Introduction to Aerospace Engineering
Problem Sheet 8

Due 2 December, 2003

Read "9. Orbital Mechanics" <www.aoe.vt.edu/~lutzeAOE2104/

36. For this problem, assume that the Earth is non spinning and has no atmosphere. We also note that it has an inverse gravitational field with the associated gravitational potential (per unit mass of $U = -\frac{\mu}{r}$, where r is measured from the center of the Earth. On the other hand, if we didn't know better, we might assume that the gravitational field was a constant with the associated gravitational potential (per unit mass) of $U = g_0 h$. If we launched vertically upward from the surface of the Earth with launch speed of 7.9054 km/s

a) How high (above the Earth's surface would we go (assuming inverse square gravitational field) in km.

b) How high would we go assuming a constant gravitational field, in km
c) What is the % error (true - wrong)/true X100 ?

37. A satellite has a perigee radius of 6778 km. It also is in an orbit with an eccentricity of 0.1.
a) Determine the semi-major axis of the satellite's orbit (km)
b) Determine the period of the satellite (hours)

38. Assume a spherical, non-rotating Earth with no atmosphere. A vehicle is launched from the surface of the Earth at 7.9054 km/s (same as problem (36)) However, it is launched in such a way that it reaches an apogee height of 600 km.
a) Determine the satellite velocity at apogee (km/s).
b) How much additional velocity (ΔV) would be needed to put the vehicle in a circular orbit at that altitude (600km)?

39. If the ΔV in problem (38) were 2.5 km/s, the payload was 2000 kg, and the structural mass ratio, $\lambda_s = 0.3$, how much fuel would be required to provide this increment in velocity, in kg. Assume that the I_{sp} = 350 s.

40. A mail-rocket service is to be used to provide high speed, same day, mail service. The orbit to be used has a semi-major axis that is equal to the Earth's radius, and an eccentricity of 0.85. Determine the following:
a) The maximum altitude (apogee height) of the rocket (km)
b) The distance (or range) between launch point and receive point (in km).

This new rocket mail service is just starting up and they are hiring folks for the position of a "rocket catcher" Before you sign up, you may want to calculate the velocity of the rocket that you will be catching.