1 **(a) (i)** 1 is 20°C
2 is 15 ± 1°C, need both correct for a mark — A1

(ii) more heat lost at higher temperature — B1 [2]

(b) heat in = 60 x 210 or *Wt* or 12 600 (J) — C1
heat in water = *m* x *s* x $\Delta\theta$ or 75 x *s* x 40 — C1
s = 12600/75 x 40 — C1
= 4.2 J/g °C — A1 [4]

(c) outline correct, two wires with clear junction and a meter/datalogger/computer — M1
labels, hot and cold junctions or clear, two different metals — A1 [2]

[Total: 8]

2	**(a)**	start temp. and final temp. or change in temperature	B1	
		mass of iron	B1	
		time heater on	B1	**3**
	(b)	P x t, VIt or in words	B1	
		= m x shc x cit or words	B1	**2**
	(c)	heat lost to surroundings/air	B1	
	(ii)	add lagging/insulate	B1	**2**
				[7]

3	**(a)**	turn on heater and wait until water starts dripping in beaker	**B1**	
		empty beaker & replace, start watch	**B1**	
		stop watch & remove beaker at same time	**B1**	
		record time	**B1**	
		find and record mass of water in beaker	**B1**	**[M4]**
	(b)	60 x t = 120 x 340	**C1**	
		t = 680 s	**A1**	**[2]**
	(c)	ice gains heat from surroundings/ice falls through funnel	**B1**	
	(ii)	lag or fit lid to funnel/place gauze in funnel bottom	**B1**	**[2]**
				Total [8]

4	**(a)**	**(i)**	put hot junction in beaker (of hot water)	**1**	
			read temperature from galvo. in some way (calibration)	**1**	**2**
		(ii)	high/low temperatures stated or high/low values quoted or temperature varying rapidly or small site/at point or remote place (from meter) or in control systems any 2	**2**	**2**
	(b)	**(i)**	raises the water temperature	**1**	
		(ii)	provides latent heat or boils/evaporates water	**1**	**2**
					(6)

5	**(a)**	Y is a wire of different metal/not copper	**B1**	
		Z is a galvanometer/millivoltmeter/milliammeter	**B1**	**2**
	(b)	2 junctions at different temperatures, accept one hot, one cold	**B1**	
		temperature difference causes e.m.f./voltage/current	**B1**	
		reading of meter changes (with temperature)	**B1**	
		1 junction at known temperature/need for calibration	**B1**	**max 3**
	(c)	dull or black surface	**B1**	**1**
				[6]

6	**(a)**	**(i)**	nitrogen	**M1**	
		(ii)	copper-solid-molecules very tightly bonded together so separate little	**B1**	
			water – liquid – molecules less tightly bonded/still small separation	**B1**	
			nitrogen – gas – molecules “free” and not bonded so separate most	**B1**	**M3**
			(N.B. accept 2 bonding statements for 2 marks. 1 separation statement for 1 mark)		
	(b)	**(i)**	size of movement/change in length of liquid column per degree	**B1**	
		(ii)	change in length (of liquid column) same for all degrees	**B1**	
					[5]

7 a junction of two metals, other ends to meter/alternative arrangements — C1
two metals named, meter labelled — 2 A1 2

b(i) meter calibrated in degrees or read value and use calibration chart — B1
(ii) change in temp. causes change in voltage/current — 2 B1 2

c high (low) temperatures — B1
rapidly changing temperatures (or low thermal capacity) — B1
any valid physical reason e.g. distance reading needed, small site etc — 2 B1 M2*
QT 6

4 a(i) $L = VIt/(m_1 - m_2)$ accept for 2 eq. $VIt = (m_1 - m_2)L$ only 1 or $m_2 - m_1$ — 2 C1, A1
(ii) $= 12 \times 2 \times 3750 / 40$ — C1
$= 2250$ J/g* or 2.25×10^6 J/kg — 2 A1 4

b (large) intermolecular forces in liquid / bonds — B1
(great) energy needed to separate molecules of liquid — 2 B1 2
QT 6