

For a Hohmann transfer orbit, the time taken to transfer between the orbits is one half of the orbital period for the whole ellipse, where  $a_H$  is the semi-major axis of the Hohmann transfer orbit.

$$T_{\text{transfer}} = \frac{\pi}{\sqrt{\mu}} (a_H)^{\frac{3}{2}} \quad [\text{seconds}]$$

- 1 Calculate the transfer time from the low Earth orbit to the Moon (in days).
- 2 Calculate the transfer time from the Earth to Mars (in days).

**Note:** The value of  $\mu$  will be different in the each of the above problems.

Assume that a mission to the Moon/Mars consists of 1) the time to get to the Moon/Mars, 2) one orbit of the Moon/Mars around the Earth/Sun, and 3) The time it takes to get back.

- 3 Calculate the total length of a Moon mission.
- 4 Calculate the total length of a Mars mission.

Based on historical records, there is about a 5% chance of a major solar storm occurring every year (365.24 days).

- 5 What is the chance of a major solar storm occurring during a Moon mission?
- 6 What is the chance of a major solar storm occurring during a Mars mission?

The height of mountains on planets is limited by the crushing strength of rocks (this is a simplified assumption, but it is good for a first-order estimate). If the pressure at the base of the mountain is greater than the crushing strength of rock, the mountain will slump. The pressure at the base of a mountain can be expressed by:

$$P = \rho gh \quad [\text{N/m}^2]; \quad 1 \text{ N/m}^2 = 1 \text{ Pascal [Pa]}$$

where  $\rho$  is the density of rock,  $g$  is the surface gravity ( $\mu/R_{\text{planet}}^2$ ) and  $h$  is the height of the mountain (all of this assumes  $h \ll R_{\text{planet}}$ ). Basalt has a density of  $3000 \text{ kg/m}^3$  and a crushing strength of  $300 \times 10^6 \text{ Pa}$ .

- 7-9) Calculate how high a basalt mountain can you make on the Earth, Moon, and Mars.

**Please show all your work (including units) in as complete, concise, neat, and organized a manner as possible.**

**Due: Thur April 30 in class (–2% for every hour late)**