



## Mass Weight and Gravity Using Computational Methods

### Purpose

This activity introduces students to the concept of mass, weight, and gravity from a computational thinking perspective.

### Overview

Students will actively determine the weight of a student on various planets given his weight on the moon thereby applying concepts taught in the classroom. The first part of the calculations, finding the weight on a given planet, will be performed by hand with a calculator, and then the calculations for the other planets will be performed with the computational tool Microsoft Excel. This method will reinforce what the students learn, as well as give them a greater appreciation for the benefits of computational tools.

### Student Outcomes

- Students will be able to explain mass of objects with reference to a basic atomic structure
- Students will be able to differentiate between weight and mass
- Students will be able to calculate weight using the formula:  
$$\text{Force} = \text{mass} \times \text{acceleration due to gravity}$$
- Students will use the computational tool, Microsoft Excel, to solve for weights on different planets and graphically analyze the effects of gravity on weight

### Standards Addressed

MS-PS2-2: Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass – eg, Earth and the sun.

MS-PS2-4: Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Basic atomic structure – nucleus and electrons

### Time

A double class period

### Level

6<sup>th</sup> Grade



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## Materials and Tools

Technology – Microsoft excel, calculator, Internet access

Suggested resources or equipment needed – Chrome book or laptop or netbook (anything with access to Microsoft excel)

[Microsoft Excel Template](#)

[PowerPoint presentation](#)

[Worksheet](#)

[A completed Excel spreadsheet](#) is also provided for reference.

## Preparation

Ensure connection to the following visual aids:

<http://phet.colorado.edu/en/simulation/gravity-and-orbits>

<http://www.youtube.com/watch?v=SegMt7sa42E>

[http://www.wolframalpha.com/widget/widgetPopup.jsp?p=v&id=14c4f36143b4b09cbc320d7c95a50ee7&title=Value%20of%20g&theme=red&i0=moon&podSelect=&podstate=Result\\_Show%20metric&showAssumptions=1&showWarnings=1](http://www.wolframalpha.com/widget/widgetPopup.jsp?p=v&id=14c4f36143b4b09cbc320d7c95a50ee7&title=Value%20of%20g&theme=red&i0=moon&podSelect=&podstate=Result_Show%20metric&showAssumptions=1&showWarnings=1)

A Microsoft Excel template should be sent to all students before class so time is not taken up in class sending out the document.

Teachers must have a clear understanding of mass, weight, and gravity as the Socratic method is mostly used to teach this activity and students are encouraged to ask many questions. It is advised that the teacher perform this activity in advance to help direct students through the process easily.

## Prerequisites

None needed

## Background

Students will need to know how to do math calculations on a calculator, and how to rearrange a math equation. If  $\text{Force} = \text{mass} \times \text{acceleration}$ , then  $\text{mass} = \text{Force} \div \text{acceleration}$ .

Students should be familiar with the device chosen by the instructor.

## Teaching Notes

A combination of teaching methods and tools are used to complete the objectives. Please follow the PowerPoint for a description of the method used in each slide.

Slide 1 – Students are welcomed back to class enthusiastically and the topic is stated

Slide 2 – Four student volunteers are chosen to read the class objectives aloud while the rest of the class listens.

Slide 3 – Students are asked which will get to the ground first in free-fall if thrown from the top of a tall building, an elephant or a feather. Class open for discussion to get student's ideas. Students are paired



together to discuss for a minute and class open again for discussion. The students are told the final answer is they will get to the ground at the same time, and we will find out today in class why.

Slide 4-5 – Students asked what is gravity? Two volunteers are asked to stand and the class is asked if the volunteers have a force pulling on each other and why. This question makes them think about what was said about gravity being a force of attraction between any two masses, and recognize they themselves are made up of atoms, and have gravity. A question is asked about why are they not pulling toward each other, so students recognize the earth’s gravity is pulling on them more.

Slide 5 – Students are shown the simulation with gravity affecting the earth  
(<http://phet.colorado.edu/en/simulation/gravity-and-orbits>)

Slide 6-7 – Students introduced to mass as the amount of stuff or matter in a material. This matter is atoms. Students also shown an atom containing electrons and a nucleus. Students are asked, “if I take a pen on earth to the moon, will the mass change?” This question allows to see if they really understand what mass means.

Slide 8 – Students are shown that they already know what acceleration is from car racing. Students introduced to weight as a force = mass x acceleration due to gravity. Students are asked, “if I take a pen on earth to the moon, will the weight change?” This question allows to see if they really understand what weight means. Show video of difference between mass and weight  
(<http://www.youtube.com/watch?v=SegMt7sa42E>). Students asked to complete first part of their activity sheet.

Slide 9 – The previous pen example is re-stated, but instead of the pen a boy called Tommy is used. Will Tommy’s mass change when he moves to another planet? Will Tommy’s weight change when he moves to another planet?

Slide 10 – Students are asked how they will find Tommy’s weight on the moon if they know Tommy’s weight on earth. If no student knows, they are given a hint that they should first find something that always stay the same on earth and other planets. Students are grouped and guided through the first example to find Tommy’s weight on the moon, and the ones that understand what to do are asked to help those that do not understand. Students then complete activity 2 in their activity sheet packet and the teacher walks around to ensure they understand.

The students are then given their netbooks and the teacher demonstrates how to log onto the excel document (see excel template). Once all students are logged on, they are given instructions showing how to code in the calculation in excel and the concept of columns and rows are explained using reference to the familiar game battleship. Students are instructed to use the link in the excel template to find the gravity on different planets and are advised to pay attention to the correct units. They are then shown how to do the shortcut and double click to get all the calculations and answers filled in the cells. This will activate the graph that was already set for them. Students are then shown how to interpret the graph by showing the graph on the board and asking what happens to Tommy’s weight when gravity on the planets increase and decrease.

Students are then asked to finish the critical thinking section of their activity sheet.

### **Assessment**

The teacher will evaluate if the objectives have been met by correcting the activity sheet for the students.

Also, the teacher does not wait to the end to determine if students understand, because the activities during the lesson help the teacher to gauge what should be emphasized.

**Additional Information**

This website is a great resource to better understand the topic of free fall and acceleration due to gravity:  
<http://www.physicsclassroom.com/class/1dkin/u115e.cfm>