8(a)	packet / quantum of <u>energy</u>
	of electromagnetic radiation
8(b)(i)	$E = c^2\Delta m$
	$\Delta m = (4.274 \times 10^6 \times 1.60 \times 10^{-19}) / (1.66 \times 10^{-27} \times (3.00 \times 10^8)^2)$ (= 0.00458 u)
	m = 233.915174 + 4.000407 + 0.00458 = 237.92016 u
8(b)(ii)	$E = hc / \lambda$ **or** $E = hf$ **and** $c = f\lambda$
	$(4.274 - 4.200) \times 1.60 \times 10^{-13} = (6.63 \times 10^{-34} \times 3.00 \times 10^8) / \lambda$
	$\lambda = 1.7 \times 10^{-11}$ m
8(b)(iii)	(true) energy of gamma photon is smaller so (true) wavelength is larger
8(c)	(anti)neutrinos are emitted during beta decay
	particles emitted during beta decay carry varying amounts of energy, so energy of gamma photon is also variable (between decays)

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 $F = L / (4\pi d^2)$

8(a)	(radioactive) substance introduced into the body
	substance absorbed by the tissues being studied
8(b)(i)	$P = 15$ **and** $R = 0$
	$Q = 7$ **and** $S = (+)1$
8(b)(ii)	(electron) neutrino
8(c)(i)	number of nuclear disintegrations per unit time
8(c)(ii)	decay constant $= \ln 2 / (2.04 \times 60)$
	$= 5.66 \times 10^{-3}\ s^{-1}$
8(c)(iii)	$N = (2.85 \times 10^{-6}) / (15 \times 1.66 \times 10^{-27})$
	$A = \lambda N$
	rate $= (5.66 \times 10^{-3}) \times (2.85 \times 10^{-6}) / (15 \times 1.66 \times 10^{-27})$
	$= 6.48 \times 10^{17}\ s^{-1}$
8(d)(i)	gamma photons
8(d)(ii)	positron collides with electron (in body)
	annihilation results in their masses becoming photon energy

Multiple Choice Answers

Q38: D