Third Class Levers

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

OBJECTIVES

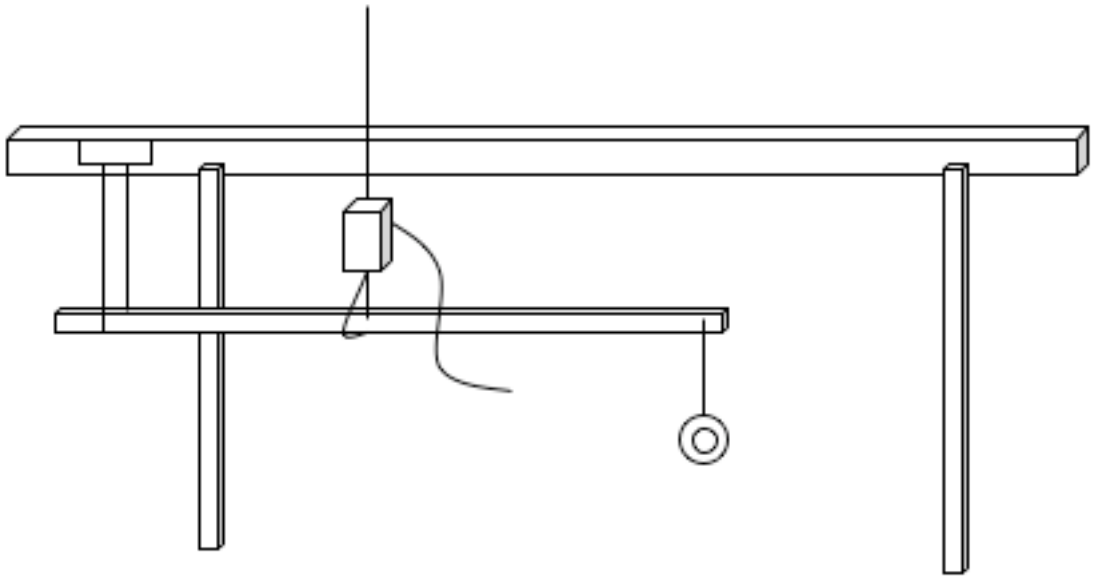
In this experiment, you will

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

MATERIALS

Computer	3-loops of string
Go Link Adapter	Meter stick
LoggerLite Software	Large washers (about 150g)
Vernier Force Sensor	Duct tape or packaging tape

Figure 3



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 Zero to zero the sensor.

3. To measure the resistance force (F_r) for Trials 1, 2 and 3 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, and 3.

4. Zero the Force Sensor again with its hook pointing down.
   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 Zero to zero the sensor.

5. Set up your third class lever as shown in Figure 3.

6. Attach your fulcrum string to the table with tape. You will need to shorten/tighten the loop so that the meter stick inserted in the loop can barely move. Place the fulcrum string on the 5 cm line of your meter stick.

7. Slide your string attached to your force sensor over the meter stick and position it at the 80 cm mark. Attach your resistance to the meter stick at the 95 cm mark. With the effort force between the fulcrum and the resistance, this is a third-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 resistance should not change. Repeat Step 7.

9. Now move the resistance to the 20 cm line. The position of the fulcrum and the resistance should not change. Repeat Step 7. 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 third 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 Effort Force (cm)	Resistance distance (cm)	Resistance force (N)	Effort distance (cm)	Effort force (N)
1	50				
2	70				
3	90				

PROCESSING THE DATA

1. What did you observe?

2. What happened to the force needed to lift the resistance as the distance between the effort force 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 third-class lever? What do you lose?

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

$$\text{AMA} = F_r / F_e$$

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

6. Ideal mechanical advantage is determined by the formula

$$\text{IMA} = D_e / D_r$$

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 the table.

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

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

Record the results in the following table.

Trial	AMA	IMA	Percent Efficiency
1			
2			
3			

8. What happened to the mechanical advantage as you decreased the effort distance?

9. Give a real-life example of a third-class lever.

Conclusions:

Write a summary of what you learned about levers. Compare and contrast each lever type discussing amount, location and direction of effort force, resistance force and resistance movement, and efficiency to the best of your ability. State the advantages and disadvantages of each type of lever.