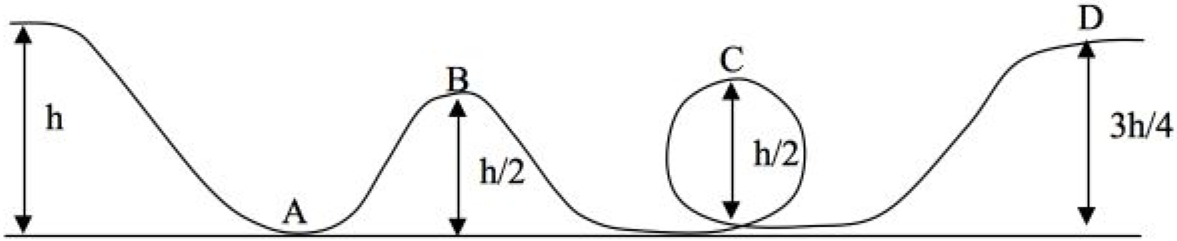
So Much Work

1. For the roller coaster pictured, calculate the speed of the car at points A, B, C and D. Let h = 50 m and assume the car starts at rest.



2. A mass is attached to a 2 meter pendulum and raised to an angle of 25 degrees to the vertical. Calculate the velocity of the mass when it reaches the bottom of its swing.

3. At the end of the level section of the Top Thrill Dragster, the ride reaches a speed of approximately 120 miles per hour.
    a. Determine the maximum height the car could reach if the track went directly up without the curve at the top.
    b. The Dragster does have a curved top that is 420 feet above the level section. Calculate the speed of the car at the top of the track.

4. A 0.5 kg block is launched upward by a spring (k = 400 N m^{-1}). The spring was initially compressed by 0.5 m.
    a. Calculate the maximum potential energy in the spring.
    b. Determine the amount of gravitational potential energy in the system when the spring reaches relaxed position.
    c. Assume the block leaves the spring at the relaxed position. Deduce the kinetic energy of the mass just before it leaves the spring.
    d. Calculate the speed of the block just before it leaves the spring.
    e. Calculate the maximum height of the block.

5. A 0.5 kg ball is dropped from 15 meters above the ground. Sketch the graphs of gravitational potential energy vs height and kinetic energy vs height on the same axes.

6. A 0.25 kg block is attached to a spring with k = 150 N m^{-1} and placed on a frictionless horizontal surface. The block is pulled 0.20 meters from the relaxed point and released from rest. Sketch the graphs of spring potential energy vs position and kinetic energy vs position on the same axes.

7. Matthew (m = 60 kg) is going to bungee-jump from a bridge that is 50 meters above a river and he must choose his bungee-cord. All of the cords have a relaxed-length of 18 meters. Determine the minimum spring constant needed to guarantee that he misses the water by 5 meters.

8. The barrel of a gun on a World War II battleship was 5 m long. The shells had a mass of 1250 kg and were fired with a muzzle speed of 750 m s^{-1}.
    a. Assuming the shell is fired horizontally, calculate the average force of the exploding gases on the shell in the barrel.
    b. If the shell is launched at 45°, determine the maximum height of the shell above the ground. (Assume the same muzzle speed)
    c. Explain why the muzzle speed for the 45° launch would not be slightly different than the horizontal launch. Justify ignoring this difference in the above problem.

9. A spring with k = 2000 N m^{-1} is compressed by 5.0 cm to launch a 3.0 kg block along a smooth, horizontal surface. The block then slides up a smooth (frictionless) ramp inclined at 20 degrees.
    a. Calculate the total energy of the system when the spring is compressed.
    b. Determine the maximum speed of the block.
    c. Calculate the distance the block slides along the ramp.

10. A spring with k = 3000 N/m is compressed by 7.0 cm to launch a 5.0 kg block. During the launch, the block slides along a smooth (frictionless) surface. After the block leaves the spring, it slides on a surface with μ_k = 0.3 until it stops.
    a. When the spring is compressed, calculate the total energy of the system.
    b. Determine the maximum speed of the block.
    c. State how much energy is dissipated due to friction.
    d. Calculate the distance the block slides after it leaves the spring.

11. A 70 kg skydiver jumps from a plane 3500 m above the ground. Assume the drag force is equal to Bv^2, and B = 0.3 N m^{-2} s^2.
    a. Calculate the terminal velocity of the skydiver.
    b. Calculate the amount of energy dissipated due to air resistance during the fall.