Problem Set 2

Consider a spacecraft in circular orbit about the Sun at a distance of one astronomical unit. Calculate the total change in velocity $\Delta v$ required to get to the Sun. Also calculate the total time it takes for the following paths:

a) Assume the spacecraft stops dead in its orbit and falls in,

b) Assume the spacecraft first boils into an elliptical orbit of minimum distance 1 AU and maximum distance 5 AU (astronomical units from Sun). Then when the spacecraft reaches 5 AU, it stops dead and falls all the way in.

Calculate the ratio of the gravitational cross section for a comet to strike Jupiter (such as Shoemaker-Levy 9) compared to the gravitational cross section to strike Earth. Note you need to calculate the relative velocity of a typical comet and Jupiter, which is different from the typical relative velocity with Earth. Use the following data:

Earth-Sun Distance $= 1$ AU $= 1.496 \times 10^{13}$ cm
Earth mass $= 5.972 \times 10^{27}$ kg
Earth radius $= 6.371 \times 10^8$ cm
Jupiter-Sun Distance $= 5$ AU
Jupiter mass $= 0.001$ M$_{\text{Sun}}$
Jupiter radius $= 12$ Earth

Note, Jupiter's gravity is so large that
the first order calculation done in class is no
longer valid. Go back to the exact expression
\[ R_{\text{f}} = R_{\text{m}} = \frac{\left[ 1 + \left( \frac{V_0^2 b}{x} \right)^2 \right]^{\frac{1}{2}} - 1}{\left[ 1 + \left( \frac{V_0^2 b}{x} \right)^2 \right]^{\frac{1}{2}} + 1} \]
and solve it numerically for the maximum impact parameter \( b \).

(3) Fetter, Wolicka 2.5 about a canon pointing due east.