**3. Ballistic rocket (8 p)**

A rocket is launched from a pole of the Earth with the first cosmic velocity (near-Earth orbital velocity) in such a way that it lands at the Equator. The radius of the Earth $R = 6400\,\text{km}$.

**1)** Find the longer semi-axes $a$ of the rocket's orbit (1.5 pts).

**2)** What is the maximal height of the rocket's orbit $h$ (from the Earth's surface; 3.5 pts)?

**3)** What is the rocket's flight time $\tau$ (3 p)?

*Remark:* The mechanical energy of a planet rotating around a star $E = -GMm/2a$, where $G$ is the gravitation constant, $M$ — the star mass, $m$ — the planet mass, and $a$ — the orbit's longer semi-axes (zero potential energy corresponds to an infinite departure). The surface area of an ellipse $S = \pi ab$, where $b$ is the shorter semi-axes.