9(a)	difference between mass of nucleus and mass of (constituent) nucleons
	when nucleons are separated to infinity
9(b)	$\Delta m = (2 \times 2.013553) - (4.001505)$ (u) (= 0.025601 u)
	$E = c^2 \Delta m$
	energy from one He-4 nucleus= $0.025601 \times 1.66 \times 10^{-27} \times (3.00 \times 10^8)^2$ $(= 3.82 \times 10^{-12}$ J)
	energy to form 1.00 mol= $3.82 \times 10^{-12} \times 6.02 \times 10^{23}$ $= 2.30 \times 10^{12}$ J
9(c)(i)	$L = 1.09 \times 10^{11} \times (3.00 \times 10^8)^2$
	$= 9.81 \times 10^{27}$ W
9(c)(ii)	$L = 4\pi \sigma r^2 T^4$ $9.81 \times 10^{27} = 4\pi \times 5.67 \times 10^{-8} \times (1.19 \times 10^9)^2 \times T^4$
	$T = 9930$ K
9(d)	standard candles have known luminosity
	radiant flux intensity (from star) measured (on the Earth)
	distance found from $F = L / (4\pi d^2)$

11(a)(i)	(nuclear) fusion
11(a)(ii)	$\Delta m = [0.030377 - (3 \times 0.002388)]$ u (= 0.023213 u)
	$E = \Delta m\, c^2$
	$= 0.023213 \times 1.66 \times 10^{-27} \times (3.00 \times 10^8)^2 = 3.47 \times 10^{-12}$ J
11(b)(i)	mass of 1 mol of helium-4 = 4 g **or** mass of 1 helium atom = 4 u
	N rate = $(6.02 \times 10^{23} \times 7.34 \times 10^{11}) / (4 \times 10^{-3})$ **or** N rate = $(7.34 \times 10^{11}) / (4 \times 1.66 \times 10^{-27})$
	luminosity $= 1.10 \times 10^{38} \times 3.47 \times 10^{-12}$ $= 3.83 \times 10^{26}$ W
11(b)(ii)	$L = 4\pi \sigma r^2 T^4$ $3.83 \times 10^{26} = 4\pi \times 5.67 \times 10^{-8} \times (6.96 \times 10^8)^2 \times T^4$
	$T = 5770$ K

9(a)(i)	*either*: cannot predict when a (particular) nucleus will decay *or*: cannot predict which nucleus will decay next
9(a)(ii)	not affected by external / environmental factors
9(b)	time for activity to halve
9(c)	energy $= (189 \times 7.826) + (4 \times 7.074) - (193 \times 7.774)$
	= 7.03 eV
9(d)(i)	decay constant
9(d)(ii)	decay constant / magnitude of gradient = 1.4 / 0.84
	half-life = ln2 / (1.4 / 0.84) = 0.42 ms
9(e)(i)	positrons collide with electrons and annihilate
9(e)(ii)	long enough to have time to conduct investigation, not so long as to cause patient <u>unnecessary</u> exposure to radiation