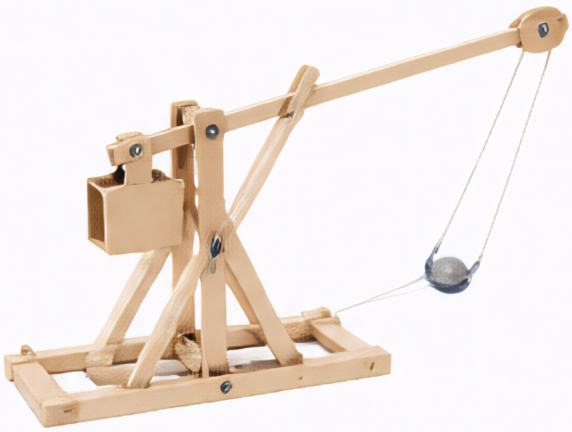
HOMESCHOOL SCIENCE EXPERIMENT

Name: _____ Date: _____

BUILDING A TREBUCHET
TO STUDY ANGULAR MOMENTUM



GOAL: Build a working trebuchet and investigate how changes to mass and lever arm affect angular momentum and the distance the projectile travels.

BACKGROUND

Angular momentum (L) is the rotational equivalent of linear momentum. It depends on mass (m), how far that mass is from the axis of rotation (r), and how fast it is moving (v).

$$L = I\,\omega$$

I = moment of inertia
ω = angular velocity

By changing the mass or the distance of the counterweight from the pivot, we change the moment of inertia (I) and angular momentum (L) of the arm, which affects how far the projectile is launched.

MATERIALS

- Wood or popsicle sticks (for frame and arm)
- Small plastic cup or bottle cap (sling)
- String or twine
- Screw/bolt and nuts (pivot)
- Small box or container (counterweight holder)
- Assorted washers or coins (counterweights)
- Hot glue or wood glue
- Tape measure
- Protractor (optional)
- Sticky notes and pen (for data table)
- Small foam ball, ping pong ball, or wadded paper (projectile)
- Safety glasses (recommended)

HYPOTHESIS

If I _____,
then I predict the projectile will travel _____
because _____
_____.

PROCEDURE

1. **Build Your Trebuchet**
   Construct a sturdy base and frame. Attach the throwing arm to the pivot so it swings freely.
   Attach a cup or cap to one end for the projectile (sling). Attach a counterweight holder to the other end.
2. **Choose Variables**
   Decide which variable you will change for each set of trials:
   - **Mass**: Change the mass of the counterweight (add or remove washers/coins).
   - **Lever Arm**: Change the distance of the counterweight from the pivot (move it closer or farther away).

   Keep all other factors the same (same projectile, same release method, same start angle).
3. **Set Up Measurements**
   Mark a launch line. Measure distance from the pivot to the launch line (keep constant). Use a tape measure to measure how far the projectile lands from the launch line.
4. **Run Trials**
   For each condition, swing the arm to the same starting angle and release without pushing.
   Record the distance the projectile travels. Repeat each condition at least 3 times and calculate the average.
5. **Calculate (Optional)**
   Estimate the moment of inertia change by considering mass and distance ($I \approx m r^2$ for a point mass).
   Compare how changes in I relate to launch distance.
6. **Clean Up**
   Disassemble carefully and store parts.

DATA TABLE

Record your results. Use additional rows if needed.

Trial #	Counterweight Mass (g)	Counterweight Distance from Pivot (cm)	Launch Distance (cm)
1			
2			
3			
3			
Average			

Constants (keep the same):

Projectile: _____

Start Angle (approx.): _____

Distance to Launch Line: _____

ANALYSIS & CONCLUSION

1. What happened to the launch distance when you increased the counterweight mass? _____
2. What happened when you moved the counterweight farther from the pivot? _____
3. How do your results support the idea that greater moment of inertia (I) leads to greater angular momentum? _____
4. What would you test next? _____

SAFETY FIRST! Always wear safety glasses. Do not stand in front of the trebuchet when launching. Use soft projectiles. Keep the area clear of people, pets, and breakable items.

Be curious. Be safe. Have fun experimenting!