Part 1 - 1<sup>st</sup> Class Levers
In this part of the lab you will find out how changing the position of the resistance arm affects the mechanical advantage. A spring scale will be used to measure the resistance and the effort involved. Both the resistance and the effort are forces and should be measured in Newtons. However, not all spring scales are marked in Newtons so you may have to convert grams to Newtons by using the following relationship: 1000 g = 9.8 Newtons. If for example, you use a 100 g mass, a force of 0.98 Newtons is needed to lift it.

Materials: meterstick, spring scale, string, 500 g mass, triangle fulcrum

Procedure: Record all data on the separate data sheet.

1. Answer the hypothesis question on the data sheet.

2. Hang the 500 g mass from the spring scale. Read the force in Newtons and record as resistance in the data chart. **You will use the same mass for all of Part 1.**

3. Set up a 1<sup>st</sup> class lever as shown in the diagram provided by placing the meterstick on the fulcrum at the 50 cm mark. Place the string that will hold the spring scale (the effort arm) at the 90 cm mark. Place the 500 g mass so it is centered at the 10 cm mark. The effort arm and resistance arm are of equal length. This is lever A. **A diagram is drawn** in the data chart which shows the position of the fulcrum, effort, and resistance on the meter stick.

4. Pull down on the spring scale until your pull (effort) just balances the resistance of the 500 g mass. The meterstick should be level. Record the effort on the data chart.

5. Now place the 500 g mass on the 30 cm. Mark and repeat Step 4. The effort arm is twice as long as the resistance arm in this lever. This is lever B. **Draw a diagram** in the data chart which shows the position of the fulcrum, effort and resistance.

6. Now place the 500 g mass on the 42 cm. Mark and repeat step 4. The effort arm is 5 times as long as the resistance arm in this lever. This is lever C. **Draw a diagram as you did for Lever B.**

7. Place the string that holds the spring scale on the 70 cm mark and the 500 g mass on the 10 cm. Mark and repeat step 4. The effort arm is one half as long as the resistance arm in this lever. This is lever D. **Draw a diagram as you did for the other 1<sup>st</sup> class levers.**
PART 2 - 2nd CLASS LEVERS
A 2nd class lever has the resistance between the fulcrum and effort. This means that the effort arm is always longer than the resistance arm. In this part you will investigate how this affects the mechanical advantage. Also, you will find out how moving the resistance affects the mechanical advantage.

Procedure: Record all data on the separate data sheet.

1. Answer the hypothesis question on the data sheet.

2. Record the resistance of a 500 g mass in the data chart

3. Set up a 2nd class lever as shown in the diagram provided. Make the effort arm (the distance between the spring scale and the fulcrum) 60 cm. Make the resistance arm (the distance between the center of the 500 g mass and the fulcrum) 45 cm. This is lever A. **Draw a diagram** of this lever in the data chart which shows the position of the fulcrum, effort, and resistance.

4. Pull up on the spring scale until your effort just balances the resistance. The meterstick should be level. Record the effort on the data sheet.

5. Change the position of the resistance so it is 30 cm away from the fulcrum. Do not change the length of the effort arm. This is lever B. **Draw a diagram** of this lever as you did before. Repeat step 4.

6. Now position the resistance so it is 15 cm. Away from the fulcrum. Do not change the length of the effort arm. This is lever C. **Draw a diagram** of this lever in the data chart. Repeat step 4.

PART 3 - 3rd CLASS LEVERS
In a 3rd class lever, the effort is between the fulcrum and the resistance. This means that the effort arm is always shorter than the resistance arm. In this part of the lab you will investigate the mechanical advantage of a 3rd class lever by changing the position of the effort.

Procedure: Record all data on the separate data sheet.

1. Answer the hypothesis question on the data sheet.

2. **Hang a 200 g mass** from the spring scale and record its resistance force in Newtons on the data sheet. You will use the same mass for all of Part 3.

3. Set up a 3rd class lever as shown in the diagram provided. Note that the end of the lever is taped to the underside of the table and that the edge of the table acts as the fulcrum. Position the string to which you will fasten the spring scale 45 cm away from the fulcrum.
Setting up the rest will require 2 people. Be careful not to drop the spring scale or 200 g mass on the floor. Put the 200 g mass so that it is centered 60 cm away from the fulcrum. This is lever A. Draw a diagram of this lever which shows the position of the fulcrum, effort and resistance in the data chart.

4. Attach the spring scale to the string and pull up until your effort just balances the resistance. The meterstick should be level. Record this effort on the data sheet.

5. Change the position of the string so it is 30 cm away from fulcrum. Do not change the position of the mass. This is lever B. Draw a diagram of this lever in the data chart. Repeat step 4.

6. Now change the position of the string so it is 15 cm away from the fulcrum. Do not change the position of the mass. This is lever C. Draw a diagram of this lever in the data chart.
### 1st Class Levers

**Hypothesis** - If the resistance arm is shortened, then the mechanical advantage will (increase, decrease, stay the same.)

<table>
<thead>
<tr>
<th>Diagram of lever</th>
<th>Resistance (R)</th>
<th>Effort (E)</th>
<th>Mechanical Advantage (R ÷ E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>▲</td>
<td>E</td>
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<td>B</td>
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<tr>
<td>C</td>
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<tr>
<td>D</td>
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</tbody>
</table>

### 2nd Class Levers

**Hypothesis** - If you move the resistance closer to the fulcrum, then the mechanical advantage will (increase, decrease, stay the same).

<table>
<thead>
<tr>
<th>Diagram of Lever</th>
<th>Resistance (R)</th>
<th>Effort (E)</th>
<th>Mechanical Advantage (R ÷ E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10</td>
<td>55</td>
<td>7</td>
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<td></td>
<td>▲</td>
<td>R</td>
<td>E</td>
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<td>B</td>
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<td>C</td>
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</table>

### 3rd Class Levers

**Hypothesis** - If I move the effort closer to the fulcrum, then the mechanical advantage will (increase, decrease, stay the same)

<table>
<thead>
<tr>
<th>Diagram of lever</th>
<th>Resistance (R)</th>
<th>Effort (E)</th>
<th>Mechanical Advantage (R ÷ E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
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</tr>
<tr>
<td>B</td>
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<td>C</td>
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</table>
CONCLUSION QUESTIONS - LEVER LABS

1\textsuperscript{st} Class Levers
1. How did the effort force compare to the resistance force when the effort arm and resistance arm were equal in length? (Lever A)

2. What was the mechanical advantage of the first class lever in which the effort arm and resistance arm were equal in length?

3. How did the effort force change when the resistance was moved closer to the fulcrum? How did the mechanical advantage change?

4. How did the effort force change when the EFFORT was moved closer to the fulcrum? How did the mechanical advantage change? (Lever D)

5. Did your results support your hypothesis? Explain why and be specific.

2\textsuperscript{nd} Class Levers
1. When the mechanical advantage was the lowest, was the resistance located close to the fulcrum or close to the effort?

2. When the mechanical advantage was the greatest, was the resistance located close to the fulcrum or close to the effort?

3. Did your results support your hypothesis? Explain why and be specific.

3\textsuperscript{rd} Class Levers
1. Which third class lever had the greatest mechanical advantage? (A, B, or C)

2. Which third class lever had the least mechanical advantage? (A, B, or C)
3. If you wanted to have the greatest possible mechanical advantage for a third class lever, would you move the effort closer to the fulcrum or closer to the resistance? Explain why using your data.

4. Did your results support your hypothesis? Explain why and be specific.

**General Questions**

1. Describe the difference between a 1\textsuperscript{st}, 2\textsuperscript{nd}, and 3\textsuperscript{rd} class lever in terms of placement of the effort, resistance and fulcrum. You may use diagrams, but be sure to label the fulcrum, effort, and resistance.

2. What CLASS of lever gave you the greatest mechanical advantage?

3. A 1\textsuperscript{st} class lever has the greatest mechanical advantage when the effort is located (close to or far from) the fulcrum.

4. A 2\textsuperscript{nd} class lever has the greatest mechanical advantage when the resistance is located (close to or far from) the fulcrum.

5. A 3\textsuperscript{rd} class lever has the greatest mechanical advantage when the effort is located (close to or far from) the fulcrum.

6. Why can’t a 3\textsuperscript{rd} class lever have a mechanical advantage greater than 1? (Hint: How do you calculate the IMA for a lever)