

- 4 (a) Define *gravitational field strength*.

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..... [1]

- (b) Io, a satellite of Jupiter, has an orbital period T of 1.77 Earth days, and an orbital radius r of 4.22×10^5 km.

- (i) Show that

$$T^2 = 4\pi^2 \frac{r^3}{GM}$$

where M is the mass of Jupiter

[1]

- (ii) Hence, determine the mass of Jupiter.

mass = kg [1]

- (c) There is a point X between Jupiter and Io where the gravitational field strength is zero. Given the mass of Io is 8.93×10^{22} kg, find the ratio

$$\frac{\text{distance between centre of Jupiter and X}}{\text{distance between centre of Io and X}}$$

ratio = [2]

(d) On Fig. 4.1,

(i) sketch the variation of gravitational field strength g with distance, from the surface of Jupiter to the surface of Io, [2]

(ii) indicate the approximate position of X. [1]



Fig. 4.1 (not to scale)

(e) On 4 July 2016, NASA's Juno spacecraft entered a polar orbit around Jupiter to begin a scientific investigation of the planet. Juno passed through Jupiter's north pole where it encountered high speed electrons in Jupiter's atmosphere. NASA's scientists and engineers anticipated the issue in the design stage. In response, they built a titanium vault to house most of the crucial electronic and computer systems.

Suggest why there is a need to shield the systems using a titanium vault.

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[Total: 9]

