1. The size of the gravitational force between any two spherically-symmetric masses in the Universe is given by $F_G = G\frac{m_A m_B}{r^2}$; r is the separation distance between the masses.

a. Star A is twice as massive as star B; no other masses are nearby. No information about their motions is given. Make a FBD on each star, drawing the force arrows to scale.

b. Draw a labeled acceleration arrow below each star, once again to scale. Explain the selected length of your acceleration arrows.

2. The gravitational PE stored in a system of two spherically-symmetric masses, M and m, separated by a distance r, is most conveniently written as $U_G(r) = -G\frac{Mm}{r}$.

a. Find the expression that results from taking $-\frac{d}{dr}U_G(r)$. For M at the origin (a reasonable choice if we let $M >> m$), what is the physical significance of your result?

b. Show that, given this choice of $U_G(r)$, if a projectile was fired from the surface of a planet of mass M and radius R with a launch speed of $\sqrt{2GM/R}$, then the planet-projectile system would have a total mechanical energy of zero! What would happen to such a projectile launched vertically from the surface of an airless world?

c. Consider a 100-kg projectile to be launched from the surface of an airless world having $M = 6.0 \times 10^{24}$ kg and $R = 6500$ km. Find the launch speed needed to create $K+U = 0$ (as in (b)), and calculate each of K and U at the instant of launch.

d. For the launch of part (c), what would be the system KE when the projectile has achieved an altitude equal to twice the radius of the planet (*i.e.* $r = 3R$)?