

SOURCE Lesson Plans Detail

Playing with Gravity

Topic	Gravity, Forces, Energy, Kinematics
Program	Brown Science Prep
Developed by	Mark Sabbagh
Developer Type	Undergraduate students

Overview / Purpose / Essential Questions

The purpose of this lesson is twofold. Firstly, the lesson aims to teach students about several key physical concepts including forces, potential and kinetic energy, kinematics, and projectile motion utilizing gravity as the foundational piece and narrative for these topics. Secondly, the lesson focuses on teaching the subject matter via an integrative lecture/experiment format. This format is preferential in that it will train the students to become better scientists and thinkers allowing them to synthesize facts, data, and observations into meaningful approaches to answering questions and reaching solid conclusions. Hopefully such an approach will engage the students and stimulate them to translate the question asking skills and connection making abilities required in experimenting to the realm of static lectures.

Essential questions include:

1. What is gravity?
2. What is a force?
3. What is acceleration? velocity?
4. What is the difference between potential and kinetic energy?

Most importantly: how do all of these ideas relate to each other and how can one utilize information about one to solve questions involving the others?

Performance / Lesson Objective(s)

By the end of this lesson, students should feel comfortable explaining the above mentioned topics as well as be able to solve projectile motion, gravity, and conservation of energy physics problems.

Lesson Materials

Anti-Gravity Water Demo:

- Tall glass with round edge
- A handkerchief
- A pitcher of water

Marble Gravitron Demo:

- A marble
- A wine glass
- A hand

Genie in a Bottle Demo:

- Small bottle with a long neck
- A short length of cotton rope (about 1 foot long)
- A small piece of aluminum foil (about 6 square inches)

Measuring acceleration due to gravity:

- Super ball (bouncy ball)
- Meter stick
- Timer

Projectile motion:

- Marble
- Ramp
- Ruler

Lesson Motivation

1. Physics provides a wonderful backdrop for practicing reasoning and mathematical skills. Furthermore, gravity functions as a wonderful narrative for what science is: making an observation and then trying to explain it.

Lesson Activities

The lesson will open with three demonstrations attempting to discredit gravity.

1. Water antigravity demo
2. Marble spinning in a cup demo
3. Genie in a bottle demo

These demos will be done in front of the entire class. Then students will be split into groups for the two experiments:

1. The first experiment involves attempting to measure the acceleration due to gravity by dropping an object and timing its descent.
2. The second experiment involves using concepts of potential and kinetic energy along with projectile motion formulas to determine where a marble dropped on a ramp will land on the floor.

Procedure

1. Open the lesson by asking the entire group of students what gravity is. For this purpose, describe gravity as the attractive force on objects by the earth.
2. Ask the students if they believe in gravity. Ask them what would be required to make them not believe in it.
3. Perform the three demos that attempt to "cheat" gravity. (See attached documents)
4. Separate students into groups. Begin the Measuring the Acceleration due to Gravity experiment.
5. This opens with a demo illustrating that objects fall at the same rate. Wrap up a feather in aluminum foil and drop from same height as a brick. First ask the students which they think will fall faster.
6. Preface the experiment with some information on what gravity is (a force) and explain what a force is. Here present Newton's second law: $F = ma$. Now explain that when falling, there is a force on you. (Ask students what that force is, they should say gravity). Now by algebra show that this force is equal to your weight which is proportional to your mass times some constant. Call constant g . So $Weight = mg$. But the weight is a force, so $Weight$ should also equal ma where a represents your acceleration falling down. (At this point or prior explain that acceleration is the rate of change in velocity over time) Can go over Kinematic equations at this point if you like. Basically, $mg = ma$. The masses cancel, and you see that this constant is the acceleration due to gravity.
7. Perform the experiment: see attached.
8. Now perform projectile motion experiment (see attached).
9. In this case, explain concepts of gravitational potential energy and kinetic energy. Explain conservation of energy. Try and pull out of students how we can use the two equations and that fact that energy is conserved to calculate the speed of something dropped from a given height. Also, talk about kinematic equations. Rather than tell the students, have them try and synthesize how we put all these formulas together to determine where a marble will land if fallen down a ramp and then shot horizontally off of a table.
10. Everyone meets again in the main room for wrap-up discussed above.

Wrap up / Conclusion

All the students will reconvene in the main classroom to discuss their results. A brief discussion will be given on extending gravity to planets and the gravitational force equation will be explained. The class will then be posed the question: If all objects that have mass exert a gravitational force on other objects, why do two people (or any other object in the room) orbit around each other? A quick discussion will take place.

Follow up

At the next meeting, give a sample physics problem and see if students can solve it.

Pre Assessment Plan

Give a kinematics problem.

Post Assessment Plan

Give similar kinematics problem with different numbers.

Alignment Info

Audience(s)	High school students
STEM Area(s)	Physics
Standard(s)	<i>Physical Sciences (RI GSE) PS3.9–11.9a</i> Students demonstrate an understanding of forces and motion by... explaining through words, charts, diagrams, and models the effects of distance and the amount of mass on the gravitational force between objects (e.g. Universal Gravitation Law). <i>Physical Sciences (RI GSE) PS3.9–11.9b</i> Students demonstrate an understanding of forces and motion by... using Newton's Laws of Motion and the Law of Conservation of Momentum to predict the effect on the motion of objects. <i>Physical Sciences (RI GSE) PS3.9–11.8b</i> Students demonstrate an understanding of forces and motion by... using modeling, illustrating, graphing explain how distance and velocity change over time for a free falling object.
Activity Type(s)	Hands-on
Grade Level(s)	High School
Version	1
Created	11/08/2011 02:49 PM
Updated	12/08/2011 12:29 PM

Brown University

Providence, Rhode Island 02912, USA

Phone: 401-863-1000

© 2016 Brown University
