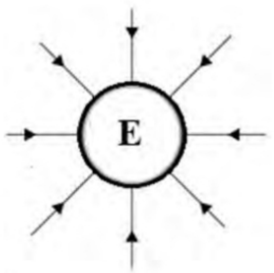
Gravitational Fields MS2

Question Number	Answer		Mark
1 (a)	Use of $g = \frac{GM}{r^2}$ Use of ratio $g_2 = 9.7\ \text{N kg}^{-1}$ (accept ms^{-2}) **Or** Use of $g_1 = \frac{GM_E}{r_1^2}$ to calculate M_E Use this value in $g_2 = \frac{GM_E}{r_2^2}$ $g_2 = 9.7\ \text{N kg}^{-1}$ (accept ms^{-2}) <u>Example of calculation</u> $\frac{g_2}{g_1} = \frac{r_1^2}{r_2^2}$ $g_2 = \left(\frac{6400\ \text{km}}{6437\ \text{km}}\right)^2 \times 9.81\ \text{N kg}^{-1} = 9.70\ \text{N kg}^{-1}$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
(b)	At least four straight evenly spaced radial lines (tolerate lines that extend inside the circle). Arrows pointing towards centre  	**(1)** **(1)**	**2**
(c)	The jump took place in a very small region of the Earth's field **Or** The height of the jump is much less than the radius of the Earth Field lines are (approximately) parallel **Or** idea that g is approximately constant	**(1)** **(1)**	**2**
	Total for Question12		**7**

Question Number	Answer		Mark
2	Use of $F = \frac{Gm_1m_2}{r^2}$	**(1)**	
	F = 8.2 × 10^{16} N	**(1)**	**2**
	Example of calculation: $F = \frac{Gm_1m_2}{r^2} = \frac{6.67\times10^{-11}\ \text{N m}^2\ \text{kg}^{-2}\times6.4\times10^{23}\ \text{kg}\times6.0\times10^{24}\ \text{kg}}{(5.6\times10^{10}\ \text{m})^2}$ $F = 8.17\times10^{16}$ N		
			2

Question Number	Answer		Mark
3 (a)(i)	Use of $\omega = \frac{2\pi}{T}$	**(1)**	
	See $F = \frac{GMm}{r^2}$ **and** $F = m\omega^2 r$	**(1)**	
	GM = 4.07 × 10^{14} ($\text{m}^3\ \text{s}^{-2}$)	**(1)**	
	Or		
	Use of $v = \frac{2\pi r}{T}$	**(1)**	
	See $F = \frac{GMm}{r^2}$ **and** $F = \frac{mv^2}{r}$	**(1)**	
	GM = 4.07 × 10^{14} ($\text{m}^3\ \text{s}^{-2}$)	**(1)**	**3**
	[If reverse "show that" attempted, max 2]		
	Example of calculation: $\omega = \frac{2\pi}{T} = \frac{2\pi\ \text{rad}}{2.36\times10^6\ \text{s}} = 2.66\times10^{-6}\ \text{rad s}^{-1}$ $\frac{GMm}{r^2} = m\omega^2 r$ $GM = \omega^2 r^3 = (2.66\times10^{-6}\ \text{s}^{-1})^2\times(3.86\times10^8\ \text{m})^3 = 4.07\times10^{14}\ \text{m}^3\ \text{s}^{-2}$		
(a)(ii)	Use of $g = \frac{GM}{R^2}$ with g = 9.81 N kg^{-1}	**(1)**	
	R = 6.4 × 10^6 m [6.5 × 10^6 m if show that value used]	**(1)**	**2**
	Example of calculation: $R = \sqrt{\frac{GM}{g}} = \sqrt{\frac{4.07\times10^{14}\ \text{m}^3\ \text{s}^{-2}}{9.81\ \text{N kg}^{-1}}} = 6.44\times10^6\ \text{m}$		

(b)	Force varies with distance (from the Earth) according to inverse square law $F \propto \frac{1}{r^2}$ **(1)** so force (on these asteroids) is (very) small **(1)** **Or** Gravitational field strength varies with distance (from the Earth) according to inverse square law $g \propto \frac{1}{r^2}$ **(1)** so gravitational field strength is (very) weak at this distance **(1)** [Accept idea that since the asteroids are much further from the Earth (than the moon) they are only weakly bound (to the Earth) for max 1 mark]	2
	Total for Question 14	**7**

Question Number	Answer	Mark
4(a)	Use of $F = \frac{Gm_1m_2}{r^2}$ **Or** Use of $g = \frac{Gm}{r^2}$ with $F = mg$ **(1)** $\frac{F_{sun}}{F_{moon}} = 180$ **(1)** [Allow max 1 if only $g = \frac{Gm}{r^2}$ is used to find $\frac{g_S}{g_M} = 183$] Example of calculation: $\frac{F_{\text{sun}}}{F_{\text{moon}}} = \frac{m_{\text{sun}}}{m_{\text{moon}}} \times \left(\frac{r_{\text{moon}}}{r_{\text{sun}}}\right)^2 = \frac{2\times10^{30}\text{ kg}}{7\times10^{22}\text{ kg}} \times \left(\frac{3.8\times10^{8}\text{ m}}{1.5\times10^{11}\text{ m}}\right)^2 = 183$	2
(b)(i)	$g = \frac{GM}{x^2}$ and $g = \frac{GM}{(x+D)^2}$ (on either side of the Earth's diameter D) **(1)**	1
(b)(ii)	$x \gg D$ **Or** $(x + D) \approx x$ **(1)** So $\Delta g \approx 0$ [MP2 dependent upon MP1] **(1)** **Or** The distance of the Sun from the Earth is very large compared with the Earth's diameter **(1)** Hence the difference in g (at opposite sides of the Earth due to the Sun) is (very) small [MP2 dependent upon MP1] **(1)** [Accept g is approximately the same at both positions for MP2]	2
	Total for Question 12	**5**

Question Number	Answer		Mark
5 (a)	Use of $g = \frac{GM}{r^2}$	(1)	
	M = 4.5 × 10^{23} kg	(1)	
	<u>Example of calculation</u> $M = \frac{gr^2}{G} = \frac{9.81\,\mathrm{N\,kg^{-1}} \times (1.74 \times 10^6\,\mathrm{m})^2}{6.67 \times 10^{-11}\,\mathrm{N\,m^2\,kg^{-2}}} = 4.45 \times 10^{23}\,\mathrm{kg}$		**2**
(b)	(the gravitational force on the Moon would be larger), but the centripetal acceleration would be independent of the mass of the Moon **Or** $r\omega^2 = \frac{GM}{r^2} \quad \therefore\ \omega^2 = \frac{GM}{r^3}$	(1)	
	(angular) velocity and hence *T* is independent of mass of Moon	(1)	**2**
(c)	Gravitational forces on the seas/oceans/Earth would be greater **Or** Tidal variations would be more extreme [accept tides would be bigger, higher, larger, faster; do **not** accept tides would be stronger]	(1)	**1**
	Total for Question 13		**5**