Roller Coaster Project

**Purpose**: This project will be a culminating project of the concepts of physics we covered during the first semester. It will allow you to demonstrate your knowledge of motion, energy, and forces, as well as other areas that may apply. It is meant to be a fun project to do in class as a group. No one student is responsible for all portions of this project. **All members of the group should perform work.** **All work should take place in class in groups of four people or fewer.**

**Requirements:**

1. The Roller Coaster. Using any materials that you wish, construct a roller coaster with your group that will meet the requirements. I will be supplying pipe insulation.
   1. We will be using marbles for the “roller coaster cars.”
   2. Possible materials: duct tape, tubing, wood, boxes, foil, glue, PVC piping, plastic bottles, etc…
2. Presentation of roller coaster. This should be three minutes max, and should demonstrate the areas of physics as well as perform a run of the roller coaster.
3. Data table/calculations- see rubric for more information

Due Date: Week of December 15, 2014

*I understand that the student is responsible for supplying materials, except for pipe insulation. The final group project is due the week of December 15, 2014. The students will receive a grade for lab, presentation, and final test. Grading will be based on the attached rubrics.*

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Please detach this portion and return, stating the above criteria are understood concerning the roller coaster project.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Parent Signature

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Student Signature

Roller Coaster Project and Rules

**Introduction:** Western Playland Amusement Park has been hearing from its customers that their roller coasters are boring. The public is threatening that if the amusement park does not build a new, more exciting roller coaster they will stop going to the amusement park.

You are part of a team of engineers that has just been asked to submit a new roller coaster design to the amusement park. Using the concepts of forces, motion, and energy, design and build a model of a workable roller coaster that could be built in the Western Playland Amusement Park.

To appease the public, your roller coaster must have a “thrill factor.” There must be at least one loop, at least one turn, and a hill. Your roller coaster also needs to be safe for the public, so you will also need to calculate the speed, acceleration, PE and KE on various locations of your roller coaster.

You will need to be able to explain your roller coaster to the owners of Western Playland. You will need to include in your explanation why you think your roller coaster is the “best choice” and should be built in the amusement park. You will want to impress them with your knowledge of how forces, motion and energy help your roller coaster work, why it is safe to ride, and why it is “thrilling.”

Rules

1. Your roller coaster must fit within the confines of your “construction area.” There is no height limit, and you may not intrude on another group’s area without their permission.
2. You will get 6 feet of pipe insulation.
3. Your roller coaster must bring your marble safely to a stop. Drops and jumps are permitted, but the marble must be safely caught by the track without getting stuck.

1. Hills and loops must involve trading kinetic energy for potential energy. Horizontal loops are considered turns.
2. Hold on to your marbles!!! You must pay for lost marbles, and many roller coasters will work best with one, specific marble. You may need to redesign your roller coaster if you lose your marble.
3. Do not mess around with another group’s roller coaster. This will result in an automatic zero, and removal from the class for the rest of the project.
4. Extra time will not be permitted. Deadlines are absolute. Absences or unexpected school closures will not result in extra time. The tape changes shape as it dries out, and roller coasters stop working after a few days and are often unusable after awhile. You may come in at lunch if you need more time.
5. Your group is responsible for completely removing your roller coaster and cleaning the surrounding area after completion of the project. Any classroom equipment that is damaged must be paid for.

**DATA: collect data for 10 positons on the roller coaster using the glass marble. Label each position on your drawing of the roller coaster.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Position | Height (m) | Time (s) | Distance traveled (m) | Speed of marble (m/s) |
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|  |  |  |  |  |

**Measure and record the following measurements for your roller coaster.**

Time of ride A = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (seconds)

Time of ride B = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (seconds)

Time of ride C = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (seconds)

Mass of the marble A=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (kg)

Mass of the marble B=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (kg)

Mass of the marble C=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (kg)

Length of the track = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (meters)

Calculations and Analysis

1. **Calculate the potential, kinetic, and total mechanical energy at each position.**
2. **Graph Energy vs. Position. Use a different color for PE, KE, and ME.**
3. **Draw your roller coaster and label the following points:**
   1. Where the kinetic energy is the highest
   2. Where the kinetic energy is the lowest
   3. Where the potential energy is the highest
   4. Where the potential energy is the lowest
   5. Where there is positive acceleration
   6. Where there is negative acceleration
   7. Newton’s 1st Law
   8. Newton’s 2nd Law
   9. Newton’s 3rd Law
   10. Two forces that might slow your marble down (what kinds of forces have we talked about in class?)

**Using the data, calculate the following items for your roller coaster. Please show all of your work and label all of your answers with the correct units!!!!**

1. Average speed of the ride for masses A, B, and C.
2. Acceleration of marble at one location on your roller coaster for masses A, B, and C.
3. The Force at one location on your roller coaster for masses A, B, and C.

Conclusions

1. How do hills and valleys affect motion?

2. How is height related to the speed of the marble on a roller coaster?

3. How is motion on a roller coaster related to energy?

4. Is energy transformation from potential to kinetic 100%?

5. How does mass influence the motion of a marble on a roller coaster?

6. How do you predict the speed of a marble on a roller coaster?

7. How does mass influence the motion of a marble on a roller coaster?

Roller Coaster Project Rubrics

|  |  |  |
| --- | --- | --- |
| Where the kinetic energy is the highest | 2 |  |
| Where the kinetic energy is the lowest | 2 |  |
| Where the potential energy is the highest | 2 |  |
| Where the potential energy is the lowest | 2 |  |
| Where there is positive acceleration (speeding up) | 2 |  |
| Where there is negative acceleration (slowing down) | 2 |  |
| Newton’s 1st Law | 2 |  |
| Newton’s 2nd Law | 2 |  |
| Newton’s 3rd Law | 2 |  |
| Two other forces present on your roller coaster | 2 |  |
| Time of Ride (in seconds) | 2 |  |
| Length of Track (in meters) | 2 |  |
| Average Velocity of the ride | 2 |  |
| Acceleration at one location | 2 |  |
| Gravitational P.E at beginning of ride | 2 |  |
| Force at one location of roller coaster | 2 |  |
| Kinetic Energy at one location | 2 |  |
| **Total Points** | **34** |  |

**Criteria for Calculations and Analysis:**

**Criteria for Presentation** **Possible Points Points Earned**

|  |  |  |
| --- | --- | --- |
| **Presentation was appropriate length (2-3 minutes)** | **5** |  |
| **Information was organized** | **5** |  |
| **Presentation was understandable** | **5** |  |
| **Total Points** | **15** |  |

**Criterion for The Actual Roller Coaster**

**Possible points Points Earned**

|  |  |  |
| --- | --- | --- |
| **Appearance:** Does the roller coaster look good? Is it neat? Does it have a name? | **5** |  |
| **Safety:** Does the marble stay on the track? Does the marble complete the entire track without getting stuck or stopping? Is it brought to a stop? | **5** |  |
| **Number of loops/Hills:** Does the roller coaster have one or more loops or hills? | **5** |  |
| **Building:** Does your marble go off the track? Does it touch anything other than the track before the end? Did you follow the rules? | **5** |  |
| **Thrill:** Is the track open for all/part of the ride? Can the passengers “see” out? How abrupt are any changes in motion? Are there any jumps? | **5** |  |
| **Total Points** | **25** |  |

## Student Evaluation

### Roller Coaster # \_\_\_\_\_\_\_

### Roller Coaster Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
| **Criterion** | **Points Possible** | **Points Earned/ Comments** |
| **Appearance**: Does the roller coaster look good? Is it neat? Is it decorated? | **3** |  |
| **Number of Loops/Hills:** Does the roller coaster have one or more loops or hills? How does it compare with others? | **3** |  |
| **Number of Turns:** How many turns does the roller coaster have? How does it compare with others? | **3** |  |
| **Thrill:**  Is the track open for all/part of the loops? Can the passengers “see” out? How abrupt are any changes in motion? Are there any jumps? | **3** |  |
| **Creativity:** Does the roller coaster have a name? Is there anything unique about this roller coaster? | **3** |  |
| Total Points | **15** |  |

For an evaluation to be counted, you must give a comment explaining the score to the designers. You may not give something a score of zero unless that feature is missing completely. You must give at least two positive comments for your scores to count. Any overly negative comments will be thrown out.

**Self Evaluation**

Student Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Roller Coaster Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Group Member Names: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
| **Criterion** | **Points Possible** | **Points Earned/ Reasons** | |
| **Teamwork**: Did you help each other? Did you work together, or did everyone try to do their own thing? | **2.5** |  | |
| **Individual participation**; Did you do your fair share of the work? Did you help with every step, or just do one part? | **2.5** |  | |
| **Group Participation**: Did everyone contribute equally? Was everyone involved in each step (building, analysis, clean up, etc.)? Give each person in your group up to 2.5 points for their participation. | **2.5** | Name | Points and Reasons |
|  |  |
|  |  |
|  |  |
|  |  |
| **Respecting each other:** Did you listen to each other? Did everyone get to share their ideas? Were any group members put down? | **2.5** |  | |
| **Total points** | **10** |  | |

**Total Possible Points for Project: 100**