

**Mark Scheme**

Q1.

Question Number	Answer	Mark
	<p><b>A</b> melting</p> <p><b>A</b> is the only correct answer.</p> <p><b>B</b> is incorrect because the change from solid to liquid is not freezing.</p> <p><b>C</b> is incorrect because the change from solid to liquid is not evaporation.</p> <p><b>D</b> is incorrect because the change from solid to liquid is not condensation.</p>	<b>(1)</b>

Q2.

Question Number:	Answer	Additional guidance	Mark
	100 (°C) (1)	<p>accept any answer between and including 95 and 102</p> <p>(possibility that it is not pure water and possibility of heat loss prevents reaching boiling point)</p>	<b>(1)</b> AO 2 1

Q3.

Question Number:	Answer	Additional guidance	Mark
	substitution (1) $(Q =) \frac{380 \times 3.34 (\times 10^5)}{(1000)}$ evaluation (1) $1.27 \times 10^5 \text{ (J)}$	127 kJ 126920 (J)  accept answers that round to $1.27 \times 10^5$ e.g. $1.2692 \times 10^5$  accept 130 kJ or $1.3 \times 10^5 \text{ (J)}$  POT error max. 1 mark  award full marks for correct answer without working	<b>(2)</b> AO 2 1

Q4.

Question number	Answer	Additional guidance	Mark
	An explanation that combines identification – improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark): <ul style="list-style-type: none"> <li>• place the beaker on an insulator (1)</li> <li>• so this (material) will reduce rate of energy transfer (1)</li> </ul> or <ul style="list-style-type: none"> <li>• wrap the beaker in an insulator (1)</li> <li>• so this (material) will reduce the rate of energy transfer (1)</li> </ul> or <ul style="list-style-type: none"> <li>• reduce the surface areas of the water (1)</li> <li>• to give less evaporation (1)</li> </ul>	allow named insulator, e.g. cork mat  put a lid on the beaker/make the beaker taller and narrower	<b>(2)</b>

Q5.

Question number	Answer	Additional guidance	Mark
	substitution (1) $566\,000 = 0.25 \times L$  rearrangement (1) $\frac{566\,000}{0.25}$  evaluation (1) $2\,260\,000 \text{ (J/kg)}$	substitution and rearrangement in either order       award full marks for correct answer without working	<b>(3)</b>

Q6.

Question number	Answer	Additional guidance	Mark
	rearrangement (1) $(l =) \frac{\Delta Q}{\Delta m}$  substitution (1) $l = \frac{270\,000}{0.12}$  answer (1) $2\,250\,000 \text{ (J/kg } ^\circ\text{C)}$	award full marks for correct numerical answer without working       $2250 \text{ (J/kg } ^\circ\text{C)}$ gains 2 marks as power of 10 error	<b>(3)</b>

Q7.

Question number	Answer	Additional guidance	Mark
	An answer that combines <b>any four</b> of the following points of understanding to provide a logical description: <ul style="list-style-type: none"> <li>chooses either thermocouple or infra-red thermometer (1)</li> <li>molten steel is poured into a crucible (1)</li> <li>a stopwatch is started (1)</li> <li>the crucible + contents are allowed to cool down (in the room) (1)</li> <li>temperatures are taken at regular intervals (e.g. every minute) (1)</li> </ul>	any interval with steel – every 10 minutes etc.	(4)

Q8.

Question number	Answer	Mark
(i)	C	(1)

Question number	Answer	Additional guidance	Mark
(ii)	Equating the same variable in both equations (1) $\Delta Q = m \times c \times \Delta\theta = P \times t$  Rearrangement (1) $t = \frac{m \times c \times \Delta\theta}{P}$  Substitution and evaluation (1) $t = \frac{(1 \times 4200 \times 77)}{3500}$ $= 92 \text{ s}$	allow $\Delta\theta$ seen as 95 – 18         92.4 evaluation must be seen to at least 2 s.f. at some point in the working	(3)

Q9.

Question Number	Answer	Additional guidance	Mark
(i)	29(g)		(1)

Question Number	Answer	Additional guidance	Mark
(ii)	25(cm <sup>3</sup> )		(1)

Question Number	Answer	Mark
(iii)	<p><b>D</b> density = <math>\frac{\text{mass}}{\text{volume}}</math></p> <p><b>D</b> is the only correct answer</p> <p><b>A</b> is incorrect because the equation density = mass + volume is incorrect</p> <p><b>B</b> is incorrect because the equation density = mass – volume is incorrect</p> <p><b>C</b> is incorrect because the equation density = mass x volume is incorrect</p>	(1)

Question Number	Answer	Additional guidance	Mark
(iv)	<p>Any two improvements from:</p> <p>use balance that reads to one or more decimal places/more decimal places (1)</p> <p>use tare/zero balance for first measurement (1)</p> <p>use measuring cylinder with smaller divisions (1)</p> <p>use larger volume of liquid (1)</p> <p>repeat <u>and</u> average (1)</p> <p>read measuring cylinder at eye level (1)</p>	<p>Accept use more accurate/precise balance in this context</p> <p>Allow reset for tare</p> <p>Allow more accurate/ different scale / different divisions / thinner measuring cylinder</p> <p>Allow use more liquid / larger mass of liquid</p> <p>Allow avoid parallax error / read from bottom of meniscus</p>	(2)

Q10.

Question Number	Answer	Additional guidance	Mark
(i)	substitution (1) $(\Delta Q) = 1.5 \times 4200 \times 50$  evaluation (1) 320 000 (J)	accept 315 000 (J) 310 000 (J)  award full marks for the correct answer without working  320 000 000 315 000 000 310 000 000 score 1 mark (mass in grams)	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	substitution (1) $3500 = \frac{670\,000}{t}$  rearrangement (1) $(t =) \frac{670\,000}{3500}$  evaluation (1) 190(s)	accept substitution and rearrangement in either order      accept any answer that round to 190(s)  power of ten error award 2 marks maximum  award full marks for the correct answer without working	(3)

Q11.

Question number	Answer	Additional guidance	Mark
(i)	two from: lagging (1) lid (1) repeat and average (1)  surround heater/thermometer with oil (1)	repeat with different time/temp rise/power Allow to reach maximum temperature at switch off.	(2)

Question number	Answer	Additional guidance	Mark
(ii)	temperature rise = 34 (°C) (1)  substitution (1) $\frac{50 \times 300}{0.92 \times 34}$  evaluation (1) 480 (J/kg°C)	ecf temperature rise  award full marks for correct answer without working	(3)

Q12.

Question number	Indicative content	Mark
*	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;"><b>AO1 (6 marks)</b></p> <ul style="list-style-type: none"> <li>• Use of top pan balance to measure mass</li> <li>• Insulate beaker to reduce heat loss</li> <li>• Ammeter connected in series with heater</li> <li>• Voltmeter connected in parallel with heater</li> <li>• Use of <math>E = I \times V \times t</math> to determine energy supplied to the water</li> <li>• Accept use of joule-meter to measure energy supplied</li> <li>• Use of <math>\Delta E = m \times c \times \Delta\theta</math> to determine the specific heat capacity of the water</li> <li>• Measure p.d. across heater</li> <li>• Use stopwatch to measure time liquid is heating</li> <li>• Measure current in heater</li> <li>• Determine mass of water as mass of (beaker and water) – mass of beaker</li> <li>• Measure temperature before and after heating</li> </ul>	<b>(6)</b>

Level	Mark	Descriptor
	0	No awardable content.
Level 1	1-2	<p>Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1)</p> <p>Presents a description which is not logically ordered and with significant gaps. (AO1)</p>
Level 2	3-4	<p>Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1)</p> <p>Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)</p>
Level 3	5-6	<p>Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1)</p> <p>Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)</p>

Q13.

Question number:	Answer	Additional guidance	Mark
(i)	<p>(measurement of) the mass of water (1)</p> <p>(measurement of) the temperature (rise/change) (1)</p> <p>(measurement of) the energy supplied / from heater (1)</p> <p>detail of any of the above (1)</p>	<p>accept volume / weight of water ignore amount</p> <p>accept (take) thermometer reading</p> <p>accept (take) reading of the joulemeter</p> <p>ignore 'change in thermal energy' (from equation)</p> <p>e.g. measure temp at the start and end or measure mass of empty cup or start and end readings on the meter</p>	(4) AO 1 2

Question Number:	Answer	Additional guidance	Mark
(ii)	any two improvements from:	both marks can be scored in one answer space	<b>(2)</b> AO 3 3b
	add lid /cover (1)	ignore repeating readings ignore increase voltage / power / energy ignore use of clamp to hold thermometer / heater	
	add lagging / insulation (1)	accept use better insulator or better insulated / thicker cup accept use calorimeter	
	add a stirrer (1)	ignore use glass beaker unless cup is inside it ignore different type of cup	
	use a more sensitive thermometer (1)	accept use digital / electric thermometer / data logger	
	ensure heater fully submerged (1)		

Q14.

Question Number	Answer	Additional guidance	Mark
(i)	substitution into $\Delta Q = m \times c \times \Delta\theta$ (1)  $84\,000 = 0.25 \times 4200 \times \Delta\theta$  rearrangement $\frac{\Delta Q}{m \times c}$ (1)  $(\Delta\theta = ) \frac{84\,000}{0.25 \times 4200}$  (= 80)  evaluation (1)  (temperature before heating = ) 20 (°C)	accept substitution and rearrangement in either order           answer of 80 (°C) scores 2 marks           award full marks for the correct answer without working	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	substitution into $Q = m \times L$ (1)  $0.34 = 0.15 \times L$  re-arrangement and evaluation (1)  $(L = \frac{0.34}{0.15} = )$  2.3 (MJ/kg)	allow values that round to 2.3 (MJ/kg)           allow 1 mark for POT error           award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
(iii)	A description that makes reference to any <b>two</b> of the following  (density) increases between 0°C and 4°C (1)  reaches a maximum at 4°C (1)  (density) decreases above 4°C (1)	increases initially / at first / up to 4°C    then decreases   if no other marks scored then credit reference to large volume means low density (OWTTE) for 1 mark only	(2)

Q15.

Question number	Answer	Additional guidance	Mark
(i)	Substitution: Density = mass/ volume (1) = $28 \times 10^{-3} / 3.6 \times 10^{-6}$ (1)  Evaluation = $7777 \text{ kg / m}^3$ (1)	(recalled / used) ignore any power of ten (pot) error here  do not penalise any sf errors  (7.77 etc. would get 2 marks: losing the pot mark in the evaluation)	(3)

Question number	Answer	Additional guidance	Mark
(ii)	(Use $\Delta Q = m \times c \times \Delta \theta$ ) substitution thermal energy gained = $0.028 \times 510 \times 80$ (1)  evaluation = $1100 \text{ (J)}$ (1)	ignore any pot error here  1142 (J)	(2)

Question number	Answer	Mark
(iii)	<p>An explanation that combines identification – knowledge (2 marks) and reasoning / justification (1 mark)</p> <p>Solid state → particles vibrate (1)  → about fixed positions (1)</p> <p>Liquid state → particles move randomly / freely (1)</p>	(3)

Q16.

Question number	Answer	Mark
(i)	<p>An answer that combines the following points of understanding to provide a logical description:</p> <ul style="list-style-type: none"> <li>when steam condenses, its molecules move closer together, so the internal energy decreases (1)</li> <li>when the water from the condensed steam cools, its molecules move more slowly, therefore storing less kinetic energy (1)</li> </ul>	<p>allow as water cools, the distance between the particles decreases which increases the intermolecular forces</p> <p>(2)</p>

Question number	Answer	Additional guidance	Mark
(ii)	<p>equating the variables in the three equations/principle of conservation of energy (1)</p> $(m_w \times l_w) + (m_w \times c_w \times \Delta\theta_w) = (m_m \times c_m \times \Delta\theta_m)$ <p>rearrangement (1)</p> $m_m = \frac{(m_w \times l_w) + (m_w \times c_w \times \Delta\theta_w)}{(c_m \times \Delta\theta_m)}$ <p>substitution of correctly calculated quantities (1)</p> $= \left( \frac{\left( \left( \frac{25}{1000} \right) \times 2260000 \right) + \left( \left( \frac{25}{1000} \right) \times 4200 \times 35 \right)}{3840 \times 60} \right)$ <p>evaluation (1)</p> <p>0.26 (kg)</p>	<p>allow in words or with suitable alternative subscripts</p> <p>temperature changes and <math>l_w</math> must be correct</p> <p>allow maximum of 3 marks for calculations that omit the energy from cooling of water</p>	(4)

Question number	Answer	Mark
(iii)	<p>Any two of the following reasons:</p> <ul style="list-style-type: none"> <li>• more steam must condense and transfer the energy that is dissipated to the jug during the process (1)</li> <li>• more steam must condense and transfer the energy that is dissipated to the surroundings during the process (1)</li> <li>• more steam must condense and transfer the energy needed to cause the milk to froth (1)</li> <li>• more steam must condense to replace any steam that might leave the milk without condensing (1)</li> </ul>	(2)