

Instructional Teacher Guide - Catapult Activity



Figure 1: Replica of a Petrarca Arcatius

Disclaimer

This activity guide is a general guideline of the engineering design process, intended to serve as a reference for teachers. The teacher is responsible to incorporate and comply with the New Generation Science Standards of design for 3rd to 8th grade students in their lesson plans.

Teacher preparation

For additional information about engineering concepts to aid the understanding of this activity visit the link below. In addition, It is recommended to watch the instructional teacher guide videos provided in the same link:

<http://research.engr.oregonstate.edu/pigroup/engineering-design-toolkit>

Materials

- One Engineering Design Toolkit containing all materials needed for this activity.



Figure 2: Engineering Design Toolkit

Constraints

The students are expected to finish activity within a 45-50 minute time frame. (Note: Every engineering design step has a recommended time limit shown in the engineering design process section of this document.)

Learning outcomes - The student must...

1. Show an understanding of the problem.
2. Show an understanding of the solution and the purpose of the solution.
3. Be able to plan/design the solution.
4. Be able to implement their plan to the solution with the materials provided.
5. Be able to test the solution.
6. Be able to understand why the solution does not work.

7. Show an understanding of the engineering design process steps.

Note: The learning outcomes are general guidelines of the engineering design process, intended to serve as a reference for teachers. The teacher is responsible to incorporate and comply with the New Generation Science Standards of design for 3rd to 8th grade students in their lesson plans.

Source: <http://www.nextgenscience.org/sites/ngss/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf>

Introducing the activity

To introduce the activity follow the following procedure:

Note: This procedure was only created with the intent to serve as a reference on how to structure and teach this activity. Teachers have the full flexibility of teaching this activity based on their teaching style.

1. Setup the materials for students before session starts as shown in Figure 3.



Figure 3: Engineering Design Toolkit materials setup for the Catapult activity

2. Introduce the Engineering design process to students.

- **Definition - Engineering design process:**

The engineering design process is a series of steps that engineering teams use to guide them as they solve problems. The design process requires that

engineers repeat the steps as many times as needed, making improvements along the way.

Sources: <https://www.teachengineering.org/engrdesignprocess.php>



Figure 4: Engineering Design Process

Source: <http://shop.dowlingmagnets.com/p/engineering-design-process-magnets>

3. Introduce the activity's problem description to the students.

Problem Description

Sarah a soldier of the Medieval area wants to build a catapult to shoot a ping pong ball onto a wall of plastic cups that is placed at a distance of 5ft. Sarah does not know how to adjust the correct angle to reach her goal of knocking down the castle wall made up of plastic cups. Sarah needs help building the catapult.

4. Instruct the students to follow the Engineering design process steps.

- **Step 1: Ask** (*Duration = 10 minutes*)
 - Question
 - What is the problem that Sarah is facing? (**Learning outcome 1**)
- **Step 2: Imagine and plan** (*Duration =10 minutes*)
 - Question
 - Why does Sarah need a catapult? (**Learning outcome 2**)
 - How can we make/build a catapult? (**Learning outcome 3**)
 - Mission
 - Have the students draw out their designs of the catapult on the whiteboard provided.
- **Step 3: Create** (*Duration = 20 minutes*)
 - Questions
 - Using the materials provided at hand, how will you make the catapult? (**Learning outcome 4**)
 - Mission
 - Show the students the possible designs diagram then let them create the catapult
- **Step 4: Test** (*Duration of 5 minutes*)
 - Questions
 - To check if the catapult works, we should test if the ping pong ball reaches a distance of 3ft when launched (**Learning outcome 5**)
 - Mission
 - Have the students test their catapult designs at the hallway by measuring a distance of 3ft. Launch the ping pong ball , if it reaches the distance then the catapult is a success.
- **Step 5: Improve** (*Duration = 5 minutes*)
 - Questions
 - For the catapults that did not reach a distance of 5ft , Why so? How can we re-make the catapult to improve it? (**Learning outcome 6**)
 - What have you learned ? (**Learning outcome 7**)

Adjusting difficulty (Optional)

New problem descriptions

Re-define problem statement so that the students explore the different angles, to identify the best angle that scores the ball into the cup as shown in figure 5.

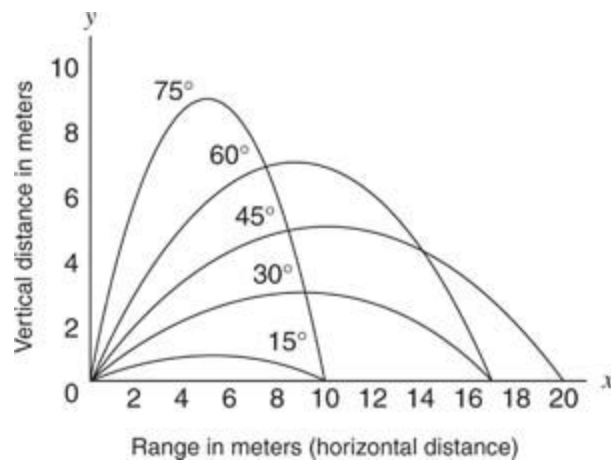


Figure 5: Angle vs horizontal distance relationship graph.

source: <https://myphysicsclass12.wordpress.com/2013/11/11/applications-projectile-motion/>