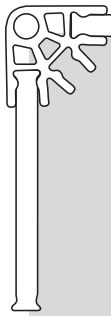


# The Wheelbarrow:

An example of a 2nd Class lever.



## OBJECTIVES

### Students will:

1. Identify the fulcrum, resistance and effort on a wheelbarrow.
2. Determine the lever class of a wheelbarrow.
3. Demonstrate how the wheelbarrow functions as a 2nd Class lever.
4. Modify the wheelbarrow to make lifting a load even easier.

## MATERIALS

### Each group of 2 students will need:

- |  |   |   |
|--|---|---|
| - 1 K'NEX Levers and Pulleys Building Set with Building Instructions booklet | - Marker  | - A piece of aluminum foil or plastic wrap, approximately 15 x 20 cms. (6 x 8 inches) |
| - Extra K'NEX pieces   | - Dot stickers or pieces of masking tape                | - Student Journals  |
|  | - A large pile of washers, small paper clips or pennies |   |

## PROCEDURE

### Introduction

- Review the concept that simple machines help to make work easier. Remind the class that they have already discovered, with the seesaw activity, how a 1st Class lever can help lift a heavy load (an adult) with only a small amount of applied effort (a small student), so long as the load is positioned close to the fulcrum. This principle is the basis of all levers – **if a heavy load is positioned close to the fulcrum, less force (effort) is needed to move it.**
- Review with the class where the fulcrum, load and effort are located in a 1st Class lever. Refer to the examples displayed around the classroom.
- Ask the class if they would use a seesaw or a balance to move a heavy load across their back yards. Probe for reasons for their responses.

*Students should respond that the seesaw moved a load vertically and not horizontally and would be of no use to them in this situation; the balance, in the form of two equally weighted carriers, could be used, but only if they could first lift it vertically onto their shoulders.*
- Ask what else they could use to move the load across the yard. (*Students may suggest a 4-wheeled cart, a handcart, or a wheelbarrow.*) Explain that they will continue their investigations into levers by building and experimenting with a wheelbarrow. The students may be familiar with a wheelbarrow but not recognize it as a lever in action. Explain that a wheelbarrow is a lever but, because it has a wheel, it not only lifts a heavy load but it can make transporting that load easier - the wheel on the front reduces friction with the ground.
- Ask the following questions:

  - (a) What types of loads are generally carried in a wheelbarrow?
  - (b) How are wheelbarrows loaded and unloaded?

**Building Activity**

- Organize the class into teams of 2 (maximum 3) students and distribute 1 K’NEX Levers and Pulleys Building Set to EACH group.
- Invite the students to build the **WHEELBARROW** model (Pages 6-7 of the Building Instructions booklet.) We recommend that one student build Steps 1-2 and the other, Steps 3-4. The parts should then be assembled, as shown, to form the completed wheelbarrow..
- **BUILDING TIP: Add gray spacers to the axle, one on either side of the wheel. This will provide greater stability as the wheelbarrow carries its load.**

**Inquiry Activity: How does a 2nd Class lever make moving a heavy load easier?**

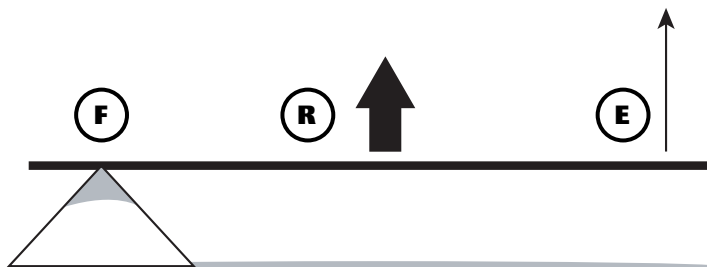
- Encourage the students to explore their machine to discover where the fulcrum (pivot point,) load and effort force are located.
- Ask the students to prepare stickers, or tape, to identify and label the parts of the wheelbarrow.

**F** - Fulcrum

**L** - Load

**E** - Effort

- They should position their labels in the appropriate places.
- Ask the students to which class of lever the wheelbarrow belongs and why. *(They should look at the examples displayed around the classroom for clues.)* On the blackboard draw a diagram to show the positions of the fulcrum, load and effort in a 2nd Class lever. Using the diagram, ask them to think about the characteristic features of a 2nd Class lever. Record their answers on the board. Leave this information on the board for reference.



- *The resistance is always closer to the fulcrum than the effort.*
- *Resistance and effort always move in the same direction.*
- *Work is easier because the effort is applied a long way from the fulcrum. (There is a long effort arm to magnify the force.)*

- Use the following script to help the students inquire into how a 2nd Class lever helps to make moving a heavy load easier.

**Steps**

1. (a) Ask one student from each group to collect a large pile of washers, paper clips, or pennies from the teacher’s desk. Ask them to carry the pile back to their work area in one hand only.
- (b) Was it hard to carry these loose items in your hand? Did any fall out on your way to your desk?
- (c) While many of you managed to return to your desks without dropping anything, do you think that would have been possible if you had been provided with a large handful of sand?

*Students should notice that the loose items can easily fall out of their hands as they transport them to their desks. Sand would easily slip through their fingers.*





2. (a) Give each group a sheet of aluminum foil or plastic wrap.
- (b) Line the tray of the K'NEX wheelbarrow with the aluminum foil or plastic wrap. Fill the tray with the pile of washers, paper clips, or pennies. Then use the wheelbarrow to lift, move, and dump the load. Make sure you dump the load over the front of the wheelbarrow, not the side.
- (c) What did you notice about moving the pile of material with the wheelbarrow? What kinds of loads would be easiest to move in a wheelbarrow and why?

*Students should notice that it is easier to move the loose pile in the wheelbarrow because it is collected in one place and all they have to do is lift the handle to move it. The wheelbarrow can be used to move many different loads, but is particularly useful for moving loose, heavy loads like sand or bricks.*


- (d) Imagine that you have to provide someone who has never used a wheelbarrow with precise instructions for its use. In your journals record step-by-step what they need to do.

*Students should include: place objects in the wheelbarrow - apply effort to lift the handles and the supports so that the wheelbarrow pivots on the wheel - this lifts the load at the same time - apply effort to push the wheelbarrow forward - the wheel helps overcome friction as the wheelbarrow travels over the ground - apply more effort to raise the handles higher to dump out the load - lower the handles of the wheel barrow so the supports rest on the ground.*

3. (a) An even heavier load needs to be moved. What changes could be made to your present design to allow it to move this heavier load without increasing the effort needed to lift the handles? Using extra K'NEX pieces, change your wheelbarrow to make it easier to lift the load. (Students may need some help with this; ask them what they know, from their inquiries so far, about making a load easier to move.)
- (b) What did you do to your model to make it easier to lift the load?
- (c) Why did you choose to do that?

*The wheelbarrow is a 2nd class lever so to make lifting easier, the students should **lengthen the wheelbarrow's handles**. This will move the effort even further from the fulcrum and make it easier to lift the load.*

### Applying The Idea

 Review with the class the characteristics of a 2nd Class lever:

- (a) Where is the fulcrum located?
- (b) Do the effort and resistance (load) move in opposite directions, as is the case with a 1st Class lever?
- (c) What happens when the effort is applied to the lever a long way from the fulcrum?

*At one end of the lever, closer to the load than the effort.*

*No. Effort and resistance always move in the same direction. Lift up the lever and the load also moves upwards.*

*It increases the force and makes work easier.*

- Ask the students to record in their journals the reasons why the wheelbarrow is a 2nd Class lever and how this helps make lifting heavy loads easier. They should include diagrams and sketches.

*Students should understand that the effort is further from the fulcrum than the load and that **the longer the effort arm, the more the effort force is multiplied.** This makes it possible to move a large load with a small input of effort.*

- Using K'NEX, invite the students to build another example of a 2nd Class lever. Ask them to explain how the machine works and why it is a 2nd Class lever.

*Suggestions for 2nd Class lever model - door, paper cutter, joystick.*

### Extending The Idea

Using the library and Internet, investigate a **travois** and find out how Native Americans on the Great Plains used this tool to move heavy loads. Explain that not all cultures use the wheel to help move heavy loads.

Explain how a travois is like a wheelbarrow. You may want to visit this web site for information:  
<http://www.encyclopedia.com/html/t1/travois.asp>

*Like a wheelbarrow, a travois is a device used to transport a load. It consists of a pair of long poles hitched to a horse or dog. The load is strapped across the poles. The animal pulls the load as it walks while the ends of the poles drag on the ground. The travois is like a wheelbarrow, without the wheel; it is pulled instead of pushed.*

### JOURNAL CHECK:

- ✓ Identification of the wheelbarrow as a 2nd Class lever.
- ✓ Characteristics of a 2nd Class lever, with diagrams.
- ✓ Reasons why a 2nd Class lever makes work easier.

