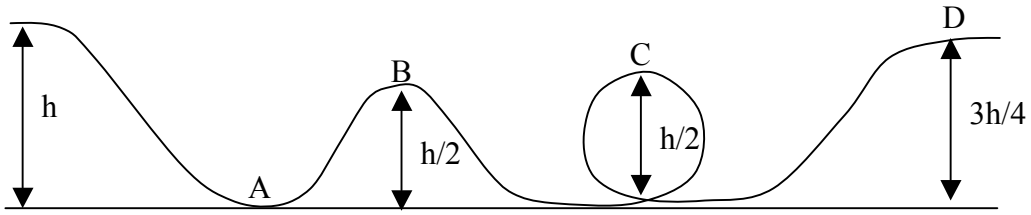
Energy

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



2. Francis (m = 70 kg) uses a 7 m rope to swing out over a lake. He pulls the rope back to 40 degrees to the vertical to start his swing.
a. What is his speed at the bottom of the swing?
b. What is the tension in the rope at the bottom of the swing?

3. Jackie (m = 60 kg) is going to bungee-jump from a bridge that is 50 meters above a river and she must choose her bungee-cord. All of the cords have a relaxed-length of 18 meters. What is the minimum spring constant needed to guarantee that she misses the water by 5 meters?

4. At the end of the level section of the Top Thrill Dragster, the ride reaches a speed of approximately 120 miles per hour.
a. What is the maximum height the car could reach if the track went directly up?
b. What is the speed of the car at the top, 420 feet above the bottom?
c. What is the smallest radius of the curve at the top for the riders to stay in their seats without needing seatbelts to pull them down?

5. A pole-vaulter "loads" the pole by running and planting it into the ground. This causes the pole to bend, then uses that to propel him upwards.
a. How much energy must be stored in the pole to send a 75 kg vaulter to a height of 20 feet from an initial height of 3 feet?
b. How fast was he traveling immediately before he planted the pole in the ground?

6. The Mantis has a vertical loop that is 36 meters tall. The speed of the cars entering the bottom of the loop is 27 m/s. Assume that the mass of the cars and riders is 3000 kg.
a. What should the curvature be for the top of the loop if you want the riders to have an apparent weight that is half of their actual weight?
b. Assuming that the top of the loop has the calculated curvature. What is the maximum amount of energy that can be dissipated by friction and air resistance during the upward motion of the car and still have the car make the loop?

7. Surgical tubing is used to launch a 3.0 kg pumpkin off a platform that is elevated at 60° above the horizontal. The tubing has an effective spring constant of 500 N/m. It is extended 50 cm past its relaxed length before being released.
a. At what position (relative to relaxed) will the pumpkin be traveling the fastest?
b. What is the speed of the pumpkin at that point?
c. The pumpkin can travel 10 cm past the relaxed point before it leaves the platform. What is the speed of the pumpkin as it leaves the platform?
d. What is the maximum height of the pumpkin above the end of the platform?