

Total 36 marks.

Each marking point ends with ✓ and is worth one mark. Words in « » are not needed for the mark. A correct numerical answer with no working is awarded full marks unless the Notes say otherwise. ECF = error carried forward: award the mark if the candidate used their own wrong earlier answer correctly. Do not penalize errors in units or significant figures unless the Notes say so.

Question 1: Boiling water on a balance

Part	Answers	Notes	Total
1(a)	the energy required to change 1 kg of liquid into vapour at constant temperature «and pressure» ✓		1
1(b)	mass boiled away = 0.015 «kg»; energy = $Pt = 60 \times 600 = 3.6 \times 10^4$ «J» ✓ $L = 3.6 \times 10^4 / 0.015 = 2.4 \times 10^6$ «J kg ⁻¹ » ✓		2
1(c)	some of the energy from the heater is transferred to the surroundings «beaker, air» ✓ so less than Pt is used to vaporize the water, but all of Pt was used in the calculation ✓		2
1(d)	the energy supplied increases the intermolecular potential energy / separates the molecules / breaks the bonds between them ✓ the average «random» kinetic energy of the molecules does not change, so the temperature is constant ✓		2
1(e)	in vaporization the molecules are separated completely / the increase in separation is much larger ✓ so much more work must be done against the intermolecular forces ✓		2

Question 2: Cooling a drink

Part	Answers	Notes	Total
2(a)	the total random kinetic energy of the molecules «particles/atoms» ✓ plus the total intermolecular potential energy of the molecules ✓	Do not accept “kinetic energy plus potential energy” with no reference to molecules, atoms or particles, or “average”.	2
2(b)	warming: $0.050 \times 2100 \times 15 = 1575$ «J»; melting: $0.050 \times 334\,000 = 16\,700$ «J» ✓ total = 1.8×10^4 «J» «18 275 J» ✓		2
2(c)	the juice gives $0.35 \times 4000 \times 24 = 3.4 \times 10^4$ J in cooling to 0 °C, which is more than 1.8×10^4 J ✓		1

2(d)	energy lost by juice = $0.35 \times 4000 \times (24 - \theta)$ ✓ energy gained by ice = $18\,275 + 0.050 \times 4200 \times \theta$ ✓ $\theta = 9.5$ «°C» ✓	Allow ECF from (b).	3
2(e)	it increases ✓ because the intermolecular potential energy increases «the average kinetic energy does not change» ✓		2

Question 3: A window in winter

Part	Answers	Notes	Total
3(a)	$\Delta Q/\Delta t = kA\Delta T/\Delta x = 0.80 \times 1.6 \times 10/5.0 \times 10^{-3}$ ✓ $= 2.6 \times 10^3$ «W» ✓	Award [1 max] if the thickness is not converted to metres.	2
3(b)	particles at the warmer surface have a higher average kinetic energy / vibrate more ✓ they pass energy to neighbouring particles «by collisions/through the bonds», so energy moves from the warm side to the cold side ✓		2
3(c)	$\Delta Q/\Delta t = 0.025 \times 1.6 \times 9.7/0.012$ ✓ $= 32$ «W» ✓		2
3(d)	the air near the window cools, contracts and becomes denser «than the surrounding air» ✓ so it sinks «and warmer air takes its place, forming a convection current» ✓		2

Question 4: Two stars

Part	Answers	Notes	Total
4(a)	$T = 2.9 \times 10^{-3}/480 \times 10^{-9} = 6.0 \times 10^3$ «K» ✓		1
4(b)	$L = \sigma 4\pi R^2 T^4 = 5.67 \times 10^{-8} \times 4\pi \times (9.0 \times 10^8)^2 \times (6.04 \times 10^3)^4$ ✓ $= 7.7 \times 10^{26}$ «W» ✓	Allow ECF from (a).	2
4(c)	$b = L/(4\pi d^2) = 7.7 \times 10^{26}/(4\pi \times (3.0 \times 10^{17})^2)$ ✓ $= 6.8 \times 10^{-10}$ «W m ⁻² » ✓	Allow ECF from (b).	2
4(d)	same b and twice the distance, so $L_B = 4L_A$ ✓ $L \propto R^2 T^4$: $4 = (R_B/R_A)^2 \times (1/2)^4$ ✓ $R_B/R_A = 8$ ✓		3
4(e)	B is redder «its peak is at a longer wavelength because it is cooler» ✓		1