The Challenge: Engineer your Judo-Bot to knock over an opponent or push them out of the arena.

Time Limit: Two-minutes

Difficulty: Easy-Medium

Challenge Supplies

- Two (or more) assembled Judo-Bots
- Extra TeacherGeek components
- Arena materials (tape, chalk)
- Recycled or found materials
- TeacherGeek tools
- Timer
- Ruler

Tip: Build a base to stabilize your Judo-Bot.

These are example Judo-Bots. You can make them so much better. Engineer your bot for combat with different bases and end effectors.
Judo-Bots need an arena for combat. It consists of two rectangles marked on a flat surface. Use **tape** or **chalk** to outline, as shown.

**THE CHALLENGE**

Use **hydraulic power** to battle your Judo-Bots.

<table>
<thead>
<tr>
<th>Ready? Get Set!</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong> Place your Judo-Bot inside the <strong>arena</strong>, (no portion of the base should be outside the rectangle).</td>
</tr>
<tr>
<td><strong>B.</strong> Start with the bot’s lever arms <strong>not</strong> touching, nor extending over the opponent’s arena edge.</td>
</tr>
<tr>
<td><strong>Go!</strong> <strong>Battle for Two Minutes!</strong></td>
</tr>
<tr>
<td><strong>C.</strong> <strong>KO!</strong> Knocking an opponent over is an immediate win!</td>
</tr>
<tr>
<td><strong>D.</strong> If the opponent’s base is outside the arena by the end of two-minutes, they lose on default.</td>
</tr>
<tr>
<td><strong>E.</strong> Both bots in-bounds and upright by the end of two-minutes? <strong>It's a draw!</strong></td>
</tr>
</tbody>
</table>

**Note:** If both bots are “out-of-bounds” after two-minutes, measure with a ruler to determine which is further from the arena’s edge. **Shortest distance wins!**
(rules and limits for your design)

- Only **hydraulic power** may be used to move and control the Judo-Bot.
  - Hydraulic lines may not be pushed or pulled to move the bot - just **pistons**.
- The **base** may not be anchored (taped, screwed, bolted) to the arena surface.
- The weight of the Judo-Bot and components may not exceed **250 grams**.
- Additional materials should be brought in for Judo-Bot designs, if they are:
  - TeacherGeek Components
  - Found & Recycling Bin Materials
  - Teacher Approved
  - Non-Hazardous (no sharp edges, harmful chemicals, etc.)
- You will have ___________ to complete your design challenge.

How Will You Stabilize Your Judo-Bot?
The example Judo-Bot **base** is light and easy to tip-over. Its footprint (dimensions) should not exceed 18 cm x 35 cm. You can design your base to be any size - but consider:

**Center of Gravity**
The center of gravity is the point where your bot is **equally balanced**.

The **maximum weight** of your Judo-Bot should not exceed 250 grams (0.5 lbs). Where will you place your weight? Will you use heavy or light materials for your base and end effector?

**High Center of Gravity**
*Raising* the center of gravity with heavier end effectors makes the bot unstable. A top-heavy arm is great for whacking opponents!

**Low Center of Gravity**
*Lowering* the center of gravity by placing more weight on the base makes bots more stable.
Trading Force for Distance

Your Judo-Bot uses more than hydraulic power to move – **levers** allow you to trade **force** for **distance** in battle.

### Mechanical Advantage

\[
\text{Mechanical Advantage} = \frac{\text{Output Force}}{\text{Input Force}}
\]

### Try It Out!

Reposition the base’s cylinder as **high** on the upright as possible. Is the effort it takes to move the upright **easy** or **difficult**?

Reposition the base’s cylinder as **low** on the upright as possible. Is the effort it takes to move the upright **easy** or **difficult**?

Teachers **initial** here when students are finished:

### End Effectors

An **end effector** is the device or tool at the end of your lever arm. Its design changes how your Judo-Bot can battle – slapping, pushing, gripping, and swinging. Use found or recycling bin materials.

- Try **Styrofoam**, **old cardboard**, **paper**, **plastic**, **TeacherGeek components**
- Use blocks, screws, tape and **hole punchers** to attach your end effectors.
Tally your design’s wins + losses in the chart below. Record notes for the engineering process.

<table>
<thead>
<tr>
<th>Group Names</th>
<th>Win!</th>
<th>Lose!</th>
<th>What happened?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>[e.g. How did you win or lose? What parts of your design changed? How would you redesign your Judo-Bot for future competition?]</td>
</tr>
</tbody>
</table>
Use an elimination tournament bracket for class competition. This bracket can fit sixteen Judo-Bot teams or designs.