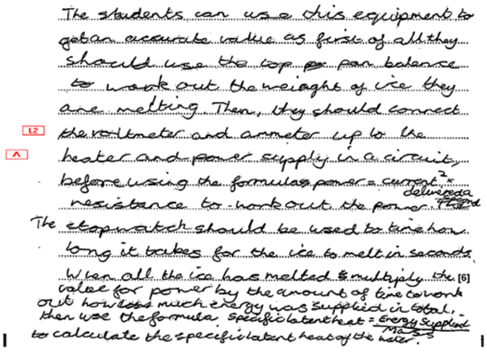
Mark scheme – Changes of State (H)

Question			Answer/Indicative content	Marks	Guidance
1			A	1 (AO2.1)	
			Total	**1**	
2	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) Use petroleum jelly to transfer heat between the immersion heater and the block (1) Wait until the maximum temperature is reached (1)	4	Max 2 reasons and 2 improvements **ALLOW** (idea of) residual heat not reaching the block before the final temperature is recorded.
			Improvements Lag / insulate the aluminium block (1) Make sure all of the heater is in the block/use a smaller heater (1) Use petroleum jelly to transfer heat between the immersion heater and the block (1) Wait until the maximum temperature is reached (1).		**ALLOW** (idea of) residual heat not reaching the block before the final temperature is recorded.
			Total	**9**	
3	a		Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question.	6 (AO 2 × 2.2) (AO 2 ×	**AO1.2 and AO2.2 Applies knowledge and understanding of how to use the equipment to find specific latent heat of water. For example:**

			Level 3 (5–6 marks) **A detailed explanation of experimental procedure** **AND** **detailed discussion about accuracy** *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)** **EITHER** **a detailed explanation of the experimental procedure** **OR** **detailed discussion about accuracy** **OR** **a brief explanation of the experimental procedure and simple discussion about accuracy** *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)** **Brief explanation of the experimental procedure** **OR** **simple comment about accuracy** *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.*	3.3a) (AO 2 × 1.2)	• Measure the initial mass / weight of beaker • Turn on the heater • Start timing • Use the voltmeter, ammeter and stopclock to calculate the energy supplied (E=VIt) • Turn off the heater • Stop timing • Use a balance to measure the mass of the beaker and melted ice • Subtract the original mass of the beaker to find the mass / weight of the melted ice / calculate mass / weight of melted ice • Calculate specific latent heat by dividing energy by **mass** **AO3.3a Analyses information and ideas to develop experimental procedures and consider accuracy of the experiment. For example:** • Make sure that the heater is always covered with ice • Insulate / put lid on the funnel to reduce heat losses • Make sure that the mass of water produced is sufficiently large – run the experiment for long enough • Repeat the experiment to minimise (random) errors **<u>Examiner's Comments</u>** This six mark level of response question is the only one on this paper. It gave the full range of marks and discriminated well at higher grade demand with about 10% giving level 3 answers and gaining 5 or 6 marks. The procedure was explained quite well with many gaining level 2 scores. A few were very brief with the description (level1) and did a little more than relate the equipment given in the question. Most got the idea of measuring the ice melted, measuring the voltage and current (and multiplying them to get power). Many showed how to calculate the energy and then use this to calculate the specific latent heat (SLH). Very few wrote about accuracy and therefore did not get level 3 rewards at all. A few misread the question and wrote about specific heat capacity (SHC) rather than SLH. As in previous qualifications candidates highlighted key words in the question. This helped them focus their attention on

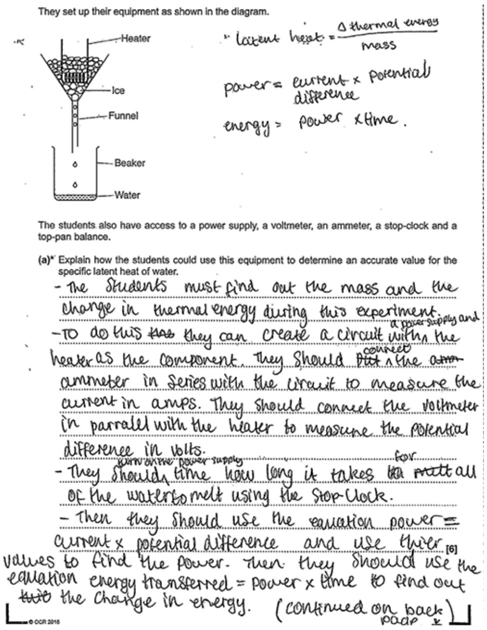
structuring their answers in a clear and concise manner thus gaining marks along the way.

Exemplar 4


The students can use a this equipment to get an accurate value as first of all they should use the top pa pan balance to work out the weight of ice they are melting. Then, they should connect the voltmeter and ammeter up to the heater and power supply in a circuit, before using the formulas power = current² × resistance to work out the power delivered. The stopwatch should be used to time how long it takes for the ice to melt in seconds. When all the ice has melted multiply the value for power by the amount of time to work out how much energy was supplied in total, then use the formula specific latent heat = Energy Supplied / Mass to calculate the specific latent heat of the water. [6]

This answer has some idea of the method but often restates the information in the diagram. For example connects the ammeter and voltmeter to the heater – rather than connects the voltmeter in parallel and the ammeter in series. The formula suggested seems a little insecure for a full level 2 answer so the candidate is credited 3 marks.

Exemplar 5


They set up their equipment as shown in the diagram.

The students also have access to a power supply, a voltmeter, an ammeter, a stop-clock and a top-pan balance.

(a)* Explain how the students could use this equipment to determine an accurate value for the specific latent heat of water.

- The Students must find out the mass and the change in thermal energy during this experiment.
- To do this they can create a circuit with a power supply and the heater as the component. They should connect the ammeter in series with the circuit to measure the current in amps. They should connect the voltmeter in parrallel with the heater to measure the potential difference in volts.
- They should turn on the power supply time how long it takes for all of the water to melt using the stop-clock.
- Then they should use the equation power = current × potential difference and use thier values to find the power. Then they should use the equation energy transferred = power × time to find out the change in energy. (continued on back page) [6]

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					This answer clearly explains the method in some detail. It describes the measurements taken and the calculations and formulae needed. It does not attempt to describe anything about accuracy so it is limited to level 2 and is credited 4 marks.
	b		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 380 000 (J) award 3 marks** SLH = E ÷ m ✓ = 95000 ÷ 0.25 ✓ = 380000 (J/kg) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	Rearranging equation 95 ÷ 250 or 0.38 scores ✓ (evidence of rearranged formula) 95 000 ÷ 250 = 380 scores ✓✓ Or 95 ÷ 0.25 = 380 ✓✓ Or 380 ✓✓ **Examiner's Comments** Slightly over a half gained all 3 marks for this calculation. Some gained fewer marks because of power of 10 errors in conversions for example 360 [2] rather than 360 000 [3]. Others gained [1] for the correct rearrangement of the formula.
			Total	**9**	
4	a	i	40 (g) ✓	1 (AO3.2b)	**Examiner's Comments** Most candidates correctly stated that the mass was 40 g.
		ii	Mass before = mass after / Mass is conserved AW ✓ Explanation in terms of particle rearrangement / conservation of numbers of particles✓	2 (AO1.1 x2)	**ALLOW** no mass is lost **ALLOW** matter for mass **ALLOW** atoms/molecules for particles **Examiner's Comments** Most candidates were able to state that the mass was conserved; few candidates explained their answer in terms of the number of particles (atoms or molecules) not changing but particles are rearranging.
	b		**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✓	1 (AO1.1)	**ALLOW** in a chemical change particles join together in a different way

			The substance after the change is the same as the substance before the change for physical changes ORA ✓		**Examiner's Comments** Most candidates answered this question in terms of a physical change being reversible while a chemical change was not (easily) reversible. Some candidates confused their answers in terms of products.
	c	i	**Any three from:** 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 ✓	3 (AO2.2 x3)	**IGNORE** put thermometer or heater in beaker 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 gain full marks on this question by repeating the question, e.g. place heater and thermometer in the beakers. Ideally candidates were expected to measure the temperature of both beakers at the start of the experiment before switching on the heaters for a set time. It was then expected that candidates would measure the temperature at the end. Other workable alternatives were allowed. Credit was also given for appropriate methods to measure the mass of the water or to determine the energy.
		ii	**Any one from:** Beakers are different sizes OR different volumes /mass of liquid in A and B ✓ Beakers are not insulated / no lids✓	1 (AO3.3a)	**ALLOW** Heater is not fully in the water **Examiner's Comments** Most candidates identified that the beakers were different sizes. Credit was also allowed for identifying that the beakers were not insulated or did not have a lid. Some

					candidates correctly referred to the heaters not being totally submerged.
		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>** The majority of the candidates gained at least one mark for this question. One easy improvement was linked to the previous question. Examiners did not allow same amounts of water. Candidates need to use specific terms such as mass, or volume.
			Total	**10**	
5	a		**FIRST CHECK THE ANSWERS ON ANSWER LINES** **If answer = 385 (J/kg˚C) AND material = zinc award 5 marks** c = (E / mθ) ✓ (θ = 900 – 420 =) 480 (°C) ✓ (c =) 462000 / (2.5) x 480) ✓ (c =) 385 (J/kg°C) ✓ (substance is) zinc ✓	5 (AO1.2) (AO2.2) (AO2.2) (AO2.2) (AO3.2b)	**ALLOW** ecf for missing or incorrect unit conversion e.g. 0.385 (J/kg°C) for 3 marks (E = mcθ does not score a mark) **ALLOW** ecf for closest material to the answer calculated for shc if answer is incorrect. **IGNORE** another material quoted with its value from the table given as the answer unless workings shown
	b		**Any two from:** Not all substances are shown in the table / it could be a substance not in the table ✓ Named uncertainties/errors in the experiment ✓ It assumes all of the energy went to heat the material ✓ The value is (very) close to other values ✓ It assumes the substance is pure/not a mixture ✓	2 (AO2x3.1b)	**ALLOW** there could be more than one substance with the same shc **ALLOW** assumes no energy transferred to other stores / no energy/heat loss **ALLOW** ecf from the part above **ALLOW** maximum of 1 mark for idea of results not repeated/reproduced
			Total	**7**	

6		i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 72 (%) award 5 marks** Select from data sheet: change in thermal energy = mass × specific heat capacity × change in temperature (no mark) (change in thermal energy =) 1.2 × 4200 × 75 ✓ (change in thermal energy =) 378 000 (J) ✓ (Recall: efficiency =) useful output energy transfer / input energy transfer **OR** (Efficiency =) 378 000 / 525 000 ✓ (Efficiency =) 0.72 ✓ (Efficiency =) 72 (%) ✓	5 (AO1.2) (AO2.1) (AO1.2) (AO2.1) (AO1.2)	**ALLOW** ecf for incorrect thermal energy calculated **ALLOW** 4 marks for answer of 0.72 (%)
		ii	some energy is transferred to the (thermal energy store of the) kettle/surroundings/air ✓	1 (AO2.1)	**IGNORE** sound
			Total	**6**	