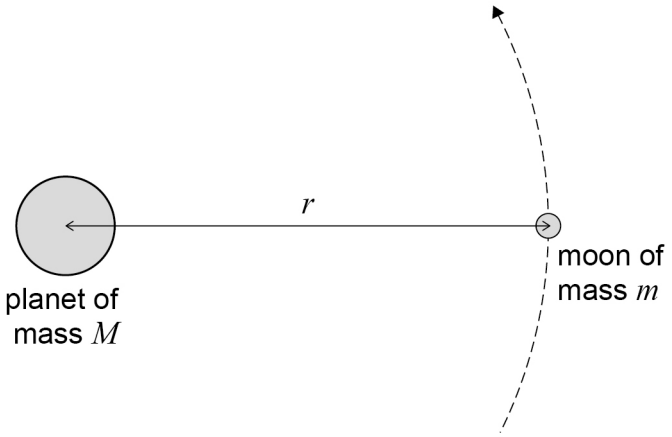
Do not write outside the box

0 2 **Figure 2** shows a moon of mass m in a circular orbit of radius r around a planet of mass M, where $m << M$.

Figure 2



The moon has an orbital period T.
T is related to r by

$$T^2 = kr^3$$

where k is a constant for this planet.

0 2 . 1 Show that $k = \dfrac{4\pi^2}{GM}$

[3 marks]

Do not write outside the box

Table 2 gives data for two of the moons of the planet Uranus.

Table 2

Name	T / days	r / m
Miranda	1.41	1.29×10^8
Umbriel	4.14	**X**

0 2 . 2 Calculate the orbital radius **X** of Umbriel.

[2 marks]

orbital radius = _____ m

0 2 . 3 Calculate the mass of Uranus.

[3 marks]

mass = _____ kg

Question 2 continues on the next page

Turn over ►

Do not write outside the box

Table 3 gives data for three more moons of Uranus.

Table 3

Name	Mass / kg	Diameter / m
Ariel	1.27×10^{21}	1.16×10^{6}
Oberon	3.03×10^{21}	1.52×10^{6}
Titania	3.49×10^{21}	1.58×10^{6}

0 2 . 4 Deduce which moon in **Table 3** has the greatest escape velocity for an object on its surface.
Assume the effect of Uranus is negligible.

[3 marks]

Do not write outside the box

0 2 . 5 A spring mechanism can project an object vertically to a maximum height of $1.0\ \text{m}$ from the surface of the Earth.

Determine whether the same mechanism could project the same object vertically to a maximum height greater than $100\ \text{m}$ when placed on the surface of Ariel.

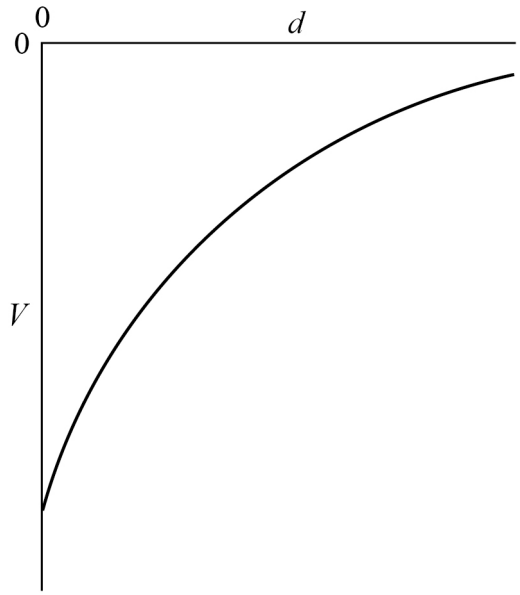
[3 marks]

14

Turn over for the next question

Do not write outside the box

1 2 The graph shows how the gravitational potential V varies with the vertical distance d from the surface of the Earth.



What does the gradient of the graph represent at the surface of the Earth?

[1 mark]

A potential energy ⬭

B mass of the Earth ⬭

C magnitude of the gravitational constant ⬭

D magnitude of the gravitational field strength ⬭

Do not write outside the box

1 3 What is the angular speed of a satellite in a geostationary orbit around the Earth?

[1 mark]

A 1.2×10^{-5} rad s^{-1} ⬭

B 7.3×10^{-5} rad s^{-1} ⬭

C 4.4×10^{-3} rad s^{-1} ⬭

D 2.6×10^{-1} rad s^{-1} ⬭

Turn over for the next question