Summer Challenge Program 2015

Course Title: Feel Those G's: The Physics of Roller Coasters

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Physics/Astronomy Building, Room 156

Course Description

Almost everyone loves riding a roller coaster. Amusement parks are building them higher, faster, longer, and much more thrilling. The physics underlying the design and building of a roller coaster are amazingly simple. In this course, we will be learning when potential and kinetic energy trade places, how forces work to move us around and keep us in our seats, what happens when we accelerate, why we feel weightless during the dips, plus a whole lot more. Each student will design, build, and test their own model roller coaster using engineering techniques pioneered by the coaster experts. The class will include a field trip to a nearby amusement park.

Essential Questions

- How can Newton's three laws be applied to roller coasters?
- How can physics be used to assure a safe roller coaster is designed and yet still be thrilling?
- How can playground equipment be used to help understand the physics of roller coasters?
- How can we use all of our learned knowledge of physics to make accurate calculations of the rides at Enchanted Village?
- Using pipe insulation, marbles, and popsicle sticks along with common roller design practices, what will be the velocity, potential and kinetic energy, and amount of g's felt at various points along the coaster?

Outcomes

- Students will be introduced to Newton's three laws through simple experiments.
- Students will understand the concept of energy transforming from gravitational potential to kinetic and how to calculate both of these using example problems and collected data.
- Students will be able to work in small groups to build specific roller coaster components such as hills, dips, klothoid loops, and banked curves.
- Students will use these roller coaster components to further demonstrate understanding of the physics concepts of energy transformation, velocity, g's felt, and safety guidelines involved in roller coaster construction.
- Students will use their learned knowledge of physics to make accurate calculations of the velocities, GPE, KE, total energy, and g's felt on various rides at Enchanted Village.

Instructional Strategies

We follow the gradual release of responsibility method as laid out by Fisher and Frey in *The Effective Teachers Guide*. We introduce a concept or skill, work through some examples with them, and then release them into small groups or individually to work through experiments and problems while we circulate the room listening to their ideas and asking probing questions. The idea is to gradually build confidence and skill while increasing their responsibilities in the class.

Student Assessment

We review their various workbook activities and experiments as well as observations made during classwork and use those to report their growth to parents at the end of each week.

The final summative assessment is an individual project centered on using the physics and math concepts we've learned in class to design, build, and test a pipe insulation roller coaster. They also use their roller coasters to perform calculations on velocity, potential and kinetic energy, and amount of g's felt. These results are presented to fellow classmates and parents on the last day along with a demonstration of their coaster.

Resources and Materials

-Physics of Roller Coasters Workbook
-Various small toys used to demonstrate physics concepts
-Science measurement tools
-Roller coaster construction materials: pipe insulation, cardboard platforms, popsicle sticks, marbles, glue.
-If possible, download the smart phone app "seeLevel"

Tentative Course Schedule

	Approximate Schedule for Week 1				
	Monday	Tuesday	Wednesday	Thursday	Friday
9:00	Orientation and Getting to Know Each Other	Tuesday Read overview, review Newton's Laws, speed, velocity, & acceleration	Field trip to LAURELHURST PARK for data gathering on a straight slide, swing, and merry-go-round (5) (Bus #25 there; #65 back)	Maniac Math (8.3)	Pendulum cont. (6.2)
9:30		Newton's Laws cont. (3.1 – 3.2)			Weightless Demo (6.3)
10:15	Break	Break		Break	Travel to OUGL
10:30	Orientation and Getting to Know Each Other cont.	Newton's Laws (3.3 – 3.5)		Triangulation (4.1 - 4.2)	Computer Lab: Tutorial Packet 1
11:30	Lunch	Lunch	Lunch (bring lunch or $$$ for BurgerMaster)	Lunch	Lunch
12:15	Newton's Laws (3.1 – 3.2)	Maniac Math (8.1)	Maniac Math (8.2)	Triangulation (4.3)	Triangulation (4.4 - 4.5)
1:15	pm Break	pm Break	pm Break	pm Break	pm Break
1:30	Roller Coaster Video (Wild Rides #1)	Newton's Laws cont. (3.3 – 3.5)	Simple Coaster (6.1)	Pendulum (6.2)	Roller Coaster Video (Amer-ica's Greatest)
2:10	Wrap-up, Clean-up, Clear out	Wrap-up, Clean-up, Clear out	Wrap-up, Clean-up, Clear out	Wrap-up, Clean-up, Clear out	Wrap-up, Clean-up, Clear out
2:20	Leave	Leave	Leave	Leave	Leave
TO DO AT HOME!	Get Field Trip Permission Forms signed – bring back tomorrow!	Reread the "Overview" section. Take notes on all vocabulary words.	Finish up Simple Coaster (6.1) if you didn't finish in class.	Read section 2.1: Amusement Park Physics with a NASA Twist. List 3 things you did not understand.	No homework for the weekend. Yeah!!!!!

Tentative Course Schedule

	Approximate Schedule for Week 2				
	Monday	Tuesday	Wednesday	Thursday	Friday
9:00	Review	Discussion	Field trip to COWEN PARK for data gathering on a curved slide, zip line, and merry-go-round (5) (Bus #48, 72)	Discussion of Field Trip Activities (5)	Discussion of Week
9:30	Maniac Math (8.4)	Hills & Dips cont. (6.6)		Coaster Loops cont. (6.10)	Maniac Math (8.6 & 8.7)
10:15	Break	Break		Break	Travel to OUGL 102
10:30	Free Fall Design (6.4)	High g's & Low g's (6.8)		Center of Mass (6.11)	Computer Lab: Packet 2
11:30	Lunch	Lunch	Lunch (on the Ave, bring $$$)	Lunch	Lunch
12:15	Hills & Dips (6.6)	Centripetal Force (6.9)	Playfield write up	Design of Banked Curves (6.12)	NASA Reading & Student Reading Guide (2.2 & 2.3)
1:15	pm Break	pm Break	pm Break	pm Break	pm Break
1:30	Roller Coaster Video (Wild Rides #2)	Coaster Loops (6.10)	Coaster Loops cont. (6.10)	Design of Banked Curves cont. (6.12)	Roller Coaster Video (America's Greatest)
2:10	Wrap-up, Clean-up, Clear out	Wrap-up, Clean-up, Clear out	Wrap-up, Clean-up, Clear out	Wrap-up, Clean-up, Clear out	Wrap-up, Clean-up, Clear out
2:20	Leave	Leave	Leave	Leave	Leave
TO DO AT HOME!	Read Maniac Math 8.5: Measurements	Complete Hills & Dips (6.6), High & Low g's (6.8), & Centripetal Force (6.9).	Complete all Physics of Playground Activities (5)	Complete Coaster Loops (6.10), Center of Mass (6.11), & Design of Banked Curves (6.12)	If you didn't finish the NASA Space & Roller reading Qs, then finish them!

Tentative Course Schedule

	Approximate Schedule for Week 3				
	Monday	Tuesday	Wednesday	Thursday	Friday
9:00	Discussion	Discussion	Leave for Field Trip from the Burke Museum	Enchanted Village Calculations	Decorate Roller Coaster & and do calculations on Roller Coaster Rubric
9:30	Collisions I & II (6.13)	Build and support hills and dips	Travel Field Trip to SIX FLAGS: Wild Waves & Enchanted Village	Build and support banked curves	
10:15	Break	Travel to OUGL 102		Break	Break
10:30	Outdoor Marble Run I - IV (7)	Computer Lab: Finish Packet 2 & Internet Scavenger Hunt		Build and support banked curves	Prepare for Parent Visit & complete Roller Coaster Rubric
11:30	Lunch	Lunch		Lunch	Lunch
12:15	Outdoor Marble Run I - IV cont. (7)	Finish Outdoor Marble Run I – IV (7) & work on coasters		Work on coasters	Parents & Friends Visit: Potluck, Demos, & Presentations!
1:15	pm Break	pm Break		pm Break	
1:30	Build up first drop platform and let dry overnight	Mystery Video		Work on coasters	
2:15	Wrap-up, Clean-up, Clear out	Wrap-up, Clean-up, Clear out		Wrap-up, Clean-up, Clear out	Wrap-up, Clean-up, Clear out
2:20	Leave	Leave	4:30pm Pick Up!	Leave	Leave
TO DO AT HOME!	Make a sketch design of your roller coaster.	Remember to bring swimming suits, sunscreen, and money for lunch!	Returning from Six Flags at 4:30pm! Make roller coaster plaque.	Bring in decorations for your coaster and food or drink for potluck!	Have a great rest of the summer!