10.13. Model: Model the car as a particle with zero rolling friction. The sum of the kinetic and gravitational potential energy, therefore, does not change during the car’s motion.

Visualize:

Solve: (a) The initial energy of the car is

\[ K_0 + U_{y0} = \frac{1}{2}mv_0^2 + mgy_0 = \frac{1}{2} (1500 \text{ kg})(10.0 \text{ m/s})^2 = 7.50 \times 10^4 \text{ J} \]

The energy of the car at the top of the hill is

\[ K_1 + U_{y1} = K_0 + mgy_1 = K_0 + (1500 \text{ kg})(9.8 \text{ m/s}^2)(5 \text{ m}) = K_0 + 7.35 \times 10^4 \text{ J} \]

If the car just wants to make it to the top, then \( K_1 = 0 \). In other words, an energy of \( 7.35 \times 10^4 \text{ J} \) is needed to get to the top. Since this energy is less than the available energy of \( 7.50 \times 10^4 \text{ J} \), the car can make it to the top.

(b) The conservation of energy equation \( K_0 + U_{y0} = K_2 + U_{y2} \) is

\[ 7.50 \times 10^4 \text{ J} = \frac{1}{2}mv_2^2 + mgy_2 \Rightarrow 7.50 \times 10^4 \text{ J} = \frac{1}{2}(1500 \text{ kg})v_2^2 + (1500 \text{ kg})(9.8 \text{ m/s}^2)(-5.0 \text{ m}) \]

\[ \Rightarrow v_2 = 14.1 \text{ m/s} \]

Assess: A higher speed on the other side of the hill is reasonable because the car has increased its kinetic energy and lowered its potential energy compared to its starting values.