Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*		Use of $F = Ap$ **and** $A = \pi r^2$ **or** accept $A = 4\pi r^2$ (1) Correct answer = 3 173 [N] (1) [no **ecf** from use of $A = 4\pi r^2$]	1	1		2	2	
	(b)		Fewer collisions …. (1) …because greater distances between molecules (or smaller density or more free space) (1)		2		2		
	(c)	(i)	Application of conservation of energy i.e. $E_k = \frac{Qq}{4\pi\varepsilon_0 r}$ (1) Conversion of 4.7 MeV → J i.e. $4.7 \times 10^6 \times 1.6 \times 10^{-19} = 7.52 \times 10^{-13}$ J (1) Answer = 4.8×10^{-14} [m] (1)		3		3	3	
		(ii)	Smaller than atomic radius or inside plum pudding (1) So force / PE never great enough (for rebound) or scattering angle too large in experiment (1)			2	2		
	(d)		Use of conservation of energy to get speed or momentum e.g. $p^2 = 2mE_k$ etc. $v = 3.75 \times 10^7$ [m s^{-1}] or $p = 3.41 \times 10^{-22}$ [N s] (1) Calculation of a wavelength using $\lambda = \frac{h}{p}$ (even if incorrect, 1.94×10^{-11} m is the correct value) (1) Comparison of the calculated wavelength with atomic separation (or 10^{-9} to 10^{-11} m) (1) Correct final conclusion **and** correct wavelength (1.94×10^{-11} m) (1)			4	4	3	
	(e)		Proton repulsion or like charges repel etc.	1			1		
	(f)		Photon mom calculated $\left(p = \frac{h}{\lambda}\right)$ = 2.73×10^{-22} [kg m s^{-1}] (1) Electron momentum calculated = 9.11×10^{-26} [kg m s^{-1}] (1) [Initial momentum negligible] so final momenta must cancel (1)			3	3	2	

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	(g)		Charge of $\bar{u}d = -\frac{2}{3} - \frac{1}{3}$	1			1		
	(h)		**Either:** Mass = $\frac{172\ \text{G[eV]}}{931\text{M[eV u}^{-1}]}$ = 185 [u] (1) $\therefore$ Mass = 185 [u] $\times$ 1.66 $\times$ 10^{-27} [kg u^{-1}] = 3.07 $\times$ 10^{-25} [kg] (1) **Or:** Mass energy = 172 GeV $\times$ 1.60 $\times$ 10^{-19} J eV^{-1} = 2.75 $\times$ 10^{-8} [J] (1) $\therefore$ Mass = $\frac{2.75\times10^{-8}\ \text{[J]}}{\left(3.00\times10^{8}\ \text{[m s}^{-1}\text{]}\right)^2}$ = 3.06 $\times$ 10^{-25} [kg] (1)		2		2	2	
			Question 7 total	**3**	**8**	**9**	**20**	**12**	**0**