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)

8(a)	• quantum of energy
	• of electromagnetic radiation
8(b)(i)	$(\Delta)E = hc / \lambda$
	$\lambda = (6.63 \times 10^{-34} \times 3.00 \times 10^8) / (1.96 \times 1.60 \times 10^{-19})$
	$= 6.3 \times 10^{-7}$ m
8(b)(ii)	number per unit time = power / energy per photon $= (1.0 \times 10^{-2}) / (1.96 \times 1.60 \times 10^{-19})$ $= 3.2 \times 10^{16}$ s^{-1}
8(b)(iii)	*either*: force = rate of change of momentum *or*: $F = \Delta p / t$
	$p = E / c$
	half the photons have change in momentum p, the other half have change in momentum $2p$
	$F = [(1.96 \times 1.60 \times 10^{-19}) / (3.00 \times 10^8)] \times 3.2 \times 10^{16} \times [(2 + 1) / 2]$ $= 5.0 \times 10^{-11}$ N