

Second Class Levers

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In a second-class lever, the resistance is placed between the effort force and the fulcrum. Let's see how this lever differs from the first class lever.

OBJECTIVES

In this experiment, you will

- Use a computer to measure force.
- Calculate actual mechanical advantage (AMA).
- Calculate the ideal mechanical advantage (IMA).
- Calculate the efficiency of the second-class lever.
- Compare the first and second-class levers.

MATERIALS

Computer

Go Link Adapter

LoggerLite Software

Vernier Force Sensor

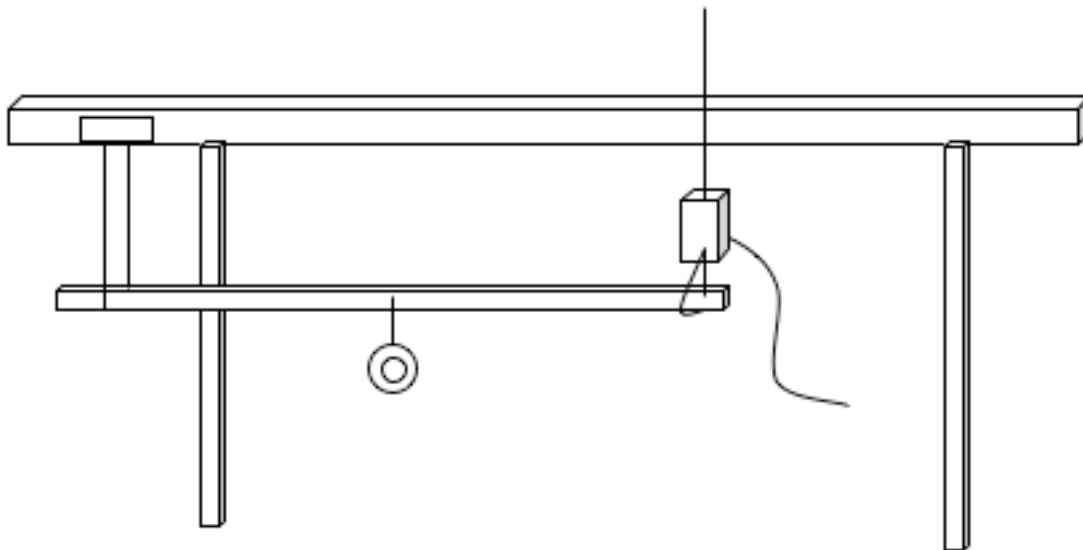
3-loops of string

Meter stick

Large washers (about 150g)

Duct tape or packaging tape

Figure 2



PROCEDURE

1. Connect the Go Link Adapter to the computer USB port. Plug in the Dual-range Force sensor to the Go Link adapter. Set the range switch to 10N. Prepare the computer for data collection by opening the file “30 First Class Levers” from the *Middle School Science with Computers* folder.
2. Zero the Force Sensor with its hook pointing down.
 - a. Attach a loop of string to the hook of the Force Sensor.
 - b. Hold the Force Sensor in a vertical position with its hook pointing down. Make sure the hook and string are not touching anything.
 - c. Click to zero the sensor.
3. To measure the resistance force (F_r) for Trials 1, 2, 3 and 4 hang the resistance from the Force Sensor. After the reading has stabilized, record this force reading in the Resistance Force blanks for Trials 1, 2, 3, and 4.
4. Zero the Force Sensor with its hook pointing down once more.
 - a. Remove the loop of string from the Force Sensor.
 - b. Hold the Force Sensor in a vertical position with its hook pointing down.
 - c. Click to zero the sensor.
5. Set up your second class lever as shown in Figure 2.
6. Attach your fulcrum string to the table with tape. Place the fulcrum string on the 5 cm line of your meter stick.
7. Slide your bundle of washers (resistance) over the meter stick and position it at the 70 cm mark. Attach the other loop of string to the hook of the Force Sensor. Loop this string over the meter stick at the 95 cm mark. With the resistance between the fulcrum and the effort, this is a second-class lever. Record the distance from the fulcrum to the resistance and the distance from the fulcrum to the effort. Click the “START” button to begin data collection. Pull up with the Force Sensor until the meter stick is balanced. Click the “KEEP” button. Record the force needed to balance the meter stick. This is the effort force (F_e).
8. Now place the resistance at 50 cm mark. The position of the fulcrum and the effort force (force sensor) should not change. Repeat Step 7.
9. Now move the resistance to the 30 cm line. The position of the fulcrum and the effort force should not change. Repeat Step 7. Repeat with the resistance located at 10 cm. When you have finished your last trial, click “STOP” to end data collection. Save your results to your desktop.
10. Label the diagram of your second-class lever. Label the resistance force and effort force. Draw arrows to indicate the direction of the applied effort force. Draw an arrow to indicate the direction of the resistance movement when the effort force is applied.

DATA

Trial	Position of Resistance (cm)	Resistance distance (cm)	Resistance force (N)	Effort distance (cm)	Effort force (N)
1	70				
2	50				
3	30				
4	10				

PROCESSING THE DATA

1. What did you observe?
2. What happened to the force needed to lift the resistance as the distance between the resistance and fulcrum decreased?
3. In what direction is the force being applied?
4. In what direction is the resistance moving?
5. What will be gained by using a second-class lever? What do you lose?

6. Calculate the actual mechanical advantage for each of your four trials using the formula

$$AMA = F_r / F_e$$

where AMA = actual mechanical advantage, F_r = resistance force, and F_e = effort force. Record in the table on the next page.

7. Ideal mechanical advantage is determined by the formula

$$IMA = D_e / D_r$$

where IMA = ideal mechanical advantage, D_e = effort distance, and D_r = resistance distance. Calculate the ideal mechanical advantage of the levers you tested. Record in table.

8. Calculate the efficiency of the second-class lever, using the formula:

$$\% \text{ Efficiency} = AMA/IMA$$

Record the results in the following table.

Trial	AMA	IMA	Percent Efficiency
1			
2			
3			
4			

9. What happened to the mechanical advantage as you shortened the resistance distance?

10. What was the average efficiency of this simple machine?

11. Give a real-life example of a second-class lever.

* Go to Activity “Third Class Levers”.