

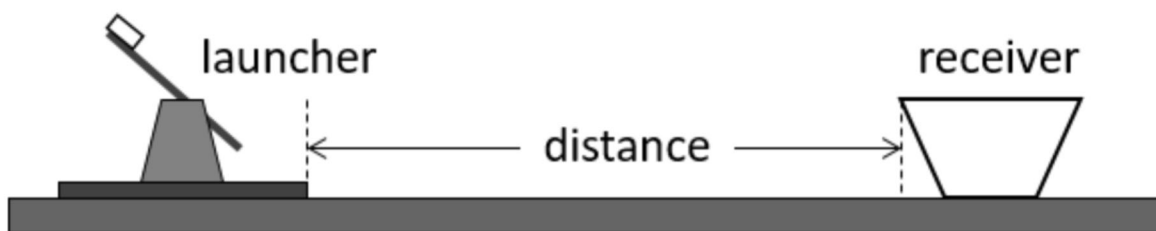
Ball Launcher Challenge

Instructions

Name: _____

Date: _____

Overview: Your goal in this project is to build a launcher that can launch a ball as far as possible and a receiver to catch the ball without letting it touch the ground. The “ball” will be a crumpled up sheet of aluminum foil.



Materials

You can use the following materials to build your launcher and receiver. Each item has a maximum allowable quantity and a point cost that will be deducted from your score.

Item	Maximum Quantity	Point cost (each)
Corrugated cardboard base (max size 12"x12" or 30x30 cm)	1	0
Large paper or plastic cups (16–18 oz, or about 450–500 mL)	4	50
Wooden ruler or paint stirrer (12"/30 cm)	2	100
Paper (printer/copier paper, not construction paper or card-stock; letter or A4 size)	10	10
Wooden pencils (circular or hexagonal cross-section, approx. 7–8" or 18–20 cm length)	10	10
Rubber bands (size 32, 3" long unstretched and 1/8" wide)	10	20
Large paper clips (approx. 2" or 50 mm length)	10	5
Roll of clear adhesive tape (Scotch® tape or equivalent, 1/2" or 3/4" width, max length 500")	1	100

Ball Launcher Challenge

Page 2

Name: _____

Scoring

Calculate your score using this equation:

$$\text{Total Score} = 50 \times (\text{distance in centimeters}) - \text{total materials cost}$$

where:

- The distance in centimeters is the distance between the launcher and the receiver, as shown in the figure on page 1.
- The total materials cost is the sum of the point costs for all the materials used in your final design, as shown in the table on page 1.

Rules

You must follow all of these rules when building and testing your device:

1. You can only use items listed in the table in the materials section to build your launcher *and* receiver.
 - a. The maximum quantities listed are total for the project, not for each separate device.
 - b. No other materials are allowed. For example, you cannot build your launcher out of LEGO® bricks.
 - c. The cardboard base must remain flat. It cannot be folded, and you cannot cut off smaller pieces to use for construction.
 - d. You are allowed to cut the materials (for example, cut a piece of paper in half, cut holes in a cup, etc.). However, point costs for the materials are not pro-rated.
2. The launcher must fit on top of a 12"x12" (about 30x30 cm) piece of cardboard. There is no height restriction.
3. The receiver can measure no more than 12" wide by 12" long (about 30x30 cm). There is no height restriction.
4. Only one person can operate the launcher at a time.
5. You can use both hands to load the ball into the launcher. You cannot touch the ball after it is loaded. You *cannot* use both hands to store energy in the machine (e.g., stretch a rubber band or raise a weight) only to load the ball.
6. You can use one hand to hold down the cardboard base of the launcher when launching the ball. You cannot hold on to any other part of the launcher in order to stabilize it or prevent it from moving.

Ball Launcher Challenge

Page 3

Name: _____

7. You can use only one finger to activate the launcher (if you are holding down the base with one hand, you will use one finger from your other hand). This includes any action that exerts a force or stores energy. For example, pressing on one side of a lever, stretching a rubber band, or lifting a weight into the air can only be done with one finger. You cannot use your whole hand or fist to strike a lever. You cannot use multiple fingers to stretch the rubber band and then include a "trigger" mechanism that allows you to release it with just one finger.
8. The receiver must be free-standing (it cannot be held in place or stabilized by a person, or taped to the ground). No one is allowed to touch the receiver during a test.
9. The ball must land and stay in the receiver without touching the ground or anything else (a wall, a person, etc.). The ball cannot roll or bounce into the receiver or bounce out of the receiver after landing in it initially. If the receiver falls over, but the ball remains in the receiver and does not touch the ground, that is OK.
10. There is no limit to the number of tests you can do to try to get a higher score, but you can only submit one official score per team.

Page 4

Name: _____

Student worksheet

Directions: Use this worksheet to document your ideas and progress as you work on the ball launcher challenge.

1. **Design.** Use this space to draw design ideas for your ball launcher and receiver.
2. **Build.** Compare designs with your teammates and agree on what you will build. You can build one person's design, or combine multiple designs into a single new design.
3. **Test.** Test your launcher and receiver, following the rules on pages 2-3. Does it work like you expected? Does anything break? How far can you launch the ball? How well does your receiver catch the ball? Write down your observations (answers to these questions and other things you notice) here.

Ball Launcher Challenge

Page 5

Name: _____

Student worksheet

4. **Iterate.** Your devices probably did not work perfectly on the first try. That's OK! You might need to cycle through steps 1-3 multiple times. What changes can you make to your design to improve it? What happens when you modify your devices and test them again? Write down three observations and/or changes you made here (draw new sketches if necessary).
5. **Final Design.** What is working well about your final design? What could be improved if you had more time?

Ball Launcher Challenge

Page 6

Name: _____

Student worksheet

6. Calculate your score.

- a. What was the distance between the launcher and the receiver (see figure on first page)?

_____ centimeters

- b. Use this table to calculate your total materials points. Even if you only used part of an item (like half a piece of paper or part of a roll of tape), you still have to count all the points for that item. Fill in the “number you used” column and then multiply by the “Points (each)” column to calculate the subtotal for each material.

Item	Points (each)	× number you used	= points subtotal
Large paper or plastic cups	50		
Wooden ruler or paint stirrer	100		
Paper (letter or A4 size)	10		
Wooden pencils	10		
Rubber bands (size 32)	20		
Large paper clips	5		
Roll of clear tape	100		
Total materials cost:			

- c. Calculate your total score using this equation.

$$(50 \times \text{distance in cm}) - \text{total materials cost} = \text{total score}$$