Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic : 12_Gravatational Fields

Name of the Student:____
Max. Marks : 25 Marks **Time : 25 Minutes**

Mark Schemes

Q1.

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

(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)	2
	[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]		
	Total for Question		7

Q2.

Question Number	Answer		Mark
	Use of $F = \frac{Gm_1m_2}{r^2}$	(1)	
	$F = 8.2 \times 10^{16}$ N	(1)	2
	<u>Example of calculation:</u> $F = \frac{Gm_1m_2}{r^2} = \frac{6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2} \times 6.4 \times 10^{23}\,\text{kg} \times 6.0 \times 10^{24}\,\text{kg}}{(5.6 \times 10^{10}\,\text{m})^2}$ $F = 8.17 \times 10^{16}$ N		
			2

Q3.

Question Number	Answer	Mark
	B	1

Q4.

Question Number	Acceptable answers		Additional guidance	Mark
i	• Use of $\omega = 2\pi/T$ • For at least 2 full cycles • $\omega = 6.5 \times 10^{-6}$ (radian s^{-1})	(1) (1) (1)	For MP3, accept correctly rounded answers in range 6.5×10^{-6} radian s^{-1} to 6.6×10^{-6} radian s^{-1} <u>Example of calculation</u> $\omega = 5 \times 2\pi / (56 \times 24 \times 60 \times 60)$ s $= 6.49 \times 10^{-6}$ radian s^{-1}	3
ii	• Equates $F = Gm_1m_2/r^2$ and $F = m\omega^2 r$ **Or** $F = Gm_1m_2/r^2$ and $F = mv^2/r$ with $v = 2\pi r/T$ • Correct rearrangement and substitution (e.g. in $r^3 = Gm_1/\omega^2$) • $r = 7.2 \times 10^9$ m (ecf from (b)(i))	(1) (1) (1)	<u>Example of calculation</u> $r^3 = 6.67 \times 10^{-11}$ N m^2 kg$^{-2} \times 0.12 \times 1.99 \times 10^{30}$ kg / $(6.5 \times 10^{-6}$ radian $s^{-1})^2$ $r = 7.2 \times 10^9$ m ($r = 7.6 \times 10^9$ m for 'show that' value)	3

Q5.

Question Number	Answer		Mark
(a)	Use of $F = \dfrac{Gm_1 m_2}{r^2}$ $G = 6.6 \times 10^{-11}$ (N m^2 kg^{-2}) [must see 6.6×10^{-11} when rounded to 2 sf] <u>Example of calculation</u> $G = \dfrac{1.5\times10^{-7}\,\text{N}\times(0.23\,\text{m})^2}{160\,\text{kg}\times0.75\,\text{kg}} = 6.61\times10^{-11}\,\text{N}\,\text{m}^2\,\text{kg}^{-2}$	(1) (1)	2
(b)(i)	Read (peak) times from graph for at least 3 cycles T = 6.4 min (±0.2 min) [T = (380 ±12) s] [max 1 mark if correct answer shown without working] <u>Example of calculation</u> $T = \dfrac{(28.0-2.5)\,\text{min}}{4} = 6.38\,\text{min}$	(1) (1)	2
(b)(ii)	Air resistance acts on the sphere [accept frictional forces **Or** (viscous) drag for air resistance] Energy is removed from the oscillation/system **Or** the oscillation/system is damped [For mp 2 do not credit 'energy is lost' but accept 'energy is dissipated'; answer must indicate idea of transfer of energy]	(1) (1)	2

(b)(iii)	Evidence of values of at least 3 consecutive peaks read from graph [accept values of 3 points separated by equal time intervals] Attempt to obtain amplitudes, by subtracting 0.75 Calculation of two values of A_{n+1}/A_n with corresponding conclusion **Or** Calculation of two values of difference of ln A_{n+1} and ln A_n with corresponding conclusion **Or** Use peaks of graph to sketch curve Use curve to determine "half-life" [accept other ratio] Calculation of two values of "half-life" with corresponding conclusion <u>Example of calculation</u> $A_0 = 1.45\text{-}0.75 = 0.7$, $A_1 = 0.75\text{-}0.25 = 0.5$, $A_2 = 1.1\text{-}0.75 = 0.35$, $A_4 = 0.75 - 0.5 = 0.25$ $\frac{A_1}{A_0} = \frac{0.50}{0.70} = 0.71$ $\frac{A_2}{A_1} = \frac{0.35}{0.50} = 0.70$ $\frac{A_3}{A_2} = \frac{0.25}{0.35} = 0.71$	(1) (1) (1) (1) (1) (1)	3
	Total for question		**9**