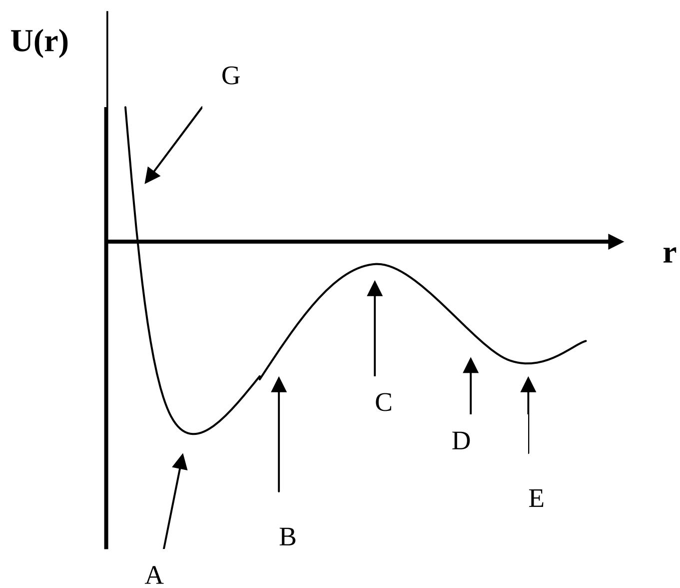
Physics 113 - Fall 2006 – Problems for workshop 7
Momentum conservation, collisions

1. Two atoms in a molecule are separated by a distance r. The potential energy between these two particular atoms depends on the separation of the atoms and is shown below as a function of the distance between the atoms (on some arbitrary scale). *Note: a realistic potential function would have only one well.*

a) At what distance(s) is there no force of one atom on the other?
b) Suppose the atoms are separated by the distance shown in point A on the graph, what happens if they are moved apart slightly? What about if they are moved together slightly?
c) How does your answer change if they start at position B? Or C?
d) What is the meaning of the word "equilibrium"? Think about what you've concluded in parts a-c and determine the positions of "stable" and "unstable" equilibrium.
e) Why is a chemical bond similar to a spring?



2. A machine gun is fired at a steel plate. Is the force on the plate from the bullet impact greater if the bullets bounce off or if they are squashed and stick to the plate? Why?
3. Before the wars between Kobe and Shaquille, at the LA Lakers' basketball arena in Los Angeles, a maintenance man tried out a new type of floor wax that rendered the floor of the court *completely frictionless*. Shaquille O'Neal was standing in the middle of the court dreaming of another NBA championship during the waxing process, and became stranded there. Luckily, he was carrying his NBA Most Valuable Player trophy, which weighs 50 pounds. If O'Neal, who weighs 300 pounds, hurled the trophy away from himself at 6 m/s, how long did it take him to reach the unwaxed edge of the court, 30 meters away?

4. A 5.00 g bullet is shot through a 1.00 kg wood block suspended on a string 2.000 m long. The center of mass of the block rises a distance of 0.45 cm. Find the speed of the bullet as it emerges from the block if its initial speed is 400 m/s.
5. An important thing to learn in the process of becoming a physicist is how to be spacey. Let's get spacey. In a zero-gravity environment, can a rocket-propelled spaceship ever attain a speed greater than the relative speed with which the burnt fuel is exhausted?
6. A cannon is situated on a railcar as shown in the sketch below. The cannon fires a shell (or cannonball) with a mass of 50 kg with a velocity of 400 m/s at an angle of 60 degrees with the horizontal. Assume the cannon and railcar combination has a mass of 11000 kg both before and after the cannon is fired. What is the recoil velocity of the railcar+cannon immediately after it is fired. Ignore friction and air resistance in this problem.