6

(a)

State what is meant by a *field of force* around a mass and hence define *gravitational field strength.*

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.....

.....

.....

.....

[2]

(b)

Using Newton's laws, show that, for a circular orbit of an object about the centre of a planet,

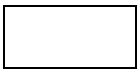
$$T^2 = \frac{4\pi^2 r^3}{GM}$$

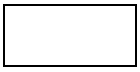
where T is the orbital period of the object,

M is the mass of the planet, and

r is the distance between the centre of mass of the object and the planet.

[3]





(c)

The planet Jupiter has several moons. Deriving from the expression in **(b)**, data for some of these moons are plotted on a graph of $\log_{10}$ (T/days) against $\log_{10}$ (r/m) on Fig. 6.1.

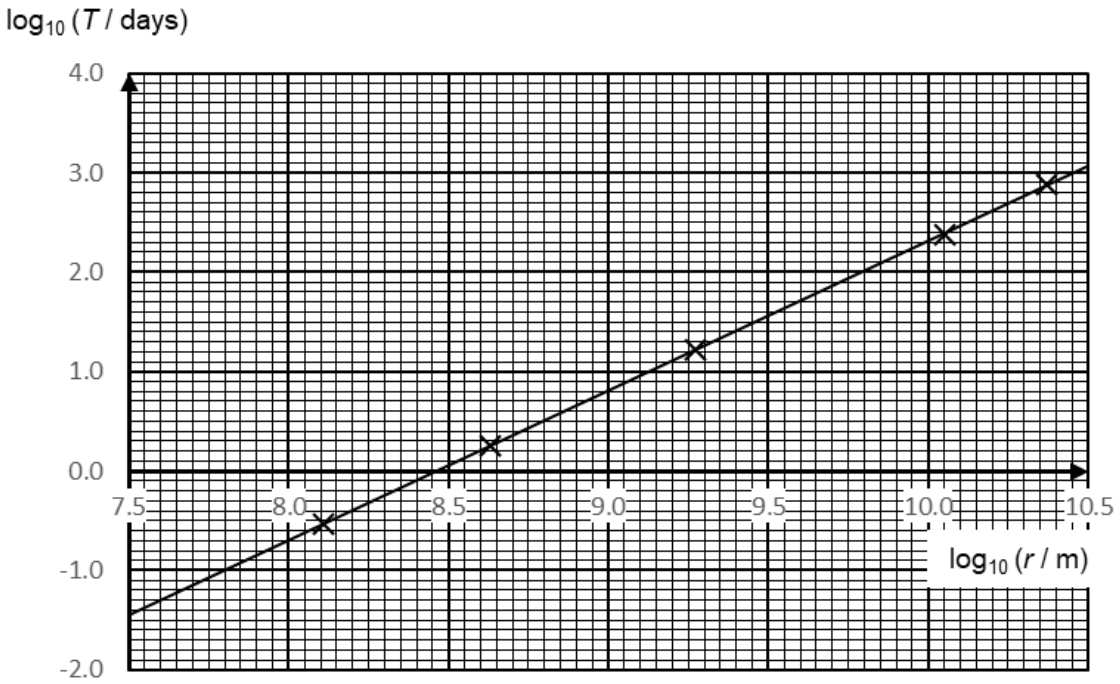
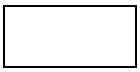
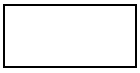
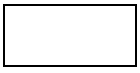


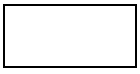
Fig. 6.1

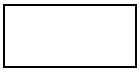
Observations show that the moon Ganymede orbits Jupiter with a period of 7.16 Earth days. Use Fig. 6.1 to estimate the orbital radius of Ganymede.

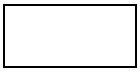












orbital radius = …….. m

[2]

(d)

It is reported in the media that the moon Thebe is discovered to orbit Jupiter once every 16.2 hours at a height of 2.22×10^5 km above the surface of Jupiter.

Referring to Fig. 6.1, comment on the accuracy of this media report.

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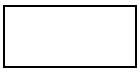

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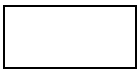

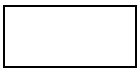

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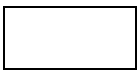

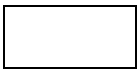

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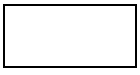
[2]



(e)

Fig. 6.2 shows how the gravitational potential, Φ, vary due to the Earth at three orbits, A, B and C. These orbits could be occupied by a 53.2 kg satellite in circular orbit around the Earth, E, of radius 6.38×10^3 km.

orbit	Φ / MJ kg^{-1}	distance from surface / km
A	– 42.5	3000
B	– 47.6	2000
C	– 54.1	1000

Fig. 6.2

(i)

Determine the change in gravitational potential energy (GPE) from orbit B to orbit A. Leave your answer in standard form.

change in GPE = ... J

[2]

(ii)

Using data from Fig. 6.2, show that the gravitational potential is inversely proportional to the radial distance.

[1]