Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			**First check the answer on the answer line** **If answer = 61.6 (J) award 3 marks** Select: (gravitational potential energy =) mass × gravitational field strength x height / (E =) mgh ✓ (E =) 77 × 0.5 × 1.6 ✓ (E =) 61.6 (J) ✓	3 (AO 1.2) (2 x AO 2.1)	**ALLOW** 62 (J) **ALLOW** equation in any form
			Total	**3**	
2			B	1 (AO 2.2)	
			Total	**1**	
3			C	1 (AO 2.1)	
			Total	**1**	
4			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**	
5	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 **<u>Examiner's Comments</u>** 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 **<u>Examiner's Comments</u>** 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)	<u>**Examiner's Comments**</u> 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**	
6			**C**	1 (AO 1.1)	<u>**Examiner's Comments**</u> This question required candidates to identify the relevant equation from the equation sheet and rearrange it to

					determine the mass of the car. The vast majority of candidates were able to do this successfully, often writing down their calculations next to the question. **Assessment for learning** Even though there are no compensatory marks for an incorrect answer to a numerical multiple choice question, it will still benefit candidates to write down their calculations next to the question. By doing this, they are less likely to make a mistake compared to working out the answer purely on the calculator and/or in their head.
			Total	**1**	
7			**C**	1 (AO 2.1)	**ALLOW** 0.060 (m) **<u>Examiner's Comments</u>** This question required candidates to identify the relevant equation from the equation sheet and rearrange it to determine the extension of the spring. The majority of candidates wrote down their calculations next to the question and were able to manipulate the equation correctly to find the extension. Some common errors seen included choosing the wrong equation, incorrectly rearranging the equation, or calculating $(\text{extension})^2$ but forgetting find the square root of this number.
			Total	**1**	
8	a		Power supply attached to electric heater **AND** correct symbol for ammeter in series with heater ✓ Correct symbol for voltmeter in parallel with heater or power supply ✓	2 (2 × AO1.2)	Maximum of 1 mark if a line drawn through the ammeter and/or voltmeter **IGNORE** extra ammeters/other components in series **ALLOW** 1 mark for incorrect symbols for ammeter and voltmeter in the correct places

	b	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) **<u>Examiner's Comments</u>** 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 **<u>Examiner's Comments</u>** 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.
	c		Block C (has the highest specific heat capacity) ✓ It has the smallest change in temperature (for the same rate of input in energy) ✓	2 (AO3.1b) (AO3.1b)	No mark if block A or B chosen **ALLOW** it has the lowest gradient/slope **ALLOW** it has the slowest change in temperature **IGNORE** (idea that) it needs more energy to raise temperature by 1°C **<u>Examiner's Comments</u>** This AO3 question assessed candidates' ability to interpret the temperature-time graph and draw the correct conclusions about which metal had the highest specific heat

					capacity. Most candidates scored zero, as they identified the wrong metal, or 2 marks. Responses that gained just 1 mark usually included the idea that block C needed more energy to raise the temperature by 1 °C. This did not score as it was based on the definition of specific heat capacity and not what was shown by the graph.
			Total	**10**	
9			C ✓	1 (AO2.1)	**Examiner's Comments** This question required candidates to take account of the squared relationship between energy stored in the spring and the extension of the spring. A number of candidates chose option B.
			Total	**1**	