Answer on Question #42595, Physics, Mechanics | Kinematics | Dynamics

Question.

The period of a satellite in a circular orbit of radius R is T. The period of another satellite in a circular orbit of radius $4R$ is?

Solution.

Newton's law of universal gravitation:

$$F = G\frac{Mm}{R^2}$$

F is the force between bodies M and m, the force with which body M acts on body m;

M is a mass of planet;

m is a mass of satellite;

R is a distance between M and m;

$G = 6.67 * 10^{-11} \frac{N \cdot m^2}{kg^2}$ is a gravitational constant.

Newton’s second law for the satellite:

$$F = ma$$

a is the centripetal acceleration.

$$a = \frac{v^2}{R} = \omega^2 R$$

$$v = \omega R$$

v is linear velocity;

ω is the angular velocity.

$$\omega = \frac{2\pi}{T}$$

T is a period of motion.

So,

$$a = \frac{v^2}{R} = \omega^2 R \rightarrow a = \frac{4\pi^2}{T^2} R$$

$$F = ma \rightarrow G\frac{Mm}{R^2} = m\frac{4\pi^2}{T^2} R$$

Therefore,

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

$$T = \sqrt{\frac{4\pi^2}{GM}} R^{3/2}$$

Thus, if $R_0 \to 4R_0$:

$$T_0 = \sqrt{\frac{4\pi^2}{GM}} R_0^{3/2}$$

$$T = \sqrt{\frac{4\pi^2}{GM}} R^{3/2} = \sqrt{\frac{4\pi^2}{GM}} (4R_0)^{3/2} = \sqrt{\frac{4\pi^2}{GM}} R_0^{3/2} \cdot 4^{3/2} = \sqrt{\frac{4\pi^2}{GM}} R_0^{3/2} \cdot 8 = 8T_0$$

So, if $R_0 \to 4R_0$, then $T \to 8T_0$

Answer.

$8T$