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NSF GK-12 Vibes and Waves in Action
Honors Physics
Lesson 10: Simulation of a Roller Coaster Ride

Summary of Lesson

In this lesson, students were asked to simulate a roller coaster ride under two conditions, with friction and with out friction. The goal was to determine the velocity at the bottom of the first hill and the top of the second hill. For both cases, the students were required to derive the appropriate equations from the Conservation of Energy. The program was required to prompt the user for the coefficient of friction. If the coefficient was entered as zero, then the calculation was to be taken for the frictionless case. This program served as the introduction to if-else statements. An example of the if-else statement syntax was shown at the beginning of class.

Honors Physics Lesson Plan

Text: Conceptual Physics, Paul G. Hewitt
Chapter: Ch 9- Energy (Section 9.7)
Objectives: Write a program in R to calculate the velocity of a roller coaster at the bottom of the first hill and the velocity over the next hill if friction is present or not present.
Essential Question:
Frameworks: Conservation of Energy and Momentum- 2.1, 2.2, 2.4; SIS1, SIS2, SIS3, SIS4

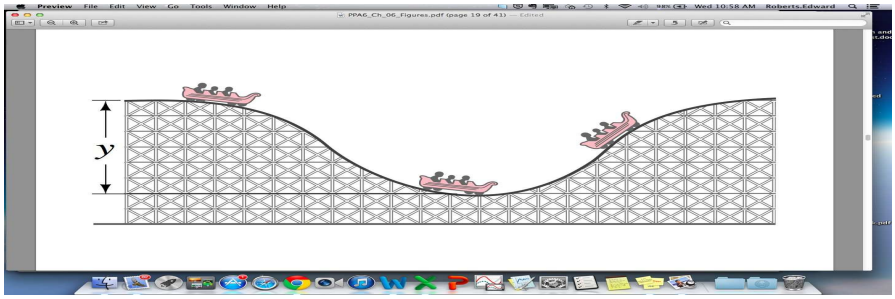
L-Side Activities: Teacher	R-Side Notes: Students
At the Bell: Derive the velocity equations from the conservation of energy for the following cases: - without friction at the bottom of the first hill - without friction at the top of the second hill - with friction at the bottom of the first hill - with friction at the top of the second hill **Agenda:** 1. Show the syntax example for the if-else statement 2. Review the equations derived in the At the Bell 3. Write the roller coaster program 4. Check to see if results are correct with sample input data **Working It Out:** 1. What is the purpose of an if-else statement? 2. How does friction affect the velocity of the roller coaster cart? **Class Activity:** Use R to help design a roller coaster ride. Assume the coaster starts at a height of 20 meters. Prompt the user for the height of the next hill. The program will calculate the velocity of a roller coaster at the bottom of the first hill and the velocity over the next hill. Modify the code to have the program ask the user if friction should be included. If friction is included, then have the user input a coefficient of friction and calculate the velocities. **Homework:** None	1. Prompt the user for the height of the second hill and coefficient of friction 2. Calculate d2 3. If friction is present – Calculate: velocity at bottom, velocity at top 4. If friction is not present – Calculate: velocity at bottom, velocity at top 5. Display appropriate output 6. At least 5 comments that describe main step

R Coding Activity #5 **Name:** _____

Assignment #1: Frictionless Roller Coaster

You will use R to help you design a roller coaster ride. Assume the coaster starts at a height of 20 meters. You will have the program prompt the user for the height of the next hill. It will calculate the velocity of a roller coaster at the bottom of the first hill and the velocity over the next hill. The program must:

- use at least five (5) comments that are appropriately placed throughout the code.
- prompt the user for the initial height and height of next hill.
- calculate and display (in the Console) the velocity of the car at the bottom of the first hill.
- calculate and display (in the Console) the velocity of the car at top of next hill.



Use the space below to determine the equations you will need for the program:

WORK SPACE

Save this file as Coaster_#*lastname*, where the # is your class period.

Assignment #2: IF ELSE Statements

Modify the code you created to have the program ask the user if friction should be included. If friction is included, then you must have the user input a coefficient of friction and calculate the speeds.

NOTE: You will need to know the distance over which friction acts as it goes up and down the track. Assume the coaster travels a distance of 30 m to the bottom of the hill and an additional 1.3x the height of the next hill. If friction is not present, it should calculate the speeds just like before.

Save this file as Coaster2_#*lastname*, where # is your class period.

Save your work to Google Drive!

Work Space for Equation including Friction

$\Delta U + \Delta K = W_f$

General Outline for Program

Define h and g here since they are used in both sections
Prompt for Height of Second Hill
Prompt for "Enter the coeff of friction. Enter 0 for frictionless."

If friction is present, do this… (if coeff > 0 then do this)

Prompt for the coefficient of friction
Calculate the total distance from start to top of next hill
Calculate speed at bottom of hill (new equation with friction acting over 30 m)
Calculate speed at top of next hill (new equation with friction acting over total distance)

If friction is not present, do this… (if coeff = 0, then do this)

(this was your original program)

Simple Rubric - COASTER Name: _____

- use at least five (5) comments that are appropriately placed throughout the code _____

- prompt the user for the initial height and height of next hill (4)

  _____
- calculate and display (in the Console) the velocity of the car at the bottom of the first hill

  _____ without friction (4) _____ with friction (4)
- calculate and display (in the Console) the velocity of the car at top of next hill

  _____ without friction (4) _____ with friction (4)

Rubric for Coaster Program

Criteria	5	4	3	2	1	0
A minimum of five comments is used.	Five helpful comments are used at strategic locations in program.	Four helpful / relevant comments are used.	Three helpful / relevant comments are used.	Two helpful / relevant comments are used.	One helpful / relevant comment is used.	No comments are used or none are helpful / relevant.
Prompt for second hill and coefficient of friction works correctly and provides clear instructions.	Readline / as.numeric commands are utilized properly and prompt provides clear, professional-looking instructions to the user, including units.	Readline / as.numeric commands are utilized properly but prompt lacks in a single dimension: clarity, professionalism in the instructions or units.	Readline / as.numeric commands are utilized properly but prompt lacks more than one element: clarity, professionalism or units.	Readline / as.numeric commands are not working correctly and prompts lacks at least one element.	Some attempt was made to include the appropriate prompt.	No attempt was made at including the prompt.
Calculate and display the velocity at the bottom of the hill and the top of the next hill. NO FRICTION		Calculation is correct and message displayed meets all criteria: appears on single line; is clear; and includes units.	Calculation is correct but message displayed lacks one element: on single line; is clear; and includes units.	Calculation is correct but message displayed lacks two elements: on single line; is clear; and includes units.	Calculation is incorrect but message meets all elements: on single line; is clear; and includes units.	Calculation is incorrect and message displayed lacks one element: on single line; is clear; and includes units.
Calculate and display the velocity at the bottom of the hill and the top of the next hill. WITH FRICTION		Calculation is correct and message displayed meets all criteria: appears on single line; is clear; and includes units.	Calculation is correct but message displayed lacks one element: on single line; is clear; and includes units.	Calculation is correct but message displayed lacks two elements: on single line; is clear; and includes units.	Calculation is incorrect but message meets all elements: on single line; is clear; and includes units.	Calculation is incorrect and message displayed lacks one element: on single line; is clear; and includes units.
Follow-up questions were answered correctly.				All questions were completed and provided a correct analysis of the scenario.	The questions were attempted but were not correct due to programming difficulties or student's understanding.	Questions were not completed.
Total	**20**					