

First-class inquiry

In this activity, students will explore how variables in a first-class lever, specifically arm length, position of the fulcrum, and placement of the load, affect the effort needed to lift the load. To begin the lesson, demonstrate to the class how a first-class lever works (Figure 1) and review what is meant by the terms *fulcrum*, *effort*, and *load/resistance*. During the demonstration, change the location of the fulcrum and position of the load, but always keep the fulcrum between the effort and load/resistance. Also, demonstrate how to attach a spring scale to the lever to measure the effort used to lift a load, but keep the load and fulcrum in the same place as this is being explained. Wrap a large rubber band around one end of the board and connect the hook of the spring scale to the band. At this point, invite students up to the demonstration area to measure the amount of effort needed to lift a variety of different loads. Now it is time to introduce the discrepant event.

Break the students into groups and provide each with one fulcrum, one load (object of a defined mass), one board, and a spring scale. The load for each group should be identical, but the boards should be of different lengths and the fulcrums of various sizes. (Ask your woodshop teachers to help you with the materials preparation.) When these are distributed, location for placement of the load and location for placement of the fulcrum should be varied so that there are a variety of setups. Next, distribute the student activity sheets and ask students to complete Part A.

During Part A, each group will measure and record the force needed to lift the same load (weight) using the first-class lever. The discrepancy arises when students share their results. Even though each one was given an identical weight, the amount of force needed to lift it will vary from group to group because of the length of the boards, position of the fulcrum, and placement of the loads used by the different groups. Students should

now move on to Part B to explore what is responsible for this discrepancy.

In Part B, students are asked to identify any variables that might affect the amount of force required to lift the load. These variables should be brainstormed in groups, shared with the class, and recorded on the board. Then, have groups take turns selecting a variable to explore and write the group's name next to the variable on the board. A typical list of variables that students generate includes

- size/length of the board,
- size of the fulcrum,
- where the fulcrum is placed, and
- where the load is placed.

These are listed on the worksheet as possibilities to investigate, but you can include others brainstormed by students. Make sure at least two groups are assigned to each variable for independent confirmation. Once the variables have been selected, each group develops an experimental design to determine if the variable affects the amount of force required to lift the load. If you prefer, you can review the designs before allowing groups to begin their experiments.

Once the experiments are completed, each group shares their results with the class, and their data are posted on the board. As a class, you can then examine the data and determine the variables that affect the amount of effort needed to lift the weight.

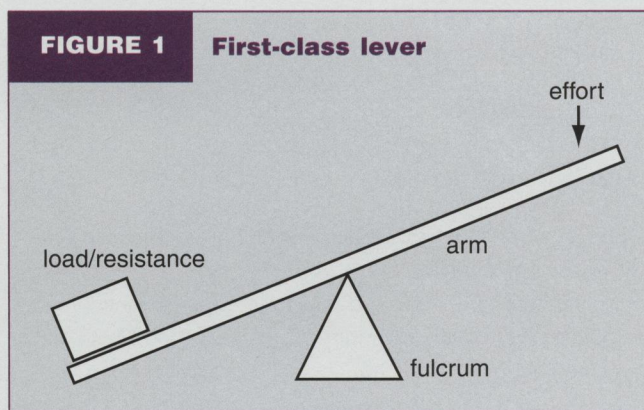
Final thoughts

Developing inquiry activities for your classroom can feel like a daunting task. However, you will find that many of the science lessons you already teach can be adapted to a scientific inquiry approach. As you plan to adapt lessons, look for those that involve testable questions, as do many of the lessons about motion and forces. Students get excited about posing authentic questions and having the opportunity to test them. They are naturally curious, and providing them with a variety of activities that allow them to construct meaning will not only spark their interest in science, but will also enhance their achievement.

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Lever lessons

Part A

Materials (per group)

- one 1" × 4" boards
- triangular block of wood
- load (300 to 500 mg, identical for each group)
- spring scale
- large rubber band

Setup

1. Use a red pen to mark 1-cm increments along the length of the board.

Procedure

1. Place the board on top of the triangular block of wood to create a seesaw arrangement.
2. Place the load on one end of the board.
3. Attach the spring scale to the other end of the board. The spring scale is attached by hanging it from a large rubber band approximately 2.5 cm from the end of the lever.
4. Record the distance between the fulcrum and the load, and the fulcrum and the effort using the centimeter markings on the board.
5. Press down on the end of the board attached to the spring scale until the mass is lifted off the table. The load should be lifted 5 cm off the table and held at that height while a reading is taken from the spring scale.
6. Take a reading from the spring scale and record it in a data table. Take 3 to 5 readings from the spring scale, and record the average of these in a data table.
7. Share your findings—the spring scale readings and the distances between the fulcrum, load, and effort—with the class. Your teacher will record the class data in a table on the board.

Questions

1. Each group had an identical load to lift. How do you explain the different forces required to lift it off the table?
2. What variables can you identify in the experimental setup?
3. Which ones do you think affect the amount of force required to lift the load?
4. Which one do you think will have the greatest effect? Why?

Part B

Materials

- 1" × 4" boards of different lengths (50 to 100 cm), marked in 1-cm increments
- triangular blocks of wood of different sizes
- load (300 to 500 mg, identical for each group)
- rubber band
- spring scale

Procedure

1. Select one of the following four variables that you would like to investigate to see how they affect the amount of force needed to lift the load:
 - the placement of the fulcrum (and corresponding lengthening or shortening of the lever arm)
 - the length of the lever
 - the size of the fulcrum
 - the position of the load on the lever
2. Devise experimental procedures to test the variable. Be sure to design an appropriate data table to record your findings and observations.
3. Conduct your experiments and then share your data with the class. Your teacher will post your data on the board.

Questions

After analyzing and discussing the data collected by the class, answer the following questions.

1. A friend, who is much smaller than you, asks you to join him on a seesaw. Where should each of you sit to enjoy a balanced ride? Provide a sketch of where each person would sit. Explain why you selected these positions. Use data from class to support your decisions.
2. You are having trouble opening a heavy trapdoor. You decide to purchase an iron crowbar to help you. What would you look for in a crowbar to make your job easier? Sketch how the bar might be positioned and label the fulcrum, effort, lever, and load.

Standards

This lesson was developed to incorporate Content Standard B by engaging students in active construction of ideas and explanations related to motion and forces as students discover how the use of first-class levers makes work easier. The lesson also incorporates Content Standard A by providing an opportunity to develop skills

necessary to do scientific inquiry such as asking scientific questions, investigating those questions, and constructing reasonable explanations in answer to the questions. In addition, students have the opportunity to use process skills such as predicting, inferring, hypothesizing, observing, manipulating materials, collecting and recording data, and communicating.