Module 2: Forces and Newton's Laws

Topic 3 Application: Newton's Second Law Scientific Investigation

Before you begin the scientific investigation below, make sure to download the Newton's Second Law Scientific Investigation Report. As you complete this scientific investigation, fill in any needed information on the report template. If you need more information about each section of the report, please visit the Developmental Module.

Introduction

Newton's Laws describe motion and forces in the world around us. Objects have inertia, undergo acceleration, and experience forces. Forces are measured in Newtons (N).

Newton's First Law states that an object at rest will remain at rest, and an object in motion will remain in motion with a constant velocity, unless acted upon by an unbalanced external force. Newton's Second Law describes what happens when unbalanced forces act on an object.

Objectives

In this scientific investigation, you will:

- explore the relationship between forces and acceleration.
- explore the relationship between mass and acceleration.

Hypothesis

Using the Procedure and Data Collection section below, read through the procedural information for this scientific investigation. Based on your understanding of the procedure, develop your own hypotheses which describe your expected results. What do you think the relationship between acceleration and force and the relationship between acceleration and mass will be? Record these hypotheses on your Newton's Second Law Scientific Investigation Report in the Hypothesis section.

Required Simulation

Forces in 1 Dimension PhET Simulation

Provided by:
PhET Interactive Simulations
University of Colorado
http://phet.colorado.edu

Procedure and Data Collection

Simulation Set-Up

1. Open the Forces in 1 Dimension simulation.
2. On the right side of the simulation window, click the Friction radio button to Off.
3. Click Graph Acceleration.

Effect of Force on Acceleration

1. Using the simulation, select the File Cabinet from the "Object" list to the right.
2. In the Applied F... (Applied Forces) text field, change the applied force to 100.0 N, as specified in the Effect of Force on Acceleration data table in the Data section of your Newton's Second Law Scientific Investigation Report.
3. Click Go.
4. Click Pause to pause the simulation. Record the acceleration as shown in the acceleration graph.
5. Click Clear to clear the simulation.
6. Repeat steps 1 through 5 two more times, replacing the amount of applied force with the amount provided to you in the Effect of Force on Acceleration data table.

Effect of Mass on Acceleration

1. Click Clear to clear the simulation.
2. Using the simulation, select the File Cabinet from the "Object" list to the right. Record the mass of the object in the Effect of Mass on Acceleration data table in the Data section of your Newton's Second Law Scientific Investigation Report.
3. In the Applied F... (Applied Forces) text field, change the applied force to 200.0 N, as specified in the Effect of Mass on Acceleration data table in the Data section of your Newton's Second Law Scientific Investigation Report.
4. Click Go.
5. Click Pause to pause the simulation. Record the acceleration as shown in the acceleration graph.
6. Click Clear to clear the simulation.
7. Repeat steps 1 through 6 three more times, replacing the object with the name of the object provided to you in the Effect of Mass on Acceleration Data Table.

Data

Use the data tables provided on your Newton's Second Law Scientific Investigation Report to record your data from this scientific investigation. The data tables are also shown below:

Effect of Force on Acceleration

Applied Force	Cabinet Mass	Acceleration (m/s^2)
100.0 N	200.0 kg	
200.0 N	200.0 kg	
400.0 N	200.0 kg	

Effect of Mass on Acceleration

Applied Force	Object	Mass (kg)	Acceleration (m/s^2)
200.0 N	File Cabinet		
200.0 N	Refrigerator		
200.0 N	Crate		
200.0 N	Sleepy Dog		

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Data Analysis

In the Data Analysis section of your Newton's Second Law Scientific Investigation Report, provide responses to the following questions:

Effect of Force on Acceleration

1. What happens to the acceleration when you double the force on the cabinet from 100 to 200 Newtons?
2. What happens to the acceleration when you quadruple the force on the cabinet from 100 to 400 Newtons?
3. What is the relationship between force and acceleration?

Effect of Mass on Acceleration

1. Compare the acceleration of the file cabinet and the refrigerator, which has two times the file cabinet's mass, by completing the following sentence: The acceleration of the file cabinet is _____ times [greater/less] _____ than the acceleration of the refrigerator.
2. Compare the acceleration of the sleepy dog and the crate, which has twelve times the sleepy dog's mass, by completing the following sentence: The acceleration of the sleepy dog is _____ times [greater/less] _____ than the acceleration of the crate.
3. What is the relationship between mass and acceleration?

Conclusion

Using the Conclusion section of your Newton's Second Law Scientific Investigation Report, compose three to four sentences describing an overall conclusion about the relationship between acceleration and force and the relationship between acceleration and mass, based on your data. Were your hypotheses true or false, and how do you know? Use the data and notes that you collected from your simulation experience to form your conclusion. Make sure that you include information that you gained from data analysis to support your conclusion.

Experimental Sources of Error

On your Newton's Second Law Scientific Investigation Report, provide responses to the following questions: Are there any sources of error? If so, what are they, and what could be done to minimize error?

Once you have completed the Newton's Second Law Scientific Investigation Report, please submit your work to the dropbox.