

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

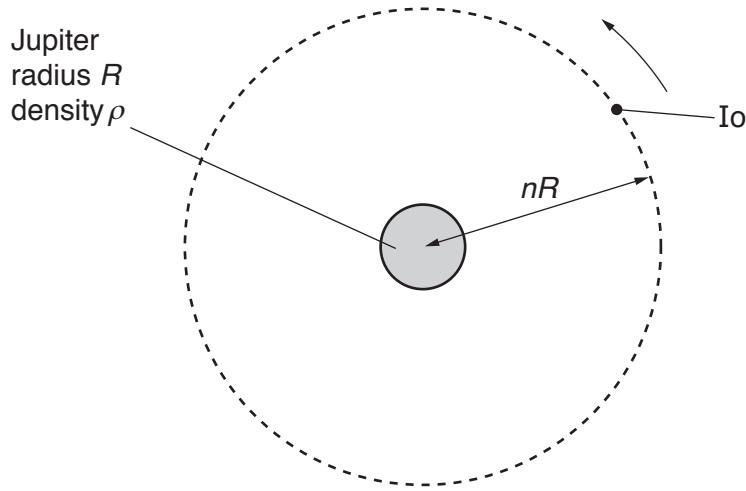
- 1 (a) State Newton's law of gravitation.

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 ..... [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  $\rho$ .

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  $\rho$  of Jupiter by the expression

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

where  $G$  is the gravitational constant.

[4]

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

Calculate the mean density  $\rho$  of Jupiter.

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

- (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.

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..... [1]

[Total: 10]