Marking Scheme

Question		on	Marking details A0		Marks available					
	Question				A02	A03	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			
	(b)	(i)	Use of $V = [-] \frac{GM}{r} (1)$ Answer = 1.16 × 10 ⁵ or 1.29 × 10 ⁵ (1)							
	Answer = -1.29 × 10 ⁶ *** J kg ⁻¹ *** unit mark (1)			1		3	1			
		(ii) Use of $g = [-] \frac{GM}{r^2}$ (implied by 0.0034) (1)		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		2	1			
(iii)		(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		

Ousstian	Marking details	Mark		Marks available				
Question	Marking details	A01	AO2	AO3	Total	Maths	Prac	
(a)	Arrow at C going left (1) Arrow at C going up (1)	2			2			
	Allow at a going up (1)							
(b)	Use of the equation $\frac{kq}{r^2}$ (1)	1						
	52 500 000 or 39 400 000 correct (1)		1					
	Applying Pythagoras (52.5M² + 39.4M²) ^{0.5} (1)							
	Method for obtaining angle correct e.g. $tan^{-1} \left(\frac{525}{394} \right)$ (1)		1					
	Correct answers 65.6 MV m ⁻¹ unit mark		1		5	5		
	and 53 or 37[°] or 0.93 or 0.64 [rad] (1)							
(c)	Use of the equation $\frac{kq}{r}$ (1)	1						
	$\frac{28}{8} - \frac{21}{6}$ or equivalent seen to be zero (1)		1		2	2		
(d)	Conservation of energy applied e.g. $eV = \frac{1}{2} mv^2$ or E_k calculated							
	to be 1.34 × 10 ⁻¹⁵ [J] (1)						ĺ	
	8 300 [V] (1) Negative sign (1)		3		3	2		
	i.e. 8 300 [V] gets 2 marks, (-8 300 [V] 3 marks)					_		
	Question total	4	8	0	12	9	0	

Question total

Question	Marking details	Marks available AO1 AO2 AO3 Total					
Question			AO2	AO3	Total	Maths	Prac
(a)	Use of the equation $\frac{M_2d}{(M_1+M_2)} = x$ even if wrong $M_2(1)$	1					
	$\frac{9.2 \times 10^{24} \times 5.3 \times 10^{10}}{(9.5 \times 10^{-24}(9.2 \times 10^{-3})^{24})^{24}} \text{ seen (1)}$	1			2	2	
	($\{+9.2 \times 10^{24}\}$ can be omitted from the above equation) or 513 263 [m] seen etc.						
	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 × 3600) (1)	1	1				
	Answer = 0.287 [m s ⁻¹] (ecf on day conversion) (1)		1		3	3	
	ii) Redshift is small or the redshift is proportional to velocity or small Δλ 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)	$F = \frac{GMm}{r^2} \text{ used (1)}$	1	1		2	2	
	Answer = 2.08×10^{23} [N] (1)				2		
	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) $F = 6.9 \times 10^{22}$ [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		

Comparison Co	Question			Marking details		Marks available				
$\frac{1}{2}mn^2 - \frac{GAbm}{r} = \text{total [initial] energy or } \Delta KE = [-]\Delta PE (1)$ Final and initial energy are zero and equal [accept final $KE = 0$ or final $PE = 0$] (1) Final and initial energy are zero and equal [accept final $KE = 0$ or final $PE = 0$] (1) (ii) Rearrangement / simplification i.e. $v^2 = \frac{2GM}{r}$ (1) [accept $m = 1$		(uesuo			A01	AO2	AO3	Total	Maths	Prac
Final and initial energy are zero and equal [accept final KE = 0 or final PE = 0] (1) (ii) Rearrangement / simplification i.e. $v^2 = \frac{2GM}{r}$ (1) [accept $m = 1$ 1 1 3 3 3 3 3 3 3 3	2	(a)	(i)							
Final and initial energy are zero and equal [accept final KE = 0 or final PE = 0] (1) (ii) Rearrangement / simplification i.e. $v^2 = \frac{2GM}{r}$ (1) [accept $m = 1$ 1 1 3 3 3 3 3 3 3 3				$\frac{1}{2}mv^2 - \frac{GN2M}{v}$ = total [initial] energy or $\Delta KE = [-]\Delta PE$ (1)						
Rearrangement / simplification i.e. $v' = \frac{s-s-s}{r}$ (1) [accept $m = 1$ inserted] Substitution e.g. $v^2 = \frac{2 \times 6.67 \times 10^{-11} \times 1.99 \times 10^{10}}{6.96 \times 10^{1}}$ (1) Answer = 618 [or 620] km s ⁻¹ (1) c.a.o. [accept ~600 km s ⁻¹ b.o.d.] (b) (i) Applying KE of moleculer/atom/particle = $\frac{1}{2}kT$ (or deriving) (1) Rearrangement e.g. accept $v^2 = \frac{3kT}{m}$ (1) Substitution e.g. $v^2 = \frac{3 \times 1.38 \times 10^{-23} \times 5780}{m}$ (1) Answer = 513 km/s (1) [accept just ~500 km s ⁻¹ only with correct substitution] (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 (iii) Valid activation carried out correctly e.g. $F_E = 2.4 \times 10^{-28}$ N and $F_g = 2.5 \times 10^{-28}$ N or charge = 0.084 C (1) [Or using GMm = $kOQ \rightarrow 1.2 \times 10^{-10}$ [N m²] and 1.15 × 10 ⁻¹⁰ [N m²]] 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] (iv) Sun electrons $\frac{1.99 \times 10^{20}}{6.60 \times 10^{-20}} \approx 1.2 \times 10^{-57}$ (assumption dependent, allow Sun composed of deuterium) (1) [Accept $M_0 / 1$ u] $\frac{0.08}{e} = 5 \times 10^{17}$ electrons lost or charge on Sun's electrons = 1.92 $\times 10^{28}$ [C] (1) $\%$ lost $\approx 10^{-28}$ (1)				Final and initial energy are zero and equal [accept final KE = 0 or				3		
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forces calculated/equated or other (1) $Valid \ calculation \ carried \ out \ correctly \ e.g. \ F_E = 2.4 \times 10^{-28} \ N \ and \\ F_8 = 2.5 \times 10^{-28} \ N \ or \ charge = 0.084 \ C \ (1) \\ [Or \ using \ GMm = kQq \rightarrow 1.2 \times 10^{-10} \ [N \ m^2] \ and \ 1.15 \times 10^{-10} \ [N \ m^2]] \\ Valid \ conclusion \ (not \ independent) \ e.g. \ she's \ quite \ close \ (1) \ ecf \ from \ calculation \ of forces \ [not \ fields] \ or \ alternative \ above. \\ [Accept: E \ force \ bigger / G \ force \ smaller] \\ (iv) \ Sun \ electrons \approx \frac{1.99 \times 10^{30}}{1.66 \times 10^{-37}} \approx 1.2 \times 10^{57} \ (assumption \ dependent, \ allow \ Sun \ composed \ of \ deuterium) \ (1) \ [Accept \ M_g \ / \ 1 \ u] \\ \frac{0.08}{e} = 5 \times 10^{17} \ electrons \ lost \ or \ charge \ on \ Sun's \ electrons = 1.92 \\ \times 10^{38} \ [C] \ (1) \\ \% \ lost \approx 10^{-38} \ (1)$										
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$F_8 = 2.5 \times 10^{-28} \text{N or charge} = 0.084 \text{C (1)}$ [Or using $GMm = kQq \rightarrow 1.2 \times 10^{-10} [\text{N m}^2] \text{and } 1.15 \times 10^{-10} [\text{N m}^2]]$ $Valid conclusion (not independent) e.g. she's quite close (1) ecf from calculation of forces [not fields] or alternative above. [Accept: E force bigger / G force smaller]$ $(iv) Sun electrons \approx \frac{1.99 \times 10^{30}}{1.66 \times 10^{-37}} \approx 1.2 \times 10^{57} (\text{assumption dependent,}$ $allow Sun composed of deuterium) (1) [\text{Accept } M_0 / 1 \text{u}]$ $\frac{0.08}{e} = 5 \times 10^{17} \text{electrons lost or charge on Sun's electrons} = 1.92$ $\times 10^{38} [\text{C] (1)}$ $\% \text{lost} \approx 10^{-38} (1)$										
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from calculation of forces [not fields] or alternative above. [Accept: E force bigger / G force smaller] (iv) Sun electrons $\approx \frac{1.99 \times 10^{30}}{1.66 \times 10^{-37}} \approx 1.2 \times 10^{57}$ (assumption dependent, allow Sun composed of deuterium) (1) [Accept M_0 / 1 u] $\frac{0.08}{e} = 5 \times 10^{17} \text{ electrons lost or charge on Sun's electrons} = 1.92$ $\times 10^{38} \text{ [C] (1)}$ % lost $\approx 10^{-38} \text{ (1)}$							3	3	2	
[Accept: E force bigger / G force smaller] (iv) Sun electrons $\approx \frac{1.99 \times 10^{30}}{1.66 \times 10^{-37}} \approx 1.2 \times 10^{57}$ (assumption dependent, allow Sun composed of deuterium) (1) [Accept M_0 / 1 u] $\frac{0.08}{e} = 5 \times 10^{17} \text{ electrons lost or charge on Sun's electrons} = 1.92$ $\times 10^{38} \text{ [C] (1)}$ % lost $\approx 10^{-38} \text{ (1)}$										
Sun electrons $\approx \frac{1.59 \times 10^{-37}}{1.66 \times 10^{-37}} \approx 1.2 \times 10^{57}$ (assumption dependent, allow Sun composed of deuterium) (1) [Accept M_0 / 1 u] $\frac{0.08}{e} = 5 \times 10^{17} \text{ electrons lost or charge on Sun's electrons} = 1.92$ $\times 10^{38} \text{ [C] (1)}$ % lost $\approx 10^{-38}$ (1)										
allow Sun composed of deuterium) (1) [Accept M_0 / 1 u] $\frac{0.08}{e} = 5 \times 10^{17} \text{ electrons lost or charge on Sun's electrons} = 1.92$ $\times 10^{38} \text{ [C] (1)}$ % lost $\approx 10^{-38} \text{ (1)}$			(iv)							
$\frac{0.08}{e} = 5 \times 10^{17} \text{ electrons lost or charge on Sun's electrons} = 1.92$ $\times 10^{38} \text{ [C] (1)}$ $\% \text{ lost} \approx 10^{-38} \text{ (1)}$				1.00×10						
× 10 ³⁸ [C] (1) % lost ≈ 10 ⁻³⁸ (1)										
× 10 ³⁸ [C] (1) % lost ≈ 10 ⁻³⁸ (1)				$\frac{1.92}{\rho}$ = 5 × 10 ¹⁷ electrons lost or charge on Sun's electrons = 1.92		3		3	3	
Question 2 total 5 10 3 18 11 0				% lost ≈ 10 ⁻³⁸ (1)						
				Question 2 total	5	10	3	18	11	0