PHY 211 Recitation 19

March 24, 2020

1

A toy gun shoots a spherical plastic bullet ($m = 2\,\text{g}$) using a spring with spring constant $k = 2000\,\text{N/m}$. When the gun is cocked, the spring is compressed by 5 cm. A sketch of just the barrel is shown below.

(a) Assuming there is no friction as the ball moves down the barrel, is the total mechanical energy conserved? Why or why not?

(b) What are the initial potential energy and kinetic energy?

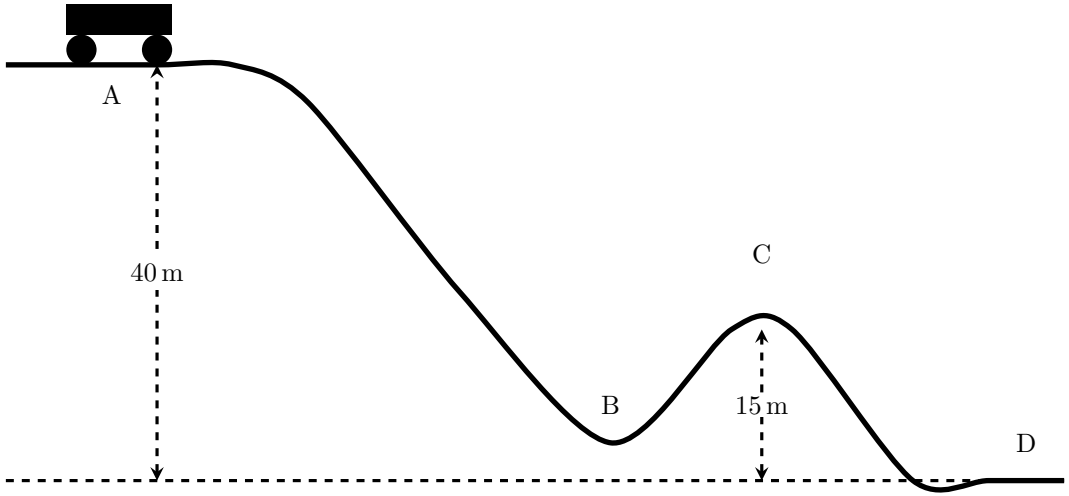
(c) What are the final potential and kinetic energy?

(d) With what speed does the ball leave the end of the barrel?

(e) Now assume as the ball moves down the 30 cm long barrel, there is a constant frictional force $|F_f| = 2.5\,\text{N}$. With what velocity will the ball leave the barrel in this case?

2

Consider the rollercoaster ride as shown below with the heights indicated. The total mass of the roller car and people is 400 kg, and the velocity of the car at point A is 5 m/s. Assume no energy is lost due to friction as the car makes its way down the track. Take the ground (the height of point D) as your "zero point" for gravitational potential energy.



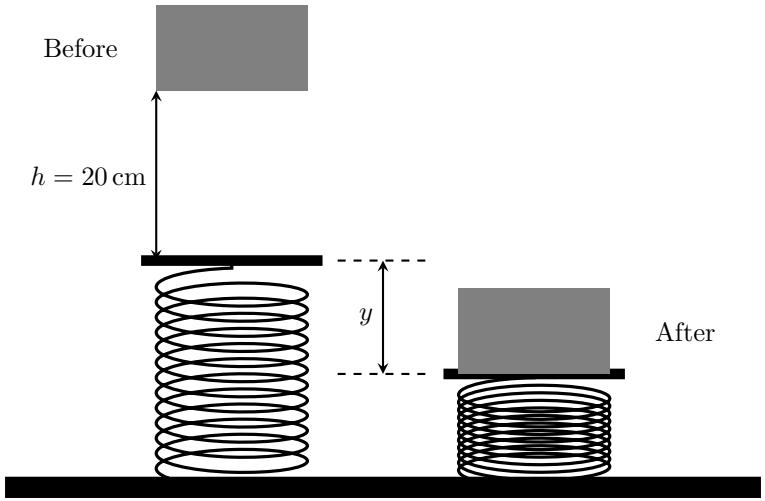
(a) What is the total energy of the roller car at point D? How do you know?

(b) Determine the velocity of the car at point C.

(c) If a second car came, and had the same velocity at point A, but double the mass, how would the velocity at point D compare to the first car?

3

A block of mass $m = 2\,\text{kg}$ is dropped from a height $h = 20\,\text{cm}$ onto a spring whose spring constant is $k = 1000\,\text{N/m}$ as shown below. When the block stops the spring is compressed by an amount y with respect to its unstretched position. Assume no energy is lost due to heat or friction. Define your "zero point" reference for gravitational potential energy as the location of the platform on top of the unstretched spring.



(a) What is the initial total mechanical energy of the system on the left? Express your answer in symbols.

(b) What is the total mechanical energy of the system on the right? Again, express your answer in symbols only.

(c) If total mechanical energy is conserved, the expressions you obtained in parts (a) and (b) must be equal. Equate them, and solve for y in terms of the other known quantities. You should end up with a quadratic equation; solve it. Which of the two solutions is the correct one?

(d) What is the meaning of the second solution?