

## Legendary Legume Launcher

You will design and construct a launcher that will launch beanbags at a target placed on the ground at a variety of known distances (**Figure 1**). Your objective is to minimize the total distances off target for three launches. To do this, you will first need to calibrate your launcher carefully over a set of test launches at targets at distances of 8 m, 10 m, and 12 m.



Figure 1

### Purpose

To design and construct a beanbag launcher and calibrate it to fire beanbags accurately at various target distances

### Equipment and Materials

Select the equipment and materials you will need to construct, test, and calibrate your beanbag launcher. Include a list of these parts with the written description of your design. Be sure to include any necessary safety equipment, such as eye protection.

### Design

Prepare three labelled diagrams of your launcher, drawn to scale, and a written description of your design. The diagrams may be drawn on computer or by hand, and should include a left side view, top view, and front view. Your teacher will approve your design before you begin construction.

Consider the following when designing your launcher:

- How will your launcher be powered?
- How will your device launch a beanbag and successfully accomplish the assigned task?
- How will you ensure that your launcher is mechanically sound, environmentally friendly, and safe?
- How will you calibrate your launcher for various distances?
- How will you trigger your launcher?
- What will you do to ensure you fill your beanbags consistently?
- What will you do to make your launcher easy to transport, store, set up, and fire?
- What modifications are you considering for this project?
- Is there anything else about your project that you feel your teacher should know?
- Your launcher must be deemed to be completely safe by your teacher; otherwise, launches will not be allowed.
- Your launcher is to be no larger than 1.0 m<sup>3</sup> before launch and must be self-contained: it must not include a remote control or any wires, strings, or levers extending from it.
- The force propelling the beanbag must be mechanical. That is, human force may only be used to set the machine prior to launch. No explosives or compressed gases are to be used.
- Include a complete parts list for your project, specifying measurements and materials for each part.

### Procedure

1. Construct your beanbag. Beanbags must be made of non-rigid material and must be between 5.0 cm and 7.0 cm in diameter. Your teacher will check the size of the beanbag before it is launched. Dried beans in the beanbag must be in the same natural state as when purchased. No additives are allowed.
2. Construct your launcher according to your approved design.

- Complete trials to calibrate your launcher for distances of 8 m, 10 m, and 12 m by making test launches at each of these distances and adjusting the settings of your launcher. The target is a coloured pie plate 15 cm in diameter.
  - Present your calibration data in the form of a data table or graph.
  - For the final trial, launch three beanbags at each target. Only launches based on calibration data are allowed. Measure the distance from the centre of the target to where the beanbag hits the ground for each launch. If a beanbag breaks during a launch, you may relaunch. 
-  **No launches are to take place without teacher approval and supervision. You must indicate to your teacher when you are ready to launch, and you must receive teacher permission before launching your beanbag. Ensure no one is in front of the launcher. You must operate your launcher safely at all times. Eye protection must be worn at all times.**
- Record your final score as the sum of the three distances off target. The lower the sum, the better your launcher's performance.

### Analyze and Evaluate

- Describe what you did to adjust your launcher for the different calibration distances. 
- Based on your understanding of projectile motion, explain why the adjustments you described in Question (a) were effective.  
- For the final trial, explain how you determined the correct setup for your launcher. 

### Apply and Extend

- Discuss the environmental impact of your launcher and beanbag, and explain how you could reduce the negative environmental impact of your design.  
- Discuss changes you could make, either to your setup or to your design, to reduce the sum of your distances off target in your final trials.  

## ASSESSMENT CHECKLIST

Your completed Unit Task will be assessed according to the following criteria:

### Knowledge/Understanding

-  Demonstrate knowledge and understanding of the characteristics of projectile motion.
-  Demonstrate knowledge and understanding of the relationship between the horizontal and vertical components of a moving projectile.

### Thinking/Investigation

-  Develop a plan for constructing an effective beanbag launcher.
-  Construct and safely operate a beanbag launcher.
-  Incorporate environmental considerations into the design and construction of a beanbag launcher.
-  Analyze launch results.
-  Collect calibration data for a beanbag launcher.
-  Evaluate and modify your beanbag launcher design.

### Communication

-  Communicate to your peers how your beanbag launcher operates, has been modified, and has been calibrated.
-  Communicate to your peers the materials used.
-  Communicate in a clear and concise way.
-  Use appropriate terminology related to kinematics.

### Application

-  Alter a number of design variables to modify the projectile's motion.
-  Successfully achieve the goal of this Unit Task.
-  Build a mechanically sound, environmentally friendly, and safe beanbag launcher.