Answer on Question #41178 - Physics - Other

Question.

The minimum energy required to launch a m kg satellite from earth surface in a circular orbit at a height 2r will be

Solution.

We proceed in non-inertial reference frame with respect to the Earth. In this case the object in orbit will be at rest, as two forces act on him: the centrifugal force and the gravitational force.

Gravitational force:

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

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

M is the mass of Earth; $M = 6 \cdot 10^{24}\ kg$

m is the mass of satellite;

R is a distance between the center of the Earth and the satellite in orbit;

Centrifugal force:

$$F = \frac{mv^2}{R}$$

Equate these formulas and calculate the square of rate v^2:

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

$$v^2 = \frac{GM}{R}$$

Here, $R = R_E + 2r$, where

R_E is a radius of Earth; $R_E = 6400\ km$

$2r$ is a height of orbit

The minimum energy required to launch a satellite is

$$E = \frac{mv^2}{2}$$

So,

$$E = \frac{GMm}{2R} = \frac{GMm}{2(R_E + 2r)}$$

Answer.

$$E = \frac{GMm}{2(R_E + 2r)}$$