

Answer **all** the questions in the spaces provided.

- 1 (a) State Newton's law of gravitation.

.....

.....

.....[2]

- (b) The planet Jupiter and one of its moons, Io, may be considered to be uniform spheres that are isolated in space.

Jupiter has radius R and mean density ρ .

Io has mass m and is in a circular orbit about Jupiter with radius nR , as illustrated in Fig. 1.1.

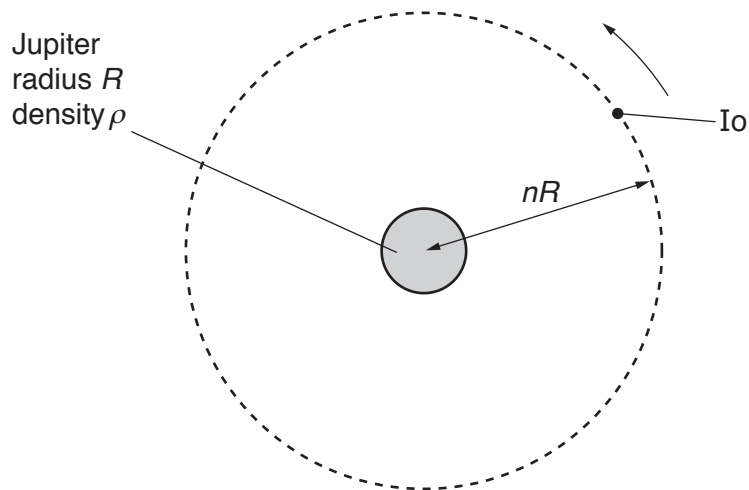


Fig. 1.1

The time for Io to complete one orbit of Jupiter is T .

Show that the time T is related to the mean density ρ of Jupiter by the expression

$$\rho T^2 = \frac{3\pi n^3}{G}$$

where G is the gravitational constant.

- (c) (i) The radius R of Jupiter is 7.15×10^4 km and the distance between the centres of Jupiter and Io is 4.32×10^5 km.
The period T of the orbit of Io is 42.5 hours.

Calculate the mean density ρ of Jupiter.

$$\rho = \dots\dots\dots \text{kg m}^{-3} \text{ [3]}$$

- (ii) The Earth has a mean density of $5.5 \times 10^3 \text{ kg m}^{-3}$. It is said to be a planet made of rock.
By reference to your answer in (i), comment on the possible composition of Jupiter.

.....
.....[1]

[Total: 10]