3(a)(i)	number of particles per unit amount of substance
3(a)(ii)	$N_A = R / k$
3(b)(i)	X pressure and Y pressure both = NkT / V
	X amount = N / N_A **and** Y amount = $2N / N_A$
	X mean-square speed = $3kT / m$ **and** Y mean-square speed = $3kT / 2m$
	X internal energy = $3NkT / 2$ **and** Y internal energy = $3NkT$
3(b)(ii)	line passing through the origin and not returning to either axis
	curve with positive decreasing gradient

3(a)(i)	(P and Q are at the) same temperature
	no net 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 = $\sqrt{[(3 \times 1.38 \times 10^{-23} \times (210 + 273) / (4.7 \times 10^{-26})]}$ $= 650\,\text{m s}^{-1}$

8(a)	234, 92 for the uranium nucleus
	4, 2 for the alpha particle
8(b)(i)	$N_0 = 0.874 / (238 \times 1.66 \times 10^{-27})$ $= 2.21 \times 10^{24}$
8(b)(ii)	$A = \lambda N$
	$= \dfrac{\ln 2}{87.7 \times 365 \times 24 \times 3600} \times 2.21 \times 10^{24}$ $= 5.54 \times 10^{14}$ Bq
8(b)(iii)	power $= 5.54 \times 10^{14} \times 5.59 \times 10^{6} \times 1.60 \times 10^{-19}$
	$= 496$ W
8(b)(iv)	$65.3 = 100e^{-\frac{\ln 2}{87.7}t}$
	$\ln 0.653 = -(\ln 2 / 87.7)\, t$ $t = 53.9$ years
8(c)	advantage: less mass so less energy needed to launch probe
	disadvantage: half-life shorter so will not provide power for as long