

# Mass and Motion: How Do Changes in the Mass of an Object Affect Its Motion?

## Introduction

The motion of an object depends on all the different forces that are acting on the object, how strong those different forces are, and how much mass the object has. Changing the number of forces acting on an object, the direction of those forces, or the strength of the forces will have an effect on the object's motion. But what happens if you apply all the same forces to two different objects, one with a small mass and one with a larger mass?

The amount of mass of an object is a measure of the amount of matter in that object. Objects with more mass have more weight (a measure of the force of gravity) because there is a stronger attraction between the object and Earth due to gravity. Motorcycles are lightweight vehicles, about 250 kg, with strong engines that help them travel at high speeds (see figure to the right). How might the speed of a motorcycle change if it is carrying one rider or two riders? In this example the strength of the engine doesn't change, but the total mass of the motorcycle and riders increases. It is important for scientists and engineers to understand the relationship between the forces applied to an object and the mass of that object so that they can predict the object's motion.

**Motorcycles are lightweight, but their engines generate a lot of force.**



## Your Task

Use what you know about forces, stability and change, and patterns to design and conduct an investigation that will allow you to describe the motion of a cart (e.g., does it speed up, slow down, or travel at a constant speed) and how its motion is affected by changing the mass of the cart while keeping the pulling force the same.

The guiding question of this investigation is: **How do changes in the mass of an object affect its motion?**

## Materials

You may use any of the following materials during your investigation:

- Pull cart
- Pull car track or flat table
- Pulley
- Pulley clamp
- Cart masses
- String
- Hanging weights
- Meterstick
- Balance
- Motion sensor with interface

## Getting Started

To answer the guiding question, you will need to plan an investigation to measure the motion of a cart as it is pulled across the tabletop. To accomplish this task, you must determine what type of data you need to collect, how you will collect it, and how you will analyze it.

To determine *what type of data you need to collect*, think about the following questions:

- What information do you need to describe the motion of the cart?
- What information or measurements do you need to calculate the speed of the cart?

To determine *how you will collect your data*, think about the following questions:

- What equipment will you need to collect the data you need?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of the data you collect?
- How will you organize your data?

To determine *how you will analyze your data*, think about the following questions:

- What type of calculations will you need to make?
- What type of table or graph could you create to help make sense of your data?
- How will you determine the effect of different pulling forces on the cart's motion?

## **Report**

Once you have completed your research, you will need to prepare an investigation report that consists of four sections (be sure to have section headings):

1. Introduction: Give some background information on the topic. Explain what question were you trying to answer and include a hypothesis. (Background info, research question and hypothesis)
2. Procedure: What did you do during your investigation and why did you conduct your investigation in this way? (How you collected and analyzed data)
3. Data: Include a data table and/or graph to show your results. Be sure to include a title for your table or graph with labels for the variables.
4. Conclusion: What is your argument? (Claim - Evidence - Reasoning)

Your report should answer these questions in two pages or less. The report must be typed, and any diagrams, figures, or tables should be embedded into the document. Type your report on Google Docs (12 point font, double-spaced) and share it with your teacher. Your report will be graded based on the rubric in the class syllabus.