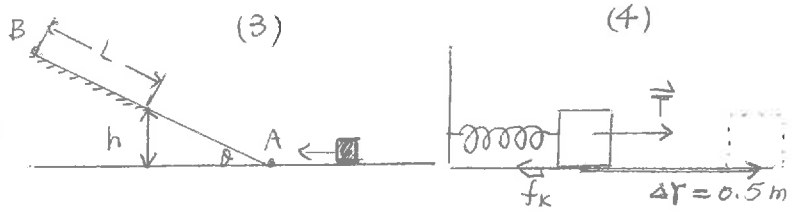
Chapter 8: Conservation of Energy



1. A roller coaster car of mass m is at rest against a spring of stiffness k and initially compressed, then the spring is released and the car is projected by it horizontally until it reaches a "loop - the - loop" of radius r. There is no friction in this problem. What is the minimum value of compression such that the car moves around the loop without falling off at the top of the loop?

2. A pendulum consists of a string of length L and a bob of mass m. The string is brought to a horizontal position and the bob is given the minimum initial speed enabling the pendulum to make a full turn in the vertical plane. (a) What is the minimum kinetic energy K of the bob? (b) What are the tension in the string when it is at the initial position?

3. A block slides along a path that is without friction until the block reaches the section of length L = 0.75 m , which begins at height h = 0.20 m on a ramp of angle $\theta = 30^{o}$. In the section, the coefficient of kinetic friction is $\mu k = 0.40$. The block passes through point A with a speed of 8.0 m/s. If the block can reach point B (where the friction ends), what is its speed there, and if it cannot, what is its greatest height above A?

4. An exercise machine at the gym has a 5.0 kg weight attached to one end of a horizontal spring with spring constant 80 N/m. The other end of the spring is anchored to a wall. When a woman walking out on the machine pushes her arms forward, a cable stretches the spring by dragging the weight along a track with a coefficient of kinetic friction of 0.30. What is the woman's power output at the moment when the weight has moved 50 cm if the cable tension is a constant 100 N?

5. Two blocks, of masses M and 2M, are connected to a spring of spring constant k that has one end fixed. The horizontal surface and the pulley are frictionless, and the pulley has negligible mass. The blocks are released from rest with the spring relaxed. (a) What is the combined kinetic energy of the two blocks when the hanging block has fallen h? (b) What is the kinetic energy of the hanging block when it has fallen h? (c) What maximum distance does the hanging block fall before momentarily stopping?

6. A small block of mass m slides along the frictionless loop-the-loop track. (a) The block is released from rest at point P. What is the net force acting on it at point Q? (b) At what height above the bottom of the loop should the block be released so that it is on the verge of loosing contact with the track at the top of the loop?

7. A sled starts from rest at the top of the frictionless, hemispherical, snow-covered hill. (a) Find an expression for the sled's speed when it is at angle ϕ. (b) Use Newton's laws to find the maximum speed the sled can have at angle ϕ without leaving the surface. (c) At what angle ϕ_{max} does the sled "fly off" the hill?

8. A system's potential energy is given by $U(x) = (2x^3 - 3x^2)$ J, where x is a particle's position in meter. Where are the equilibrium positions for this system, and are they stable or unstable equilibria?