Marking Scheme

#1

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)		Field lines radial minimum of 3 (1) Field lines / arrows towards the Earth (1) Equipotentials are spheres minimum of 1 (circular cross-section) (1)	3			3		
	(b)	(i)	Use of $V = [-]\frac{GM}{r}$ (1) Answer = 1.16×10^6 or 1.29×10^5 (1) Answer = -1.29×10^6 *** J kg^{-1} *** **unit mark** (1)	1	1 1		3	1	
		(ii)	Use of $g = [-]\frac{GM}{r^2}$ (implied by 0.0034) (1) Evidence of cancelling fields e.g. $\frac{597}{342^2} - \frac{7.37}{38^2}$ or 0.0034 – 0.0034 or difference in fields = 1.71×10^{-7} or checking ratio of fields is equal to 1 (1)	1	1		2	1	
		(iii)	Definition of SHM or force / acceleration proportional [& opposite] to displacement (can be implied through logical argument) (1) Force is in same direction as displacement / space craft will accelerate towards Moon or Earth (1) Hence, Dafydd is wrong consistent with argument and ecf (1)			3	3		
			Question 2 total	**5**	**3**	**3**	**11**	**2**	**0**

#2

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(a)		Arrow at C going left (1) Arrow at C going up (1)	2			2		
	(b)		Use of the equation $\frac{kq}{r^2}$ (1) 52 500 000 **or** 39 400 000 correct (1) Applying Pythagoras $(52.5M^2 + 39.4M^2)^{0.5}$ (1) Method for obtaining angle correct e.g. $\tan^{-1}\left(\frac{525}{394}\right)$ (1) Correct answers 65.6 MV m^{-1} **unit mark** and 53 or 37[°] or 0.93 or 0.64 [rad] (1)	1	1 1 1 1		5	5	
	(c)		Use of the equation $\frac{kq}{r}$ (1) $\frac{28}{8} - \frac{21}{6}$ or equivalent seen to be zero (1)	1	1		2	2	
	(d)		Conservation of energy applied e.g. $eV = ½ mv^2$ or E_k calculated to be 1.34×10^{-15} [J] (1) 8 300 [V] (1) Negative sign (1) i.e. 8 300 [V] gets 2 marks, (-8 300 [V] 3 marks)		3		3	2	
			Question total	**4**	**8**	**0**	**12**	**9**	**0**

#3

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(a)	(i)	Use of the equation $\frac{M_2 d}{(M_1 + M_2)} = x$ even if wrong M_2 (1) $\frac{9.2 \times 10^{24} \times 5.3 \times 10^{10}}{\{9.5 \times 10^{29} + 9.2 \times 10^{24}\}}$ seen (1) ({ +9.2 × 10^{24} } can be omitted from the above equation) **or** 513 263 [m] seen etc.	1 1			2	2	
		(ii)	$v = \frac{2\pi r}{T}$ applied or $v = \omega r$ and $\omega = \frac{2\pi}{T}$ combined (1) Conversion of 130 days (130 × 24 × 3 600) (1) Answer = 0.287 [m s^{-1}] (**ecf** on day conversion) (1)	1	1 1		3	3	
		(iii)	Redshift is small **or** the redshift is proportional to velocity **or** small $\Delta\lambda$ **or** shown using the Doppler equation (1) Small wavelength change is difficult to measure **or** shifted wavelength is too close to the original (1)		2		2		
	(b)	(i)	$F = \frac{GMm}{r^2}$ used (1) Answer = 2.08 × 10^{23} [N] (1)	1	1		2	2	
		(ii)	Method for obtaining stress i.e. $\frac{F}{A}$ (1) 1.35 × 10^9 [Pa] (1) Correct conclusion e.g. the steel bar would break **ecf** (1) Theory doesn't work / Newton's grav law used successfully for centuries / won't work for elliptical orbits / would melt (1) **Alternative:** Use of $F = \alpha A$ (1) F = 6.9 × 10^{22} [N] (1)			4	4	2	
	(c)	(i)	PE = $-\frac{GMm}{r}$ used N.B. **ecf** if PE = Fr used (1) Answer = [-]1.10 × 10^{34} [J] (1)	1	1		2	2	
		(ii)	Realising KE is involved (1) Correct variation with distance for KE or velocity **or** as PE increases KE decreases or converse (1)			2	2		
			Question total	**5**	**6**	**6**	**17**	**11**	**0**

#4

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*	(i)	Kinetic energy and [gravitational] potential energy referred to (1) $\frac{1}{2}mv^2 - \frac{GMm}{r}$ = total [initial] energy or ΔKE = [–]ΔPE (1) Final and initial energy are zero and equal [accept final KE = 0 or final PE = 0] (1)	3			3		
		(ii)	Rearrangement / simplification i.e. $v^2 = \frac{2GM}{r}$ (1) [accept m = 1 inserted] Substitution e.g. $v^2 = \frac{2\times6.67\times10^{-11}\times1.99\times10^{30}}{6.96\times10^{8}}$ (1) Answer = 618 [or 620] km s^{-1} (1) c.a.o. [accept ~600 km s^{-1} b.o.d.]	1	1 1		3	3	
	(b)	(i)	Applying KE of molecule/atom/particle = $\frac{3}{2}kT$ (or deriving) (1) Rearrangement e.g. accept $v^2 = \frac{3kT}{m}$ (1) Substitution e.g. $v^2 = \frac{3\times1.38\times10^{-23}\times5780}{9.11\times10^{-31}}$ (1) Answer = 513 km/s (1) [accept just ~500 km s^{-1} only with correct substitution]	1	1 1 1		4	3	
		(ii)	Many electrons have enough KE to escape (ecf) or just 'some electrons escape' (1) Because (b)(i) close to (a)(ii) / some electrons have higher velocity / [Boltzmann] distribution / collisions] (ecf) (1) Or protons don't escape		2		2		
		(iii)	Valid method employed e.g. electrostatic force & gravitational forces calculated/equated or other (1) Valid calculation carried out correctly e.g. $F_E = 2.4\times10^{-28}$ N and $F_g = 2.5\times10^{-28}$ N or charge = 0.084 C (1) [Or using $GMm = kQq \rightarrow 1.2\times10^{-10}$ [N m^2] and 1.15×10^{-10} [N m^2]] Valid conclusion (not independent) e.g. she's quite close (1) ecf from calculation of forces [not fields] or alternative above. [Accept: E force bigger / G force smaller]			3	3	2	
		(iv)	Sun electrons ≈ $\frac{1.99\times10^{30}}{1.66\times10^{-27}} \approx 1.2\times10^{57}$ (assumption dependent, allow Sun composed of deuterium) (1) [Accept $M_\odot$ / 1 u] $\frac{0.08}{e} = 5\times10^{17}$ electrons lost or charge on Sun's electrons = 1.92×10^{38} [C] (1) % lost ≈ 10^{-38} (1)		3		3	3	
			Question 2 total	**5**	**10**	**3**	**18**	**11**	**0**