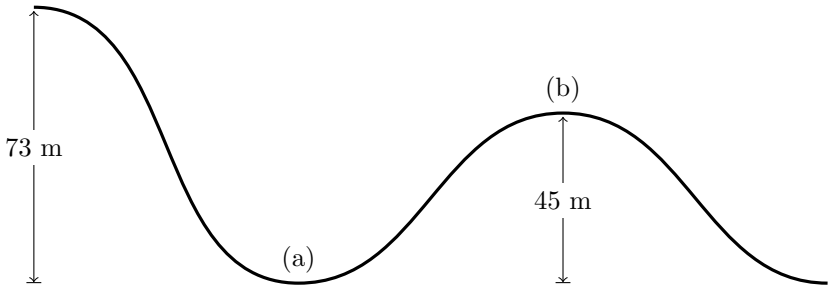
Name: Date: Period:

Energy #4

1. A 1300-kg roller coaster starts at rest on the top of a 73-meter hill. The track goes down to ground level before going up a second hill with a height of 45 meters. There is no friction.



(a) How fast is the coaster travelling at the bottom of the first hill?

Solution:

$$\begin{aligned} mgh_i &= \frac{1}{2}mv_f^2 \\ 930\,020 &= 650v_f^2 \\ 37.8\,\text{m/s} &= v_f \end{aligned}$$

(b) How fast is the coaster travelling at the top of the second hill?

Solution:

$$\begin{aligned} mgh_i &= \frac{1}{2}mv_f^2 + mgh_f \\ 930\,020 &= 650v_f^2 + 573\,300 \\ 23.4\,\text{m/s} &= v_f \end{aligned}$$

(c) Now, let's add friction to this problem. With friction, the roller coaster does not make it to the top of the second hill; instead, it only reaches a height of 32 m before stopping. How much work is done by friction?

Solution:

$$\begin{aligned} mgh_i + W &= mgh_f \\ 930\,020 + W &= 407\,680 \\ W &= -522\,340\,\text{J} \end{aligned}$$

2. A 2-kg block is kicked up a ramp with an initial speed of 5 m/s.

   (a) Assuming no friction, how high up the ramp would the block reach?

   Solution: 1.28 m

   (b) Instead, the block only makes it up 1.1 meters. How much work was done by friction?

   Solution: 3.44 J

3. Thomas the Tank Engine ($m = 11\,500$ kg) is barreling down the track at a speed of 45 m/s. Batman's Batmobile has stalled at a level crossing 600 meters in front of him. Thomas applies the brakes and comes to a stop just before running over the Batmobile.

   (a) How much work did Thomas's brakes do?

   Solution: $-11\,643\,750$ J

   (b) What was the force of Thomas's brakes?

   Solution: $-19\,406$ N