

Name: \_\_\_\_\_

Marks: \_\_\_\_\_ / 31

## Yr 12 Motion / Moments – Data Evaluation / Analysis Test

The table below describes the orbital paths of a number of natural and man-made satellites orbiting the Earth.

Name	Mass (kg)	Orbital Radius ( $\times 10^7$ m)	Period (s)	Acceleration ( $m s^{-2}$ )	Inverse of orbital radius squared (Units: $\times 10^{-14} m^{-2}$ )
Shuttle		0.671	5410	9.05	2.22
Tiros	1405	0.722	6120	7.61	1.92
Itos	340	0.787	6670	6.98	1.61
Lageos	411	1.23	13500	2.66	0.661
Nato	310	4.22	86400	0.223	0.056
Moon	$7.38 \times 10^{22}$	38.2	$2.42 \times 10^6$	$2.58 \times 10^{-3}$	0.000685

1. Using your knowledge of **circular motion theory**, show working to illustrate that the acceleration of each satellite is related to its orbital radius and its period by the expression:

$$a = 4\pi^2 r / T^2$$

$$\textcircled{1} \quad F_{\text{grav}} = F_{\text{cent}}$$

$$\textcircled{1} \quad g = a$$

$$\textcircled{1} \quad m_s g = \frac{m_s v^2}{r}$$

$$\textcircled{1} \quad a = \left( \frac{2\pi r}{T} \right)^2 \frac{1}{r} = \frac{4\pi^2 r}{T^2}$$

$$\textcircled{1} \quad v = \frac{2\pi r}{T}$$

(4 marks)