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Problems set # 7 **Physics 411** October 18, 2007

1. A comunication satellite is in circular orbit around the Earth at a distance above the Earth equal to the Earth's radius. Find the minimum velocity Δv to double the height of the satellite and put it in another circullar orbit.

2. Calculate the minimum Δv required to place a satellite already in the Earth heliocentric orbit (assumed circular) into the orbit of Venus (also assumed circular and coplanar with the Earth). Consider only the gravitational attraction of the Sun. What time of flight would such a trip take?

3. Assuming a rocket engine can fire only once from a low Earth orbit, does a Mars flyby or a Venus flyby require a large Δv?

4. A spacecraft is parked in a circular orbit 200 km above the Earth's surface. We want to use a Hohmann transfer to send the spacecraft to the moon's orbit. What are the total Δv and the transfer time required?

5. Consider a comet moving in a parabolic orbit in the plane of the Earth orbit. If the distance of closest approach of the comet to the Sun is $\beta R_{\odot-\oplus}$, where $R_{\odot-\oplus}$ is the radius of the Earth's (assumed) circular orbit and $\beta < 1$, show that the time the comet spends within the orbit of the Earth is given by

$$\frac{1}{3\pi}\sqrt{2(1-\beta)}\,(1+2\beta)\ \text{yr}.$$

If the comet approaches the Sun to the distance of the perihelion of Mercury, how many days is within the Earth's orbit.