Name:_____ Section_____

Revised Problem 4. 2 Energy in the Moon voyage

Energy conservation is a powerful check on the accuracy of a numerical integration. In this problem you will add energy calculations to a Moon voyage program (Prob. 2.7), and plot graphs of energy.

A spacecraft is launched with a large initial speed toward the Moon from near the Earth, just above the atmosphere. The spacecraft coasts to the Moon and crashes on the Moon's surface. This corresponds to the Ranger 7 photographic mission to the Moon in 1964. We will analyze a simplified model of this Moon voyage, in which the Earth and the Moon are fixed in position, and we ignore the effects of the Sun and other planets.

(a) On this graph, qualitatively sketch your prediction for the kinetic energy *K*, the gravitational potential energy *U*, and the sum *K*+*U*, vs. position *r* (relative to the Earth) during the spacecraft's trip to the Moon. Label the curves *K*, *U*, and *K*+*U*.

☐ **Ask an instructor to check your work.**

(b) Start with a running Moon voyage program (Prob. 2.7). Set the Moon's mass and radius to be those of the Earth, to make some of the effects more easily visible. Set initial v = 1.2E4 m/s and dt = 2.0 s. Add a graph with plots of *K*, *U*, and *K*+*U*, vs. position, all on the same axes. Sketch the graphs you observe. Does *K*+*U* remain constant during the process?

☐ **Ask an instructor to check your computer graph and conclusion.**

(Turn to other side)

(c) Set dt = 200.0 and rerun the program. Sketch the graphs you observe. How can energy calculations provide a check that dt is "small enough" to give accurate results?

☐ **Ask an instructor to check your conclusion.**

(d) Reset dt = 2.0 s, and set the initial v = 1.0E4 m/s. Sketch the graphs you observe. Very briefly explain why the plots of *K* and *K*+*U* have the forms you observe:

K:

K+*U:*

☐ **Ask an instructor to check your work.**

(e) Now assign the correct mass and radius to the Moon and run the program with dt = 2.0 s and initial v = 1.2E4 m/s. Sketch the graphs you observe.

Turn in this worksheet. You are finished and need not turn in the program.