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Rockets: A Unit in Forces and Engineering Design

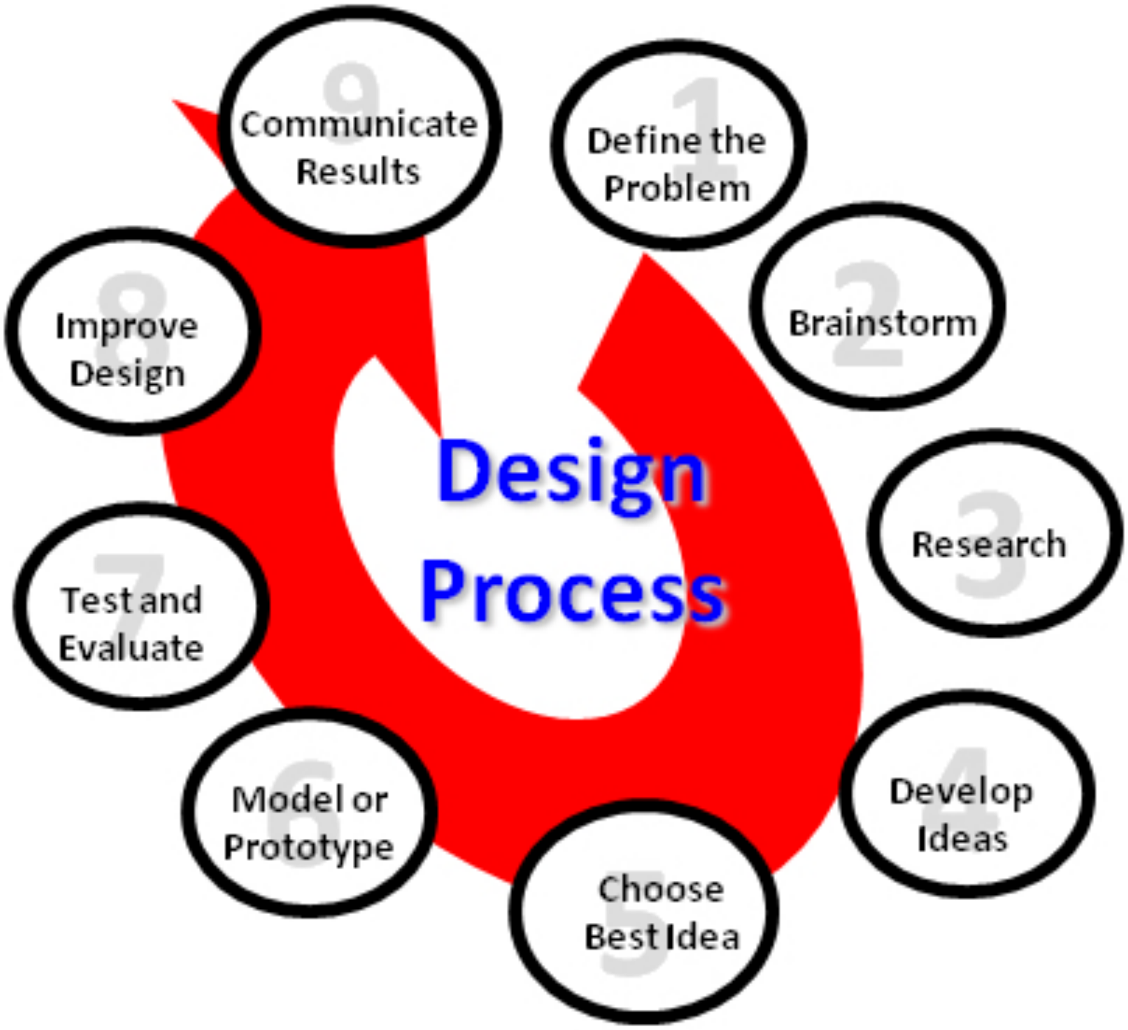
Duration
Two weeks

Projects
9 Step Design Process Review, Straw Rocket (Calculating Velocity), and Water Rockets

Materials
Pitsco Straw Rocket Launcher (and straw rocket materials)
PVC Pipe Water Rocket Launcher

Performance Objectives
- Learn about aerospace engineering.
- Learn about engineering design and redesign.
- Learn about space flight.
- Learn about forces and motion.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

Unit Activities
Students will review the 9 Step Design Process (used in every project):
1. Define the Problem
2. Brainstorm
3. Research
4. Develop Ideas
5. Choose Best Idea
6. Model or Prototype
7. Test and Evaluate
8. Improve Design
9. Communicate Results


Design Process
Define the Problem
Brainstorm
Research
Develop Ideas
Choose Best Idea
Model or Prototype
Test and Evaluate
Improve Design
Communicate Results

Unit Activities (Continued)
Newton's Laws of Motion will be reviewed prior to building the rockets. The first test (mini project) in the unit will be Comparing Rocket Lengths, followed by Varying Nose Cone Mass, and Varying Launch Angles. The final test will be to determine the Straw Rocket Velocity (documents from Pitsco are attached).

Students will submit their typed final reports upon completion of each test.

At the end of the unit, the instructor will take the students outside to launch the water rockets after asking them to compare the smaller straw rockets and propulsion system to the larger 2 liter water bottle rockets and propulsion system. The water fun of the larger rockets will be a reward for a job well done throughout the past two weeks!

Video Example: https://youtu.be/e6SaaX72LUY

QuickView

Students use data generated from previous rocket launches to calculate the average velocity of each launch.

Standards

NSTA 5-8
Students use appropriate tools and techniques to gather, analyze, and interpret data.

- Students think critically and logically to make the relationships between evidence and explanations.
- Students communicate scientific procedures and explanations.
- Students use mathematics in all aspects of scientific inquiry.

NCTM 6-8
Students select and use appropriate statistical methods to analyze data.

Students develop and evaluate inferences and predictions that are based on data.

Students recognize and apply mathematics in contexts outside of mathematics.

ITEEA 6-9
Students develop abilities to assess the impact of products and systems.

Students learn to design and use instruments to gather data.

Time Required

90-180 minutes (will vary with class size)

Content Areas

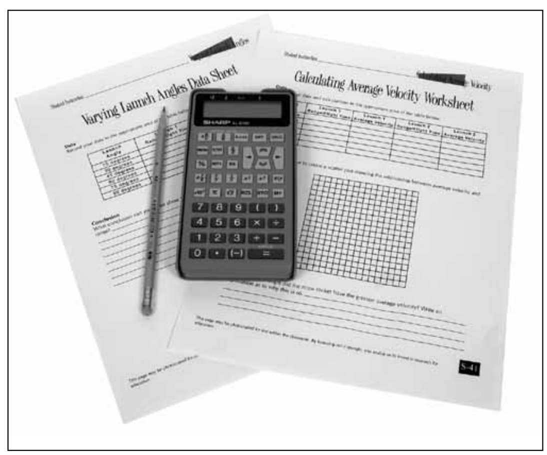
Primary: Math
Secondary: Technology; science; language arts

Vocabulary

- average
- scatter plot
- trajectory
- velocity

Materials

- Pitsco Straw Rocket Launcher
- Completed "Varying Launch Angles Data Sheet"
- Calculator
- Pencil
- "Calculating Average Velocity" worksheet



Procedure

This lesson should be done following Varying Launch Angles. Students should complete at least 12 launches and record the flight times on the data sheet. Completing two tests at each launch angle should provide the students with a good base of data to graph.

Students will create a scatter plot of their calculations. Discuss graphing and scatter plots with students.

1 Locate the completed "Varying Launch Angles Data Sheet" along with the "Calculating Average Velocity" worksheet.

2 Using the Velocity resource as a guide, calculate the average velocity for each of the 12 launches.

Be sure students understand in what units their average velocity will be recorded. If the range was measured in centimeters, the units will be centimeters/second. If in meters, then the units will be meters/second.

3 Record the average velocities on the worksheet.

4 At the bottom of the worksheet, complete the scatter plot of the completed calculations.

5 At which launch angle did the straw rocket have the greatest average velocity? Write an explanation as to why this might be so. Record responses on the worksheet.

Answers and explanations should be supported by the data.

Procedure

1 Locate the completed "Varying Launch Angles Data Sheet" along with the "Calculating Average Velocity" worksheet.

2 Using the Velocity resource as a guide, calculate the average velocity for each of the 12 launches.

3 Record the average velocities on the worksheet.

4 At the bottom of the worksheet, complete the scatter plot of the completed calculations.

5 At which launch angle did the straw rocket have the greatest average velocity? Write an explanation as to why this might be so. Record responses on the worksheet.

Calculating Average Velocity

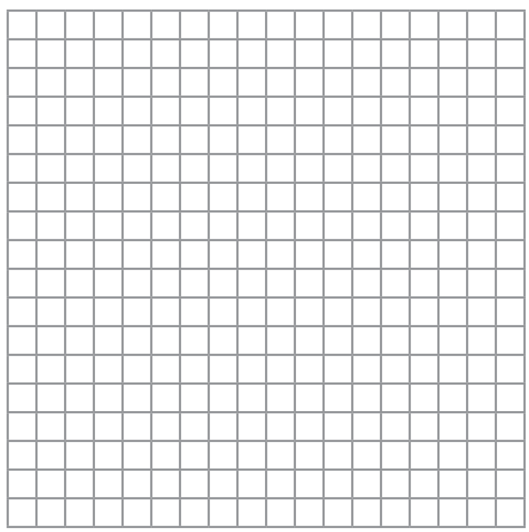
Data

Record your data and calculations in the appropriate area of the table below.

Launch Angle	Launch 1 Range/Flight Time	Launch 1 Average Velocity	Launch 2 Range/Flight Time	Launch 2 Average Velocity
15 degrees				
30 degrees				
45 degrees				
60 degrees				
75 degrees				
90 degrees				

Scatter Plot

Use the data above to create a scatter plot showing the relationship between average velocity and launch angle.



Analysis

At which launch angle did the straw rocket have the greatest average velocity? Write an explanation as to why this is so. ____

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Glossary

altitude: the distance upward a rocket travels

angle: the figure formed by two lines extending from the same point

apogee: the highest altitude a rocket reaches during flight

average: the mean value of a series of quantities, determined by dividing the sum by their number

conclusion: a reasoned judgment

constraint: limit

control: an experiment in which all conditions are identical to those in a parallel experiment except for the omission of the condition or variable being tested; a control is used as a standard by which experimental effectiveness is judged

design: the process of creating

diameter: the distance from one side of a circle to the other passing through the center of the circle

fin: a winglike projection from the body of a rocket

hypothesis: a prediction based on prior knowledge made in order to test its consequences

inference: the act or process of deriving logical conclusions from premises known or assumed to be true

mass: the amount of matter within an object

modification: a change of the properties, form, or function

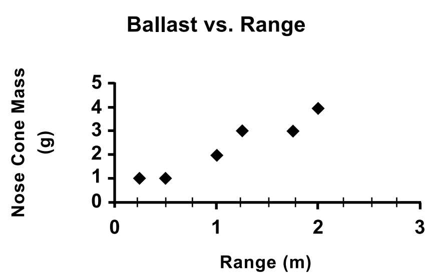
nose cone: the forward most, usually separable section of a rocket or guided missile that is shaped to offer minimum aerodynamic resistance and often bears protective cladding against heat

projectile: a fired, thrown, or otherwise propelled object

range: the horizontal distance traveled during projectile motion

rocket: a self-propelled device that carries its own fuel

scatter plot: a two-dimensional graph of two or more variables plotted on the y-axis or the x-axis to show their relationship(s)



trajectory: the curve described by a projectile in flight

variable: subject to changes; a quantity that may assume any of a set of values

velocity: speed and direction of an object's motion

weight: force that gravity exerts on a mass

(Below is an excerpt from student report.)

STRAW ROCKET PROJECT

Abstract: The project was about testing how far the rocket would go and how long it would stay in the air. I the project I made two straw rockets, one small and one big. In the project I made two different sized straw rockets and tested the distance and time of flight. Then after three of the rocket tests I chose which one was the best and recorded the time in the air, distance, and did a scatterplot on where the rocket landed on each test.

Materials and Methods:

1. Straw, scissors, clay, tape, note card, meter stick, and the rocket launch tube.

2. One rocket was cut to 9 inches and the other was cut to two inches.

3. After the rockets were cut I made the nose cones at the same weight of 4 oz.

4. Then I cut the not card into four even fins twice to put on the rockets.

5.For the testing I needed a rocket launch tube for the rocket to launch of of for the testing.

6. While testing I would use my STEM notebook to record the data of the straw rockets.

7. I would also then use the meter stick to measure the distance

8. Another tool I used was my iPod to time how long they went into the air.

Results: The results of the straw rockets were pretty good. I found out that the smaller rocket went further then the bigger rocket. Also while timing the rocket, the higher the angle is pointed up the longer it stays in the air.

Conclusion: To conclude the project, the hypothesis I had predicted was wrong. The smaller rocket went further then the bigger rocket because the smaller one had less weight on it. Also the more diagonal the angle of the launch, the further the rocket would go, the more the angle was pointed up, the longer it would be in the air. In the end, the project was a pretty fun experience on straw rockets.