

Rocket Measurements for Scale Drawing

Project Number: _____

Date: _____

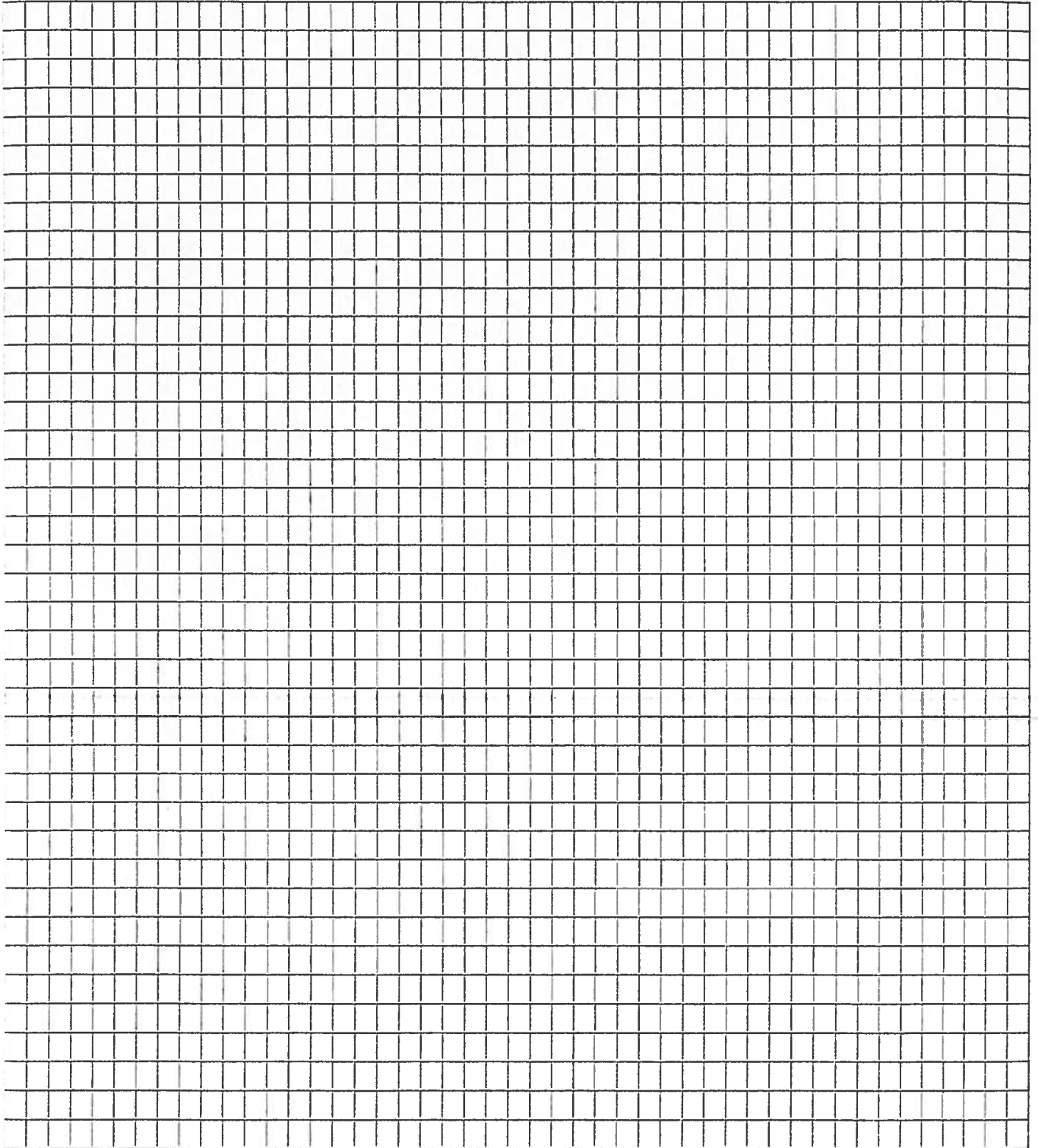
Company Name: _____

Use metric measurements to measure and record the data in the blanks below. Be sure to accurately measure all objects that are constant (such as the bottles) and those you will control (like the size and design of fins).

Object	Length	Width	Diameter	Circumference
Bottle				
Nosecone				
Fins				
Completed bottle rocket				

Scale Drawing

1 square = 2 cm



Rocket Stability Determination

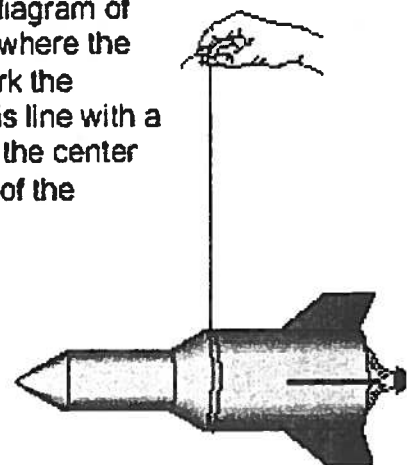
A rocket that flies straight through the air is said to be a *stable* rocket. A rocket that veers off course or tumbles wildly is said to be an *unstable* rocket. The difference between the flight of a stable and unstable rocket depends upon its design. All rockets have two distinct "centers." The first is the *center of mass*. This is a point about which the rocket balances. If you could place a ruler edge under this point, the rocket would balance horizontally like a seesaw. What this means is that half of the mass of the rocket is on one side of the ruler edge and half is on the other. Center of mass is important to a rocket's design because if a rocket is unstable, the rocket will tumble about this center.

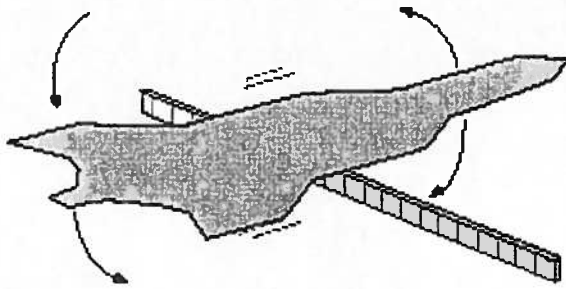
The other center in a rocket is the *center of pressure*. This is a point where half of the surface area of a rocket is on one side and half is on the other. The center of pressure differs from center of mass in that its location is not affected by the placement of payloads in the rocket. This is just a point based on the surface of the rocket, not what is inside. During flight, the pressure of air rushing past the rocket will balance half on one side of this point and half on the other. You can determine the center of pressure by cutting out an exact silhouette of the rocket from cardboard and balancing it on a ruler edge.

The positioning of the center of mass and the center of pressure on a rocket is critical to its stability. The center of mass should be towards the rocket's nose and the center of pressure should be towards the rocket's tail for the rocket to fly straight. That is because the lower end of the rocket (starting with the center of mass and going downward) has more surface area than the upper end (starting with the center of mass and going upward). When the rocket flies, more air pressure exists on the lower end of the rocket than on the upper end. Air pressure will keep the lower end down and the upper end up. If the center of mass and the center of pressure are in the same place, neither end of the rocket will point upward. The rocket will be unstable and tumble.

Stability Determination Instructions

1. Tie a string loop around the middle of your rocket. Tie a second string to the first so that you can pick it up. Slide the string loop to a position where the rocket balances. You may have to temporarily tape the nose cone in place to keep it from falling off.
2. Draw a straight line across the scale diagram of the rocket you made earlier to show where the ruler's position is. Mark the middle of the line with a dot. This is the rocket's center of mass.
3. Lay your rocket on a piece of cardboard. Carefully trace the rocket on the cardboard and cut it out.
4. Lay the cardboard silhouette you just cut out on the ruler and balance it.
5. Draw a straight line across the diagram of your rocket where the ruler is. Mark the middle of this line with a dot. This is the center of pressure of the rocket.

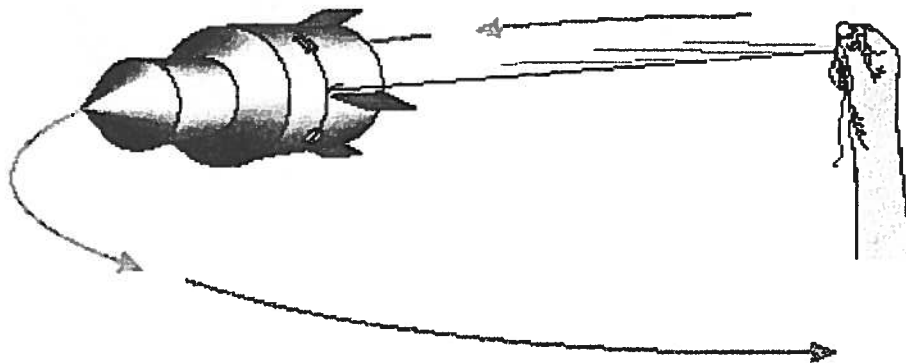
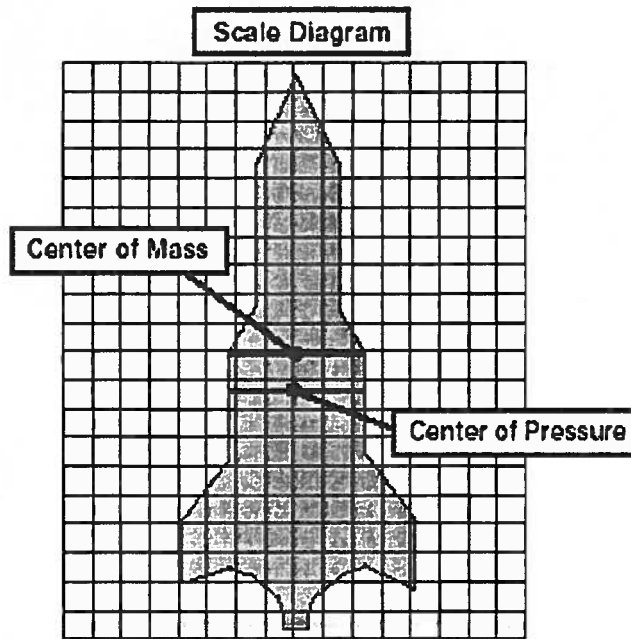




If your center of mass is in front of the center of pressure, your rocket should be stable. Proceed to the swing test. If the two centers are next to or on top of each other, add more clay to the nosecone of the rocket. This will move the center of mass forward. Repeat steps 2 and 3 and then proceed to the swing test.

Swing Test:

1. Tape the string loop you tied around your rocket in the previous set of instructions so that it does not slip.
2. While standing in an open place, slowly begin swinging your rocket in a circle. If the rocket points in the direction you are swinging it, the rocket is stable. If not, add more clay to the rocket nose cone or replace the rocket fins with larger ones. Repeat the stability determination instructions and then repeat the swing test.



Pre-Launch Analysis

Rocket Specifications

Total Mass: _____ g	Number of Fins: _____
Total Length: _____ cm	Length of Nose Cone: _____ cm
Width (widest part): _____ cm	Volume of Rocket Fuel to be used on Launch Day: _____ ml, _____ L
Circumference: _____ cm	

Rocket Stability

Center of Mass (CM)	Center of Pressure (CP)
Distance from Nose: _____ cm	Distance from Nose: _____ cm
Distance from Tail: _____ cm	Distance from Tail: _____ cm
Distance of CM from CP: _____ cm	
Did your rocket pass the swing test? _____	