

Roller Coaster Physics Assignment for Lesson 5

Name: _____

This assignment is a continuation of Assignment 4.

Given:

- The mass of the roller coaster train (including passengers) is 5000 kg.
- The height of the first hill is 95 meters above the reference or ground level.
- The height of the second hill is 65 meters above the reference or ground level.
- The length of the track going up the first hill is 176 meters.
- It takes the train 20 seconds to be pulled to the top of the first hill.

Information calculated in Assignment 4:

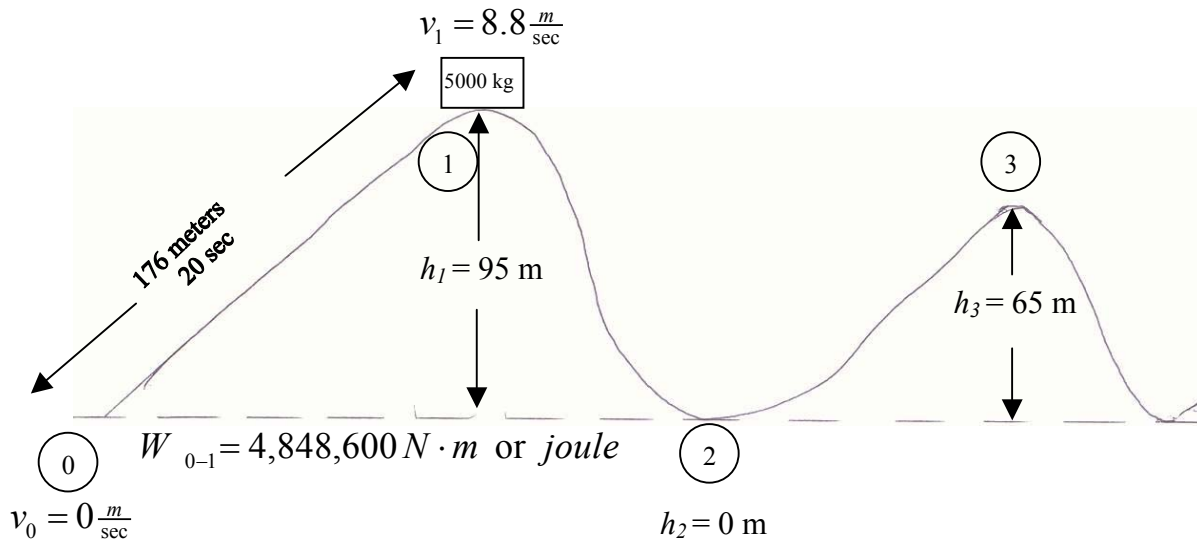
- Velocity at the top of the first hill is $8.8 \frac{m}{sec}$.
- $4,848,600 N \cdot m$ or *joule* of work is done to lift the train to the top of the first hill.

Find the Following:

1. Draw a diagram showing the information given and then label all points of interest.
2. What is the power (in horsepower) of the motors needed to lift the car and passengers to the top of the first hill?
3. What is the speed of the coaster at the bottom of the first hill in meters per second?
4. What is the speed of the coaster at the top of the second hill in meters per second?

Work:

1. Draw a diagram showing the information given and then label all points of interest.



2. What is the power (in horsepower) of the motors needed to lift the car and passengers to the top of the first hill?

$$\begin{aligned} P &= \frac{W}{t} \\ &= \frac{4,848,600 N \cdot m}{20 \text{ sec}} \\ &= 242,430 \frac{N \cdot m}{\text{sec}} \text{ or } \frac{\text{joules}}{\text{sec}} \text{ or watts} \\ &= \left(242,430 \frac{\cancel{\text{joules}}}{\text{sec}} \right) \left(\frac{1 \cancel{\text{kW}}}{1000 \frac{\cancel{\text{joules}}}{\text{sec}}} \right) \left(\frac{1.34 \text{Hp}}{1 \cancel{\text{kW}}} \right) \\ P &= 324.9 \text{Hp} \end{aligned}$$

3. What is the speed of the coaster at the bottom of the first hill in meters per second?

$$W_{1-2} = 0$$

$$h_2 = 0 \quad \therefore PE_2 = 0$$

$$KE_1 + PE_1 + \cancel{W_{1-2}}^0 = KE_2 + \cancel{PE_2}^0$$

$$\frac{1}{2} \cancel{m} v_1^2 + \cancel{m} g h_1 = \frac{1}{2} \cancel{m} v_2^2$$

$$v_1^2 + 2gh_1 = v_2^2$$

$$v_2 = \sqrt{v_1^2 + 2gh_1}$$

$$v_2 = \sqrt{\left(8.8 \frac{m}{\text{sec}}\right)^2 + 2 \cdot \left(9.8 \frac{m}{\text{sec}^2}\right) \cdot (95m)}$$

$$v_2 = \sqrt{1939.44 \frac{m^2}{\text{sec}^2}}$$

$$v_2 = 44.04 \frac{m}{\text{sec}}$$

4. What is the speed of the coaster at the top of the second hill in meters per second?

$$W_{2-3} = 0$$

$$h_2 = 0 \quad \therefore PE_2 = 0$$

$$KE_2 + \cancel{PE_2} + \cancel{W_{2-3}} = KE_3 + PE_3$$

$$\frac{1}{2} \cancel{m} v_2^2 = \frac{1}{2} \cancel{m} v_3^2 + \cancel{m} g h_3$$

$$v_2^2 = v_3^2 + 2gh_3$$

$$v_3^2 = v_2^2 - 2gh_3$$

$$v_3 = \sqrt{v_2^2 - 2gh_3}$$

$$= \sqrt{\left(44.04 \frac{m}{sec}\right)^2 - 2 \cdot \left(9.8 \frac{m}{sec^2}\right)(65m)}$$

$$= \sqrt{665.52 \frac{m^2}{sec^2}}$$

$$v_3 = 25.8 \frac{m}{sec}$$