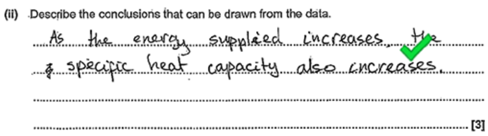
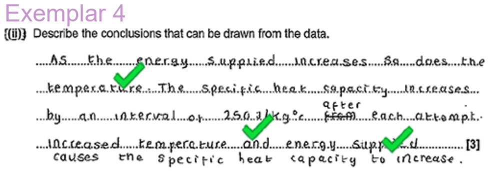
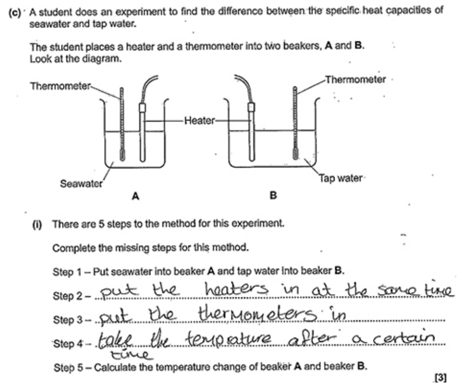
Mark scheme – Changes in State (F)

Question			Answer/Indicative content	Marks	Guidance
1			**B** ✓	1 (AO1.2)	
			Total	**1**	
2			**D** ✓	**1 (AO 2.1)**	**<u>Examiner's Comments</u>** Candidates were required to carry out a simple substitution into a given equation were generally answered well.
			Total	**1**	
3			C	1 (AO2.1)	
			Total	**1**	
4	a	i	Temperature rise or start and end temperatures (1) Time that the heater is switched on (1) Mass of the block (1)	3	
		ii	Reference to: energy = voltage × current × time (1) SHC = energy / (mass × temp rise) (1)	2	
	b		Any two reasons and any two improvements Reasons Heat escapes to the surroundings (1) Part of the immersion heater is outside of the block (1) Poor thermal contact between the immersion heater and block (1) It takes time for the thermometer to reach its maximum temperature (once the heater is turned off) (1) Improvements Lag / insulate the aluminium block (1) Make sure all of the heater is in the block / use a smaller heater (1)	4	**Max** 2 reasons and 2 improvements **ALLOW** (idea of) residual heat not reaching the block before the final temperature is recorded.

			Use petroleum jelly to transfer heat between the immersion heater and the block (1) Wait until the maximum temperature is reached (1)		
			Total	**9**	
5	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) It is not 100% efficient at transferring energy (1)	2	
			Total	**8**	
6	a	i	5250 (J/kg°C) ✓	1 (AO1.2)	<u>**Examiner's Comments**</u> Most candidates (≈ 90%) were able to calculate the mean specific heat capacity efficiently.
		ii	**Any three from:** specific heat capacity increases with temp rises ✓ specific heat capacity increases with energy supplied ✓ temp rise increases with	3 (AO3 × 3.2b)	**ALLOW** other reasonable observation, e.g. s.h.c. increases with longer heating <u>**Examiner's Comments**</u>

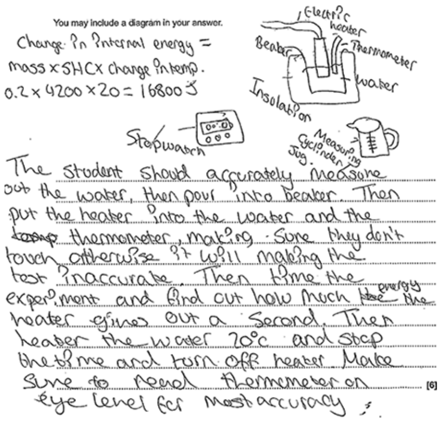
			energy supplied ✓ different amounts of energy were supplied ✓ all of the s.h.cs. are close together (within 5%) / within the range 5000 – 5500 ✓ the experiment was repeated / done 3 times ✓		This question expected the candidate to describe the patterns in the tabulated data and to recognise that the table recorded values from three repeats of the experiment with the control variable changed. There were a number of different marking points to allowed candidates to achieve full marks. However, most candidates' answers were too brief and only described one or two possible conclusions. **AfL** For this style of question which is assessing AO3 it is important to encourage candidates to write about a minimum of three different conclusions that could be drawn. The space provided is indicative of the expected answer, so in this example describing four "conclusions" briefly (Exemplar 4) would be a better approach than one "conclusion" described in greater detail (Exemplar 3). Exemplar 3  (ii) Describe the conclusions that can be drawn from the data. As the energy supplied increases, the specific heat capacity also increases. [3] Exemplar 4  (ii) Describe the conclusions that can be drawn from the data. As the energy supplied increases so does the temperature. The specific heat capacity increases by an interval of 250 J/kg°c after each attempt. increased temperature and energy supplied causes the specific heat capacity to increase. [3]
	b	i	**Any two from:** more energy (than expected) heated the water ✓ energy losses must have occurred/not all the energy went into the water ✓ energy transferred to environment /AW ✓	2 (AO2 × 3.2b)	**ALLOW** heat for energy **Examiner's Comments** Only a very few candidates answered this question well. These candidates realised that a "higher" calculated value of specific heat capacity meant that more energy had to be transferred to the beaker than was expected. These candidates concluded that much energy had been lost to the environment.
		ii	**Any two linked answers from:**		**Examiner's Comments**

			part of the immersion heater is out of the water ✓ make sure the heater is fully in the water/use a larger/deeper beaker ✓ beaker is not lagged/insulated ✓ lag/insulate the beaker ✓ there is no lid on the beaker ✓ put a lid on the beaker ✓ the temperature rises are quite small ✓ apply more energy to the water ✓ insufficient data ✓ take more readings ✓	4 (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b)	Most candidates appeared not to appreciate how the story of the topic being assessed was developed through Q18 and in particular how their answer to Q18(b)(i) should help them in answering Q18(b)(ii). Most candidates offered random comments unrelated to Q18(b)(i). A popular response was the suggestion that a Bunsen burner should be used rather than an electrical immersion heater.
			Total	**10**	
7	a		**Any one from:** Original properties return if change is reversed for physical changes ✓ Chemical change can't be reversed (easily) OR physical change easily reversible✓ The substance after the change is the same as the substance before the change for physical changes ORA ✓	1 (AO1.1)	**ALLOW** in a chemical change particles join together in a different way **<u>Examiner's Comments</u>** Question (a)(i) was correctly done by most candidates. Around half the candidates gained 2/2 in (a)(ii) where an explanation on the mass conservation in terms of particles was needed for the second mark (e.g. 'the same molecules are present'). . The most common misconception was that physical changes were hard to reverse but chemical changes were easy to reverse.
	b	i	40 (g) ✓	1 (AO3.2b)	
		ii	<u>Mass</u> before = <u>mass</u> after / <u>Mass</u> is conserved AW ✓ Explanation in terms of particle rearrangement / conservation of numbers of particles✓	2 (AO1.1x2)	**ALLOW** no <u>mass</u> is lost **ALLOW** matter for mass **ALLOW** atoms/molecules for particles
	c	i	**Any three from:**	3 (AO2.2x3)	**IGNORE** put thermometer or heater in beaker

			Measure start/initial temperatures ✓ Turn on the heaters / heat water ✓ Measurements to determine energy or mass of water ✓ For a set time✓ Measure the final/end temperatures ✓		Initial can be implied **ALLOW** for a fixed temperature change **ALLOW** for a fixed temperature change, measure time **Examiner's Comments** Many candidates did not read the stem to (c)(i) carefully. Exemplar 8 is a response where the quoted steps 2 and 3 are actually in the stems has having been done already. Fortunately, there were two reasonable suggestions on the 'Sep 4' answer line, so the candidate gained 2 marks. **Misconception** In practical skills questions many candidates want to describe the practical activity they did in the classroom rather than answering the question they have been given. It is important to read the stem to the question carefully, including any diagrams. In Exemplar 8 the candidate responses for Step 2 and Step 3of their method had already been done. Fortunately Step 4 contained two reasonable suggestions so the candidate was given 2 marks. **Exemplar 8**  (c) A student does an experiment to find the difference between the specific heat capacities of seawater and tap water. The student places a heater and a thermometer into two beakers, **A** and **B**. Look at the diagram. (i) There are 5 steps to the method for this experiment. Complete the missing steps for this method. Step 1 – Put seawater into beaker **A** and tap water into beaker **B**. Step 2 – put the heaters in at the same time Step 3 – put the thermometers in Step 4 – take the temperature after a certain time Step 5 – Calculate the temperature change of beaker **A** and beaker **B**. [3]
		ii	**Any one from:** Beakers are different sizes	1 (AO3.3a)	

			OR different volumes /mass of liquid in A and B ✓ Beakers are not insulated / no lids✓		**ALLOW** Heater is not fully in the water **<u>Examiner's Comments</u>** Many candidate answers to (c)(ii) and (c)(iii) were linked, with the response to (c)(iii) correcting one of the errors in (c)(ii), and this appeared to be a good approach. Acceptable answers to (c)(iii) had to be related to the process in (c)(i), and not just a generic 'how to do a better experiment' comment.
8		iii	**Any two from:** Use beakers of the same size / same volume✓ Use same mass or volume of liquid✓ Stir water / keep distance from thermometer to heater fixed✓ Insulate the beakers or put the beakers on an insulating material ✓ Put a lid on the beakers ✓ Make sure the heater is fully inserted into the liquid ✓	2 (AO3.3b)	**<u>Examiner's Comments</u>** Many candidate answers to (c)(ii) and (c)(iii) were linked, with the response to (c)(iii) correcting one of the errors in (c)(ii), and this appeared to be a good approach. Acceptable answers to (c)(iii) had to be related to the process in (c)(i), and not just a generic 'how to do a better experiment' comment.
			Total	**10**	
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)** 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*	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**

			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)** 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.*		• 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. 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 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**	