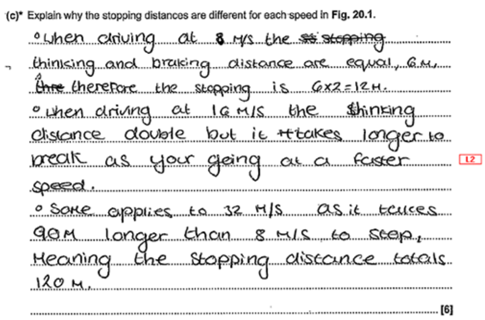
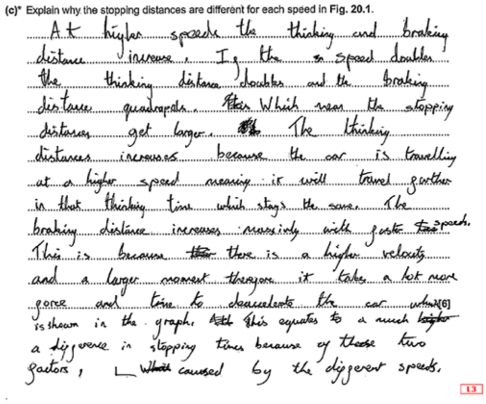
Mark scheme – Work Done (F)

Question			Answer/Indicative content	Marks	Guidance
1			**A** ✓	1 (AO1.1)	
			Total	**1**	
2			**D** ✓	**1 (AO 2.1)**	**Examiner's Comments** Candidates were required to carry out a simple substitution into a given equation were generally answered well.
			Total	**1**	
3			**C** ✓	**1 (AO 2.2)**	**Examiner's Comments** About two-thirds of the candidates got this question correct: the commonest wrong answer here was A, presumably looking at the symmetry in the bottom part of the diagram.
			Total	**1**	
4	a		Oil will not freeze (as easily as water) / **ORA** (1)	1	
	b		Reduces risk of burns to people / children (1)	1	
	c		Time conversion: 10 × 60 = 600 seconds (1) 800 × 600 / 480 000 (J) (1)	2	**ALLOW** 480 (kJ)
	d	i	Substitute into formula for specific heat capacity / 10 × 40 × 1 700 (1) 680 000 (J) (1)	2	**ALLOW** 680 (kJ)
		ii	Any two from: Some energy used to heat the radiator case (rather than the oil) (1) Energy passed from oil to air in room / oil undergoes cooling whilst heating up (1) Energy is dissipated to surroundings (1)	2	

			It is not 100% efficient at transferring energy (1)		
			Total	**8**	
5			Any 2 from: (Moving) ball has KE (1) Ball heats up (1) Some energy lost as heat to surroundings / moving air / particles in floor (1)	2	
			Total	**2**	
6			**C** ✓	**1 (AO 2.2)**	**<u>Examiner's Comments</u>** Candidates were required to carry out a simple substitution into a given equation were generally answered well. The most common error was not squaring the speed and choosing distractor B.
			Total	**1**	
7		i	Reduces <u>pressure</u> / spreads the <u>force</u> / AW ✓	**1 (AO 1.1)**	**<u>Examiner's Comments</u>** Many candidates found it difficult to use appropriate technical language in their answers to this question (for example, force and pressure). Many candidates wrote vague responses such as 'it would cover more of the body' without explaining why this was important. Higher ability candidates used specific technical language such as 'reducing the pressure' or 'spreading the force'. **AfL** The parts of a question form a story that develops a central theme. In part (a) looks at the pressure the car applies to the road, part (b) looks at the pressure that the force resulting from breaking applies to passengers, and part (c) applies this knowledge to the specific context of child safety seats. Where candidates follow these story lines, it helps them to improve the quality of their answers. However in (i) and (c) most candidates did not make the connection after they were asked to calculate pressure in (a).
		ii	Absorb energy (in a crash) ✓	**1 (AO 1.1)**	**ALLOW** higher level answers: eg. Reduces force / acceleration

					E.g. Increases time / distance to stop **<u>Examiner's Comments</u>** Higher ability candidates realised that the material was stretchy to absorb energy in a crash. Other responses referred to more generalised reasons such as allowing seatbelts 'to fit around different sized people.' Some candidates described the seat belt material as 'having a little give' or 'movement' without explicitly explain how this would increase time, reducing the rate of deceleration and thus the force exerted on the passenger.
			Total	**2**	
8			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)** **Explains quantitatively why the stopping distances are different for each speed in the table in terms of braking distance and thinking distance.** *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)** **Explains qualitatively why the stopping distances are different for each speed in the table in terms of braking distance or thinking distance increasing with speed from the table** *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	**6 (AO 2 x 1.1)** **(AO 2 x 2.1)** **(AO 2 x 3.2b)**	**AO1.1a Demonstrates knowledge and understanding of thinking, braking and stopping distance** • Thinking distance is the distance the car travels while the driver reacts • Braking distance is the distance travelled while the brakes are applied • Stopping distance is thinking distance + braking distance **AO2.1 Applies knowledge and understanding of thinking, braking and stopping distance in relation to the details in the table** • Increasing the speed, increases the thinking distance • Increasing the speed, increases the braking distance • Increasing the speed, increases the stopping distance **AO3.2b Analyses information to make judgements and draw detailed conclusions from table** • Thinking distance is directly proportional to the speed • When speed doubles, thinking distance doubles • Braking distance is proportional to speed2 • When speed doubles, braking distance quadruples

			Level 1 (1–2 marks) **States basic ideas about thinking distance / braking distance / stopping distance OR identifies variation of thinking distance / braking distance / stopping distance with speed** *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.*		**<u>Examiner's Comments</u>** This question gave candidates the opportunity to apply their knowledge and understanding of stopping distances. The question is deliberately set to be open ended so that candidates had the opportunity of structuring their answers logically. Higher ability candidates explained that the stopping distance was equal to the sum of the thinking distance and braking distance before stating that the stopping distances increased with speed. Often candidates demonstrated the change in stopping distance using the data from the table. For the highest marks, candidates were expected to analyse the data quantitatively from the table. A few candidates used part (a) and stated that thinking distance doubled with speed and carried out a similar analysis for braking distance, stating that as speed doubled, braking distance quadrupled. Common misconceptions included thinking time increasing with speed, drivers being under greater pressure at high speed, braking forces increasing with speed. Other candidates discussed factors that affected thinking distance and braking distance rather than using the data in the table. **Exemplar 2**  (c)* Explain why the stopping distances are different for each speed in **Fig. 20.1.** ° when driving at 8 M/S the ~~ss~~ ~~stopping~~ thinking and braking distance are equal, 6 M. ~~thre~~ therefore the stopping is 6x2=12 M. ° when driving at 16 M/S the thinking distance double but it ~~+t~~takes longer to break as your going at a faster speed. ° Same applies to 32 M/S as it takes 90 M longer than 8 M/S to stop, Meaning the stopping distance totals 120 M. [6] L2 This is a four mark, Level 2 response. The candidate has calculated the stopping distance for each speed and provided a limited analysis. They have made good use of mathematical expressions to show that stopping distance is equal to the product of thinking and breaking distance. The information presented is relevant, however there are limited links made between the bullet points. To progress to a Level 3 response the candidate could have added a short introduction and a final bullet point

					linking the analysis at each speed together in a summary sentence. Exemplar 3  (c)* Explain why the stopping distances are different for each speed in Fig. 20.1. At higher speeds the thinking and braking distance increase. If the speed doubles the thinking distance doubles and the braking distance quadruples. Which mean the stopping distances get larger. The thinking distances increases because the car is travelling at a higher speed meaning it will travel further in that thinking time which stays the same. The braking distance increases massively with faster speeds. This is because there is a higher velocity and a larger moment therefore it takes a lot more force and time to deccelerate the car which is shown in the graph. This equates to a much a difference in stopping times because of these two factors, caused by the different speeds. [6] L3 This is a six mark Level 3 response. This is very clear analysis of the data in the table that is linked together in a clear logical structured way. Although the candidate has not annotated their script (except in their response to (a) it is clear that they have processed the data in the table. They have described the complex mathematical relationships (for example 'if the speed doubles the thinking distance doubles and the breaking distance quadruples') although it would have been easier to present this conclusion numerically.
			Total	**6**	
9	a	i	**Any one from:** Ratio of 1:1 at a height of 40 cm ✓ ratio (seems to) increase by 0.1 when height decreases by 20 cm (until ratio is 1:1) / AW ✓	1 (AO3.2a)	**ALLOW** when drop height was 40 cm, bounce height was the same / bounce ratio coming closer to 1:1 each time / bounce height cannot be higher than drop height **<u>Examiner's Comments</u>** Many candidates answered this question correctly by referring to the previous bounce height being the same. This question again required candidates to interpret data from a table.
		ii	Some of the energy from the KE store is transferred to other energy stores as ball hits the ground AW ✓	1 (AO2.1)	**ALLOW** ball will lose energy (when it hits the ground) **<u>Examiner's Comments</u>** There was a clue in the question regarding energy. It was anticipated that candidates would understand that there is likely to be energy losses both as the ball travels through the air and as it bounces. It was hoped that there would be reference to energy being

					transferred from the kinetic energy store to other energy stores as the ball bounces.
	b		**Any two from:** Lower head to read bounce height / take bounce height readings at eye level / AW ✓ Take multiple readings and <u>average</u> them ✓ Take readings at other intervals (eg. 90, 70, 50) ✓	2 (AO2×3.3b)	**ALLOW** second person to read bounce height / idea of video camera and play back **ALLOW** drop from greater heights **<u>Examiner's Comments</u>** This was another question which required candidates to consider experimental procedures. Many candidates suggested taking other readings. Some candidates tried to suggest methods of improving the measurement of the bounce height but often the explanations were vague and lacked the necessary detail. **AfL** Candidates should be encouraged to consider improvements to experiments that are carried out as part of their practical course.
	c	i	(Mass = 60 ÷ 1000 =) 0.06 (kg) ✓	1 (AO1.2)	**<u>Examiner's Comments</u>** The majority of the candidates correctly answered this question. Many candidates who did not gain this mark wrote 0.6 kg.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.48 (J) award 2 marks** Energy = 0.06 × 0.8 × 10✓ Energy = 0.48 (J)✓	2 (AO2×2.1)	**ALLOW** ECF from **(c)(i)** E = (c)(i) × 10 × 0.8 ✓ E = answer to (c)(i) × 8 ✓ **ALLOW** E = 60 × 10 × 0.8 = 480 (J) for one mark **<u>Examiner's Comments</u>** This was well answered. Candidates should again be encouraged to show their working. There should be clear substitution of the numbers into the given equation. The advantages of this method are that

					candidates will then be able to use their calculator without having to look for the numbers and easily be able to check their answer later. It also enables candidates to gain one mark if there is an error in the calculation.
			Total	**7**	
10			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)** Detailed description of the procedure and the measurements (including a labelled diagram). **AND** Correct calculation of the change in thermal energy. *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)** Detailed description of the procedure and the measurements (with a diagram). **OR** Description of the procedure and the measurements (with a diagram). **AND** Correct calculation of the change in thermal energy. *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)**	6(AO2×3.3a)(AO2×2.2)(AO2×2.1)	**AO3.3a Analyse information and ideas to develop experimental procedures** • liquid placed in beaker • heater immersed in liquid • heater connected to power supply • insulation arranged to reduce heat loss • thermometer • instrument(s) to determine energy e.g. stopwatch, circuit **AO2.2 Apply knowledge and understanding of scientific enquiry, techniques and procedures - measurements** • Explanation of obtaining mass of 200 g • Initial temperature measured • Temperature rise / change / temperature after measured • Method to determine the energy e.g. use of joule meter / E = ItV method / power of heater and time. **AO2.1 Apply knowledge and understanding of scientific ideas to calculate change in thermal energy** • use of E = m x c x t • E = 0.2 × 4 200 × 20 • E = 16 800 J **<u>Examiner's Comments</u>** This question gave candidates the opportunity to apply their knowledge and understanding of practical procedures related to specific heat capacity. The question is open ended so that candidates have the opportunity of demonstrating their knowledge as well as having the opportunity to structure their answers logically.

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Basic description of the procedure and the measurements.
OR
Correct calculation of the change in thermal energy.

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.

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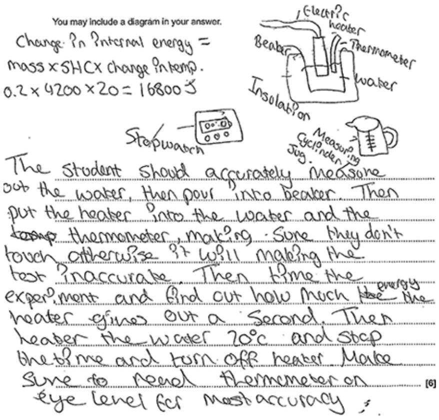
This question stated “You may include a diagram in your answer.” A diagram of the experimental arrangement would have been very helpful. Many candidates did not include a diagram. The advantage of drawing a diagram is that it will also assist candidates in their procedures. Diagrams should be labelled. Several candidates drew diagrams with a beaker, heater and thermometer. Some candidates incorrectly drew diagrams of Bunsen burners heating water.

The question also required candidates to calculate the change in internal energy for the water. Higher ability candidates stated the equation from the data sheet and then clearly substituted the numbers from the question before calculating the answer. Candidates who did not calculate the change in internal energy correctly often did not include an equation.

The question gave candidates the opportunity to discuss practical procedures. Again, several candidates used insulation and adding a lid. Some discussed stirring the water. A circuit diagram showing how the electrical heater was connected would have been useful.

For the highest marks, it was expected that candidates would explain how a mass of 0.2 kg was measured and how the energy could be measured experimentally. Some candidates did mention the use of a stopwatch.

Exemplar 3



This candidate has drawn a diagram showing the container is insulated with a heater and thermometer.

The calculation is clearly shown using an

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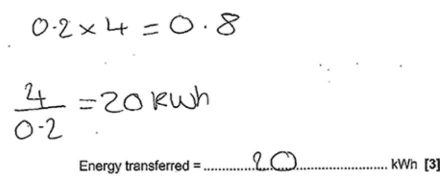
					appropriate equation. The candidate then describes the experiment; this could have included much more detail such as explaining how the water would be measured. This candidate hints at an energy determination when the energy per second of the heater is mentioned. The candidate also gives some extra detail when suggesting that the heater and thermometer should not touch. The description of the procedure lacked appropriate detail but the calculation was correct. The information given by the candidate was relevant and was presented with some structure. Overall this response was assessed as being a Level 2 response worth four marks.
			Total	**6**	
11	a		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 38.28 (W) award 3 marks** Recall (Power =) potential difference x current ✓ 12 × 3.19 ✓ (P =) 38.28 (W) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** correct equation in any form **ALLOW** 38.3 (W) or 38 (W) **Examiner's Comments** This question again required candidates to recall an equation, substitute numbers and calculate an answer. Candidates who used this method scored well. Again, a significant number of candidates wrote both answers which multiplied and divided the numbers.
	b		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.8 (kWh) award 3 marks** Recall (Energy transferred =) power × time ✓ 0.2 × 4 ✓	3(AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** correct equation in any form **ALLOW** 200 x 4 or 200 x 4 x 60 x 60 or 200 x 14400 or 200 x 4 x 60 or 0.2 x 4 x 60 x 60 or 0.2 x 14400 or 0.2 x 4 x 60 for one mark **ALLOW** 800 or 2 880 000 or 2880 or 48 000 or 48 for two marks

			(Energy =) 0.8 (kWh) ✓		**<u>Examiner's Comments</u>** Candidates needed to recall the equation, substitute in the numbers and calculate the answer. Few candidates wrote the equation. Candidates should be encouraged to look at the unit on the answer line. In this question the unit is kW × h which should then give the hint that it is power measured in kW multiplied by time measured in hours. A large number of candidates took the numbers and multiplied them together and also divided them giving possible answers of 0.8 kW h (correct) and 20 kW h (incorrect) – this did not score any marks since the candidate is not demonstrating that they understood the physics. Conflicting physics was not credited. **Exemplar 6**  0·2×4 = 0·8 4/0·2 = 20 kWh Energy transferred = ...20...... kWh [3] This candidate has written 0.2 × 4 = 0.8 which would have scored all three marks. However, the candidate then states that 4 / 0.2 = 20 kWh which incorrect physics and means that the question will not gain credit. This candidate could have gained one mark by writing the equation that needed to be recalled. By writing this equation and then substituting in the numbers, the candidate may not have needed to possibly guess whether to multiply or divide the numbers.
			Total	**6**	
12			**Maximum 2 marks from:** Higher speed increases braking distance ✓ **BUT** Double speed quadruples braking distance / braking distance is (directly) proportional to the speed squared AW ✓✓ **Maximum 2 marks from:** (Idea that) higher speed (car has) more KE ✓	3 (AO 2.1) (AO 3.1a x2) (AO 2.1) (AO 3.1a x2)	**ALLOW** numerical values from graph, e.g. at 10 (m/s), bd = 7.5 (m) but at 20 (m/s) bd = 30 (m). **ALLOW** numerical values from graph, e.g. at 10 (m/s), bd = 7.5 (m) but at 20 (m/s) bd = 4×7.5 (= 30m) for 2 marks **<u>Examiner's Comments</u>** Many answers to this question were vague. This question again required candidates to indicate the direction of the change in speed, e.g. as the speed increases. A small minority

			BUT Double speed quadruples KE / KE is (directly) proportional to the speed squared / AW ✓		of candidates realised that both the kinetic energy and the braking distance increased with increasing speed. Very few used their graph to show that as the speed doubled the braking distance and kinetic energy quadrupled.
			Total	**3**	