Intro Physics

Name ______________________________
(Each individual student will complete his or her own lab report)

Bottle Rocket Lab

Group Members: ____

____

Target Launch Date: __________________

Grade:

Before Launch questions (max 25 points) • Questions 1-10, based on accuracy and completeness	
Construction and Design reflection paragraph (max 15 points) Explain why you built your rocket the way you did, and tell where you got your ideas from. • Identify websites or resources you looked at • Mention the design elements described there • Explain how you implemented them in your rocket	
Performance (max 10 points) You get 2 points for attaining each of the following: • Looks like a rocket • Launches • Flies true (doesn't tumble or go out of control) • Parachute deploys • Descent is slowed by parachute	
After Launch questions (max 10 points) • Questions 1-4 based on accuracy and completeness • Challenge questions worth 1 pt each, based on effort and thought	

Total out of 60:

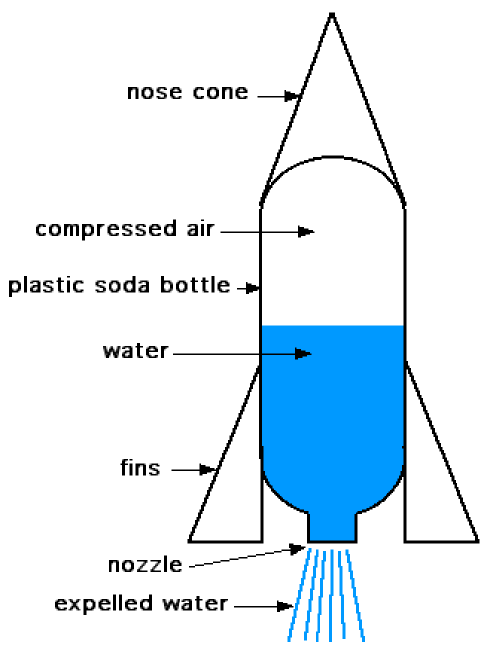
Water Rockets

In 1919 Robert Goddard, a professor at Clark University in Worcester, Massachusetts, claimed that a multistage rocket weighing only ten tons could land on the Moon. After years of research, Goddard built the first liquid-fueled rocket, achieving a height of 90 feet before angry neighbors and local police ordered him to cease rocket experiments in Massachusetts. He moved to New Mexico where he continued his pioneering work in rocketry.

NASA

> "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow…"
> -- Robert H. Goddard

The Introductory Physics students at NNHS are going to revive the Massachusetts tradition of rocket innovation by building and launching our own low-tech rockets, using 2-liter plastic soda bottles, cardboard, and water. We will use a bicycle pump rocket launcher and release the rockets in Elmwood Park on Lowell Ave.



Bottle Rocket Construction Procedure

Materials (please bring plastic 2 liter soda bottles to school)

- 2 liter bottle
- Tape / glue
- Cardboard / poster board / manila folders
- Clay

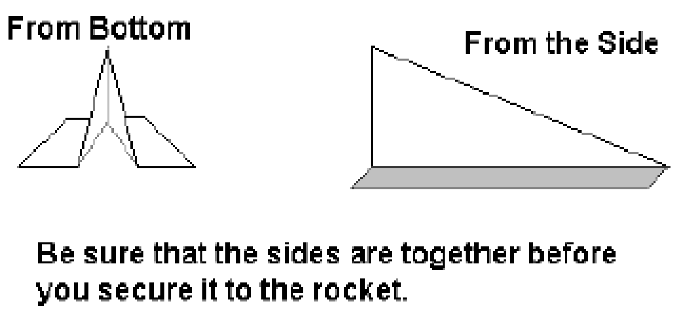
Optional for payload / parachute

- String
- Garbage Bag
- Rubber Bands
- Balloon
- Streamers

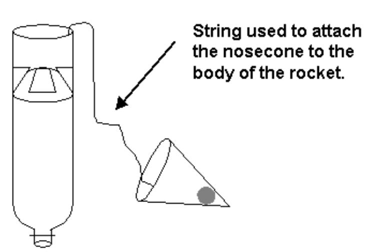
Procedure

1. Cut out nose cone from cardboard.   Place clay into tip of nose to vary the location of the center of mass.

2. Cut and glue fins onto nozzle end of bottle. Shape and orient the fins so that they will increase aerodynamic stability.



3. Optional: Create an extra compartment for a parachute or surprise (streamers, paper helicopters, etc.) just under the nosecone. Attach the nosecone with a string.



As you build the rocket, be sure that the center of mass is above the center of pressure.

<u>Bottle Rocket Lab Questions</u>: These questions should be answered <u>before</u> the launch day.

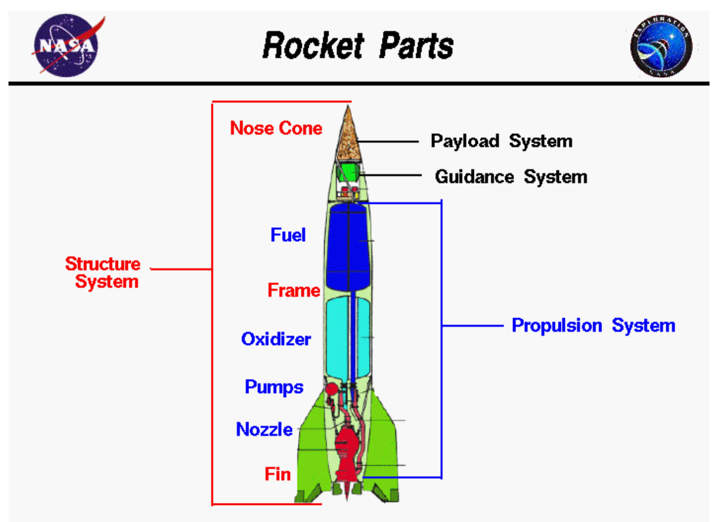
1. When Robert Goddard proposed a rocket to the Moon in 1919, the New York Times ridiculed the idea, claiming that a rocket could not possibly propel itself through the vacuum of space:

   > "…after the rocket quits our air and really starts on its longer journey it will neither be accelerated nor maintained by the explosion… [Professor Goddard] does not know of the relation of action to reaction and the need to have something better than a vacuum against which to react…[He] only seems to lack the knowledge ladled out daily in high schools." – The New York Times, 1920

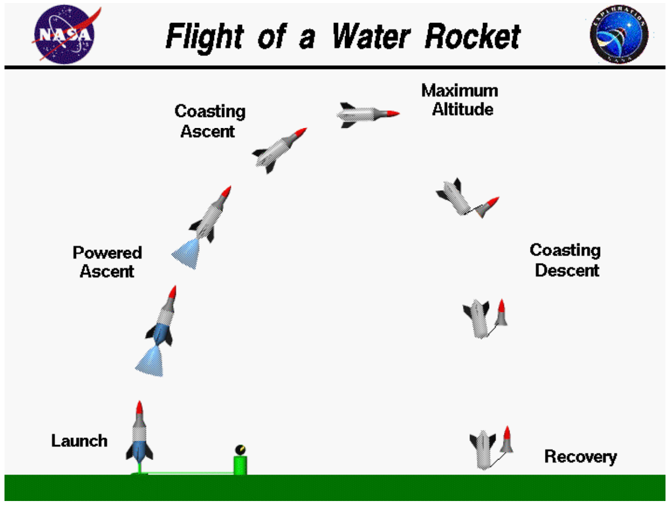
   Define Newton's Third Law (N3L):

   Explain how N3L applies to rockets and why Goddard was correct and the New York Times was wrong.

2. Consider the following diagram of a V-2 rocket. Each part of the rocket has a specific function. The nose cone reduces drag. The fins add stability. What is the function of the propulsion system?



3. Draw the direction that the net force points in each part of the trajectory. Remember that net force implies acceleration.



4. Draw a free body diagram of the bottle rocket at each of the following stages: At rest on launch pad, during launch, coasting ascent (still rising, but rockets are no longer firing), maximum altitude, coasting descent (rocket is falling, rocket is not firing).

At rest	**During launch** (engine firing)	**Coasting ascent** (engine no longer firing)	**Maximum Altitude**	**Coasting descent**

5. Describe the **gravitational potential** energy and **kinetic energy** changes at each part of the trajectory.

At rest	**During launch** (engine firing)	**Coasting ascent** (engine no longer firing)	**Maximum Altitude**	**Coasting descent**

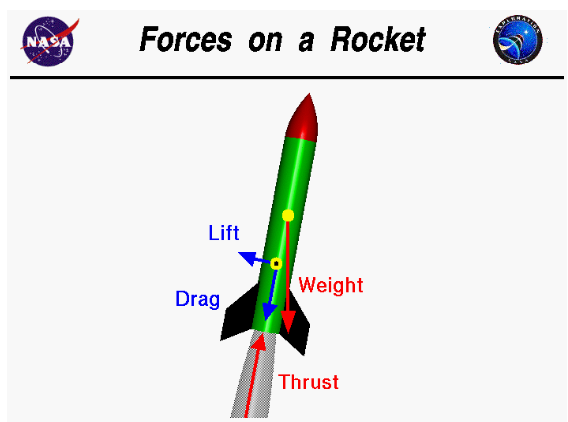
6. How high would the rocket go on the moon compared to earth? Why?

7. Define Newton's 2nd Law (N2L) here. If you want your rocket to go as fast and high as possible, what design decisions should you make? Support your design choices with N2L.

8. The momentum that the rocket attains is equal and opposite to the momentum of the escaping fluid. Why can we achieve greater speed using a combination of water and air as opposed to just air?

Use the "Forces on a Rocket Diagram" to answer the next 2 questions:

9. Describe how changing the weight would affect the flight of the rocket.



10. If the forces on the rocket are balanced, what acceleration would the rocket experience? State which of Newton's three laws applies to this situation and explain your reasoning.

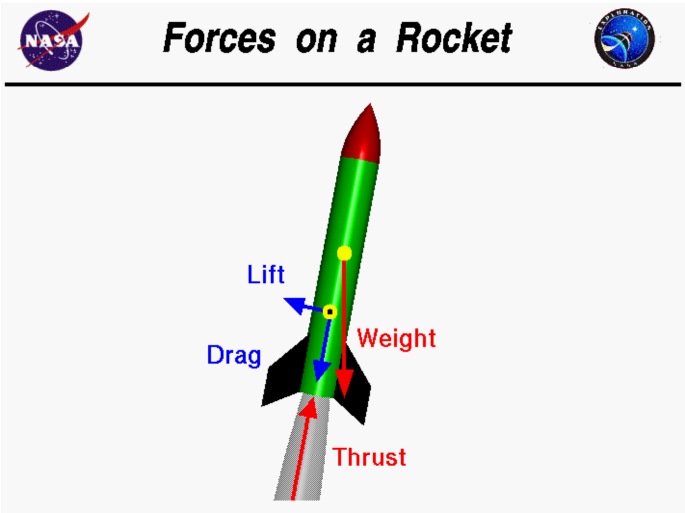
Intro Physics (614)   Name ______________________________
May/June 2009
(Each individual student will complete his or her own lab report)

Bottle Rocket Lab: After launch Questions

Group Members: ______________________________

____

____



1. Describe in detail how your group's rocket performed. Was it able to lift off the ground? How high did it go? What trajectory did it follow? Did it maintain stability? How did your rocket compare with rockets made by your classmates?

2. How could you improve *your* rocket to make it travel higher and farther? What are some specific things you would change/alter?

3. Describe how changing the weight would affect the flight of the rocket.

4. How can we tell if the forces are balanced once the rocket is in flight?

Challenge questions

5. Describe how the rocket would fly without a nose cone. What would it do differently? Why?

6. Describe how the rocket would fly without fins. What would it do differently? Why?

7. How would the function of the nose cone and fins differ on the moon?

References:

Most of the NASA pictures in this handout are taken from:

http://exploration.grc.nasa.gov/education/rocket/BottleRocket/about.htm

More information on water bottle rockets:

http://quest.nasa.gov/space/teachers/rockets/act11.html
http://www.lnhs.org/hayhurst/rockets/
http://www.scioly.org/eventpages/bottlerockets.htm
http://ourworld.compuserve.com/homepages/pagrosse/h2orocketbottlemods.htm
http://www.instructables.com/id/Soda-Bottle-Rocket./
http://www.makezine.com/05/rocket/