

Rocket Catcher Challenge

Name: _____

Instructions

Date: _____

Overview: In this contest, you will try to build something to catch a rocket so it lands vertically. Watch this video to learn about the project: <https://sbgo.org/ec25video>

Materials

To enter your design in the 2025 Science Buddies Engineering Challenge, you can **only** use the following materials:

- **Standard rocket body.** Your rocket's body must be *one* of the following three options:
 - A single cardboard paper towel tube
 - Three cardboard toilet paper tubes taped together end to end
 - A single sheet of paper (printer, graph, construction, or notebook paper; letter, A4, 9"x12", or 22x30 cm) rolled into a 4-5 cm diameter circle, resulting in a cylinder that is roughly the same length and diameter as a paper towel tube
- **Tools** (cannot be used as part of your device or rocket).
 - Pencils
 - Scissors
 - Ruler, yard/meter stick, and/or tape measure
- **Construction materials.** These materials can be used to build the rocket-catching device and to modify the rocket body. Each item has a cost associated with it, as shown in the table on the next page. See the Score Sheet for details on calculating your score.

Item	Size/type restrictions	Maximum quantity	Cost (each)
Paper	Printer, construction, graph, or notebook paper. Letter, A4, 9"x12", and 22x30 cm sizes are all allowed. Cardstock and newspaper are not allowed.	40 sheets	3 points per sheet, rounded up to the nearest whole sheet
Cardboard	12"x12" (30x30 cm) sheet. Can only be used as a horizontal base plate. Cannot be cut into smaller pieces.	1	5 points
String	Any type up to 3 mm in diameter (dental floss, fishing line, cotton string, twine, yarn, thread, etc.)	10 meters	2 points per meter, rounded up to the nearest meter
Paper clips	Any size up to 2" (50 mm), metal, coated or non-coated	20	1 point
Tape	Maximum 1" (2.54 cm) wide, clear office tape, masking tape, or painter's tape are allowed. Duct tape, packing tape, and electrical tape are not allowed.	1 roll	0 points

Table 1. Construction materials that can be used for the 2025 Engineering Challenge, including maximum quantity and cost.

Rules

1. The rocket must start above the rocket-catching device and be dropped into/onto the device. It cannot be thrown or launched upward.
2. The rocket and the rocket-catching device must be separate. They cannot be touching or attached to each other at the start.
3. The rocket-catching device must be freestanding on the ground or floor. It cannot be attached to the ground or floor or to any other supporting object or surface, such as a wall or furniture. It cannot start in the air with the rocket.
4. You may not remove material from the standard rocket body.
 - a. You may attach materials (from the approved list) to the rocket body.
 - b. Anything that is attached to the rocket body counts as part of the rocket and must follow all of the other rules.
5. Any materials you use to modify the rocket body count toward your total materials cost.
6. No part of the rocket may touch the ground or any other objects (walls, furniture, etc.) during a test.
7. Your rocket-catching device must catch the rocket on its own. After the rocket has been dropped, nobody can touch the rocket or the rocket-catching device, or somehow assist the device in catching the rocket.
8. After all parts have completely stopped moving, the lowest point of the rocket, including all attachments, must be at least 10 cm from the floor, as shown in Figure 1.
9. After all parts have completely stopped moving, the rocket's main body must be vertical. "Vertical" is defined as an angle at least 45 degrees from horizontal, as shown in Figure 1.
10. You must complete 2 successful drops in a row from the same start height, with the same rocket and the same rocket-catching device (repairs in between trials are allowed).

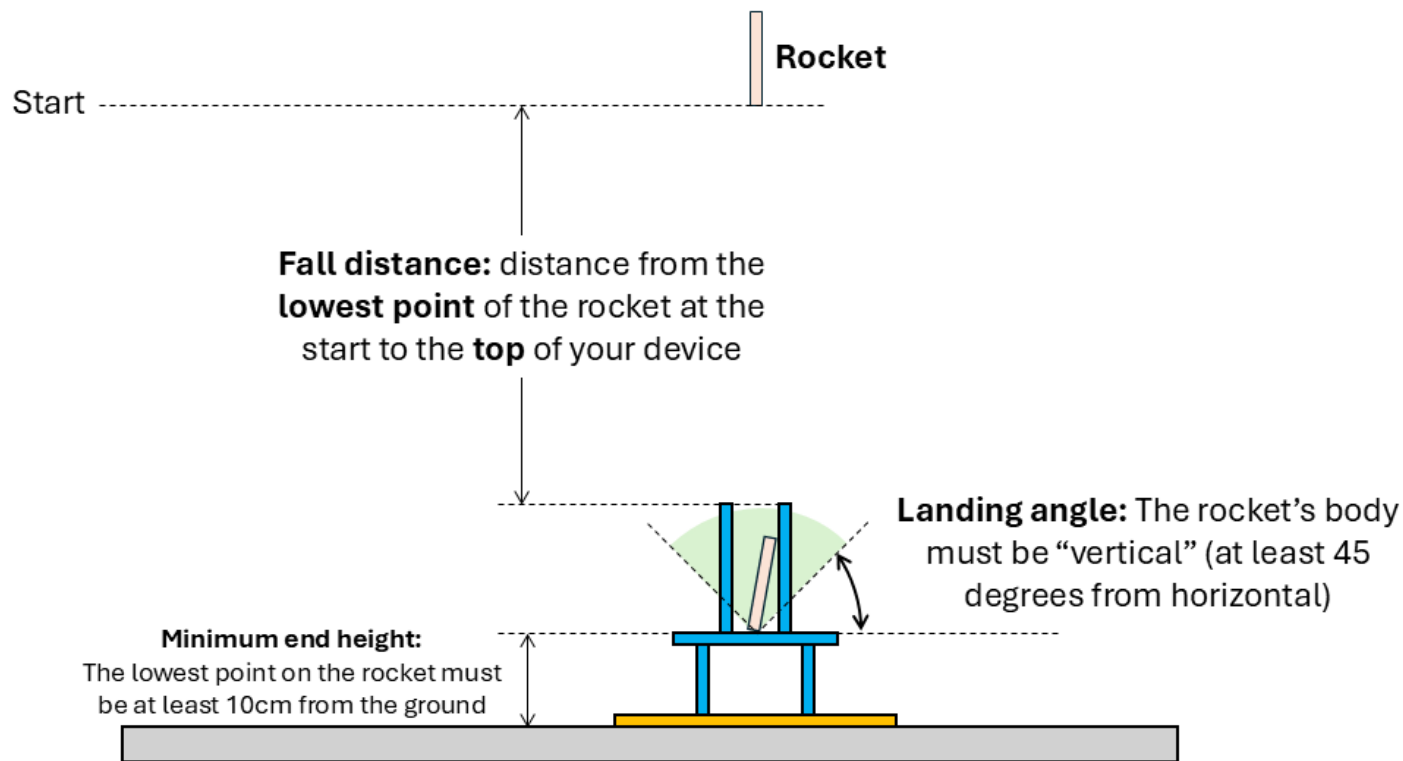


Figure 1. Diagram for challenge setup and measuring distances and the landing angle.

Scoring

Your final score is calculated with this equation:

$$\text{score} = \text{fall distance in centimeters} - \text{total materials cost}$$

The bigger your fall distance, the higher your score will be. However, try not to use too much unnecessary material, since the total materials cost is subtracted when calculating the final score.

Directions: Fill out this worksheet as you work on your project.

1. **Design.** Use this page to draw design ideas for two different rocket-catching devices. Remember that your designs can also include additions to the rocket body. Use the back of the page if you need more space.

2. **Compare.** Compare your two designs. Which one do you think will score higher in the contest? Why? Write down your answer.

3. **Share.** If you are working in a group, share your ideas with others. Talk about which designs will do the best in the contest. Decide as a group what kind of rocket-catching device you will build and what changes you may make to the rocket body. You can combine ideas from different people to make a single device.

4. **Build.** Once you have decided on a design, build your rocket-catching device and make any changes to your rocket body. You might need to make some changes as you build. That is OK.

5. **Test.** Test your rocket-catching device by dropping your rocket into it from a low height (just stand on the floor, hold out your arm, and drop the rocket). Write your answers to these questions after you test it.
 - a. Did your rocket-catching device work like you thought it would?

 - b. Did you have any problems when testing your rocket-catching device? What were they?

 - c. Why do you think these problems happened?

6. **Improve.** Your rocket-catching device probably did not work perfectly on the first try. That's OK! You might need to repair or improve it and try again. Based on your observations in step 5, what changes could you make to your rocket-catching device and rocket design to improve them?

7. **Test again.** Once you have repaired or improved your rocket-catching device, test it again. You can keep improving it as much as you want (as long as you have time). Can you drop your rocket from a higher location, for example, by standing on a chair or a desk? If the weather allows, you can even test it outside and drop your rocket from a deck or playground equipment. Continue testing until you get two successful drops in a row from the same height.
8. **Final design.**
 - a. What works well about your final design?

 - b. What could you improve if you had more time to work on your rocket-catching device?

9. Measure fall distance.

To submit your score, you will need to measure your rocket's fall distance. As shown in Figure 1, this is the vertical distance between the topmost point of your rocket-catching device and the lowest point of the rocket at the start. There are two ways to find this distance:

1. Measure the distance directly using a tape measure or meter stick.
2. If you find it easier to measure from the floor, then:
 - a. Measure your rocket's start height (the distance from the floor to the bottom of the rocket)
 - b. Measure your rocket-catching device's height (the distance from the floor to the topmost point of the device).
 - c. Subtract the device height from the rocket start height to get the fall distance.

Use this equation to calculate your fall distance if you used method #2.

$$\frac{\text{start height}}{\text{start height}} - \frac{\text{device height}}{\text{device height}} = \frac{\text{fall distance}}{\text{fall distance}}$$

To calculate your score, you will need to know your fall distance in centimeters.

If you measured in inches, convert to centimeters by multiplying by 2.54.

For example, 10 inches is $10 \times 2.54 = 25.4$ centimeters.

Use the Score Sheet on the next page to calculate your Final Score.

Note: When calculating your score, keep in mind the rules of the challenge and the limitations on how many of each material can be used (refer to the Rules and Materials sections of this worksheet).

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Name: _____

Score Sheet

1. What was your rocket's **fall distance in centimeters**? _____

(If you measured in inches, multiply inches by 2.54 to convert to centimeters.)

2. Use the table below to calculate your **total materials cost**.

- Enter the quantity for each item used in your final design. Materials used for earlier prototypes do not count.
- You cannot use more than the maximum allowed quantity of each item.
- If you use any portion of a piece of paper, it counts as one whole sheet of paper. The same rule applies for all materials. Do not enter fractions or round quantities down.
- Add up all the subtotals to calculate your total materials cost.

Item	Maximum allowed	Number you used	x Points (each)	= Points subtotal
Paper (printer, construction, graph, or notebook; letter, A4, 9"x12", or 22x30 cm size)	40		3	
Cardboard (12"x12" or 30x30 cm sheet)	1		5	
String (any type up to 3 mm in diameter), rounded up to nearest meter length	10 meters		2 per meter	
Paper clips (any size up to 2" or 5 mm)	20		1	
Total materials cost				

3. Calculate your score using this equation:

$$\frac{\text{fall distance in centimeters}}{\text{total materials cost}} = \text{score}$$

4. Round your score to the nearest whole number. The score submission form will not accept decimals. A score of 57.5 would round up to 58. A score of 57.49 would round down to 57.

Final Score