Virtual Learning

# Physics

# Hooke’s Law Simulation

April 29, 2020

# Physics

## Hooke’s Law Simulation: April 29,2020

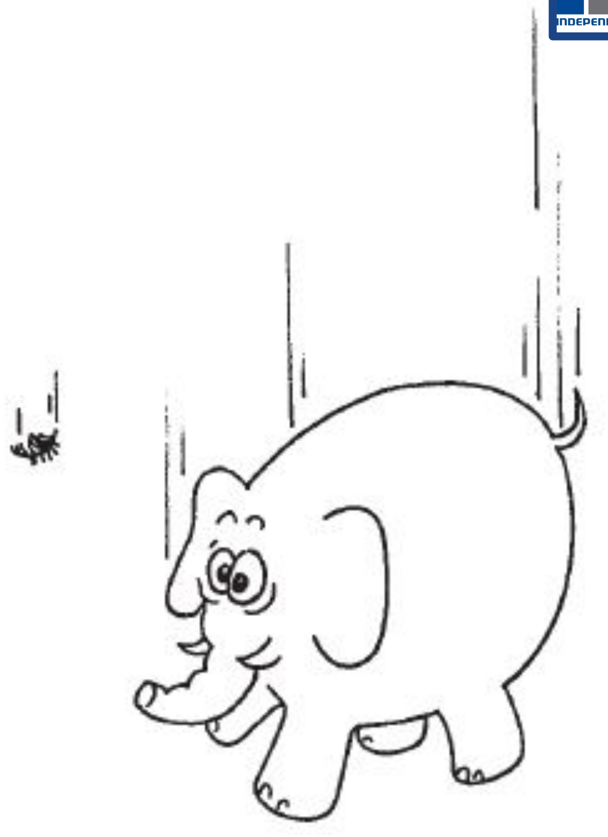
## Objective/Learning Target:

Students will use a computer simulation to examine Hooke’s Law.

Quick Review # 1

**Which encounters the greater force of air resistance:**

**A falling elephant or a falling feather?**



# Quick Review #1 Answer

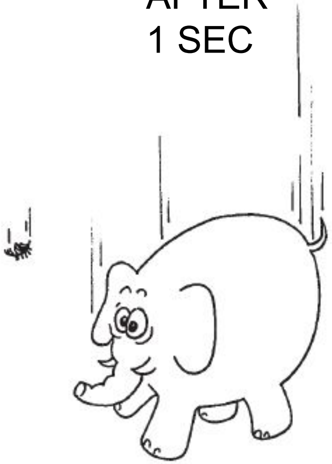
**The Elephant**

**A much greater force of air resistance acts on the elephant simple because it has to "plow through" more air to get to the ground. So air resistance is greater on the elephant. The effect of air resistance is more pronounced for the feather, however, because air resistance doesn't have to build up very much to counteract the weight of the feather. A tiny fraction of one newton of air resistance acting on a feather that weighs a tiny fraction of one newton, more easily produces a zero net force and zero acceleration, compared to several newtons of air resistance acting on thousands of newtons of elephant.**

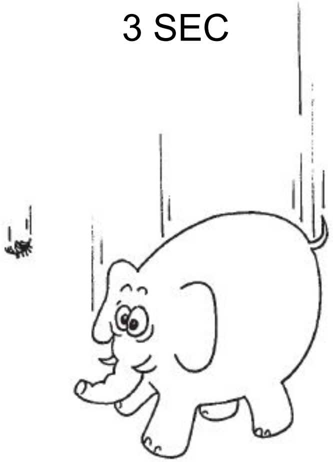
# Quick Review #2

**Draw free body diagrams for the elephant and feather for the following lengths of fall.**

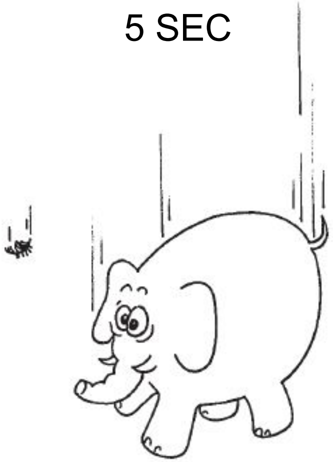
AFTER
1 SEC



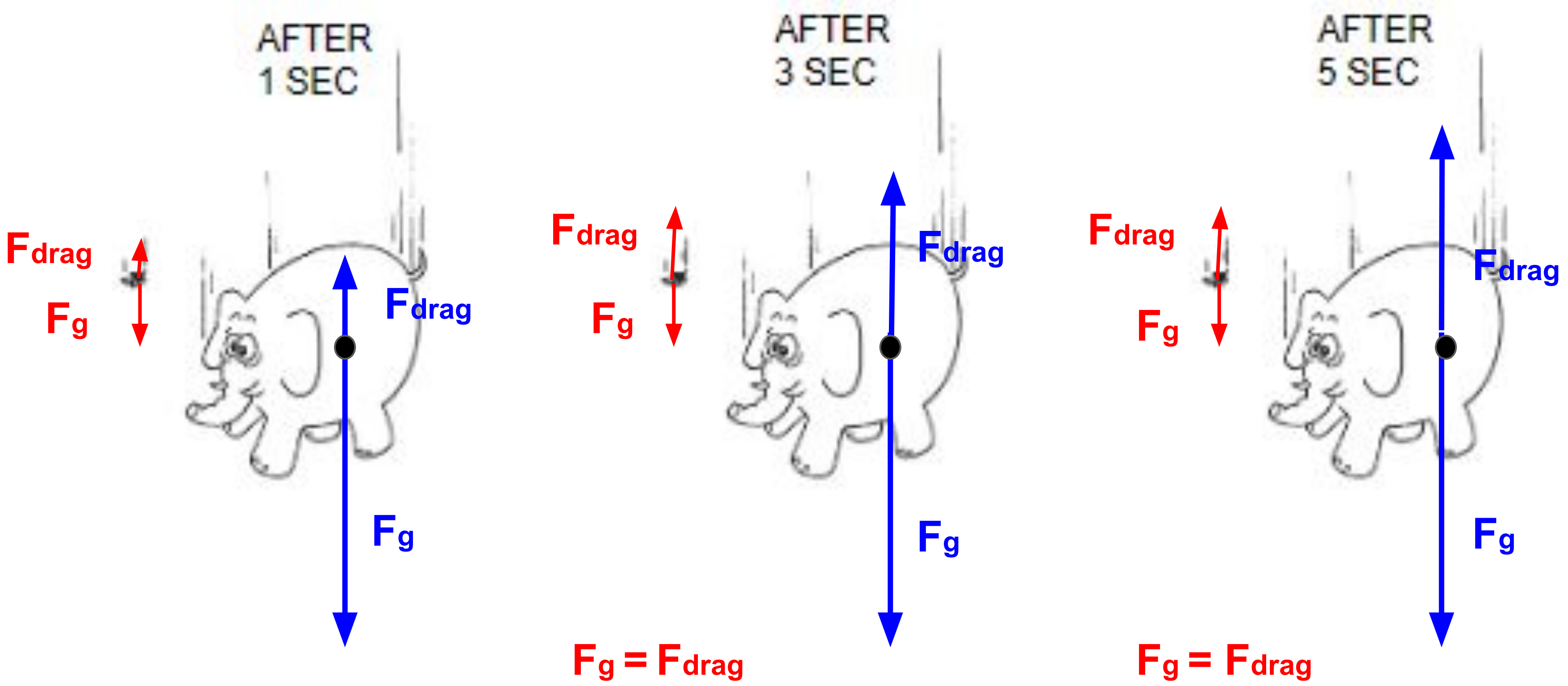
AFTER
3 SEC



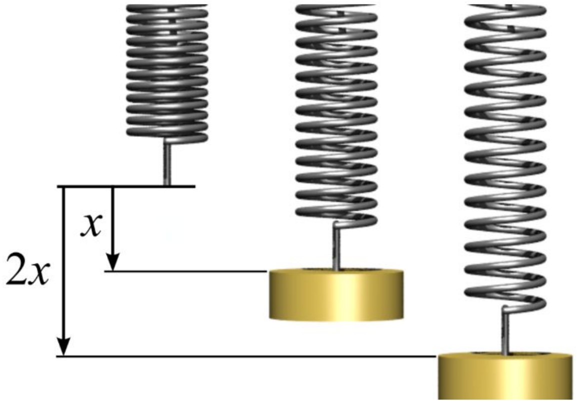
AFTER
5 SEC



# Quick Review # 2 Answer



# Hooke’s Law Simulation




## Introduction

You will use a computer simulation today to investigate Hooke’s Law. Since this is “inquiry based”, you’re not supposed to know everything going in, but learn as we walk through the lesson. **You must read the following slides carefully.** Let’s get started!

# Hooke's Law Simulation

Website: [Masses and Springs]

Make sure to use the HTML5  version.

Select the Lab icon and double click to start.

# Hooke’s Law Background Info

**Hooke's law states that extension of a spring is proportional to applied force. If a spring obeys Hooke's law, then a graph of applied force against extension will be a straight line, whose gradient (slope) is *k*:**

**The equation of the straight line is:**

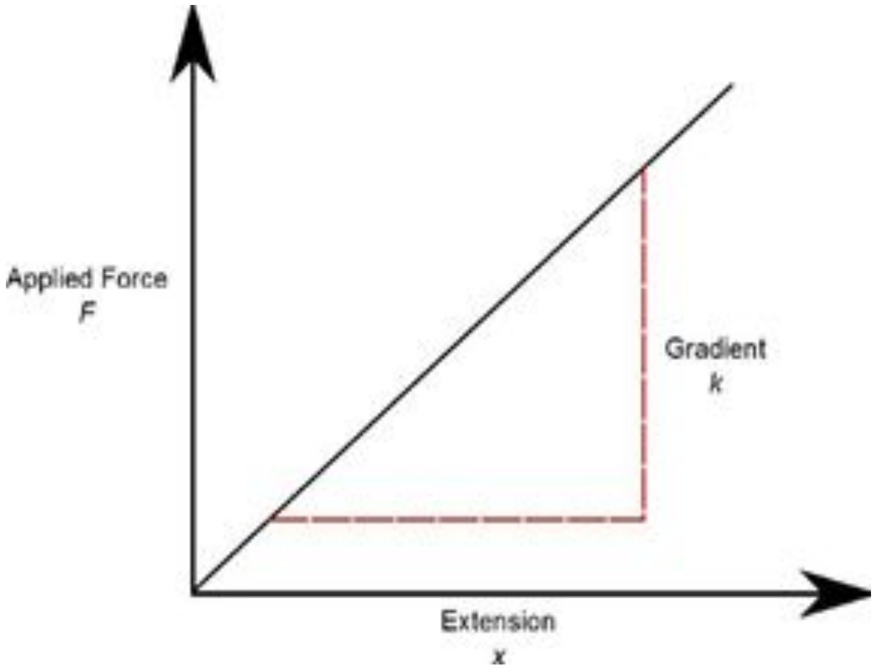
$$F = kx$$

**where:**

**F = stretching force applied to the spring**

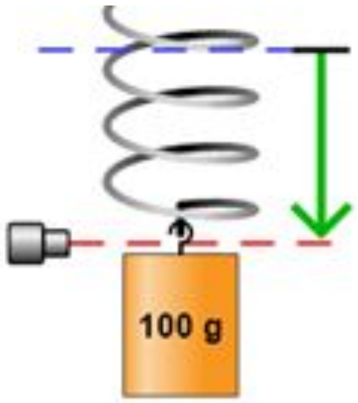
***k* = spring constant**

***x* = extension of the spring**



# Hooke's Law Simulation

1. **Place the 100g mass onto the spring. The spring will begin to oscillate up and down. Stop this by clicking on the mass several times or increasing the 'Damping' value to 'Lots'.**




2. **Click the 'Displacement' and 'Movable Line' options on the right. Adjust the movable red line to the tip of the green arrow.**

# Hooke's Law Simulation

3. **Use the ruler tool (the units are in mm) on the bottom right to measure the extension of the spring with the 100g mass. Convert this mass to a weight (N ) and add this data to the table. Remember to convert *g* to *kg* before calculating the weight (N).**

4. **Use the slider at the top to change the mass and record 5 more results of weight and extension. Add the results to the data table.**

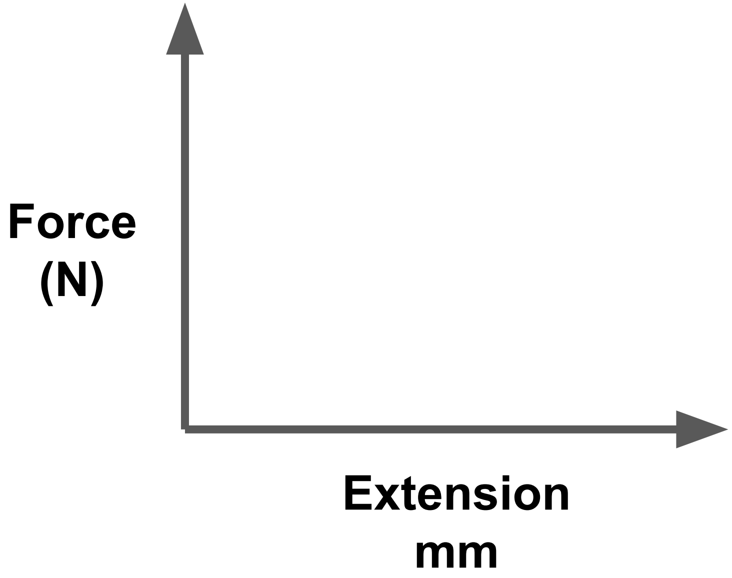
| **Mass added (g)** | **Weight (N)** | **Extension (mm)** |
|---|---|---|
| 100 | | |
| | | |
| | | |
| | | |
| | | |
| | | |

# Hooke's Law Simulation

1. Plot a graph of Force, which is the weight, (y-axis) verses extension (x-axis). Draw a line of best fit through the points.

2. Using the graph, determine the spring constant of the spring by finding the slope of the line.

3. What evidence from the graph shows that the spring obeys Hooke's Law?

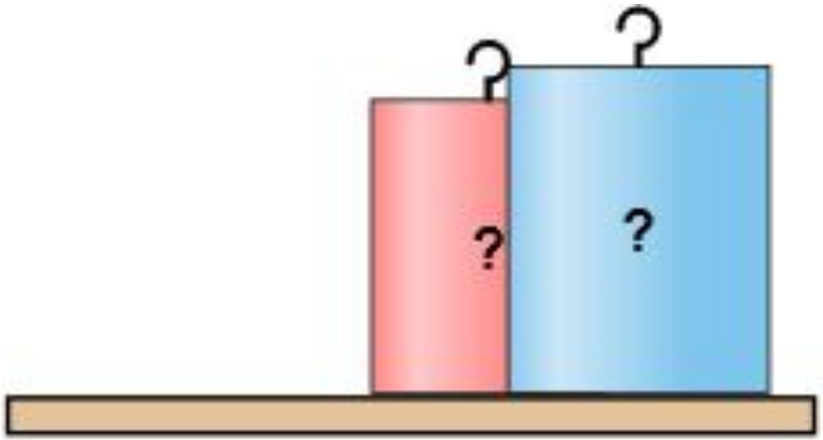


# Hooke’s Law Simulation

**Using the value for the spring constant from the graph, determine the masses of the two unknown, red and blue masses in the simulation. Show the calculations and the measurements taken. To get a good average result, at least 3 measurements should be taken for each mass.**

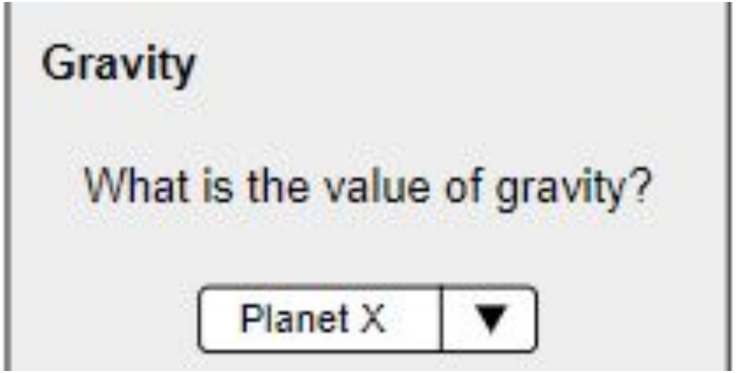
**Mass of Red ____________g**

**Mass of Blue___________g**



# Hooke's Law Simulation

**Change the 'Gravity' to 'Planet X'.**



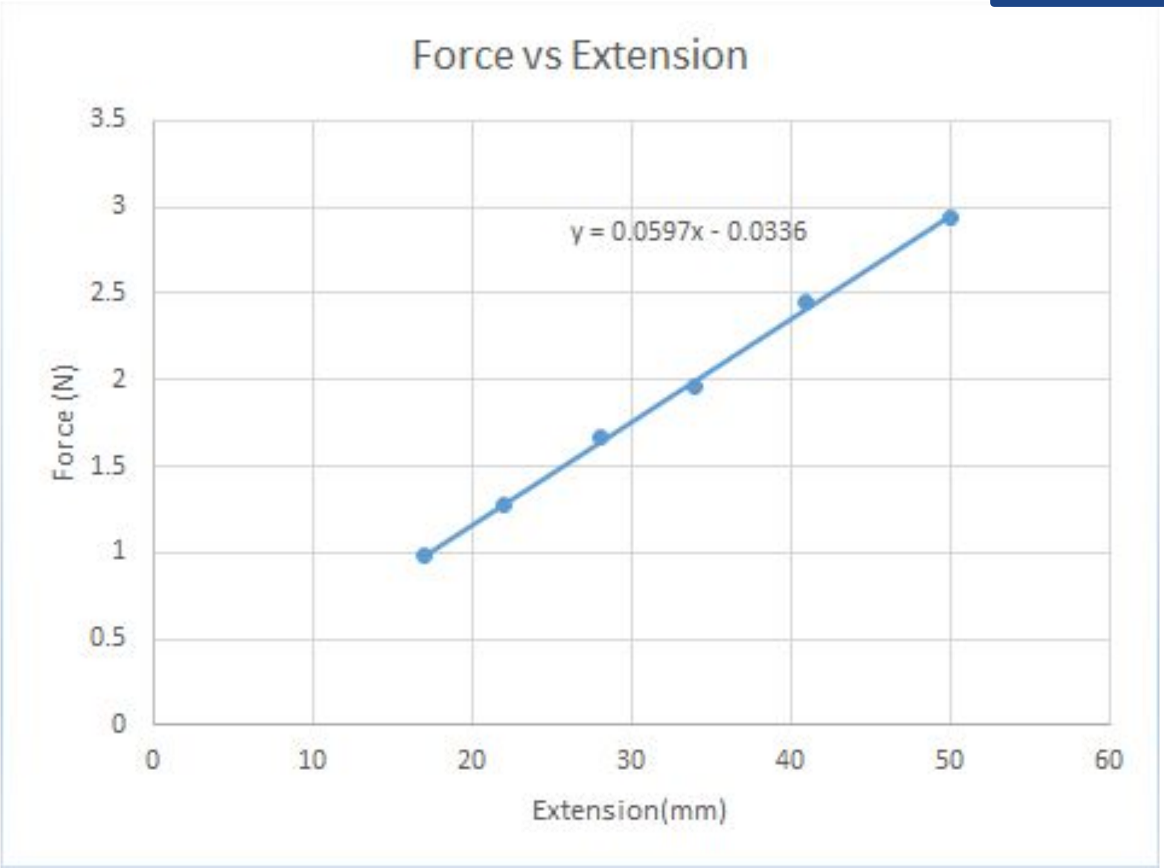

**The value of  is no longer 9.8 m/s$^2$ but something unknown.**

**Using the spring constant from the graph, determine the unknown value of gravity for this planet. Show the calculations and the measurements taken for this part. To get a good average result, at least 3 measurements should be taken for each mass.**

**Unknown g = __________________ m/s$^2$**

# Hooke's Law Simulation Answers

| Mass added (g) | Weight (N) | Extension (mm) |
|---|---|---|
| 100 | 0.98 | 17 |
| 130 | 1.27 | 22 |
| 170 | 1.67 | 28 |
| 200 | 1.96 | 34 |
| 250 | 2.45 | 41 |
| 300 | 2.94 | 50 |



# Hooke's Law Simulation Answers

The graph produced a straight line which is what Hooke's Law formula would predict. $F = kx$ is a linear relationship with the slope equalling the $k$ or spring constant. For this graph the spring constant is 0.0597 N/mm.

Red Mass - extension 60 mm, 60 mm, 60 mm, average 60 mm

$F = kx$ and $F = mg$

$mg = kx$

$m = kx/g = 0.0597\text{N/mm} \times (60\text{mm})/9.8\text{m/s}^2 = 0.36551\text{ kg} = 365.51\text{ g}$

Blue Mass - extension 38 mm, 39 mm, 38 mm, average 38 mm

$m = kx/g = 0.0597\text{N/mm} \times (38\text{mm})/9.8\text{m/s}^2 = 0.23149\text{ kg} = 231.49\text{ g}$

# Hooke's Law Simulation Answers

Unknown g on Planet X

$$g = kx/m$$

Trial 1

= (0.0597N/mm)(24mm)/0.100kg = 14.33 m/s²

Trial 2

= (0.0597N/mm)(45mm)/0.190kg = 14.14 m/s²

Trial 3

= (0.0597N/mm)(60mm)/0.254kg = 14.10 m/s²

| **Mass added (g)** | **Extension (mm)** | **g (m/s²)** |
|---|---|---|
| 100 | 24 | 14.33 |
| 190 | 45 | 14.14 |
| 254 | 60 | 14.10 |

Average = 14.19 m/s²

# Additional Practice

## Return to the simulation and repeat the experiment for Jupiter or the Moon.