temperature rise/change is more difficult to measure ✓ Student B: More turns mean more energy dissipated as thermal energy (in the tube or surroundings) ✓ a larger SHC value is obtained ✓	3 (3 × AO 3.1b)	**Examiner's Comments** It was evident that most candidates found this question, assessing AO3, the most challenging on the paper with only the higher achieving candidates gaining credit. Although nearly all candidates attempted to give an answer, many merely repeated what the students suggested and then stated that they were incorrect, rather than explaining why they were incorrect.
			Total	**14**	
5			**C**	1 (AO 2.1)	**Examiner's Comments** This question assessed candidates'

					recall of the voltage of the mains supply in the UK and rearrangement of the relevant equation from the Equation Sheet. The vast majority of candidates did this successfully. There was evidence that some candidates who chose the incorrect option had tried to use an incorrect equation such as $P = I^2R$. Exemplar 1  This response shows how the candidate identifies the correct equation from the equation sheet, recalls the voltage of the mains supply in the UK and rearranges the equation to calculate the current in the kettle.
			Total	**1**	
6			**D**	1 (AO 2.1)	**ALLOW** 1250 (MJ)
			Total	**1**	
7		i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 480 (J / kg °C) award 4 marks** 24 kJ = 24 000 J ✓ Rearrangement: Specific heat capacity = change in thermal energy ÷ (mass × change in temperature) ✓ (Specific heat capacity =) 24 000 ÷ (2 × 25) ✓ (Specific heat capacity =) 480 (J / kg °C) ✓	4 (2 × AO1.2) (2 × AO2.1)	**ALLOW** 2 marks for 24 ÷ (2 × 25) or $2.4 \times 10^n \div (2 \times 25)$ **ALLOW** 3 marks for answer of 0.48 or 4.8×10^n (J/kg°C) **Examiner's Comments** This question was answered very well, nearly all candidates scored 3 or 4 marks. The main errors made included: • incorrectly rearranging the equation • using the starting or final temperature instead of the temperature change • not converting kJ into joules.

		ii	(Idea that) thermal energy is lost/wasted to the surroundings / not all energy supplied to the heater is transferred into the metal block ✓	1(AO3.2a)	**ALLOW** heat for thermal energy **ALLOW** thermal energy is dissipated (to the surroundings)
		iii	**Any one from:** Insulate the metal block ✓ Put the heater further into the metal block / use a smaller heater ✓ Use oil/lubricant to improve contact between heater and block ✓ Repeat and calculate the mean ✓	1(AO3.3b)	**ALLOW** add lid **Examiner's Comments** Candidates usually lost the mark in part (b) (ii) for not giving enough detail in their response, e.g. heat lost on its own was not sufficient, it needed to say that the heat was being lost to the surroundings. Most correct answers referred to insulating the block or repeating the experiment and calculating a mean.
			Total	**6**	
8		i	**1** Not enough wind/force/energy/speed to turn the turbine ✓ **2** (Speed too high so) could damage the turbine / turbine is shut down to stop damage/for safety reasons ✓	2 (2 × AO3.2a)	**ALLOW** turbine does not turn **ALLOW** idea of (the turbine/it) being damaged/broken
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4.3 (MJ) award 5 marks** (Useful output energy transfer per second =) 1.5 (MJ) ✓ Efficiency = Useful output energy transfer ÷ Input energy transfer ✓ (Input energy transfer =) 1.5 ÷ 0.35 ✓ (Input energy transfer =) 4.2857… ✓ (Input energy transfer =) 4.3 (MJ) ✓	5 (AO2.2) (AO1.2) (2 × AO2.1) (AO1.2)	**ALLOW** equation in any form **ALLOW** 4.2857 … × 10^6 or 4.3 × 10^6 for 4 marks **ALLOW** an incorrect answer rounded to 2 sig. fig. for this mark **Examiner's Comments** This question required candidates to identify the correct equation from the Data Sheet, which made the question more accessible. They then had to rearrange the equation, substitute in the correct value for output energy transferred per second for a speed of 10 m/s from the graph and give their answer to two significant figures. Nearly all candidates scored full marks. The main error was using the value for the wind speed (10 m/s) as the output energy in the equation. As candidates usually showed their calculations, they were still able to gain compensatory marks.

			Total	**7**	
9			C ✓	1 (AO2.1)	
			Total	**1**	
10			B ✓	1 (AO1.2)	**Examiner's Comments** This question assessed candidates' knowledge of unit prefixes and the majority of candidates chose the correct option.
			Total	**1**	