Q1.

Question number	Answer	Additional guidance	Mark
	an explanation linking any **three** from:		**(3)** **AO1.2**
	stir the water before taking a reading of temperature (1)		
	(continue to) observe temperature**s** after switching off (1)	allow "for **longer** than 10 minutes" allow wait(ing period) in correct context	
	record the maximum / highest / peak temperature reached (1)	until the temperature stops changing	
	take temperature reading at eye level (1)		
	conduction (and convection) take time (1)	takes time (for water / thermometer) to heat through	

Q2.

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

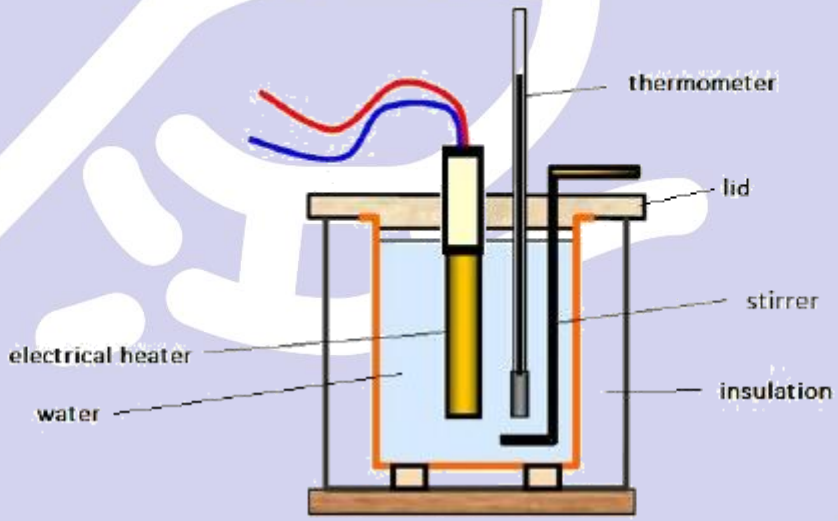
Question Number:	Answer	Additional Guidance	Mark
(ii)	any two improvements from: add lid /cover (1) add lagging / insulation (1) add a stirrer (1) use a more sensitive thermometer (1) ensure heater fully submerged (1)	both marks can be scored in one answer space ignore repeating readings ignore increase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

Q3.

Question number	Indicative content	Mark
*	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. 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. **AO1 (6 marks)** • Use of top pan balance to measure mass • Insulate beaker to reduce heat loss • Ammeter connected in series with heater • Voltmeter connected in parallel with heater • Use of $E = I \times V \times t$ to determine energy supplied to the water • Accept use of joule-meter to measure energy supplied • Use of $\Delta E = m \times c \times \Delta\theta$ to determine the specific heat capacity of the water • Measure p.d. across heater • Use stopwatch to measure time liquid is heating • Measure current in heater • Determine mass of water as mass of (beaker and water) – mass of beaker • Measure temperature before and after heating	**(6)**

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

Q4.

SSQ NO:	CS NO:	Answer	Mark
*		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. 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. (Accept the method of cooling a heated object in water but consult your TL.) **AO1 strand 2 (6 marks)** **Details of the apparatus to include:**	**(6)** **AO1.2**
		 (resourcefulphysics.org) • credit all elements seen in diagram or stated • may also include power supply / electrical circuitry • other apparatus – balance / scales ; stopwatch ; voltmeter / ammeter / joulemeter	

- ignore bunsen burner

(continued ...)

Steps taken with the procedure and calculation including:

- measure mass of water (with a balance)
- measure initial temperature (with thermometer)
- switch on for a (set) time / use of stopwatch
- measure final / highest temperature (reached)
- measure energy input on joulemeter / measure V, I and t
- extra detail e.g. stirring / how to get final maximum temperature
- rearrange $\Delta Q = m \times c \times \Delta\theta$ to find c $\quad c = \frac{\Delta Q}{m \times \Delta\theta}$
- correct use of graph to determine c

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	• 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)

		• Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Summary for guidance

Level	**Mark**	**Additional Guidance**	**General additional guidance – the decision within levels** e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> list of relevant apparatus: at least 2 items AND at least one reasonable step described OR gives equation to find c	<u>Possible candidate responses</u> some apparatus named e.g. thermometer, balance, stirrer, joulemeter, ammeter, voltmeter, beaker diagram with some labels measure mass of water use a thermometer use of $\Delta Q = m \times c \times \Delta\theta$

Level 2	3–4	<u>Additional guidance</u> list of apparatus for measurements AND logical steps including how to find Δθ **OR** ΔQ	<u>Possible candidate responses</u> balance / thermometer together with joulemeter / stopwatch etc. measure initial and final temperatures with a thermometer realistic use of joulemeter
Level 3	5–6	<u>Additional guidance</u> understanding is detailed and fully developed. includes detail about apparatus used to obtain measurements **AND** details in steps taken, including how to find Δθ **AND** ΔQ	<u>Possible candidate responses</u> (use of) balance / thermometer / stopwatch / insulated can / electrical heater etc. measure mass of water (with a balance) / measure initial and final temperatures with a thermometer + electrical heating applied
		AND how to determine c	for a (set) time + realistic use of joulemeter (or power (VI) and time) $c = \frac{\Delta Q}{m \times \Delta\theta}$

Q5.

Question number	Indicative content	Mark
*	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. 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. Procedure • Measure the temperature of the boiling water • Allow sufficient time for block to reach temperature of boiling water • Measure temperature of cold water in beaker • Using a thermometer • Transfer (hot) aluminium block to cold water in the beaker. • Work quickly to avoid thermal energy loss during transfer • Measure temperature of water • Stir to ensure even distribution • Measure maximum temperature reached by water • Calculate temp rise of water by subtracting initial from final temperature. • Calculate temp drop of aluminium by subtracting final temperature from 100. • Find mass of beaker and water and aluminium • Use a balance • Empty water from beaker and dry beaker and block • Weigh beaker and block alone • Find mass of water by subtraction. • Allow plausible method of finding mass of water before putting block in.	**(6)** **AO2 and AO3**

	Process results • Calculate thermal energy gained water using $\Delta Q = m \times c \times \Delta\theta$ • Thermal energy gained by water = thermal energy lost by aluminium • Specific heat capacity of aluminium = $\frac{\text{thermal energy transferred}}{\text{mass of Al} \times \text{temp drop of Al}}$	

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1–2	• The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) • Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	• The plan is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	• The plan is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)

Summary for guidance

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Partially complete description of a suitable procedure with at least one measurement	Possible candidate responses Heat up the block in the boiling water. Then put the block into the cold water. Measure the temperature reached by the water.
Level 2	3–4	Additional guidance Mostly complete description of a suitable procedure with at least two measurements and some description of processing the results.	Possible candidate responses As above with Measure mass of water. Use $\Delta Q = m \times c \times \Delta\theta$ to find thermal energy transferred
Level 3	5–6	Additional guidance Detailed description of a suitable procedure with most of the necessary measurements and a clear description of processing the results.	Possible candidate responses As above with Calculate temperature changes by subtraction. Calculate thermal energy lost by Al as being equal to thermal energy gained by water. Specific heat capacity of Al = $\frac{\text{thermal energy transferred}}{\text{mass of Al} \times \text{temp drop of Al}}$

Q6.

Question number	Indicative content	Mark
*	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. 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. Equipment • Thermometer • Measuring cylinder / balance • Power supply • Stirrer • Joule meter / ammeter / voltmeter • Stopwatch / clock Measurements • Mass / volume of water • Initial / final / change of temperature of water • Voltage / current / energy / power • Time (heated for) Detail • Lid/insulation to reduce energy loss • Ensure heater fully immersed / keep stirring the water • Use of equation $\Delta Q = m \times c \times \Delta\theta$ / calculation of input energy • Repeat and find average • Plot graph of temp change and time / energy Credit can be given for correctly labelled diagrams	**(6)** **AO1**

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

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance one measurement **or** two items of equipment **or** one piece of detail	Possible candidate responses measure the temperature of the water to start with **or** the student needs a power supply and a thermometer **or** insulated material around the beaker
Level 2	3–4	Additional guidance two items of equipment and at least one measurement **or** one piece of equipment and two measurements **or** two items of equipment and one piece of detail **or** one measurement and one piece of detail	Possible candidate responses The student needs a measuring cylinder to measure the volume of water. They also need a thermometer **Or** Measure the temperature rise of the water and use a balance to measure the mass **or** They need a power supply for the heater and a voltmeter. Keep the heater in the water. **or** Measure temperature rise of the water. Keep stirring the water all the time.
Level 3	5–6	Additional guidance two items of equipment and two measurements and one piece of detail.	Possible candidate responses The student needs a balance to find the mass of water. They also need a thermometer to measure the rise in temperature of the water. Then use the equation $\Delta Q = m \times c \times \Delta\theta$