

Question	Answer	Marks
1(a)	force \times displacement in the direction of the force	B1
1(b)	$P = Fs / t$ $= (\text{kg m s}^{-2} \times \text{m}) / \text{s}$	C1
	$= \text{kg m}^2 \text{s}^{-3}$	A1
1(c)(i)	$84 \times 10^3 = v^3 \times 0.56$	C1
	$v = 53 \text{ m s}^{-1}$	A1
1(c)(ii)	percentage uncertainty = $(5\% + 7\%) / 3 (= 4\%)$ or fractional uncertainty = $(0.05 + 0.07) / 3 (= 0.04)$	C1
	absolute uncertainty = 0.04×53 $= (\pm) 2 \text{ m s}^{-1}$	A1

Question	Answer	Marks
7(a)	92 protons and 146 neutrons (in nucleus)	B1
	92 (orbital) electrons	B1
7(b)	charge = $2e$ $(= 2 \times 1.60 \times 10^{-19} \text{ C})$	C1
	mass = $4u$ $(= 4 \times 1.66 \times 10^{-27} \text{ kg})$	C1
	ratio = $(2 \times 1.60 \times 10^{-19}) / (4 \times 1.66 \times 10^{-27})$ $= 4.8 \times 10^7 \text{ C kg}^{-1}$	A1
7(c)(i)	up down down / udd	B1
7(c)(ii)	up up up / uuu	B1

Question	Answer	Marks
7(a)(i)	$P = 0$ and $Q = 137$	A1
	$R = -1$ and $S = 56$	A1
7(a)(ii)	lepton(s)	B1
7(b)(i)	(charge of ddd / Y) = $-\frac{1}{3}(e) - \frac{1}{3}(e) - \frac{1}{3}(e) = -1(e)$	B1
	(charge of $\bar{u}d / Z$) = $-\frac{1}{3}(e) - \frac{2}{3}(e) = -1(e)$	B1
7(b)(ii)	meson: Z / $\bar{u}d$ because consists of a quark and an antiquark	B1
	baryon: Y / ddd because consists of three quarks	B1