1. Consider the Atwood machine shown below, with $m_2 > m_1$.

   (a) Suppose that the blocks are released from rest. Use energy conservation to find the velocity of $m_2$ after it has fallen through a vertical distance $d$.
   (b) Use your result from part (a) to find the acceleration of $m_2$. Does your answer agree with the result obtained using Newton’s second law?

2. Consider the “son of Atwood” machine shown below.

   (a) What is the condition on $m_1$ and $m_2$ such that the system is in equilibrium?
   (b) Suppose that the equilibrium condition is not satisfied, so that $m_2$ goes down when the machine is released from rest. If $m_2$ goes down by a distance $d$, how far does $m_1$ go up?
(e) If the machine is released from rest, how fast is \( m_2 \) going after it has dropped through a distance \( d \)? How fast is \( m_1 \) going? Use energy conservation.

(d) Using your result from part (c), find the acceleration of \( m_2 \) after it is released. Does your answer agree with the result obtained using Newton’s second law?

3. A block starts from rest and then slides down the track shown and flies into the air. Neglect friction.

(a) Use energy conservation to find the speed of the block just before it leaves the second incline and flies into the air.

(b) Use energy conservation to find the maximum vertical height \( h_3 \) attained by the block after it flies into the air.

4. A toy car is placed on the track shown and released from rest. What is the minimum starting height so that it makes it around the loop without falling off?
5. A ball of mass $m$ is suspended from two springs between walls, as shown below. The horizontal distance between the walls is $d$, and the unstretched length of the springs is $\ell_0$. Assume that $2\ell_0 < d$, so the springs are stretched when they are in the horizontal position shown at left below.

(a) What is the equilibrium position of the ball?

(b) Suppose that the ball is displaced by a vertical distance $y$ from its equilibrium position. Find the potential energy of the ball.

(c) Use the relation $F_y = -U''(y)$ to find the $y$ component of the force on the ball when it is displaced by a vertical distance $y$ from the equilibrium position. Check that you result vanishes in the equilibrium position found in part (b).

6. A Car starts from rest and starts rolling down a track shaped like a semicircle of radius $R$. At what angular position $\theta$ does the car leave the track?

Study Problems

Chapter 6, Problems 32, 34, 61
Chapter 7, Problems 20, 40, 41, 47, 49, 74, 85