BALL-LAUNCHER DESIGN
Technology Education

Benchmarks:
ST-4: Use a simple design process to solve a problem.
ST-5: Describe possible solutions to a design problem.

Objectives:

Students will brainstorm solutions the problem of launching a ping pong ball the farthest distance traveling in a straight line. They will then design, build, and test a launching device while adhering to design constraints. This lesson should span two class sessions. Discover the relationship between launch angle and distance. Discover the relationship between spring extension (force) and distance.

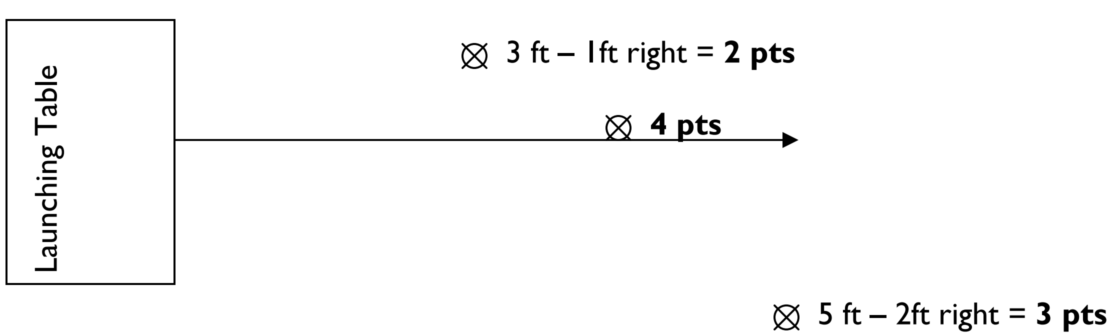
Background

- Around 1600, Galileo Galilei experimented with objects in motion. By rolling balls down a ramp, he was able to conjecture that an object in motion will not stop unless it interacts with something else.
- Galileo also showed that two objects of different masses will fall at the same rate. It is commonly believed that he demonstrated this by dropping objects off of the Leaning Tower of Piza.
- Galileo's experiments formed the basis for Isaac Newton's later formulation of the laws of motion:

1. An object in motion will remain in motion unless acted upon by an outside force.
2. The Force of an object is equal to its Mass times its Acceleration.
3. For every action there is an opposite and equal reaction.

These laws are still used today to determine everything from the distance a baseball will fly to the motion of the space shuttle around the earth.

Challenge
Make a catapult that will launch a ping pong ball the furthest distance in a straight line. One point will be deducted for each foot the ping pong ball lands away from the center line.



Name:
Partners Name:

Ball Launcher Design

Challenge

Make a catapult that will launch a ping pong ball the furthest distance in a straight line. One point will be deducted for foot the ping pong ball lands from the center line.

Consumable Materials

- 1 plastic spoon
- 2 rubber bands
- 8 craft sticks
- 2 straws
- 12 inches of masking tape (given day 2 only)
- Elmer's glue
- 1 piece of cardboard
- 10 inches of string

Non- Consumable Materials

- scissors
- ping pong ball (given day 2 only)

Design Rules

1. Complete launcher construction by the end of class on Friday.
2. Use only materials provided. You do not have to use all of the materials.
3. Launcher must be portable.
4. You will not be able to touch the ball when launching. The ball may not be pushed, pulled, or thrown by the student. The ball cannot be fixed/adhered to anything.
5. The launcher will be judged by the distance the ball flies before hitting the ground. We will mark the first place the ball hits the ground.
6. You may only use two fingers when launching your catapult. Again, you cannot touch the ball.
7. You will get 3 trials the day of testing

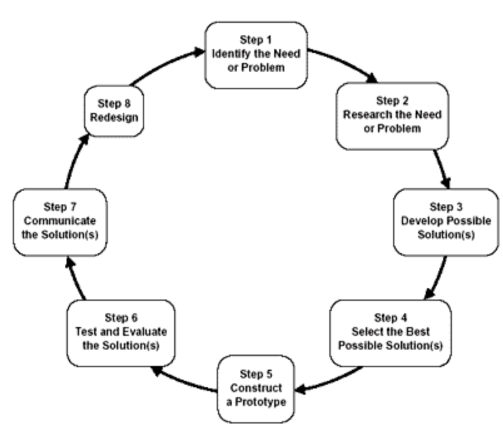
***DO NOT launch a ping-pong ball towards ANYONE. You will be given a lunch detention and book work for the remaining activity period.**

Day 1 Procedure

Your team of inventors' job is to create an invention that will launch a ping-pong ball as far as possible in a straight line. After each team builds a ball launcher, there will be a contest to see which design team comes up with the best solution. You must use a *design process*. Use the following design process to solve the problem:

1. Identify specifications
   - Are there any limitations? What materials/tools?
2. Research the Need or Problem
3. Develop possible solution(s)
   - Brainstorm possible solutions & sketch 2D & 3D
4. Analyze each idea and select the best possible solution(s)
   - Determine which solution is the best
5. Construct a prototype
   - Model the selected solution(s) in 2D & 3D
6. Test and evaluate the solution(s)
   - Does it work & meet the original design constraints?
7. Communicate the solution(s)
8. Redesign

Figure 1
Steps of the Engineering Design Process



I. Using a pencil in the space below sketch at least 3 ideas for a ping-pong ball launcher **INDIVIDUALLY!**

Idea 1	Idea 2	Idea 3

II. Discuss your plans with your partner. Pick the best design and draw it below showing the front, top, side, and isometric (3D) view below. Label materials!! Once your instructor has OK your drawing, then you will get your materials. **You will not receive your masking tape OR ping pong ball until tomorrow.**

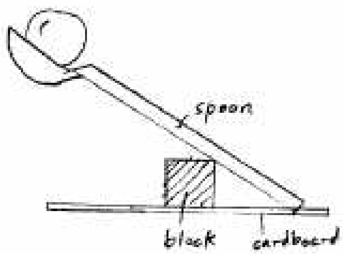
Top View	Isometric View (3D)
Front View	Side View

<u>Testing:</u> Write down your results below

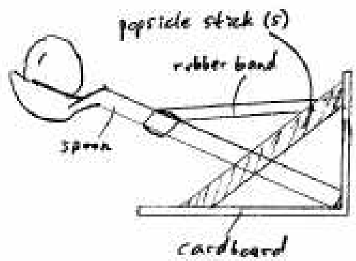
Trial 1	*Trial 2*	*Trial 3*

Question: How could you make your launcher better?

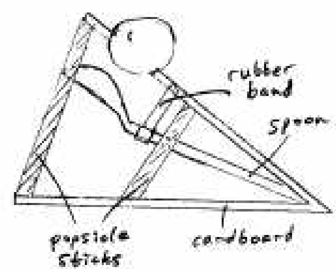
Option A – Heavy Guidance
If you believe your class could use significant help in this design process, or if time is short, you may want to explain some basic designs to them in advance, and let them choose which one they'd like to use. Three possibilities are given below, where the end of the spoon is attached to the cardboard in each case. Some other possible designs include a 1-2 hybrid, 3 but using a fulcrum (block) instead of a rubber band, or a 1-3 hybrid. Another possibility is similar to Design 3 but without a spoon, where a rubber band with a piece of wood or spoon taped to its center is stretched across the ball opening in the cardboard, and is simply pulled back and released, causing the wood or spoon piece to strike the ball. Assist the groups in their design and construction.



Design 1 – Throwing (spoon-bending)



Design 2 – Throwing (rubber band force)



Design 3 – Hitting (rubber band force)

Option B – Light Guidance
If time and/or the creative abilities of your class permit, let the groups begin their own design explorations with minimal assistance. Multiple trials may be necessary before a working ball launcher is built. Encourage groups to test their designs several times before the final launch.

Target Observations:

- Building a ball-launcher is challenging.

Target Revised Model:

- To invent a solution to a problem, such as launching a ball the farthest distance, requires the use of a design process. The best solution may not always be the first solution.

Procedure:

Day 3

Review the design process the students undertook during the previous meeting. Relocate them to a place where the launching competition can be carried out (Clear enough room in the classroom, use the hallway, or go to the playground.) and re-group them into their design teams. Allowing one student from each group to be the ball releaser, begin the competition. As a ball is launched, let another student from the participating group mark where the ball landed, while another student measures the flight distance. Allow 3 launches and count a group's best distance as its final result.

After each group has participated, tabulate the results, instructing the students to record the results in their journals. Compare each of the designs and have them think about why some worked better than others (SI-2, 3). Discuss the challenges and successes students experienced throughout the designing/building and launching process, while emphasizing problem-solving skills and the *different* kind of thinking they had to do.

Ask them what changes they could have made to their launchers to increase the ball's distance (SI-5). Let each group name their ball-launcher, entering this new name into the blank cell of the table they started during the previous science class.

Tell them that to improve technology, the build-test-modify part of the design process is often repeated many times. Finally, have students write in their journals a short summary of what they did during the last two science days, explaining the process they used to design the launcher and the challenges they faced.

Possible extension: Allow students more time (another day) to modify their designs, implementing the improvements they came up with, followed by a second launch opportunity.

Target Observations:

- The ball-launcher did/didn't work as well as the group expected.

Target Revised Model:

- Just like when inventors create solutions to problems, solutions aren't perfect the first time. However, if the design is modified after initial testing, and the modify-test sequence is reiterated many times, a better solution is likely to emerge.

Summary:

Students have experienced the design process, and now have a better understanding of the challenges (and rewards) that are inherent to such a process.