17000 Bottle Rocket Launcher

Purpose:
To launch rockets using commonly available materials such as plastic soda bottles and cardboard tubes. It also provides an exciting introduction to aerodynamics and the momentum basis of rocketry

Required Materials:
Soda Bottle
Bicycle or other air pump.
Tire pressure gauge
Dowels or straight sticks (3 or 4) 36" Long
Tape
Glue
Scrap cardboard
Water
Common pin or nail

Warning!

Do:	Do Not:
Do Wear Protective Eye Gear	Do Not Aim at Anyone
Do Wear Protective Clothing (rain gear)	Do Not Pressurize Beyond 40 psi
Do Stake Launcher Securely into the Ground	Do Not Stand Over Pressurized Rocket
	Do Not Stand Within 10 Feet of Launching Rocket

Assembly:

Congratulations! Your new bottle rocket launcher will let you use any standard plastic soda bottle with capacities of 500 ml to 2 liters! When choosing a bottle to use for rocketry, remove the cap and check the bottle's neck ring for any cracks or defects that may fail when pressurizing the bottle. If the bottle looks good you're ready to begin building your rocket.

Fig.1

Select a launch site clear of obstructions with an ample down-wind rocket recovery area. If you plan to press the stakes of the launcher into the ground it is suggested that you first push them through a scrap of cardboard or a plastic trash bag to keep the ground immediately beneath the launcher reasonably dry. In subsequent launches this will greatly aid stability. (After a very few high pressure launches the ground beneath the launcher turns to mud and the rocket launcher will incline in the direction of the lanyard: You're going to get hosed.) When you've found an appropriate launch site, press the two long pointed stakes of the launcher into the ground a minimum of 4 inches (12 CM). This will anchor the launcher in place. To improve on the stability of the launch it is suggested that three dowels of about three feet in length be pressed into the ground so that they are nearly touching the bottle rocket.

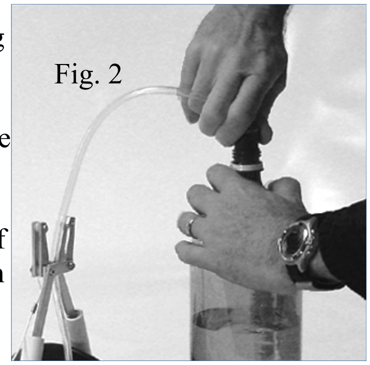


Fig. 2

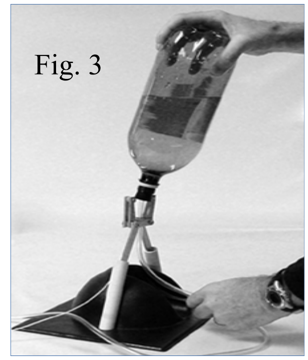


Fig. 3

If you don't have a field or open area that facilitates the use of the stakes then Science First recommends the use of the #17005 Bottle Rocket Launch Pad. (Fig. 1) This will enable successful launches from any convenient horizontal surface (even the bed of a pick-up truck) and eliminates the concern of soaking the launch pad area.

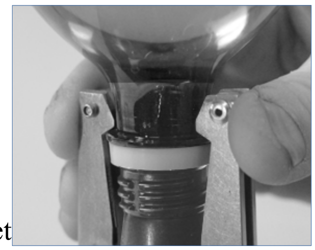



Fig. 5

Fill your soda bottle roughly half full of water. With the bottle resting upright on a solid surface place the rubber stopper in the mouth of the bottle. Using a **FIRM** twisting motion seat the rubber stopper into the neck of the bottle (Fig. 2) as far as you can. A small amount of soap or petroleum jelly on the tapered surface of the stopper or inner mouth of the bottle will help.

Thread the air tube through the horizontal brace bars on the rocket launcher apparatus (Fig. 3) and close the retaining jaws against the bottle such that the jaws have a firm "grip" on the flange of the bottle. (Fig. 4)

The trigger or "U" shaped release bracket can now be positioned on the outside of the retaining jaws (Fig. 5) Slide the trigger down the sides of the retaining jaws until it is firmly positioned holding the jaws locked against the neck of the bottle.

Before you begin to pump up the bottle, there are a few precautions you must take, and most of these are common sense.

1) While pumping up the bottle, periodically check the pressure. Use a pump with a built in pressure gauge and measure the pressure while pumping.

2) Do not exceed 40 psi.

3) Don't look down on the rocket during or after pressurization.

4) Don't aim your rocket at any people, buildings, or other structures.

5) Always set up your rocket well away from any trees, telephone wires, or houses.

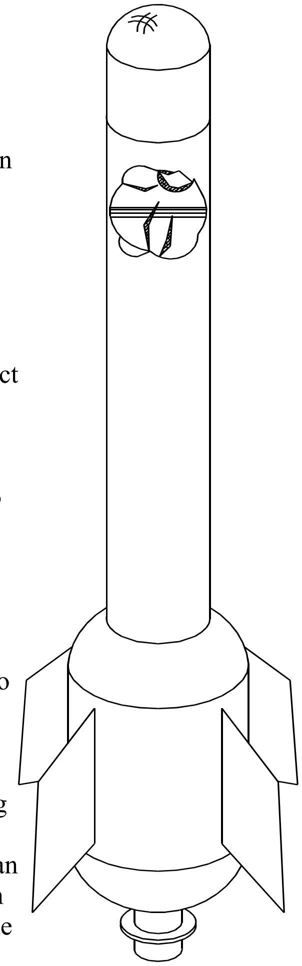
6) Do not launch your rocket in parking lots where it may damage someone's car.

Remember, when you pull the cord, you are the pilot in command and are responsible for that particular flight! So be careful! Now that you understand the precautions that must be observed with every flight, the bottle is ready to be pressurized!

With the rocket assembled on the launcher and the launsite selected it is now time to pressurize the rocket and prepare for launch.

But Wait!! The rocket is launched with a **QUICK SNAP OR TUG OF THE LANYARD.** A slow pull will almost always result in the rocket inclining toward the direction of the lanyard and the pilot getting hosed by the launch. So, before pressurizing the rocket try a couple of test launches to get the "feel" of the trigger release.
OK, now that you've had some lanyard practice it's time to clear the launch pad and pressurize the rocket. For an initial launch try 30 to 40 PSI of air over a bottle about half full of water. No rocket launch should go without a NASA count down (10…9…8…). A sharp tug of the lanyard will release the locking jaws and the rocket will blast off from the pad.

Discussion:
Now that you've launched some rockets, your head may be full of ideas for better designs to get it to go higher, fly further, or have increased thrust. The following are a few suggestions to help you get started.



The stability of the rocket depends upon the rocket's length. You'll find that longer rockets fly straighter than shorter rockets. Long cardboard tubes make excellent bodies for bottle rockets. The larger diameter tubes often found in rolls of gift and Christmas wrapping paper make the best bodies. Smaller diameter tubes will work but they are not as strong and may not hold up as well under repeated use. Another method of constructing rocket bodies is to tape several paper towel tubes together.

Fins will improve the stability of the rocket. Experiment with different size and shape fins. The fins do not have to be very large to be very effective! The fins can be made using scrap cardboard from old boxes. Select your cardboard carefully, making sure that it is reasonably flat and does not have bends or folds in it. Draw your fin pattern on a sheet of paper and then use this pattern to cut the number of fins you need from the cardboard sheets. These fins can then be glued or taped to the body of the rocket. The fins could also be taped to the bottle itself! The fins work the best when placed near the bottom of the rocket, but you can also experiment by placing the fins at varying positions along the body. **Do not use metal fins.**

The nose of the rocket is another point of consideration. The nose of the rocket must do three things: first it must streamline the rocket so the air will pass over it more efficiently, second: it must hold the parachute or other recovery system and it must be able to absorb the impact of the rocket as it hits the ground. The nose cone can be made of cardboard rolled into a cone and then taped to the top of the rocket, or you may want to use a smaller plastic bottle turned upside down so the smooth round bottom of the bottle points upward on the rocket. **Do not use metal parts.**

The parachute can be made by cutting a circular patch from a large plastic garbage bag. Six lengths of string each about sixty centimeters long (2 feet) can be cut and taped around the perimeter of the parachute. After each string is taped in place, gather the free ends of the string together and tie them into a knot. This knot can then be taped to the inside of the rocket body tube. The parachute can then be gently rolled up and placed in the rocket body. After the parachute is loaded the nose cone can be rested on top of the rocket. Don't tape the nose cone to the rocket body if you want the parachute to come out!

An inverted nose cone, securely taped, can carry a parachute -- or even a ball. The bottom 10cm of a 2 liter bottle, well taped to the top of the pressurized bottle, has lofted a real soccer ball!

Rocket Safety:

Now that you have finished building your high performance rocket, it is worth repeating a few of the safety rules that have already been mentioned.

1) **Do not exceed 40 psi while pressurizing the bottle.**

2) **Don't look down on the rocket during or after it is pressurization.**

3) **Don't aim your rocket at any people, buildings, or other structures.**

4) **Always set up your rocket well away from any trees, telephone wires, or houses.**

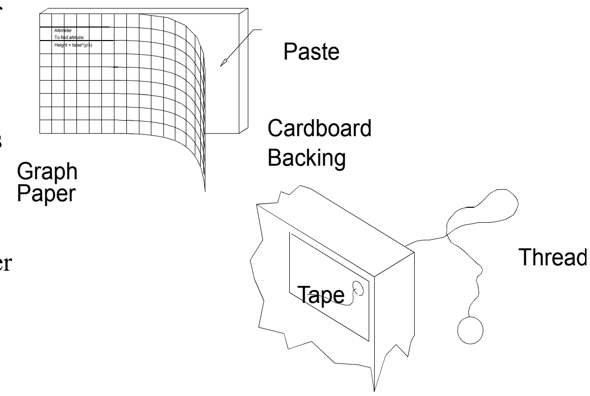
5) **Do not launch your rocket in parking lots where it may damage someone's car.**

Remember - as pilot in command, you are responsible for every flight!

Rocket Experiments:

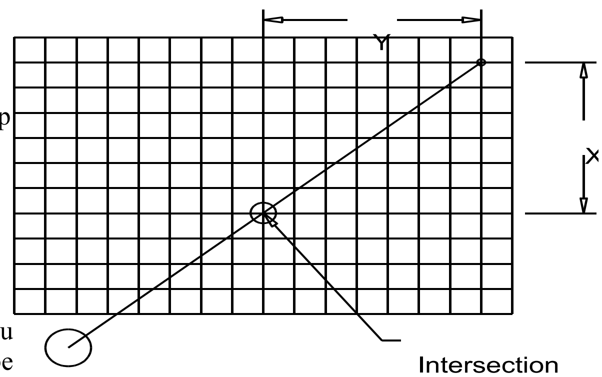
"Whoa! How high did that thing go?" has probably been a question you've asked several times as you watched you rocket soar overhead. There is a relatively simple method you can use to measure the altitude of your rocket! It is simply a sheet of graph paper mounted on a sheet of cardboard with a plumb line attached to one corner.

To assemble the altimeter, paste the altimeter face (found at the end of this manual) to a flat sheet of cardboard that has been cut to the same size. Make sure the top edge of the cardboard is flush with the top edge of the altimeter page. Use a common pin to poke a hole through the cardboard at the top front corner where indicated. Slip one end of the plumb line (thread for this is included) through this hole.



Tape the thread to the cardboard backing where it comes through the hole. Tie weight (large washer) to the free end of the thread as in **Figure 6.** Your altimeter is now ready to use.

Let's start by measuring the height of something you know. First, measure the distance between the object you're measuring and the position you will be standing when you measure its height. This distance is called the "BASE" and should be at least 10 meters. Hold the altimeter card at eye level and sight along its top edge. **Some find it easier to tape or glue a soda straw along this top edge as a sighting tube.** The place where the thread is taped to the cardboard should be away from you. Tip the cardboard upward until the top edge of the cardboard is pointing at the top of the object you're measuring. When the string is hanging freely and no longer swinging, pinch it against the face of the altimeter with your finger, as in **Figure 7**. You can now read the altimeter by finding an intersection on the graph paper that the string crosses. Read the quantity "Y" from the horizontal axis of the graph paper (this is proportional to the height of the object) and read the quantity "X" from the vertical axis of the graph paper (this is proportional to the distance between you and the object). Using similar triangles, the rocket altitude or "HEIGHT" can be calculated by using the following formula:



HEIGHT = BASE * (Y/X)

Where:

HEIGHT = height of the object

BASE = horizontal distance from the object

Y= measured from the altimeter (horizontally)

X= measured from the altimeter (vertically)

Don't forget to add your own height to the calculated height! Actually, you should measure the distance from the string hole down to the ground, and add that to your calculated height. Your most accurate measurements of height, using this device, will be found when your horizontal distance from the object is close, in value, to the actual altitude of the object.

The altitude of the object will have the same units as does the horizontal distance from the object. In other words, if you measured the distance from the launch pad in meters, then your calculations will produce an altitude in meters. If you measured the distance from the launch pad in feet, then the altitude will be in feet.

Now that you are able to get accurate measurements of the rocket's altitude, you're ready to do some serious experimenting! Remember - change only one thing at a time; keep everything else constant!

For example, to measure the effect of pressure on the rocket's altitude, use the same rocket, pour the same amount of water into the bottle, and then, for each experiment, pressurize the bottle to different amounts. Record each launch on a data sheet that might look like **Table 1.**

Note: Using simple trigonometry, rocket altitudes can be found using #10150. This Pocket Accelerometer is calibrated to be used as an astrolabe by sighting across the top edge. It is again helpful, in this regard, to attach a single soda straw as a sighting tube. Two or more sightings made at the same time with separate instruments will improve the accuracy of the measurement. The rocket altitude is given by multiplying the distance to the launch point by the tangent of the angle of elevation given by the instrument. Requires a trig calculator or trig tables.

Table 1.

Rocket Launch Data:

Launch #	Water Used Ounces or Grams	Rocket Weight Pounds or Kilograms	Pressure Used PSI or kPa	Altitude Feet or Meters
1				
2				
3				
4				
5				

You could then plot the data on a graph with the pressure on the horizontal axis and the altitude on the vertical axis. The next series of experiments might vary the amount of water used but keep the pressure the same each time. In this case, use a high enough pressure so that all the water gets expelled. Notice the relationship between amount of water expelled and the altitude reached. By throwing water in one direction, the rocket is thrown in the opposite direction. Water and rocket have equal and opposite momenta, according to Newton's Third Law.

Try changing the rocket's length, or the rocket's weight. The combinations are almost endless! Just remember, keep records, plot graphs, and only change one parameter at time!

Extensions:

You may want to have competitions with friends to see whose rocket will go the highest, stay in the air the longest, carry the most weight, or land closest to a specified spot.

What happens if no water is used, only air? What happens if there is more water in the rocket than the air can expel?

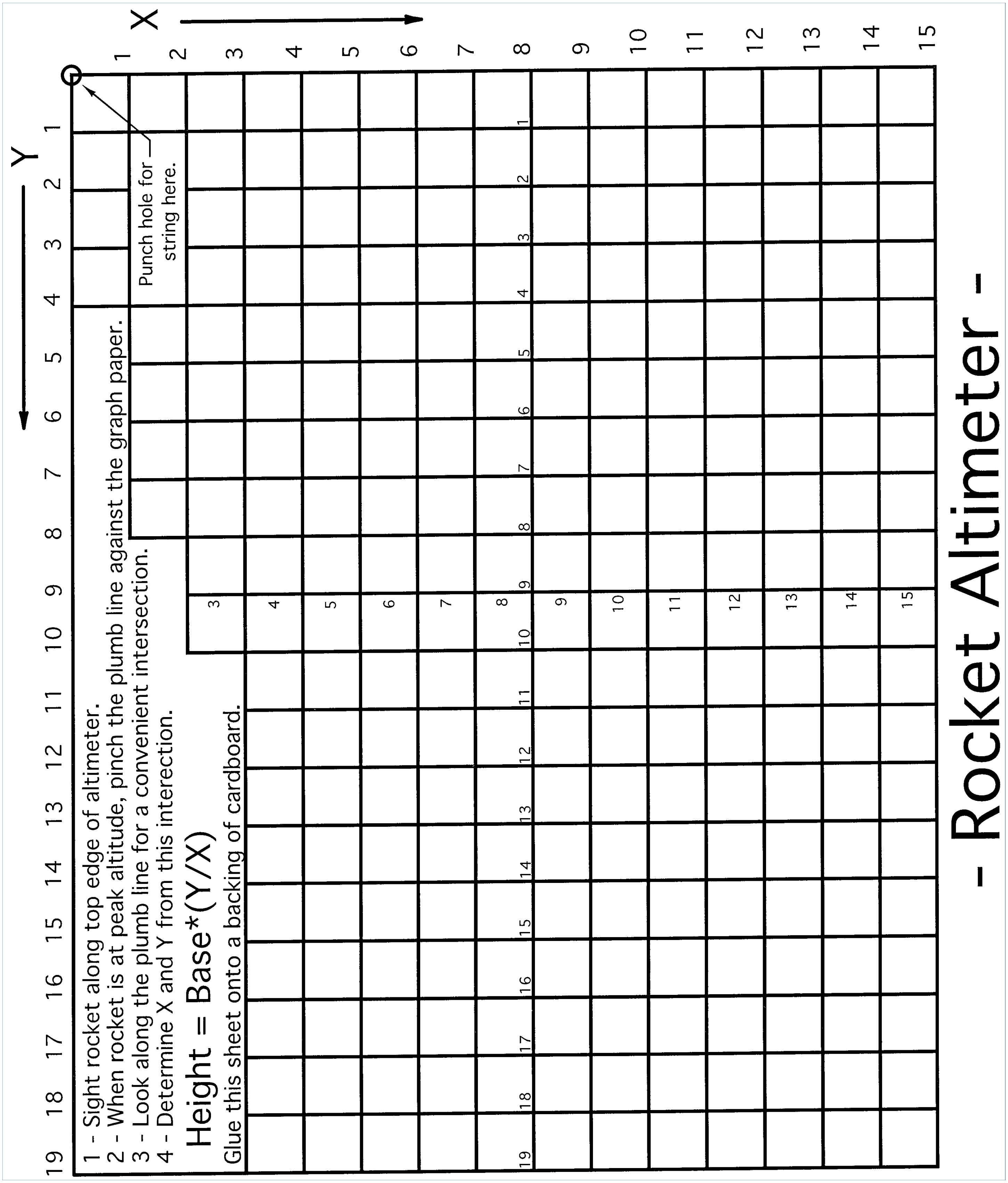
What exciting ways can you find to recover a rocket and a payload by separate parachutes?

Time Allocation:

This product arrives ready to use. Allow 10 minutes to set up and launch the first soda bottle. Individual experiment times will vary depending on the complexity of the rocket design and the methods of instruction, but ordinarily no single activity will exceed one class period.

Feedback:

If you have a question, a comment, or a suggestion that would improve this product, you may call our toll free number.


- Rocket Altimeter -
1 - Sight rocket along top edge of altimeter.
2 - When rocket is at peak altitude, pinch the plumb line against the graph paper.
3 - Look along the plumb line for a convenient intersection.
4 - Determine X and Y from this interection.
Height = Base*(Y/X)
Glue this sheet onto a backing of cardboard.
Punch hole for string here.
X
Y