

Preliminary Rules

Ballpoint Pen Top

Your objective is to design and build a spinning top out of a ballpoint pen. The top that spins for the longest period of time wins.

1. Top Construction:

- a. The top can be built out of any non-hazardous material, except as follows:
 - i. Pre-manufactured tops may not be used.
 - ii. Tops may not include lighter-than-air gases.
- b. All designs must use a 1 mm, round stick ballpoint pen for the axis of the top. Examples of this type of pen can be found here:
 - i. https://www.staples.ca/en/BIC-Round-Stic-Ballpoint-Pens-Medium-Tip-1-0mm-60-Pack/product_SS2122869_1-CA_1_20001
 - ii. https://www.staples.ca/en/Stick-Ballpoint-Pens-1-0mm-Assorted-50-Pack/product_506127_1-CA_1_20001
- c. The top must spin on the tip of the ballpoint pen.
- d. Only minor alterations to the body of the ballpoint pen are allowed, such as making small holes or slots for constructing the entire top. Adhesives may also be used, except on the tip of the pen. Disqualifying alterations include the following:
 - i. modifying the tip of the pen in any way;
 - ii. cutting the pen into multiple pieces, even if reattaching those pieces; and,
 - iii. shortening the pen.
- e. The fully-constructed top may not exceed 30 cm in diameter or height.
- f. The top's centre of gravity must be at least 1 cm above the tip of the ballpoint pen, measured upward from the tip along the spin axis.

2. Spinning Surface:

- a. The top must spin on the bowl-shaped bottom of an inverted 355 ml Canada Dry ginger ale pop-can¹ (see Figure 1). Any standard 355 ml pop-can may be used in lieu of Canada Dry.
- b. The judges will provide an unaltered pop-can that will be fixed to a base (e.g., a 30 cm by 30 cm piece of plywood -- actual dimensions may vary). *Figures will be included upon release of the final rulebook.*
- c. Teams may also choose to provide their own pop-can. If this option is selected, the pop-can must be unaltered, other than drained (if desired). The pop-can must be fixed to a base or incorporated into a spin-up device (see Section 3).
- d. The pop-can may not be held while the top is spinning, except during spin up and before timing begins.

3. Spinning up the Top:

¹ We chose to hyphenate *pop can* to avoid confusion between *can* and other verbs.

- a. The top may be spun up by either a simple hand twist or by using a spin-up device.
- b. If the team chooses to use a hand twist, then the top may only be spun by one person and that person may only use one hand. For the hand twist, no additional materials may be used (e.g., pulling by hand a string wrapped around the top).
- c. Instead of a hand twist, a spin-up device may be used, provided it meets the following specifications:
 - i. The top must be spun up using the energy released from a falling weight. No additional sources of energy are permitted. The launch device may not be combined with a hand twist.
 - ii. A 1 kg weight will be provided by the judges. The weight will have a hook on top for quick incorporation into the team's launch device.
 - iii. The weight may be dropped a vertical distance no larger than 1.8 metres.
 - iv. The pop-can and its base must be placed on a table with a tabletop height of 1 metre. The table will be provided by the judges.
 - v. The pop-can may be integrated with the launch device, provided the system is compliant with section 2.
 - vi. Parts of the launch device may be held or steadied by hand.
 - vii. Team members may not directly touch the top during spin up.

4. Scoring:

- a. The top that spins for the longest time wins.
- b. Time begins when the top has been spun up and is no longer touching a team member (for a hand twist only) or any part of the spin-up device.
- c. Time ends whenever the top stops spinning or whenever any part of the top, except the tip, comes in contact with the can, the launch device, the table, or any other object.
- d. In the event of a tie, the top with the highest centre of gravity wins.



Figure 1: The bowl-shaped bottom of an inverted 355 ml Canada Dry ginger ale pop-can.

Vinegar and Baking Soda-Powered Ballistics

Your objective is to launch a projectile a predicted distance using the pressure produced by mixing vinegar and baking soda. The team that best maximizes projectile distance and accuracy wins.

1. Launch Device Construction:
 - a. Teams must build a launch device that mixes vinegar and baking soda and then uses the resulting gas pressure to launch a projectile.
 - b. The launch device may be built out of any non-hazardous material. Care should be taken to ensure that the vinegar will not react with materials or adhesives used to construct the launch device.
 - c. The device must be designed and built by the team. Pre-manufactured devices will be disqualified. Device components that are pre-manufactured may be used.
2. Vinegar and Baking Soda Quantities
 - a. The judges will provide each team with 60 grams of white distilled vinegar (5% acetic acid by volume) and 36 grams of baking soda. Teams are not required to use the entire amount of vinegar or baking soda.
 - b. The baking soda and vinegar must be placed into the device during each team's competition time (section 8).
 - c. Only the vinegar and baking soda provided by the judges may be used in the device. Any additional pre-loaded vinegar, baking soda, or any other chemical will result in a disqualification.
 - d. Teams may bring their own measuring tools for placing the desired mixture of vinegar and baking soda into the device. A scale, dixie cups, and kitchen measuring spoons will be available for use, if desired.
3. Projectile Construction:
 - a. The projectile may be constructed out of any non-hazardous material.
 - b. The projectile should not pose any unreasonable risk to competitors, judges, or audience members.
 - c. Projectiles must be able to mark where the projectile lands with a washable material, such as washable marker ink, washable paint, etc.
4. Proving Grounds and Flight Trajectory:
 - a. The proving grounds consist of a launch zone, a hoop, and a landing zone.
 - b. The hoop is a hula hoop that is 85 cm in diameter (*actual size will be determined by availability and will be announced in the final rulebook*). The bottom of the hoop will be placed 60 cm above the floor.
 - c. All projectiles must go through the hoop to score.
 - d. Projectiles may be launched from any location within the launch zone, shown in Figure 2.

- e. The vertical distance from the floor to the tip of the projectile, as staged for launch, cannot exceed 45 cm.
 - f. Upon passing through the hoop, the projectile must land within the landing zone (Figure 2).
5. Range Prediction
- a. The range of the projectile is the perpendicular distance from the base of the hula hoop to where the projectile landed within the landing zone. The distance between the launch device and the hula hoop (i.e., within the launch zone) is not included in the range.
 - b. Prior to launch, each team must inform the judges the range that their projectile will travel. The judges will write down this prediction, and the team members will initial the prediction to verify that the judges wrote down the correct range.
6. Projectile Launch:
- a. The projectile may only be powered by gas pressure due to combining vinegar and baking soda. The use of any additional energy source (e.g., human, gravity, spring) will disqualify the team.
 - b. Team members may handle and manipulate the launch device, as long as the device is supported, in part, by the floor.
7. Scoring:
- a. Team scores are based on both projectile range and accuracy, as compared with the team's prediction.
 - b. Scoring is assigned as follows:
 - i. One point is awarded if the projectile passes through the hula hoop.
 - ii. If the projectile lands in the landing zone, additional points are awarded according to $X/\Delta X$, where X is the actual range and ΔX is the absolute difference between the predicted range and the actual range. Distances are measured in centimetres, and the minimum allowed ΔX will be 1 centimetre. As an example, assume that a team launches a projectile that passes through the hula hoop and has a range of 600 centimetres. If the team had predicted a distance of 500 centimetres, then the score would be 7.
 - c. Each team is responsible for ensuring that their projectile leaves a recognizable mark in the landing zone. Judges will also serve as spotters for the first-contact point of the projectile. In the event that a mark is not made or is not recognizable, the judges will use the spotted distance and apply a 1 point deduction.
8. Time and multiple attempts:
- a. Each team will have 4 minutes to prepare and launch their projectile. If a launch does not occur within this time period, then the team will be disqualified. Additional time may be awarded at the discretion of the judges should complications exist beyond the control of the team.
 - b. Each team may have a second launch attempt, provided the attempt can be made within the 4 minute window. Only the last launch will be scored.

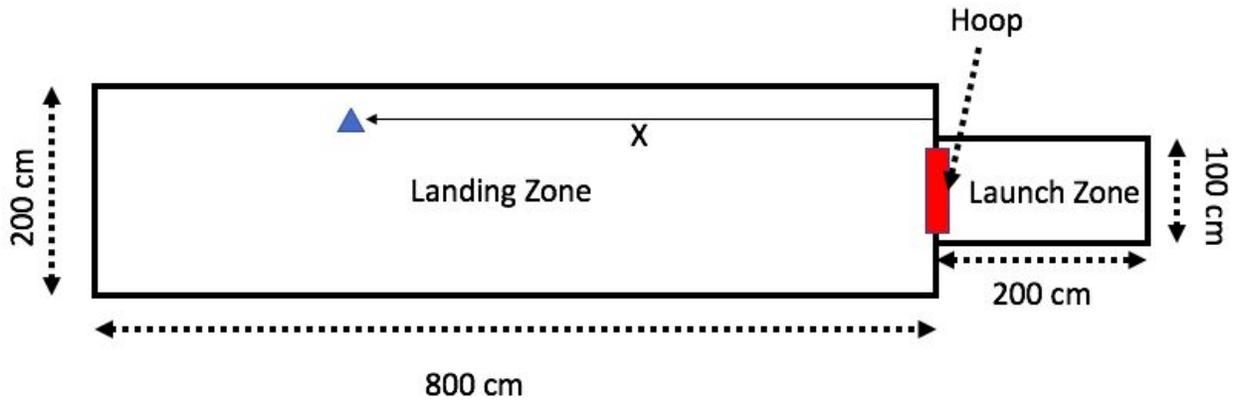


Figure 2: Proving grounds for the ballistics pre-build. All projectiles must start in the launch zone, pass through the hoop, and then land in the Landing Zone. The projectile range is the distance measured perpendicular to the base of the hula hoop. For example, if a projectile were to land at the location of the blue triangle, then the range would be given by the distance X.