Rockets, Reactions & Ratios

Introduction

A chemical reaction is defined as a process in which one or more substances called reactants are transformed into substances called products. Sometimes we can tell that a chemical change has occurred because we can detect a new color or odor. Some reactions release heat as substances are transformed. Often we can tell that a reaction has occurred because one or more of the products exists in a phase different from the reactants such as a gas or solid, that is, bubbles or precipitation is observed.

A reaction is described by a chemical equation in the same way a recipe is used in cooking. It tells us how much of each ingredient (reactant) is needed and how much of each product we should expect to make. In this activity, you will be investigating the reaction between baking soda and vinegar and one of the products formed, carbon dioxide gas, CO_2. Though CO_2 is odorless and colorless, if the reaction occurs in a closed container the production of the gas can be detected by monitoring the pressure of the container. When enough pressure has built up the container explodes. The amount of vinegar being used will be held constant throughout the activity, therefore the goal is to determine the amount of baking soda needed to reach the objectives.

Objectives

1. To propel a paper rocket a vertical distance of 1 meter using a film canister engine fueled with 15 ml of vinegar and an amount of baking soda that yields a ratio of **rocket mass to baking soda mass** equal to or greater than 20:1. (This means your rocket mass must be at least 20 times more than the amount of baking soda you choose to use, for example if you use 1 gram of baking soda then your rocket must weigh 20 grams, if you use 2 grams of baking soda then your rocket must weigh 40 grams, etc).
2. To compare your results with those of your classmates through a rocket competition. At the conclusion of the testing period, each group will launch their rocket in the front of the class. One group per class will receive extra credit for having the best ratio (20:1 is the minimum). The grand winners (best ration among all participating classes) will have their names recorded on the "Rocket Champions" trophy. Keep in mind the current record is 149:1.
3. In keeping with "Spirit Week" the rocket that looks like a rocket (rockets often morph into space pods throughout the week) and displays the best school spirit (as voted on by the science teachers) will also win extra credit.

Pre-Lab Assignemt (optional)

Watch the movie "October Sky" which chronicles the life of a real rocket scientist, Homer Hickam, in his pursuit of building a rocket and going to college. Create a table similar to Table 1. and record the information as you watch the movie. The first trial in the movie has been recorded for you.

Table 1. Rocket Development in "October Sky"

TRIAL	Objective	Observations	Conclusions
1	Build a rocket; need a starting point	rocket did not fly, it blew up and took the fence with it	Needs more information on rocket building, needs a combustion chamber
2			

Submitted by Deborah J Maloney, PO Box 1222 Wilton , NH 03086 email dm1thes411@yahoo.com

Materials

Rocket Construction:

1 manilla file folder, glue, tape, markers, scissors, balance, washers (to add mass to the rocket). You may bring in paint and decorations.

Fuel Testing:

1 film canister and cover (the type that seal by snapping into the inner diameter of the canister), vinegar, baking soda, meter stick, graduated cylinder, tissue paper (optional), large tray

Safety

Any time you enter the lab area you MUST wear goggles and an apron. The covers explode with a great deal of force and your eyes must be protected.

Procedures

1. Agree on an appropriate name for your group and record it on the Report Sheet.
2. Read and abide by all guidelines and restrictions.
3. Think through the tasks and time restrictions. Designate roles and design a plan to accomplish the objectives. Record this information on the Report Sheet.
4. Construct rocket and run trials.
5. Analyze and retest as necessary within the allotted time frame.
6. In the spirit of competition secrecy is expected throughout all phases of this activity, however, you may purposely leak misleading information to your classmates :)
7. Complete the Report Sheet. Once it is handed in, you cannot make any changes.
8. Hand in the report sheet, rocket, canister, and cover
9. Compete and complete Table 2. Raw Data from all Groups & Classes during competition.

Rocket Guidelines and Restrictions

(a) The rocket must be constructed entirely within the classroom setting; it cannot be taken home
(b) It must be made using only the materials listed under rocket construction.
(c) The manilla file folder must be used as the major visual constituent of the body of the rocket
(d) Absolutely no part of the rocket is to be attached to the canister and or cover. They can be snug fitting, but the rocket, canister and cover must be handed in separate from each other for the competition.
(e) The rocket mass used to calculate the ratio must reflect ONLY the mass of the rocket you construct. The canister, cover and fuel are not to be massed with the rocket. You may, however, choose a design that requires the canister a/o cover to fly with the rocket. This just means you are lifting weight that you do not get credit for.
(f) The entire rocket must clear the meter mark to receive full credit. The canister and cover do not.

Fuel Testing Guidelines and Restrictions

(a) The amount of vinegar is being kept constant at 15 ml. You must use 15 ml in every trial.
(b) You can use any amount of baking soda.
(c) You may use a piece of tissue paper to enclose the baking soda in a “pouch” though this is optional and the tissue paper will not be considered as part of the baking soda mass. Only the mass of the baking soda will be used in calculating the ratio.
(d) Canisters with or without rockets must be launched from a sink or a large tray set on the floor.
(e) You must yell “Fire in the Hole” as soon as you cap the canister to alert your classmates of the impending explosion.
(f) You must record the specific objective, observations and conclusions from every single trial

Submitted by Deborah J Maloney, PO Box 1222 Wilton , NH 03086 email dm1thes411@yahoo.com

attempted.

(g) You should also keep record of the amount of baking soda used in every trial, the time it takes for the cap to pop and if the meter is cleared.

Competition Guidelines and Restrictions

(a) You will be allowed two attempts to clear the meter mark.
(b) You will be allowed a maximum of two minutes to complete each attempt.
(c) Mrs. Maloney will verify the rocket mass, provide the 15 ml of vinegar per attempt and measure the amount of baking soda specified on the report sheet by each group for the competition.
(d) Members of your group are responsible for the launching of their rocket.
(e) Members of the audience will verify if the entire rocket clears the meter; video and photo finishes are acceptable proof.

Table 2. Raw Data from all Groups & Classes

TEACHER/ PERIOD	Group Name	Rocket Mass (g)	Baking Soda Mass (g)	Time (s)	Clear meter? Y/N	Rocket Height (cm)	Diameter at base (cm)	Description of Rocket

Report Sheet

Group Name: _____

Members of Group:

Work Break Down:

Specific Task	Member(s) responsible

Complete this table upon completion of group testing. This report sheet must be completely filled in and handed in prior to the competition. None of the data may be changed after it is handed in.

Final Measurements	**unit**	**Teacher confirmed:**
Amount of baking soda to be used in challenge:	gram	
Mass of rocket	gram	
Ratio (rocket mass divided by baking soda mass)	“to one”	
Diameter of rocket at base (across the very bottom)	cm	
Height of rocket (very bottom to very top)	cm	
Approximate time from capping to explosion	s	N/A

TEACHER USE ONLY:
Group use of time:

Cleanliness of work area:

Rocket cleared 1 meter: YES NO

Submitted by Deborah J Maloney, PO Box 1222 Wilton , NH 03086 email dm1thes411@yahoo.com