Title: Model Rocketry -- The Beginning

Brief Overview:

This lesson will focus on the science, math, and technology of rockets from the ancient Chinese art of pyrotechnics to model rocketry of today. Through a variety of hands on experiences students will get an understanding of the development of model rocketry. Formulas will be used to calculate altitude and velocity. The exercise infuses historical data and contemporary technology to create a fun and exciting lesson!

Links to NCTM 2000 Standards:

- **Mathematics as Problem Solving**
  Students will analyze their collected data and use their problem solving skills to hypothesize and draw conclusions about optimal fuel and gas levels required to maximize rocket apogee.

- **Mathematics as Communication**
  Students will write a report that should link their hypothesizes derived from their collected data to the dynamics of rocketry.

- **Number and Operation**
  Students will use formulas to calculate altitude and velocity. They will perform various operations when converting the unit velocity from feet per second to miles per hour.

- **Patterns, Functions, and Algebra**
  Students will collect data and use a direct physics formula. They will evaluate an expression to formulate a chart.

- **Geometry and Spatial Sense**
  Students will use their knowledge of geometric shapes in the development of their fins. They will use their observational skills to draw a conclusion as to which geometric shape and size of the shape is needed to stabilize the water rocket.

- **Measurement**
  Students will use the ratio of water to air pressure to determine the altitude of the rocket and will convert ml to ounces.

- **Data Analysis, Statistics and Probability**
  Students will create a graph showing the relationship between air pressure, ounces of water, and altitude.

Grade/Level:

Grades 6 - 8

Duration/Length:

Three one-hour lessons

Prerequisite Knowledge:

- Understanding Newton’s Three Laws of Motion
- Understanding air pressure
- Plotting a scatter plot

- Interpreting data

Student Outcomes:

Students will:

- build a prototype of a rocket.
- modify their rocket to improve velocity and altitude.
- work with the two stated physics formulas.
- evaluate the formulas.
- analyze their collected data, and use their problem solving skills to hypothesize and draw conclusions.

Materials/Resources/Printed Materials:

- Balloons
- Straws
- String
- 2 liter or 20 oz plastic bottle
- 5x7 Index cards (or cardboard)
- Air pump
- Rocket launcher
- Water
- Measuring cup
- Stop watch
- Sand paper #100

Development/Procedures:

1) Ask students how they think the concept of rocketry began. See Internet site for full historical detail concerning this topic or your local library
   a) hawastsoc.org/solar/eng/rocket.htm
   b) http://home.earthlink.net/~voraze/rocketry/history.html

2) Show the relationship between pyrotechnics and rocketry.

3) Demonstrate through the following activity how flight performance is affected by stability:
   a) Give each student a balloon. Have them inflate the balloon.
   b) Have the students fly the balloon without anything attached, and observe the instability of its flight.
   c) Have the students affix a straw to the balloon with a string and observe the slightly increased stability of its flight.
   d) Have the students affix a fin to the straw and observe continued increase in the stability of its flight.

4) Have the students build a model water rocket.
   a) Obtain a 2 liter soda container.
   b) Cut out 3 or 4 fins from the enclosed Design Sheet One (use 5x7 cards).
   c) Layout markings for the fins using Bottle Grid Sheet Two.
   d) Draw a vertical line along the 3 or 4 points on the bottle where the fins are to be attached. A door jam is recommended for this application.
   e) Attach the fins to bottle using a low temperature glue gun (score area to be glued with fine grit sand paper #100). See Design Sheet One for the sketch of the completed bottle rocket.

5) Allow student to choose any amount of water to fill the 2 liter bottle. It is recommended that you fill the rocket with no more than with one liter. The air pressure should not exceed 90 psi.

6) Launch and time rockets from lift-off to landing. A company that produces a rocket launcher is the PITSCO innovative educational products out of Pittsburg, KS, phone number 1 (800) 835 - 0686 or Internet URL www.pitsco.com.

7) Record each student's water capacity, time, and air pressure.

8) Use the following formulas to calculate the apogee height of each rocket.

$H = 1/2\ g\ (t/2)^2$ g is the force of gravity which is 32 ft/sec^2

or

$H = 16\ (t/2)^2$

9) Use the following formula to calculate the average velocity of the rockets in mph.

$V = [H / (t/2)] \times 0.68$

(0.68 is the conversion factor that changes feet per second to miles per hour).

Assessment:

Have the students create a graph showing altitude on the Y axis and amount of water on the X axis. Students will analyze data for the amount of fuel (water and air) to achieve maximum altitude. Ask students if the rocket performance is affected by the amount of water? Are there any external factors which may influence the performance? (Fin size and rigidity, wind, launch angle, nose cone, etc.)

Extension/Follow Up:

Students may visit http://www.ag.ohio-state.edu/~rockets/ for contemporary technology, which will challenge their thinking. Students also may want to make a nose cone for their bottle rockets.

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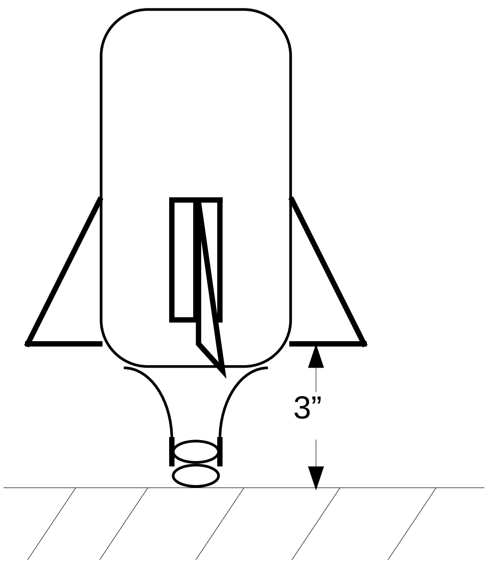
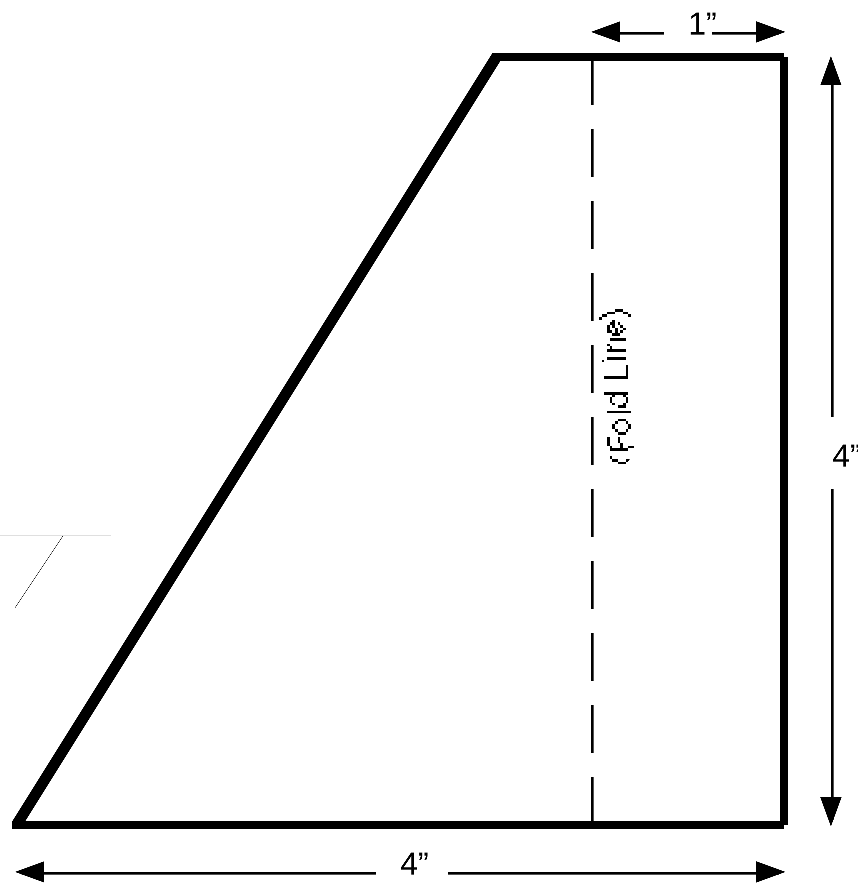
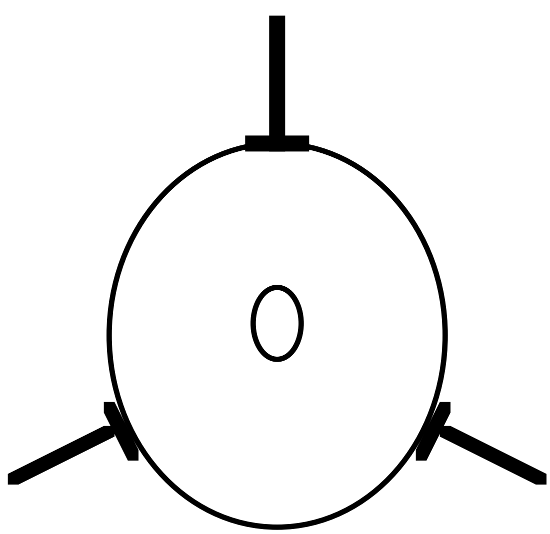
Design Sheet One

Fins - Side View

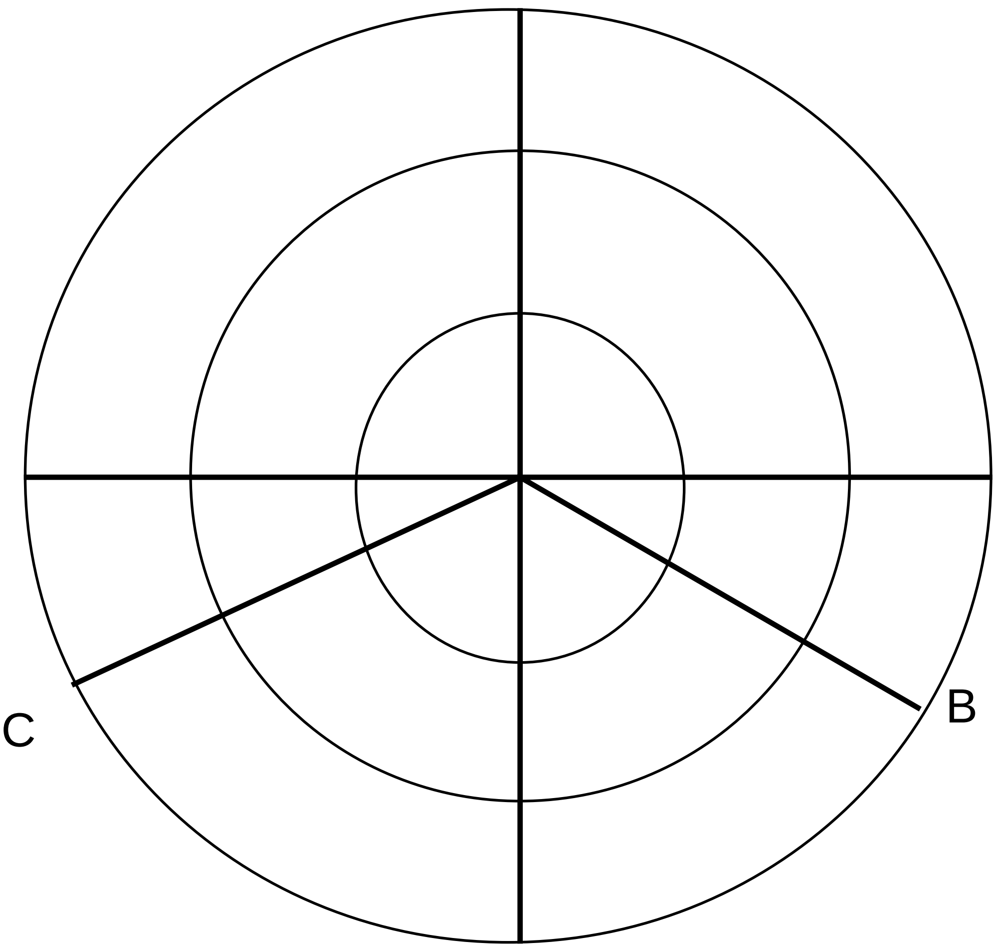




Fins - Top View



Bottle Grid Sheet Two



For 3 fins use lines A, B, C

For 4 fins use lines 1, 2, 3, 4