2(a)	same temperature (as each other)
	no net transfer of thermal energy (between them)
2(b)(i)	$E_1 = XL$
2(b)(ii)	$E_2 = Mc(t - \theta)$
2(b)(iii)	$E_3 = Xc\theta$
2(c)	$E_2 = E_1 + E_3$
	$Mc(t - \theta) = XL + Xc\theta$ **and** completion of algebra to reach $\theta = (Mct - XL) / c(M + X)$

3(a)(i)	(P and Q are at the) same temperature
	no <u>net</u> transfer of thermal energy (between P and Q)
3(a)(ii)	$Q = mc\Delta T$
	$24 \times 10^3 = (0.54 \times 390 \times \Delta T) + (0.37 \times 910 \times \Delta T)$
	$\Delta T = 44\,\text{K}$
3(b)(i)	work done = $p\Delta V$
	$= (1.6 \times 10^5) \times (0.18 - 0.32)$
	$= -2.2 \times 10^4\,\text{J}$
3(b)(ii)	$pV = NkT$
	$N = (1.6 \times 10^5 \times 0.18) / (1.38 \times 10^{-23} \times 273)$ $= 7.6 \times 10^{24}$
3(b)(iii)	$\frac{1}{2}m\langle c^2\rangle = (3/2)kT$
	r.m.s. speed $= \sqrt{[(3 \times 1.38 \times 10^{-23} \times (210 + 273) / (4.7 \times 10^{-26})]}$ $= 650\,\text{m s}^{-1}$

3(a)	no <u>net</u> thermal energy is transferred (between them)
3(b)(i)	variation (of density with temperature) is linear **or** each temperature has a unique value of density
3(b)(ii)	• variation (of density with temperature) is not linear • region where the density does not vary with temperature • different temperatures have the same density *Any two points, 1 mark each*
3(c)(i)	boiling point = 80 °C
3(c)(ii)	$Q = Pt$ **and** $t = 21\,\text{s}$ (thermal energy supplied = 810 × 21 = 17000 J)
	$c = Q / m\Delta\theta$
	thermal energy absorbed by beaker = 42 × 0.84 × (80 – 25) (= 1940 J)
	s.h.c. of liquid = [(810 × 21) – (42 × 0.84 × (80 – 25))] / [120 × (80 – 25)] $= 2.3\,\text{J g}^{-1}\,\text{K}^{-1}$
3(d)	sketch: straight diagonal line from 25 °C to 100 °C **and** then horizontal at 100 °C
	straight diagonal line starting at 25 °C with gradient approximately half that of the original line