Prof. Anchordoqui

Problems set # 5 **Physics 168**

1. During your winter break you enter a "dogsled" race across a frozen lake. This is a race where each sled is pulled by a person not dogs. To get started you pull the sled (total mass 80 kg) with a force of a 180 N at 40 degrees above the horizontal. Find (a) the work you do, and (b) the final speed of the sled after it moves $\Delta x = 5.0$ m, assuming that it starts from rest and there is no friction.

2. A force $\vec{F} = F_x\hat{i}$ varies with x as shown in Fig. 1. Find the work done by the force on a particle as the particle moves from $x = 0$ m to $x = 6$ m.

3. You and your friend are at a ski resort with two ski runs, a beginner's run and an expert's run. Both runs begin at the top of the ski lift and end at finish line at the bottom of the same lift. Let h be the vertical descent for both runs. The beginner's run is longer and less steep than the expert's run. You and your friend, who is a much better skier than you, are testing some experimental frictionless skis. To make things interesting, you offer a wager that if she takes the expert's run and you take the beginner's run, her speed at the finish line will not be greater than your speed at the finish line. Forgetting that you study physics, she accepts the bet. The conditions are that you both start from rest at the top of the lift and both of you coast for the entire trip. Who wins the bet? (Assume air drag is negligible).

4. (a) Determine the work a hiker must do on a backpack (with a mass of 15 kg) to carry it up a hill of height $h = 10$ m. Determine also (b) the work done by gravity on the backpack, and (c) the net work done on the backpack. For simplicity assume the motion is smooth and at constant velocity (i.e, acceleration is negligible).

5. Jane looking for Tarzan, is running at top speed 5.3 m/s and grabs a vine hanging vertically from a tall tree in the jungle. How high can she swing upward? Does the length of the vine affect your answer?

6. A block of mass m is attached to the end of a spring (spring stifness constant k). The block is given an initial displacement x_0, after which it oscillates back and forth. Write a formula for the total mechanical energy (ignore friction and the mass of the spring) in terms of x_0, position x, and speed v. (See Fig. 1.)

7. A 62-kg bungee jumper jumps from a bridge. He is tied to a bungee cord whose unstretched length is $L_1 = 12$ m, and falls a total of $L_1 + L_2 = 31$ m. (a) Calculate the spring stiffness constant k of the bungee cord, assuming Hooke's law applies. (b) Calculate the maximum acceleration he experiences. (c) Calculate the velocity just before the cord is starting to stretch. (d) What is the position of maximum velocity?

8. Imagine you have time-traveled back to late 1800 s and you are watching your great-great-great-grandparents on their honeymoon taking a ride on the Flip Flap Railway, a Coney Island roller coaster with a circular loop-the-loop. The car they are in is about to enter the loop-the-loop when a 100 lb sack of sands falls from a construction-site platform and lands in the back seat of the car. No one is hurt, but the impact causes the car to lose 25% of its speed. The car started from rest at a point 2 times as high as the top of the circular loop. Neglect losses due to friction on air drag. Will their car make it over the top of the loop-the-loop without falling off?

9. A pendulum consists of a bob of mass m attached to a string of length L. The bob is pulled

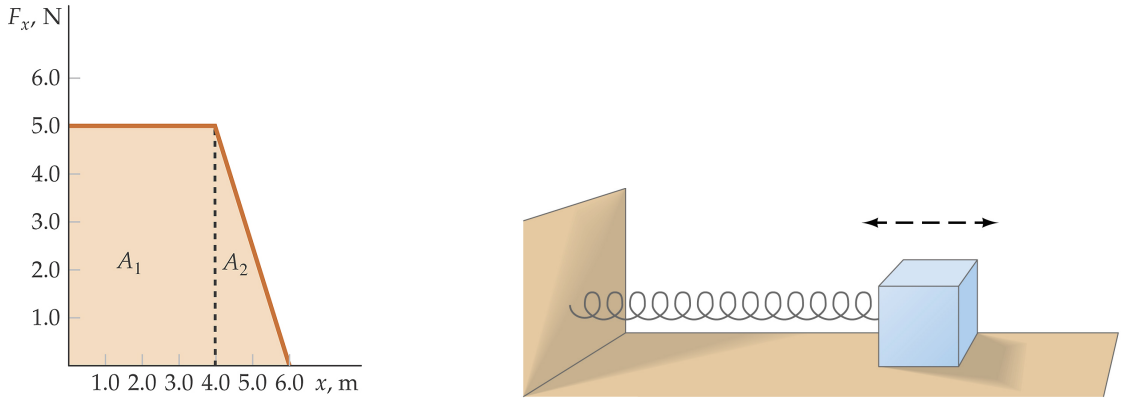

Figure 1: The situation in problems 2 (left) and 6 (right).

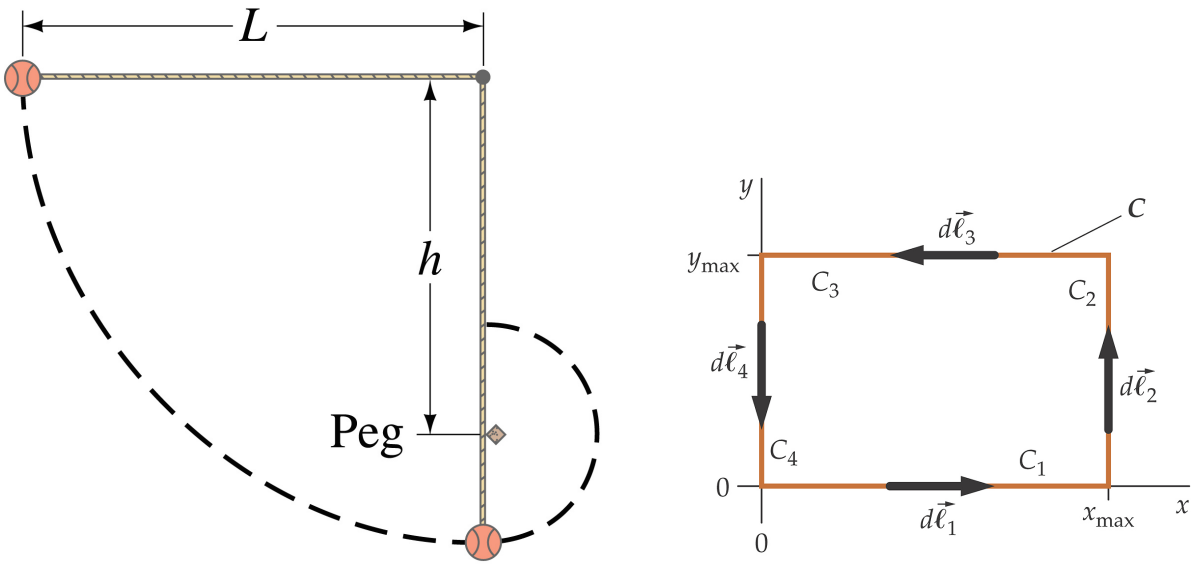

Figure 2: The situation in problems 11 (left) and 12 (right).

aside so that the string makes an angle θ_0 with the vertical, and is released from rest. As it passes through the lowest point of the arc, find expressions for (a) the speed of the bob and (b) the tension in the string. Effects due to air resistance are negligible.

10. A spring with stiffness constant k is cut in half. What is the spring stiffness constant for each of the two resulting springs?

11. A ball is attached to a horizontal cord of length L whose other end is fixed. (a) If the ball is released, what will be its speed at the lowest point of its path? (b) A peg is located a distance h directly below the point of attachment of the cord. If $h = 0.8L$, what will be the speed of the ball when it reaches the top of its circular path above the peg? (See Fig. 1.)

12. For $\vec{F} = Ax\,\hat{\imath}$ calculate $\oint_C \vec{F}\,.\,d\vec{\ell}$ for the path C shown in Fig. 2.