Physics 11

Energy Conservation: Potential ($E_p$) and Kinetic Energy ($E_k$)

Remember: $E_p = mgh$ & $E_k = \frac{1}{2}mv^2$ & $E_{K(max)} = E_{K(inc)}$

1. A 0.52 kg ball is dropped from a height of 5.3 m. How fast will it be going just before it hits the ground?

\[ E_p = E_k \]
\[ mgh = \frac{1}{2}mv^2 \]
\[ 2gh = v^2 \]
\[ \sqrt{2gh} = v \]

2. A 1800 kg car traveling at 25 m/s will reach what maximum vertical height on a hill if the driver steps off the gas pedal upon reaching the hill?

\[ E_p = E_k \]
\[ \frac{1}{2}mv^2 = mgh \]
\[ \frac{1}{2} \left( \frac{v^2}{g} \right) = \frac{v^2}{2g} = h \]
3. A 1.5 kg toy roller coaster car starts from rest at the top of a 2.1 m high hill. What speed will the coaster have when it reaches the 2nd hill of height 1.6 m? (Assume there is no energy lost due to friction generating heat.)

\[
E_{p1} = E_{k1} + E_{p2}
\]

\[
h = 2.1 \text{ m}
\]

\[
1.5 \times 9.8 \times 2.1 = \frac{1}{2} m v_1^2 + m g h
\]

\[
30.67 = 0.75 \times v_1^2 + 23.52
\]

\[
30.87 - 23.52 = 0.75 \times v_1^2
\]

\[
7.35 = v_1^2
\]

\[
0.75
\]

4. Recalculate #3, this time there is friction and the total energy lost due to heat is 5.1 m/s. What is the speed of this coaster at the top of the second hill?

\[
E_{p1} = E_{k1} + E_{p2} + Q
\]

\[
h = 2.1 \text{ m}
\]

\[
30.87 = 0.75 \times v_1^2 + 23.52 + 5.1
\]

\[
2.19 = v_1^2
\]

\[
\frac{2.19}{0.75} = v_1^2
\]

\[
v = 1.7 \text{ m/s}
\]
A 1250 kg roller coaster car is traveling at 5.0 m/s when reaches the crest of the first hill that is 32 m high.

a. How fast would this coaster be traveling at the bottom of the first hill? (Assume there is no friction.)

\[ E_p + E_{k1} = E_p + E_{k2} + Q \]
\[ mgh_1 + \frac{1}{2}mv_1^2 = mgh_2 + \frac{1}{2}mv_2^2 + Q \]
\[ 2(32 - 0) + v_1^2 = 2 \times 9.8 (32 - 0) + 5.0^2 = v_2^2 \]
\[ 652.5 = v_2^2 \]
\[ v_2 = 26 \text{ m/s} \]

b. What speed will this coaster have at the top of the second hill which has a height of 24 m? (Assume there is no friction.)

\[ 2 \times 9.8 (32 - 24) + 5.0^2 = v_2^2 \]
\[ 18.1 = v_2^2 \]
\[ 4.3 \text{ m/s} = v_2 \]