CH7 EXCERSISES

1. (7.3) A 90 kg mail bag hangs by a vertical rope 3.5 m long. A postal worker then displaces the bag to a position 2 m sideways from its original position, always keeping the rope taunt. (a) What horizontal force is necessary to hold the bag in the new position? (b) At the bag is moved, how much work is done by (i) the bag and (ii) by the worker?

2. (7.11) You are testing a new amusement park roller coaster with an empty car of mass 120 kg. One part of the track is a vertical loop with radius 12 m. At the bottom of the loop (point A) the car has speed 25 m/s, and at the top of the loop (point B) it has speed 8 m/s. As the car rolls from point A to point B, how much work is done by friction?

3. (7.15) A force of 520 N keeps a certain spring stretched a distance of 0.2 m. (a) What is the potential energy of the spring when it is stretched 0.2m? (b) What is potential energy when it is compressed 5 cm?

4. (7.21) A spring of negligible mass has a force constant k = 1600 N/m. (a) How far must the spring be compressed for 3.2 J of potential energy to be stored in it? (b) You place the vertically with one end on the floor. You then drop a 1.2 kg book onto it from a height of 0.8 m above the top of the spring. Find the maximum distance the spring will be compressed.

5. (7.25) You are asked to design a spring that will give a 1160 kg satellites a speed of 2.5 m/s relative to an orbiting space shuttle. Your spring is to give the satellite a maximum acceleration of 5 g. The spring's mass, the recoil kinetic energy of the shuttle, and changes in gravitational energy will all be negligible. (a) What must the force constant of the spring be? (b) What distance must the spring be compressed?

6. (7.29) A 62 kg skier is moving at 6.5 m/s on a frictionless, horizontal, snow covered plateau when she encounters a rough patch 4.2 m long. The coefficient of kinetic friction between this patch and her skis is 0.3. After crossing the rough patch and returning to friction free snow, she skis down an icy, frictionless hill 2.5 m high. (a) How fast is the skier moving when she gets down the hill? (b) How much internal energy as generated crossing the rough patch?

7. (7.31) CALC A force parallel to the z-axis acts on a particle moving along the x-axis. This force produces a potential energy $U(x) = \alpha x^4$, where $\alpha = 0.63\ J/m^4$. What is the force (magnitude and direction) when the particle is at x = - 0.8 m?

8. (7.33) CALC An egg of mass 0.04 kg is moving in the xy plane. The net force on the egg is described by the potential energy function $U(x) = (5.8\ J/m^2)x^2 - (3.6\ J/m^3)y^3$. What are the magnitude and direction of the acceleration of the egg when it is at point (x = 0.3 m, y = 0.6 m)?

9. (7.35) CALC The potential energy of two atoms in a diatomic molecule is given by $U(r) = (\alpha/r^{12}) - (\beta/r^6)$, where r is the spacing between atoms and a and b are positive constants. (a) Find the force F(r) on one atom as a function of r. Draw two graphs: one of U(r) versus r, and one of F(r) versus r. (b) Find the equilibrium distance between the two atoms. Is this equilibrium stable? (c) Suppose the distance between the two atoms is equal to the equilibrium distance found in part (b). What minimum energy must be added to the molecule to dissociate it –that is, to separate the two atoms an infinite distance apart? (d) Given the molecule CO, the equilibrium distance between the carbon and oxygen atoms is $1.13 \cdot 10^{-10}$ m and the dissociation energy is $1.54 \cdot 10^{-18}$ J per molecule. Find the values of constants α and β.

10. (7.49) You are to design a new spring gun for the Great Sandini, a 60 kg circus performer. This new gun has a very large spring with a very small mass and a force constant of 1100 N/m that he will compress with a force of 4400 N. The inside of the gun is coated with Teflon, so the average friction force will be only 40 N during the 4 m he moves inside the barrel. At what speed will he emerge from the end of the barrel, 2.5 m above his initial rest position?

11. (7.51) A system of two paint buckets, one 12 kg and the other 4 kg, are connected vertically by a light rope and frictionless pulley. With the 4 kg bucket resting on the floor, the 12 kg is suspended 2 m above the floor before it is released from rest. Use the principle of the conservation of energy to find the speed with which the 12 kg bucket strikes the floor.

12. (7.63) A 0.15 kg block of ice is placed against a horizontal, compressed spring mounted on a horizontal tabletop that is 1.2 m above the floor. The spring has force constant 1900 N/m and is initially compressed 0.045 m. The mass of the spring is negligible. The spring is released, and the block slides along the table, goes off the edge, and travels to the floor. Assuming frictionless contact between the ice and tabletop, what is the speed of the block when it reaches the floor?