1)

a	(use of $\Delta Q = mc\Delta T$) $30 \times 98 = 0.100 \times c \times 14$ ✓ $c = 2100$ (J kg^{-1} K^{-1}) ✓	**2**
b	(use of $\Delta Q = ml + mc\Delta T$) $500 \times 98 = 0.100 \times 3.3 \times 10^5$ ✓ $+ 0.100 \times 4200 \times \Delta T$ ✓ ($\Delta T = 38°C$) $T = 38°C$ ✓	**3**
c	the temperature would be higher ✓ as the ice/water spends more time below 25°C **or** heat travels in the direction from hot to cold **or** ice/water first gains heat then loses heat any **one** line ✓	**2**
	Total	**7**

2)

a		$\Delta T = (\frac{\Delta Q}{mc} =) \frac{8.5 \times 10^3}{4200 \times 0.12}$ ✓ 17 K ✓	2
b		$\left(\frac{\Delta T}{\Delta t} = \frac{\frac{\Delta Q}{\Delta t}}{mc}\right) = \frac{100 - 26}{\Delta t} = \frac{8.5 \times 10^3}{0.41 \times 4200}$ ✓ $t = 15$ s ✓	2

3)

(i)	(heat supplied by glass = heat gained by cola) (use of $m_g c_g \Delta T_g = m_c c_c \Delta T_c$) $0.250 \times 840 \times (30.0 - T_f) = 0.200 \times 4190 \times (T_f - 3.0)$ ✓ ($210 \times 30 - 210 t_f = 838 T_f - 838 \times 3$) $T_f = 8.4(1)$ (°C) ✓	2	1st mark for RHS or LHS of substituted equation 2nd mark for 8.4°C Alternatives: 8°C is substituted into equation (on either side shown will get mark)✓ resulting in 4620J~4190J ✓ or 8°C substituted into LHS ✓ (produces ΔT = 5.5°C and hence) = 8.5°C ~ 8°C ✓ 8°C substituted into RHS✓ (produces ΔT = 20°C and hence) = 10°C ~ 8°C ✓

(ii)	(heat gained by ice = heat lost by glass + heat lost by cola) (heat gained by ice = $mc\Delta T + ml$) heat gained by ice = $m \times 4190 \times 3.0 + m \times 3.34 \times 10^5$ ✓ (heat gained by ice = m × 346600) heat lost by glass + heat lost by cola = 0.250 × 840 × (8.41 – 3.0) + 0.200 × 4190 × (8.41 – 3.0) ✓ (= 5670 J) m (=5670/346600) = 0.016 (kg) ✓ or (using cola returning to its original temperature) (heat supplied by glass = heat gained by ice) (heat gained by glass = 0.250 × 840 × (30.0 – 3.0)) heat gained by glass = 5670 (J) ✓ (heat used by ice = $mc\Delta T + ml$) heat used by ice = $m(4190 \times 3.0 + 3.34 \times 10^5)$ ✓ (= m(346600)) m (=5670/346600) = 0.016 (kg) ✓	3	NB correct answer does not necessarily get full marks 3rd mark is only given if the previous 2 marks are awarded (especially look for $m \times 4190 \times 3.0$) the first two marks are given for the formation of the substituted equation not the calculated values if 8°C is used the final answer is 0.015 kg

4)

4 (a)	the energy required to change the state of a unit mass of water to steam/gas ✓ when at its boiling point temperature /100°C / without a change in temperature) ✓	Allow 1 kg in place of unit. Allow liquid to vapour/gas without reference to water. Don't allow 'evaporation' in first mark.	2	
4 (b)(i)	thermal energy given by copper block (= $mc\Delta T$) = 0.047 × 390 × (990 – 100) = 1.6×10^4 (J) ✓ 2 sig figs ✓	Can gain full marks without showing working A negative answer is not given credit. sig fig mark stands alone	2	
4(b)(ii)	thermal energy gained by water and copper container (=$mc\Delta T_{water} + mc\Delta T_{copper}$) = 0.050 × 4200 × (100 – 84) + 0.020 × 390 × (100 – 84) or = 3500 (J) ✓ (3485 J) available heat energy (=1.6×10^4 – 3500) = 1.3×10^4 (J) ✓ allow both 12000J and 13000 J	Allow CE from (b)(i) working must be shown for a CE Take care in awarding full marks for the final answer – missing out the copper container may result in the correct answer but not be worth any marks because of a physics error. (3485 is a mark in itself) ignore sign of final answer in CE (many CE's should result in a negative answer)	2	
4(b)(iii)	(using $Q = ml$) $m = 1.3 \times 10^4 / 2.3 \times 10^6$ = 0.0057 (kg) ✓ Allow 0.006 but not 0.0060 (kg)	Allow CE from (b)(ii) answers between 0.0052 → 0.0057 kg resulting from use of 12000 and 13000 J	1	

5)

5(a)	Tick in 4th box		1
5(b)(i)	(using heat energy = ml) energy = $0.047 \times 3.3 \times 10^5 = 1.6 \times 10^4$ (J) √ (1.55×10^4 J)	answer alone gains mark	1
5(b)(ii)	(heat in from water = heat supplied to melt and raise ice temperature) $1.8 \times 10^4 = 1.6 \times 10^4$ + (energy to raise temp of ice) energy to raise temp of ice = 2×10^3 (J) √	answer alone gains mark allow 2, 2.5 or 3 × 10^3 J allow CE if substitution is shown 1.8×10^4 – (b)(i)	1
5(b)(iii)	(using heat energy = $mc\Delta T$) $c = 2 \times 10^3 / 0.047 \times 25$ = 2×10^3 √ (1.7×10^3) (note there is a large range of correct answers) J kg^{-1} K^{-1} or J kg^{-1} $^{o}C^{-1}$ √ (allow use of dividing line but don't allow ^{o}K and $^{o}C^{-1}$ is not the same as C^{-1})	only allow CE if substitutions are seen c = (b)(ii) / 0.047 × 25 = b(ii) x 0.851 allow 1 sig fig. common answers: for 2.5×10^3 J gives 2.1×10^3 or 2×10^3 for 3×10^3 J gives 2.6×10^3 or 3×10^3	2

6)

(a)	(it takes) 130 J/this energy to raise (the temperature of) a mass of 1 kg (of lead) by 1 K / 1 °C (without changing its state) ✓	1 kg can be replaced with unit mass marks for 130J or energy +1 kg or unit mass +1 K or 1 °C Condone the use of 1 °K	1
(b)	(using $Q = mc\Delta T + ml$) = 0.75 × 130 × (327.5 – 21) + 0.75 × 23000 ✓ (= 29884 + 17250) = 47134 ✓ = 4.7×10^4 (J) ✓	For the first mark the two terms may appear separately ie they do not have to be added. Marks for substitution + answer + 2 sig figs (that can stand alone)	3

7)

(a)	using $Q = mc\Delta\theta$ $= 3.00 \times 440 \times (84-27)$ ✓ 7.5×10^4 (J) ✓	**2**
(b)	using $Q = ml$ $= 1.20 \times 2.5 \times 10^4$ $= 3.0 \times 10^4$ (J) ✓	**1**
(c)	(heat supplied by lead changing state + heat supplied by cooling lead = heat gained by iron) 3.0×10^4 + heat supplied by cooling lead = 7.5×10^4 ✓ heat supplied by cooling lead = $4.5 \times 10^4 = mc\Delta\theta$ $c = 4.5 \times 10^4/(1.2 \times (327 - 84))$ ✓ $c = 154$ (J kg^{-1} K^{-1}) ✓	**3**
(d)	any **one** idea ✓ no allowance has been made for heat loss to the surroundings or the specific heats may not be a constant over the range of temperatures calculated	**1**
	Total	**7**