Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Specific heat capacity

Time allowed: 1 hour 15 minutes

Subject code **0625**

Physics

Paper 4 (Extended)

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 75

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 9 questions worth 75 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 A student uses a 2400 W electric kettle to obtain a value for the specific heat capacity of sunflower oil.

Fig. 6.1 shows the apparatus.

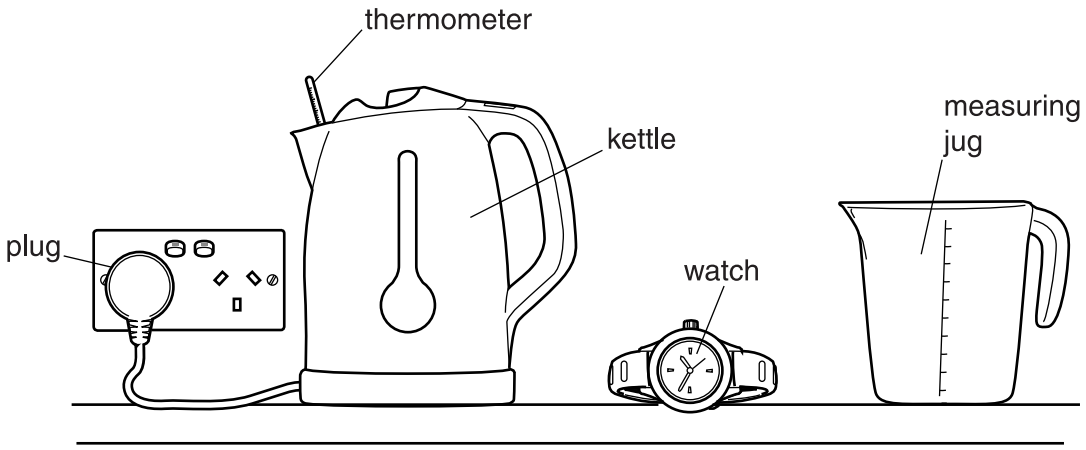


Fig. 6.1

The student uses a measuring jug and pours 1.5 kg of sunflower oil into the empty kettle. He uses a thermometer to measure the temperature of the oil.

The kettle is switched on and left on for 50 s. The temperature of the oil increases by 32 °C.

The student assumes that all the electrical energy is transferred as thermal energy to the oil.

(a) Calculate the value for the specific heat capacity of sunflower oil obtained by the student.

specific heat capacity = ... [4]

(b) State and explain whether the value for the specific heat capacity obtained by the student is too large or too small.

.....

..... [1]

[Total: 5]

Specific heat capacity Click for more variations

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1 **(a)** (Q/E =) Pt **or** 2400 × 50 — C1
1.2×10^5 (J) — C1
(c =) $Q/m\Delta T$ **or** $1.2 \times 10^5/(1.5 \times 32)$ (condone $2400/(1.5 \times 32)$)
(allow e.c.f. from candidate's $Q = 1.2 \times 10^5$) — C1
2.5×10^3 J/(kg °C) **or** 2.5 J/(g °C) (condone missing brackets)
(allow e.c.f. from candidate's $Q = 1.2 \times 10^5$) — A1 [4]

(b) (student's value) too large **and** heat lost to surroundings/kettle/evaporation — B1 [1]

[Total: 5]

2 Fig. 4.1 shows some of the apparatus that a student uses to determine the specific heat capacity of aluminium.

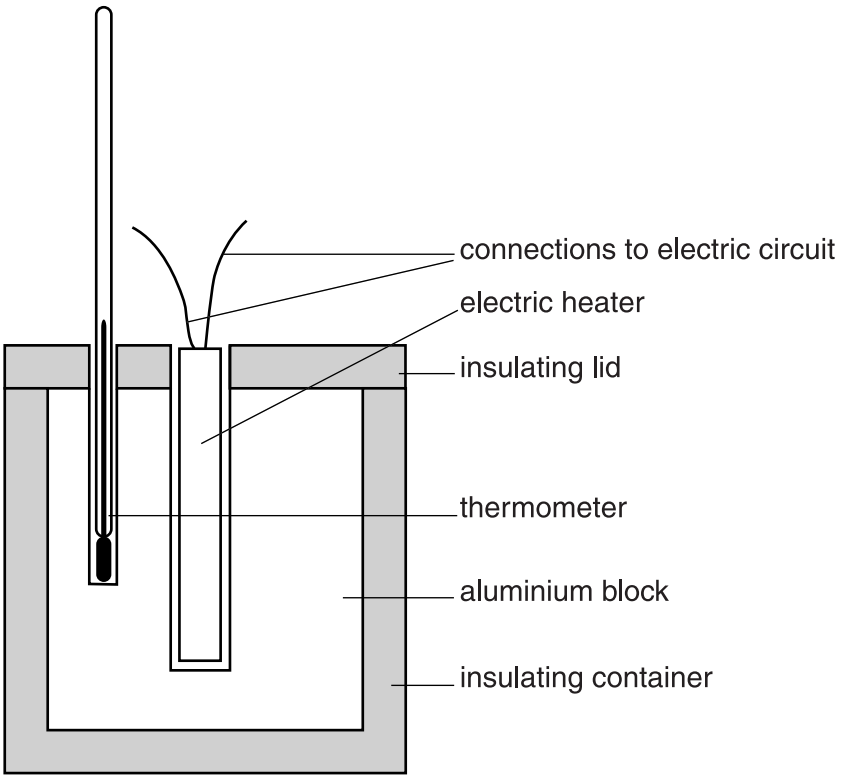


Fig. 4.1

(a) State the measurements the student needs to make, including those from the electric circuit. For each quantity measured, state a symbol.

.....

.....

.....

.....

.....

.....

.....[4]

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(b) Use your symbols from **(a)** to complete the formula used to determine the specific heat capacity c.

specific heat capacity c =

.....[2]

(c) Another student performs the experiment without using insulation. He obtains a higher value for c.

Explain why this student's measurements lead to this higher value.

.....

..... [1]

[Total: 7]

Specific heat capacity Click for more variations

2 **(a)** mass of block m B1
initial temperature θ_1 and final temperature θ_2 B1
time of heating t B1
voltage / p.d. V AND current I B1

(b) (c =) $VIt \div [m(\theta_2 - \theta_1)]$
OR $Pt \div [m(\theta_2 - \theta_1)]$ **OR** $E \div [m(\theta_2 - \theta_1)]$ as appropriate to symbols defined in **(a)**
numerator correct B1
denominator correct B1

(c) (more) thermal energy / heat lost (to surroundings) so temperature rise is less
OR more thermal energy / heat input required for same temperature rise B1

[Total: 7]

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3 **(a)** An object of mass m and specific heat capacity c is supplied with a quantity of thermal energy Q. The temperature of the object increases by $\Delta\theta$.

Write down an expression for c in terms of Q, m and $\Delta\theta$.

c = ...[1]

(b) Fig. 4.1 shows the heating system of a hot water shower.

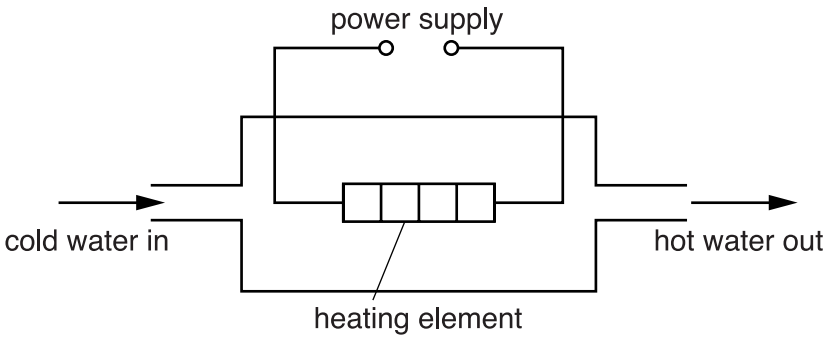


Fig. 4.1

Cold water at 15 °C flows in at the rate of 0.0036 m^3/minute. Hot water flows out at the same rate.

(i) Calculate the mass of water that passes the heating element in one minute. The density of water is 1000 kg/m^3.

mass = ...[2]

(ii) The power of the heating element is 8.5 kW.

Calculate the temperature of the hot water that flows out. The specific heat capacity of water is 4200 J/(kg °C).

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temperature = ...[4]

[Total: 7]

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3 **(a)** $c = Q/(m\Delta\theta)$ B1

(b) **(i)** $d = m/V$ in any form OR (m =) Vd OR 0.0036×1000 C1
3.6 kg A1

(ii) (E =) Pt OR 8500×60 OR 510 000 J OR 5.1×10^5 J C1
$\Delta\theta = Q/mc$ OR $\Delta\theta = Pt/mc$ in any form OR $5.1 \times 10^5/(3.6 \times 4200)$ C1
= 34 (°C) A1

OR $\Delta\theta = P/(\text{mass per second} \times c)$ (C1)
$= 8500/[(0.0036/60) \times 4200$ (C1)
= 34 (°C) (A1)

outflow temp = 15 + 33.73 = 49 °C B1

[Total: 7]

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4 **(a)** State what is meant by the *specific heat capacity* of a substance.

.....

.....

..... [2]

(b) A student carries out an experiment to find the specific heat capacity of aluminium. He uses an electric heater and a thermometer, inserted into separate holes in an aluminium block.

The following data are obtained.

mass of aluminium block = 2.0 kg
power of heating element = 420 W
time of heating = 95 s
initial temperature of block = 19.5 °C
final temperature of block = 40.5 °C

Calculate the value of the specific heat capacity of aluminium given by this experiment.

specific heat capacity = ... [4]

(c) In the experiment in **(b)**, no attempt is made to prevent loss of thermal energy from the surfaces of the block.

Suggest two actions the student could take to reduce the loss of thermal energy from the surfaces of the block.

1. .....

2. .....

[2]

[Total: 8]

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4 **(a)** energy/heat required to increase temperature
- of 1 kg / 1 g / unit mass (of the substance) B1
- by 1 °C / 1 K / unit temperature B1

(b) $E = mc\Delta\theta$ in any form OR (c =) $E \div m\Delta\theta$ C1
$E = Pt$ in any form OR 420 × 95 (= 39 900) C1
$\Delta\theta$ = [40.5 – 19.5] OR 21 C1
(c = 39 900÷42 =) 950 J/(kg °C) A1

(c) any two separate points from: max. B2
- lagging / insulation (around block) OR insulate (the block)
- raise temperature of block by a smaller amount OR heat for a shorter time OR use lower power heater <u>for same time</u> OR higher power <u>for same temperature rise / shorter time</u>
- polish the surface of the block OR wrap the block in shiny material OR paint (shiny) white
- reduce initial temperature of block (to below room temperature) OR raise temperature of room
- reduce draughts

[Total: 8]

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5 **(a)** Define specific heat capacity.

.....

.....

..... [2]

(b) A volume of 0.0024 m^3 of oil is heated in a pan for 7.0 min. The temperature of the oil increases from 20 °C to 180 °C.

The density of the oil is 910 kg/m^3. The specific heat capacity of the oil is 2000 J/(kg °C).

(i) Calculate the mass of oil in the pan.

mass = ... [2]

(ii) Calculate the energy required to increase the temperature of the oil.

energy = ... [2]

(iii) Calculate the power required to supply the energy calculated in **(b)(ii)**.

power = ... [2]

[Total: 8]

Specific heat capacity Click for more variations

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5(a)	energy transferred per unit mass per unit temperature change	**A2**
	(thermal) energy (transferred) per unit temperature change	(C1)
5(b)(i)	(m =) 2.2 kg	**A2**
	$m = \rho V$ in any form **OR** 910 × 0.0024	(C1)
5(b)(ii)	7.0×10^5 J **OR** 700 000 J	**A2**
	$c = \Delta E / \{ m\Delta\theta \}$ **OR** (ΔE =) $mc\Delta\theta$ **OR** 2.2 × 2000 × 160 **OR** 2.184 × 2000 × 160	(C1)

5(b)(iii)	1700 W	**A2**
	(P =) E / t **OR** 700 000 / 7 × 60 **OR** 704 000 / 7 × 60 **OR** 698 880 / 7 × 60	(C1)

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6 **(a)** Define *specific heat capacity*.

.....

..... [2]

(b) Solar energy is striking the steel deck of a ship.

(i) Describe how the colour of the deck affects the absorption of the solar energy.

.....

..... [1]

(ii) The solar energy strikes the deck at the rate of 1400 W on every square metre.

The steel plate of the deck is 0.010 m thick.

Steel has a density of 7800 kg / m^3 and a specific heat capacity of 450 J / (kg °C).

13% of the solar energy striking the deck is absorbed and the rest is reflected.

Using these figures, calculate

1. how many joules of solar energy are absorbed by 1.0 m^2 of the deck in 1.0 s,

number of joules = ... [1]

2. the mass of 1.0 m^2 of deck,

mass = ... [2]

3. the rate of rise in temperature of the deck, stating the equation you use.

rate of rise = ... °C / s [3]

[Total: 9]

Specific heat capacity Click for more variations

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6 **(a)** heat/energy to raise/change temperature M1
of 1 kg/g/unit mass through 1°C/1K/unit temperature A1

(b) **(i)** darker colours absorb more OR lighter/shiny colours absorb less B1

(ii) **1.** 182 B1
2. (mass of $1m^2$ =) volume × density OR $D = M/V$ OR (1 ×) 0.01 × 7800 C1
78 kg A1
3. $Q = mc\theta$ B1
$182 = 78 \times 450 \times \theta$ (e.c.f. from **1**,**2**) C1
0.00519 °C/s OR 5.19×10^{-3} °C/s (e.c.f. from **1**,**2**) A1

[Total: 9]

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7 Fig. 4.1 shows a stainless-steel saucepan being heated on an electric cooker. The saucepan contains water.

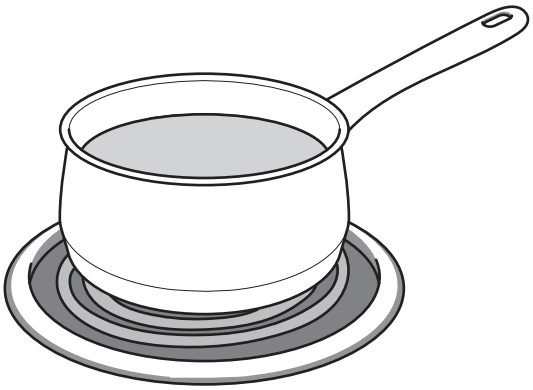


Fig. 4.1

(a) State what happens to the water particles as the water temperature increases.

..... [1]

(b) The saucepan contains 250 cm^3 of water. The specific heat capacity of water is 4200 J / (kg °C). The density of water is 1000 kg / m^3.

(i) Show that the mass of the water in the saucepan is 0.25 kg.

[2]

(ii) Calculate the energy required to increase the water temperature from 20 °C to 65 °C.

energy = ... [3]

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(iii) The heater supplies enough power to heat the water in 39 s.
A student measures the time taken to heat the water as 115 s.

Suggest why the actual time taken to heat the water is longer. Assume that the student takes accurate measurements.

.....

..... [1]

(c) The stainless-steel saucepan is replaced with an aluminium saucepan of the same mass. It contains the same volume of water.

The specific heat capacity of stainless steel is 500 J / (kg °C).
The specific heat capacity of aluminium is 890 J / (kg °C).

Explain how using an aluminium saucepan will affect the time taken to heat the water.

.....

.....

..... [2]

[Total: 9]

Specific heat capacity Click for more variations

Reduced to 78% to fit the page (wider than A4).

7(a)	(average) KE of particles increases / particles move faster	**B1**
7(b)(i)	$\rho = m / v$ **OR** (m =) ρv	**M1**
	1 cm^3 = 1 × 10^{-6} m^3 **OR** 250 cm^3 = 2.5 × 10^{-4} m^3 **OR** 1000 × 2.5 × 10^{-4} (= 0.25 kg)	**A1**
7(b)(ii)	47000 J	**A3**
	($\Delta\theta$ =) 65 – 20 °C **OR** ($\Delta\theta$ =) 45 °C	C1
	$E = mc\Delta\theta$ **OR** (E =) $mc\Delta\theta$ **OR** (E =) 0.25 × 4200 × 45	C1
7(b)(iii)	thermal energy also transferred to the pan / surroundings **OR** thermal energy escapes from the water (as it is being heated)	**B1**
7(c)	any **two** from: • (aluminium saucepan) takes longer to heat the water • more (thermal) energy is needed (with aluminium pan for the same increase in temperature) • (because aluminium) has a higher specific heat capacity	**B2**

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8 A student in a laboratory uses the apparatus shown in Fig. 4.1 to determine the specific heat capacity of aluminium.

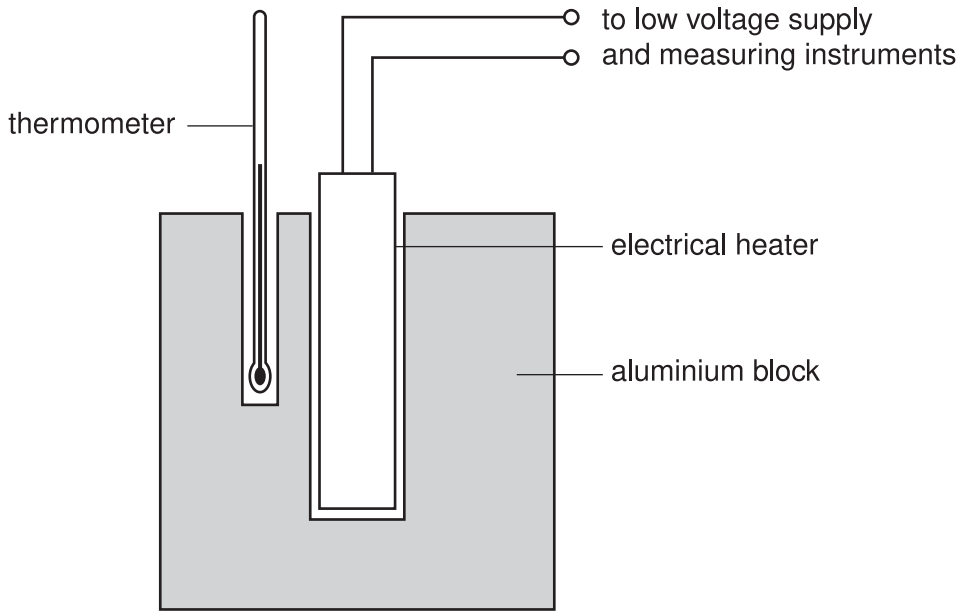


Fig. 4.1

The readings obtained in the experiment are given below.

mass of aluminium block = 0.930 kg
initial temperature of block = 13.1 °C
final temperature of block = 41.3 °C
electrical energy supplied = 23 800 J

(a) Define *specific heat capacity*.

.....

..... [2]

(b) Use the readings above to calculate the specific heat capacity of aluminium.

State the equation you use.

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specific heat capacity = ... [3]

(c) Because the student knows it is good scientific practice to repeat readings, after a short time he carries out the experiment again, supplying the same quantity of electrical energy.

This time the temperature readings are:

initial temperature of block = 41.0 °C

final temperature of block = 62.1 °C

(i) Use these figures to calculate a second value for the specific heat capacity of aluminium.

specific heat capacity = ... [1]

(ii) The student did not make any mistakes when taking the readings.

Suggest why the second value for the specific heat capacity of the aluminium is greater than the first.

.....

..... [2]

(d) Suggest two ways of improving the experiment in order to give as accurate a result as possible.

1. .....

.....

2. .....

..... [2]

[Total: 10]

Specific heat capacity Click for more variations

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8	**(a)**	heat/energy to raise/change temperature of 1 kg/1g/unit mass through 1°C/1K (mention of change of state scores zero)		M1 A1
	(b)	Q = mcθ (for θ accept t, T, Δθ, Δt, or ΔT) 23800 = 0.93 × c × (41.3 – 13.1) 907.5 or 907 or 908 or 910 J/(kg °C) or J/(kg K) at least 2 sig. figs (for unit in **(b)** and **(c)(i)** condone no brackets and extra solidus)		B1 C1 A1
	(c) **(i)**	1212.9 or 1200 or 1210 or 1213 or 1214 J/(kg °C) or J/(kg K)		B1
	(ii)	more energy lost (to surroundings) (average) temperature is higher/initial temperature higher/no cooling time allowed/temperature rise is lower/time of heating may be longer/ rate of heating may be lower		B1 B1
	(d)	insulate block/provide lid/cover with shiny foil start & finish same amount below & above room temperature get heater up to temperature before inserting put oil in gap between heater & block	any 2	B1 + B1

[Total: 10]

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9 **(a)** **(i)** In the space below, draw a labelled diagram of the apparatus you would use to measure the specific heat capacity of a liquid. If you choose an electrical method, you must include the circuit.

[3]

(ii) List the quantities you would need to measure, or previously know, in order to calculate the specific heat capacity of the liquid.

.....

.....

.....

.....

.....[3]

(b) Some sea water has a specific heat capacity of 3900 J/(kg °C) and a boiling point of 100.6 °C.

(i) Calculate the energy required to raise the temperature of 0.800 kg of this sea water from 12.0 °C up to its boiling point. State the equation that you use.

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energy = ...[4]

(ii) The energy to raise the temperature in **(b)(i)** is supplied at the rate of 620 W.

Calculate the time taken to raise the sea water to its boiling point.

time = ...[2]

[Total: 12]

Specific heat capacity Click for more variations

9 **(a)** **(i)** <u>electrical method</u>

lagged container + lid	
liquid (allow) water	5 points 3
heater in liquid	4 points 2
heater connected to electrical supply (seen or stated)	3 points 1
voltmeter and ammeter appropriately connected (seen)	
thermometer	B3

OR

<u>mixtures method</u>

lagged container	
liquid	5 points 3
hot solid/hot liquid	4 points 2
means of heating hot solid / liquid (seen or stated)	3 points 1
means of weighing hot solid / liquid / use of known mass (seen or stated)	
thermometer	B3

(ii) <u>electrical method</u>

initial & final temps of liquid OR temp rise	
voltmeter reading (however expressed)	
ammeter reading (however expressed)	–1 e.e.o.o.
heating time	
mass of liquid	B3

OR

<u>mixtures method</u>

initial and final temps of liquid OR temp rise	
initial and final temps of added solid / liquid OR temp drop	
mass of added solid / liquid	–1 e.e.o.o.
mass of liquid	
SHC of added solid / liquid	B3

(b) **(i)** $Q = mc\theta$ in any form B1
100.6 – 12 OR 88.6 C1
0.8 × 3900 × 88.6 C1
276 432 J A1

(ii) $Q = Wt$ OR (t =) candidate's **(i)**/620 C1
445.858 s ecf **(i)** A1 [12]

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