Gold Seal:

Copernicus Education Gateway

Author(s): *Michael Lucky Voiselle*			*Lesson Title:* *PLASTIC WATER ROCKET FUN*			
Grade Span			*ICLE Application Model*			
K-4	*5-8*	*9-12* *XX*	*A*	*B*	*C*	*D* *XX*

Instructional Focus:

Writing Students write for a variety of purposes and audiences with sophistication and complexity appropriate to the grade level.
Measurement Students use a variety of tools and techniques of measurement in a problem-solving situation. Students communicate the reasoning used in solving these problems.
Science as Inquiry Students demonstrate knowledge and skills necessary to perform scientific inquiry.
Communication Students communicate and apply scientific concepts.

Performance Task

Your task is to explore Newton's third law of motion using a simple water powered rocket. You can obtain a water-powered rocket in any major chain stores such as Wall-Mart and K-Mart for under 2 dollars. You are to explore the structure of the rocket to determine how the rocket can maintain its' flight. The rocket kit should contain a rocket, a pump, and a small funnel in the package.

Fill the rocket with one funnel full of water. Lock the rocket orifice onto the pump. Push the pump handle in and out 15 times. Hold the rocket upward and pull the locking mechanism. Repeat this procedure several times recording all observations in your science journal. What makes the rocket shoot upward? What two motions do you observe in the rocket as it ascends? What makes the rocket stable in flight? What gives the rocket a clockwise spinning motion? Why does the rocket fall nose first? Where is the energy stored for lift-off? Explain how momentum is conserved since the rocket system is constantly loosing water and air as exhaust? (To find more on momentum look in any physics textbook.) Remember momentum is a product of mass and velocity.

You will need a method to find the height the rocket reached as it turns and heads toward earth. Your group is to explore both methods that follow and determine which method you want to use.

One method is to use the free fall formula where distance or height is equal to ½ times the force of gravity, a constant, times the time squared. Simply measure the time from lift off till it begins to fall down and use that timing value. Be sure to repeat each launch 3 times and average the results. You must show all mathematical calculations including the units in a neat and orderly manner.

The second method uses a homemade altimeter and trigonometry. Consult the accompanying diagram (Plastic Water Rocket Fun Chart) for clarity. Make the altimeter by attaching a large straw to the straight edge of a protractor. Attach a 15centimeter segment of string holding a fishing weight to the center on the straight edge. Most protractors have a small hole at that center point. Have one student stand as far away from the launch site as they can. A hundred to two hundred meters would be ideal and yield better results than closer distances. Using the straw as a line of sight, follow the rocket upward with the curved portion of the protractor toward the ground. As soon as the rocket begins to fall, stop raising your line of sight and hold the string next to the protractor. The angle between the straight edge and where the string stops minus 90 degrees is the complimentary angle you need. According to trigonometry, knowing one side and an angle of a right triangle is enough information to determine what you need. Rearrange the tangent formula to solve for the height.

You are to pause here and summarize your observations and responses to the questions. The summary write-up should be well organized and free from spelling and grammatical errors.

Brainstorm with your group the following thoughts. You may need to research any resources available including textbooks, encyclopedias, the Internet and airport personnel.

1. Shoot the rocket with at a 45-degree angle. Draw and describe the shape of the trajectory. Why does any object thrown follow this path? As the rocket approaches earth in this path, observe carefully and describe the motion prior to hitting the ground Obtain a top and spin it on a table. Observe its motion as it begins to slow down. Is this the same motion as the rocket nose as it slows down? (Hint look up precession.)
2. Does the rocket exhaust need air to push against? Think carefully on this one.
3. If you wanted to hit a box on the ground about 25 meters away with your rocket, can you hold the rocket as if you were aiming a pistol with one eye open? Why or why not?
4. When does the rocket have maximum efficiency?
5. Can a rocket travel faster than its exhaust? Why or why not?

Pause here and summarize these questions into a well-organized second portion of your summary write-up.

Your group is to explore the effects of the amount of fuel on the height of the rocket. Make a well-organized data table to record the following information. Place 10milliliters of water and 15 pumps of air in your rocket. Have someone record the height reached. Repeat this process adding 20, 30, 40, 50, 60, 70, and 80milliliters of water keeping the 15 pumps constant plot a graph of the water amount verses the height. Consult the graph to answer the following questions. Include these questions in the final paragraph of your summary that should be free from spelling and grammatical errors.

1. Is there an optimum fuel-compression ratio?
2. How can you verify this?
3. How can you use the momentum concept to show how the fuel-compression system can be overloaded?

ICLE Essential Skills

Make observations using senses and instruments. Inferences and interpretations are arrived at based on observations. Classify observable properties and organize observations in a meaningful and logical way. (s5)
Exhibit good data management skills by collecting, organizing, and graphing data. (s19)
Observe and interpret energy and change relationships with the understanding that change occurs simultaneously at the interface between two parts of the environment where there is an energy exchange. (s60)
Understand and apply kinematics (i.e., the mathematical methods of describing motion without regard to the forces that produce it, such as velocity, acceleration and deceleration, and displacement). (s77)
Know and apply the principles of scientific inquiry. *(Implicit in this statement are the processes of prediction, estimation, developing hypotheses, drawing conclusions, evaluation, and following ethical principles and professional procedures.) (Not Ranked* s114)
Apply in writing the rules and conventions of grammar, usage, punctuation, paragraphing and spelling. (ela 1)
Identify, collect and/or select pertinent information while reading. (ela 5)
Use writing as a tool for learning in formats such as learning logs, laboratory reports, note-taking, journals and portfolios. (ela 40)
Present information in well-organized fashion that will be clear to the target audience. (ela 11)
Understand *basic algebraic properties* (i.e., commutative: ab = ba; associative: ab(c) = a(bc); and distributive: a(b+c) = (ab)+(ac)). (m3)
Know the *basic trigonometric functions* and ratios. (m18)
Know the components and properties of the *rectangular coordinate system*, (i.e., x - y axis, origin, quadrants, abscissa (x-coordinate) and ordinate (y-coordinate), and the general representation of a point (x,y)). (m23)

Scoring Guide:

RATE CRITERIA 3=Excellent, 2=Satisfactory, 1=Unsatisfactory, 0=Does not attempt or does not understand

CRITERIA	**SCORE**
Group work and experimental procedure	_____
First write-up addressed all questions	_____
First write-up well written and free from spelling and grammatical errors	_____
Student contributed to brainstorming with the group	_____
Second write-up addressed all questions	_____

Second write-up well written and free from spelling and grammatical errors _____

Student presented a well organized data table labeled correctly _____

Student graph properly labeled and neatly done _____

Last paragraph addressed all questions, well organized and free from spelling and grammatical errors _____

Student demonstrates an understanding for Newton's Third Law of motion related to rocketry _____

Keywords

English Language Arts	Mathematics	Science
Reading **Research**	**Algebra** **Graphs** **Algebraic Operation**	**Earth Science** **Energy** **Scientific Inquiry**
Writing **Spelling** **Grammar** **Technical Writing** **Journal**	**Geometry** **Triangles**	**Life Science**
Communications	**Statistics**	**Chemistry**
Literature	**Calculus**	**Physics** **Conservation of Energy Motion** **Newton's Laws**
Other	**Trigonometry** **Equation** **Ratios**	**Other**
	Other	

Chart

Plastic Water Rocket

Method One: Free Fall Formula $d = 1/2gt^2$

Method Two: Trigonometry