# Pre-Lab Information

Purpose Plan an investigation to explore Newton’s first two laws of motion.

Time Approximately 60 minutes

Question How can Newton’s laws be experimentally verified?

Hypotheses Write each hypothesis you developed during the laboratory lesson.

Part I, Newton’s first law:

 Part II, Newton’s second law:

Summary You will plan an investigation that demonstrates and validates Newton’s first two laws of motion. Two experiments will be developed, one to focus on each law. You will be given a toy car and sections of track to carry out the experiments.

# Safety

* Always wear safety goggles when performing an experiment.
* Behavior in the lab needs to be purposeful. Use caution when manipulating objects and measuring their motion.
* Report all accidents—no matter how big or small—to your teacher.
* Set up your experiment in an area that has enough room to take measurements, but is not so large as to interfere with other people in the area.

# Introduction

It is time to get you thinking about Newton’s first and second laws, and how you can demonstrate and verify them. There are two parts to this lab. You will be given an example scenario for each, which will help you think about the possible experiments you can build.

The first experiment you will devise should demonstrate Newton’s first law, also called the law of inertia, which says an object in motion tends to stay in motion and an object at rest tends to stay at rest, unless the object is acted upon by a force sufficient to change its motion. In what ways can this be demonstrated?

The second experiment involves verifying Newton’s second law, which can be summarized as *F = ma*. In other words, force is equal to mass times acceleration. To verify this, you will devise an experiment that manipulates these three variables to determine the affect they have on each other.

Your teacher will let you know what materials are available, and you and your lab partners will plan your investigations around this.

# Example Scenarios

***Part I:* *Demonstrating Newton’s First Law of Motion***

Let’s start with an example of Newton’s first law, also called the law of inertia. The law of inertia applies to resting or moving objects: an object in motion tends to stay in motion and an object at rest tends to stay at rest, unless the object is acted upon by a force sufficient to change its motion.

Imagine you are going on a family trip, and your parents ask you to load the luggage onto the car’s roof rack. The luggage sits on the porch, and has inertia: it will not move until you apply enough force to move it. You decide to overcome the inertia of the luggage and load the car.

Now you are off on your trip. As the car speeds down the road toward your destination, your dad asks you why there are luggage straps still in the back seat. Just as you realize why, a dog runs across the road and your dad slams on the brakes. The dog manages to escape, but the luggage flies forward off the roof rack, landing far ahead of the car on the road. You again recall the law of inertia: an object in motion (like luggage on a speeding car) will stay in motion unless acted upon by a sufficient force (provided by luggage straps). As your dad fumes, you explain Newton’s first law to him to divert his attention.

***Part II: Verifying Newton’s Second Law of Motion***

Your friend invites you out for a night of bowling. She is a very good bowler, and even has her own ball and shoes. You have never bowled before but you think it looks pretty simple. Besides that, you have recently been studying Newton’s laws and think you have a pretty good handle on how to be successful at this game.

Your first strategy is to choose the heaviest ball available at the alley. Because you understand that *F = ma,* you know that using a massive ball will impart a large force on the pins and you are sure to get a strike! But when you attempt to roll the ball down the lane, it is so heavy that you have a hard time getting it moving—or providing that other component of force, acceleration. Your choice of the massive ball results in it traveling very slowly down the lane and while you do hit some pins, the ball sort of pushes them out of the way rather than blasting them apart. Your friend looks on and smirks.

New strategy: since the massive ball is too heavy to move, choose a very light ball so that you can impart a very large acceleration on it; this will make up for the lower mass and still result in a large force. This time, you get the ball accelerated for sure, but your aim is wild. The ball rockets down the lane, but rolls into the gutter, and then skips over into the next lane.

This is not working well. You play it safe for your next attempt, and gently roll your ball down the lane. It heads straight for the pins, but is lacking in both mass and acceleration. The first couple of pins get knocked over, but the force is lacking and the ball sort of grazes off the others—not so great.

Your friend takes a turn. Her forearm is huge and you can tell she has had a lot of practice. She imparts a great acceleration to her massive bowling ball, sending it exactly where she wants it. The combined mass and acceleration of the ball result in a force on the pins so large that they are simply blasted off the lane. All the pins are down for a strike, and she sits down and relaxes while you take your next turn. This will be a long game!

# Lab Procedure

Here is an outline of the steps you should follow to plan your investigation for each part of this lab. Later in the guide, you will have writing space to develop your ideas, collect data, analyze and discuss results, and draw conclusions. Run through these steps twice, once for each of Newton’s laws.

1. **Devise an experiment to demonstrate Newton’s first or second law.**

Develop the main steps and how you will run each experiment. You will have a car, a track, and other possible materials as suggested by your teacher. How can you use them to develop experiments that demonstrate Newton’s first and second law? There is room provided in this lab guide to develop an experiment for each law. Develop the basic procedures and how you will run the experiments in order to determine the materials you will need for each.

Part I: Newton’s first law is also called the law of inertia. How can you manipulate your toy car or other materials to show that objects in motion tend to stay in motion and objects at rest tend to stay at rest? Focus this experiment on demonstrating inertia.

Part II: Newton’s second law can be summarized as *F = ma*,or force equals mass times acceleration. In this part, you will want to focus the experiment on changing one of the variables in order to see a change in another.

1. **Determine the types of data you will gather and what tools of measurement will be used to collect the data.**

How will you gather data for your experiment? If gathering quantitative data, you may want to devise a table in which you can record your results in an organized manner. Also, consider how you will record any qualitative or descriptive data in addition to your numerical results.

1. **Gather materials and set up your experiment.**

Now that you know what you will do, gather the necessary items. Besides the objects you will experiment with, make sure you have the necessary equipment to take measurements. If you are working with lab partners, make sure each person knows his/her role in running the experiment. Check your setup and make sure everything is in order before you proceed.

1. **Run your experiment.**

As you proceed with your experiment, make sure you record all the necessary data and that each student is performing his/her role in running the experiment. Make sure all elements of your experiment are complete. Do not forget to clean up when you are done!

1. **Use the Middle School Lab Report Guide to write your lab report.**

# Part I: Demonstrating Newton’s First Law of Motion

1. **Devise an experiment to demonstrate Newton’s first law.**

Write the steps of your experiment.

1. **Determine the types of data you will gather and what tools of measurement will be used to collect the data.**

Make a list of the data sections or tables. List the tools or devices used to make measurements.

1. **Gather materials and set up your experiment.**

Include a sketch of your experimental setup.

1. **Run your experiment.**

Record your data and observations in the space below.

1. **Use the Middle School Lab Report Guide to write your lab report.**

# Part II: Verifying Newton’s Second Law of Motion

1. **Devise an experiment to verify Newton’s second law.**

Write the steps of your experiment.

1. **Determine the types of data you will gather and what tools of measurement will be used to collect the data.**

Make a list of the data sections or tables. List the tools or devices used to make measurements.

1. **Gather materials and set up your experiment.**

Include a sketch of your experimental setup.

1. **Run your experiment.**

Record your data and observations in the space below.

1. **Use the Middle School Lab Report Guide to write your lab report.**