

Lesson Plan 9 – Final Project Work Days

Background

The length of time needed for this section of the curriculum will vary greatly depending on the size and length of the class, the students' understanding of the material, and the students' general skill base of math and Powerpoint. The students are typically broken into groups of varying sizes depending on the number of sets of building boards available. It is generally difficult for multiple groups to share a building board because it is difficult to replicate an identical track after tearing down and setting up again.

Concepts

1. Calculation of velocity
2. Potential Energy
3. Kinetic Energy
4. Scaled drawing

Student Learning Objectives	NYS Standards
Calculate the average velocity of the car on the track	
Calculate the potential energy of the car at all peaks	
Calculate the kinetic energy of the car	
Produce a scaled drawing of the track with an appropriate scale and identify the scale factor used	

Key Terms

Velocity	Potential Energy	Kinetic Energy
Scale	Scale Factor	Mass

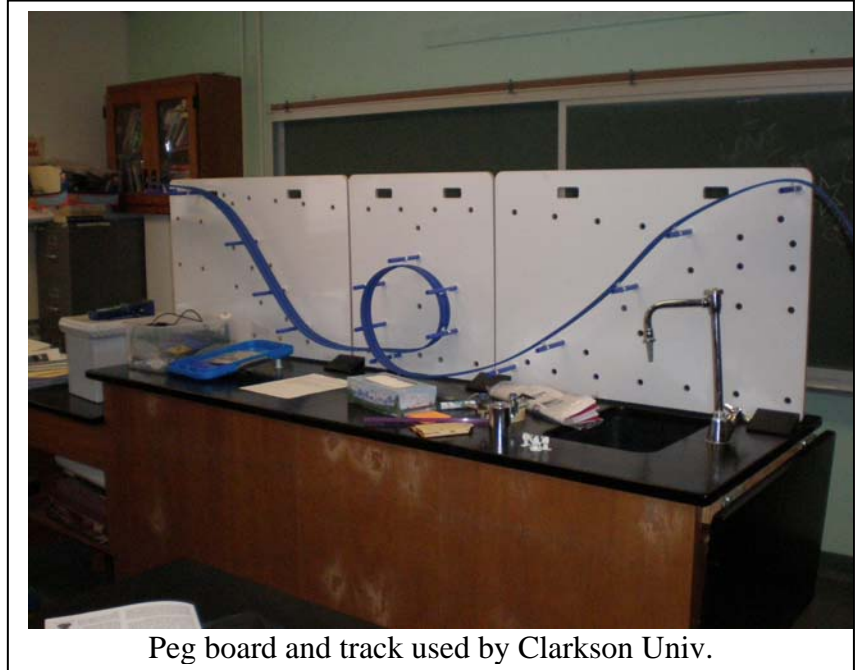
Activities

Day 1:

- Review expectations and establish a timeline
 - Remind students what deliverables are required
 - Make grading rubric clear
 - Establish dates that scaled drawings and calculations are due and when the presentations will be given
 - Explain the length and type of presentations that are expected
 - Break students into groups depending on the number of tracks available and the discretion of the instructor

Day 2:

- Break students back into work groups
- Show all materials
- Demonstrate a sample track that has been set up prior to the beginning of class
- Have students brainstorm ideas about what may and may not work with the materials given and what kind of elements they would like to include in their tracks
 - Helpful to have each group turn in sketches of potential track designs



Peg board and track used by Clarkson Univ.

Days 3, 4, and/or 5:

- Trial and error with track builder
- Selection of final design
- Establishing that the final design will perform dependably

Days 5 and 6:

- Review the equations for average velocity, potential energy, and kinetic energy

$$\bar{v} = \frac{\Delta d}{\Delta t}$$

$$PE = mgh$$

$$KE = \frac{1}{2}mv^2$$

- Review the variables necessary to use these equations and the methods used to calculate these values
 - Average velocity: take a piece of string and run along the track to find the length of the track; use a stop watch to calculate the time that it took the car to travel the length of the track
 - Potential Energy: use a scale to measure the mass of the car; give students value of gravity; use meter stick to measure the height of the initial peak – students must chose a suitable datum.
 - Kinetic Energy: use a scale to measure the mass of the car; use average velocity found previously
- Calculate average velocity, kinetic energy and potential energy of the car at the each peak

Days 7 and 8:

- Measuring track (X, Z coordinates) in preparation for scale drawing
- Select an appropriate scale for scale drawing
- Create a scaled drawing

Days 8 and 9:

- Preparation of powerpoint presentation or poster presentation
- Final revisions of scaled drawing and calculations
- Collect all hard copies of drawings and calculations for corrections

Days 10 and 11:

- Group presentations – time necessary will vary greatly depending on class size and is at the discretion of the instructor
- Collect hard copies of presentations
- Return graded drawings and calculations
- Reiterate to students the purpose of this project and the importance of conservation of energy, friction, and scaled drawing

Supply list

Final Project Expectation Handout

Extra Mass to change weight of Cars

String

Meter Sticks

Stop watches

Graph Paper

Scale

Track Building Boards and cars: A variety of options exist for building roller coaster models and cars. Some suggestions include:

Flexible and clear plastic tubing (Tygon) with marbles or ball bearings

Hot wheels track and cars

Wire with bead(s)

Resources

Lesson Plan

Final Project Expectation Handouts

Project Grading Rubric

Reflective Notes

Significant amount of time should be spent acknowledging the obstacles that the students are going to have to overcome with the materials that they are given. For example, it is not possible to make a functioning three loop roller coaster with what they are given because they cannot make a tall enough peak to harness that much energy. Brainstorming and review of the necessary equations prior to trial and error with the track boards is vital.

Final Project
Creating your own Roller Coaster

Name: _____.

Date: _____ Period: _____.

Task:

Design and build a roller coaster with the supplied boards and track. You should include as many elements (loops, drops, hills, etc) in the design as possible. Your car must remain on the track throughout the run, and the car should not run off the end of the track, it should stop on the track.

Deliverables:

- Scale Drawing of the roller coaster.
- Theoretical calculations of the potential and kinetic energy of the car at each high and low point in the roller coaster design.
- Estimation of friction factors based on difference in theoretical car performance and actual results.
- Presentation of the roller coaster design, to include a name, seating, safety data, and highlights of the coaster design. (some of this will be made up)
- Presentations will be made on the last day of the unit to the class. Presentations can be done in PowerPoint, or on a poster, the choice is yours. The presentation should also include a demo of the actual roller coaster model
- Each group will give one presentation, but each individual will identify his or her specific contribution.
- Scale Drawings and Calculations are due by the end of class on _____.

You will be graded on:

- Teamwork
- Individual Contribution
- Originality of Design
- Completeness of Presentation
- Accuracy of Calculations
- Scaled Drawing

Final Project Creating Your Own Roller Coaster

Suggested Grading Rubric

	1	2	3	4	5	Score
Teamwork	Limited to no cooperation with team	Allows team to make decisions without contributing	Adds valuable work to team but does not communicate well	Works well with team but has trouble communicating at times	Works well with team mates and communicates well	
Individual Contribution	Negligible contribution to work of group	Very small contribution to group work	Mediocre individual work that does not fit into group work	Individual work is correct but does not fit into group work well	Individual portion of work is well done and flows with other students work	
Design Concept	Unoriginal or shows little application of coursework	Very simple design but original work	Some thought to application of curriculum	Original and some application of curriculum	Original design with obvious application of curriculum	
Completeness of Presentation	Does not list most details of design	Missing three required details	Missing two required details	Missing one required detail	All details required in project description are given	
Communication of Presentation	Does not speak during presentation	Hard to understand student when speaking	Speaks quietly, quickly, but still understandable	Speaks slowly and at an audible level	Speaks clearly, loudly, and appropriately	
Calculation of Velocity	Does not show equation used nor values for length of track or time; just states an answer	Shows value for length of track and time from start to finish but not an equation used to find answer	Shows equation used, but no value for length of track or time from start to finish	Shows equation used, value for length of track and time from start to finish and answer is incorrect	Shows equation used, value for length of track and time from start to finish and correct answer is clearly marked	
Kinetic Energy Calculation	Does not show equation used nor values for velocity and mass; just	Shows value for velocity and mass of car but does not show	Shows equation used, but no value for velocity or mass of car	Shows equation used, value for velocity, and mass of car but answer is incorrect	Shows equation used, value for velocity, and mass of car and correct	

	states an answer	equation used to find answer			answer is clearly marked	
Potential Energy Calculation	Does not show equation used nor values for height of hill and mass; just states an answer	Shows value for height of hill and mass of car but does not show equation used to find answer	Shows equation used, but no value for height of hill or mass of car	Shows equation used, value for height, and mass of car but answer is incorrect	Shows equation used, value for height and mass of car and correct answer is clearly marked	
Selection of Scale	Scale is too large or too small for design and scale is very inconsistent and no scale factor is stated	Scale is too large or too small for design but is mostly consistent and no scale factor is stated	Scale is appropriate for design but very inconsistent and no scale factor is stated	Scale is appropriate for design but slightly inconsistent or no scale factor is stated	Scale is appropriate for design and consistent and scale factor is stated	
Accuracy of Scaled Drawing	Most elements are not included but no dimensions are included	Most elements are included but no dimensions are included	Most elements are included and most dimensions are included	All elements are included and most dimensions are included	All elements are included and all necessary dimensions are included	
Total Points Earned						/ 50

Here each element is grade on a scale of 1-5 as described in the columns next to each element. The score earned is then totaled and divided by the 50 points that are possible to be earned in order to find a percentage grade. It can be seen that an emphasis is placed on the calculations and scaled drawing. A score of zero shows absolutely no effort to meet the required element.