5.8 PROBLEMS

Problem 5.8.1. A block of mass 5 kg is attached to two springs S_1 and S_2 of spring constants 300 N/m and 175 N/m respectively (Fig. 5.68). The block is then put on a rough surface so that the coefficient of static friction between the block and surface is 0.65. The spring S_2

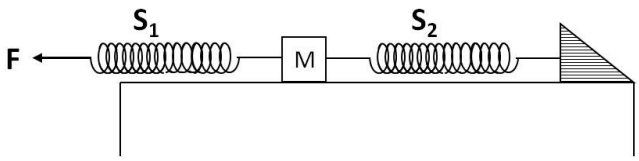

Figure 5.68: Problem 5.8.1.

is stretched by 2 cm and tied to a support without making the block move. The other end of the spring S_1 is then pulled with increasing force F. Find the stretch of the spring S_1 and the magnitude of the force F when the block just starts to slide.

Problem 5.8.2. A 100-kg person pulls a rope attached to a strong pole at an angle of 15° from horizontal (Fig. 5.69). The tension in the rope is found to be 800 N. Find the forces of friction and normal from the floor on the person.

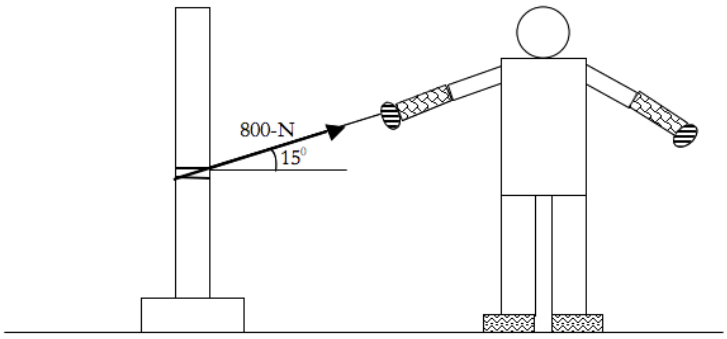

Figure 5.69: Problem 5.8.2.

Problem 5.8.3. A block is resting on a flat plane board whose angle of incline with respect to the horizontal direction can be varied by placing spacer at one end of the board. It is found that at a certain angle of inclination, say θ_0, the block starts to slide. Prove that the coefficient of static friction between the block and the board is given by $\mu_s = \tan\theta_0$.

Problem 5.8.4. A thin rod of mass 500 grams and length 50 cm rests on a cylinder of radius 20 cm (Fig. 5.70). The rod is attached to a collar of negligible mass,which is free to slide without friction over a vertical guide. Find angle at which the rod must rest so that the collar does not slide.

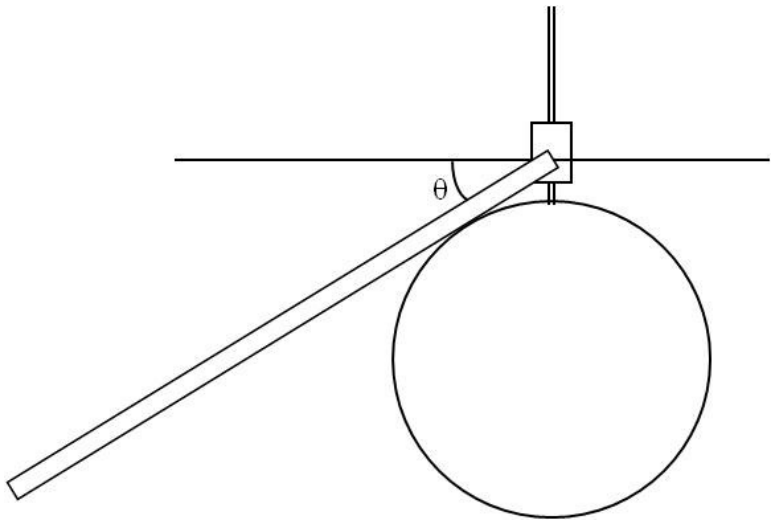

Figure 5.70: Problem 5.8.4.

Problem 5.8.5. A board of mass m and length L is resting against a vertical wall. The coefficient of static friction between the board and the wall and between the board and the floor are μ_w and μ_f, respectively. Find the minimum angle θ the board may be placed without slipping.

Problem 5.8.6. A spherical ball of mass M and radius R is resting against a step of height h with $h < R$ as shown in Fig. 5.71. A horizontal force F is applied to the ball so that its line of action always passes through the center of the ball. Find the minimum force needed to make the ball climb over the step.

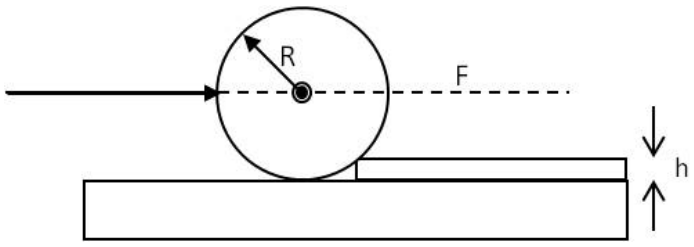

Figure 5.71: Problem 5.8.6.

Problem 5.8.7. A rectangular parallelepiped shaped wooden block of height b and square base of side a is placed on a smooth plane. There is a static frictional coefficient μ_s between the block and the plane. As the angle between the plane and the horizontal table is varied, the block may either tip first, or slide first depending upon the values of a, b and μ_s. Find the condition when the block tips first.

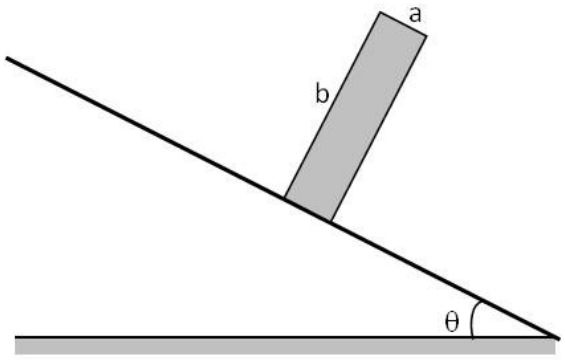

Figure 5.72: v.