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NSF GK-12 Vibes and Waves in Action
Honors and CP Physics
Lesson 1: Simulation of free fall on different planets

Summary of Lesson

This lesson involved a demo to serve two purposes: 1.) introduce the students to the R programming language and the RStudio environment. 2.) Use the concept of free fall to show how different gravitational affects how and object falls. Two programs were written in R that demonstrated free fall motion on different plants. At the beginning of the lesson, an brief explanation was given on the importance of programming and what R is. Then the purpose of the two demos were explained. The first program showed an animation of an object falling on the different planet locations (Earth, moon, Jupiter and Pluto). This animations were shown simultaneously, so the students could observe the difference between the locations. In the other program, plots were made for velocity vs. time and position vs. time. The students were asked to interpret the slopes of the velocity-time graphs to determine the gravitational constant at each planet. For the position-time graphs, they were asked to predict how the plot would change with different initial conditions. The parameters were changed live in class and students got to see the changes. This also enforced the importance of programming.

Honors and CP Physics Lesson Plan

Text: Conceptual Physics, Paul G. Hewitt
Chapter: Ch. 4 Linear Motion (Sections 4.3 and 4.4)
Objectives: Analyze free fall on other planets and understand the effect of the gravitation constant
Essential Question: How does free fall motion differ on other planets?
Frameworks: Motion and forces- 1.1, 1.2, 1.3; SIS1, SIS2, SIS3, SIS4

L-Side Activities: Teacher	R-Side Notes: Students
At the Bell: What do you know about computer programming? Why do you think it might be important or useful for you? **Agenda:** 1. Discuss importance of programming 2. Give intro to R and RStudio 3. Show the free fall animations and discuss 4. Show position-time graphs and velocity-time graphs and discuss 5. Ask students to find gravitational constant from velocity-time graphs 6. Ask students to predict changes in graphs with different initial conditions 7. Show how results change with different initial conditions and discuss **Working It Out:** 1. What do you see as the object falls in the different planets? 2. Do you think what you calculated for the slope of the velocity-time graphs makes sense with the associated planet? 3. What you think will happen to the velocity-time graph and the position-time graphs if you add an initial velocity or initial position? 4. Do the new results match your predictions? **Class Activity:** Determine the gravitational constants from the velocity-time graphs. Explore how the results change with different initial conditions. **Homework:** None	I. Programming 1. Programming allows for a more automated way to solve problems 2. Do not need to solve a problem by hand many times 3. Helps to better understand physics by building simulations II. Free fall 1. Different planets have different gravitational constants 2. Slope of the velocity-time graph will give gravitational constant

NAME _____
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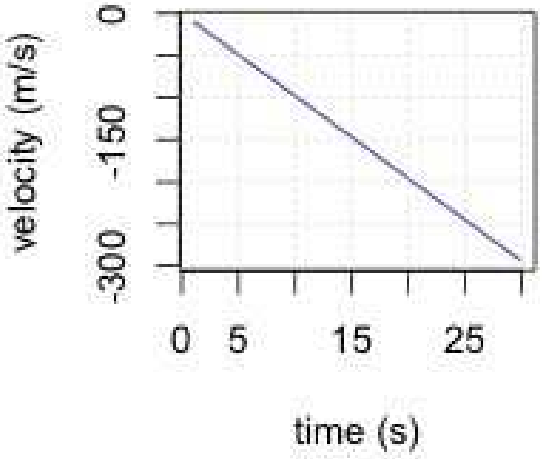
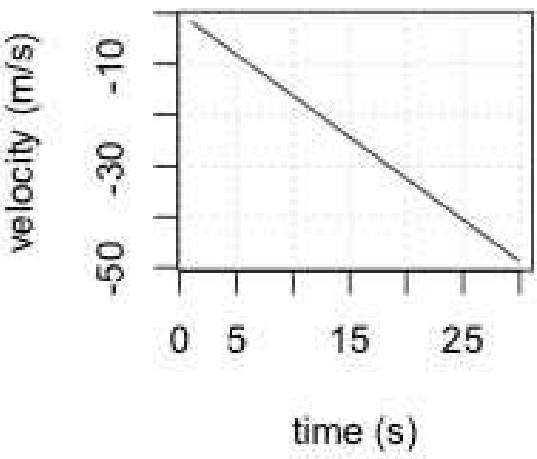
FREE FALL SIMULATION
VELOCITY VS. TIME GRAPHS

Find the slope on the velocity vs. time graphs to get the acceleration due gravity on each planet.

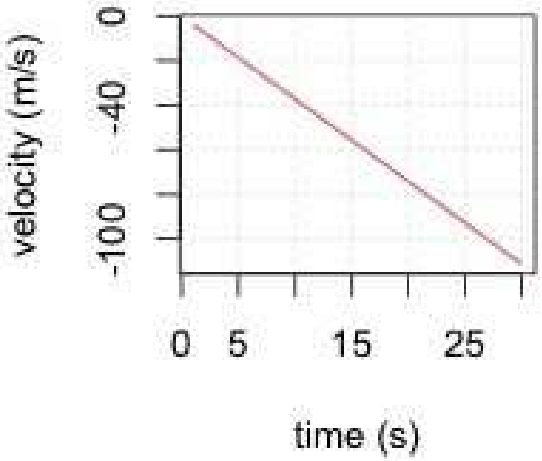
Earth



Moon



Mars



Jupiter