3

In 1600, Kepler showed from astronomical data that the period T of a planet is related to its distance r from the Sun by the expression

$$T^2 \propto r^3$$

This is known as Kepler's third law.

In 1687, Newton stated his law of gravitation using the expression

$$F = \frac{Gm_1m_2}{r^2}$$

where F is the force between two bodies separated by a distance r, G is the gravitational constant and m_1 and m_2 are the masses of the two bodies.

(a)

(i)

Use Newton's second law of motion to explain why the orbiting planet moving with uniform speed must experience a force towards the centre of the Sun.

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……..……..……[2]

(ii)

Use Newton's law of gravitation to derive an equation confirming Kepler's third law for a planet of mass m, in a circular orbit around the Sun of mass M. [2]

(iii)

Use the equation you derived in **(ii)** to determine the the mass of the Sun M. The distance between Earth and the Sun is 1.50×10^{11} m.

mass of the Sun = …….. kg [2]

(b)

Describe how you could use a similar method in **(iii)** to determine the mass of Earth.

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….[1]

[Total: 7]