

## Rocket Propellant :

**Identifying a Need:** Your job is to create the most efficient rocket propellant by mixing only one solid and only one liquid together. You will be given 3 solid chemicals, and 3 liquid chemicals to work with. You will mix the chemicals together and measure the amounts of each chemical that you used to determine the best ratio, and the best combination of solid and liquid chemical. When building rockets, the mass of the rocket is a huge issue in lift-off. The propellant needs to be the lowest possible mass, with the highest possible thrust.

**Research:** Understanding the science behind your project is an important aspect of being successful in the assignment.

Vocabulary to know:

Chemical Reaction	
Endothermic Reaction	
Exothermic Reaction	
Balanced Chemical Equation	
Reactants	
Products	
Law of Conservation of Matter	

Materials Available:

Chemical A ( $\text{NaHCO}_3 + \text{C}_6\text{H}_8\text{O}_7$ )	Chemical 1 (HCl)	Medium Balloons
Chemical B ( $\text{NaHCO}_3$ )	Chemical 2 ( $\text{CH}_3\text{COOH}$ )	Medium Test Tubes
Chemical C (Zn)	Chemical 3 ( $\text{H}_2\text{O}$ )	Rubber Bands
Ruler	String	25 ml Graduated cylinder
Electronic balance	Calculator	Test tube rack

**Procedure:**

1. Choose a Letter Chemical (A, B or C) and a Number chemical (1,2, or 3). Record each in the chart. Include the full chemical formula.
2. Carefully pour the desired amount of the liquid chemical in the graduated cylinder. Record the volume of the liquid.
3. Carefully record the mass of the desired amount of the solid chemical using the scale.
4. Pour the liquid into the test tube.
5. Pour the solid into the balloon.
6. Place the mouth of the balloon over the mouth of the test tube. Secure with a rubber band.
7. Lift the balloon allowing the solid to slide down into the test tube, mixing with the liquid.
8. Place the test tube and balloon in the test tube rack.
9. Allow reaction to take place for several minutes, until you do not see or hear a reaction taking place.
10. Remove the balloon very carefully with out allowing any of the gasses to escape. Tie the balloon.
11. Use the string to determine the circumference, in centimeters at three different locations around the balloon.
12. Use the math chart below to help you to determine the volume of the balloon and record this information.
13. Repeat as many times as you like until you have the desired rocket propellant. The greatest volume of the balloon will result from the best reaction.

**Math Chart:**

**Step 1:**

Find the average circumference

Circumference at the top of the balloon=	
Circumference in the middle of the balloon=	
Circumference at the bottom of the balloon=	
Sum of all three: top + middle + bottom=	
Divide by 3	
Average circumference =	

**Step 2:**

Use the equation to determine the radius of the balloon. Plug in your average circumference.  
(Pi = 3.14)

$$\text{Diameter} = \text{Avg. Circumference} / \text{Pi}$$

$$\text{Diameter} = \underline{\hspace{2cm}}$$

$$\text{Radius} = \frac{1}{2} \text{ Diameter}$$

$$\text{Radius} = \underline{\hspace{2cm}}$$

**Step 3:**

Use the equation to determine the volume of a sphere. Plug your radius in for the r in the equation.

$$\text{Volume} = \frac{4}{3} * \text{Pi} * r^3$$

$$\text{Volume} = \underline{\hspace{2cm}}$$

Record your volume in the chart.



**Presentation of Results:** Answer the following questions about your activity. Be prepared to share your answers with the class.

What combination of chemicals yielded the best results?	
List the chemical formulas used in your reaction.	
Is this an endothermic or exothermic reaction? How can you tell?	
Explain why you feel this propellant is the best possible for a rocket ship.	
When working with actual rockets it is important to remember that mass of the fuel is one of the major components of lift off. What did you do in this lab to make sure that you used the least possible mass?	

What problems did you face in this project?	
How did you overcome the problems that you faced?	
Did you achieve mission success?	
How do you know if you achieved mission success or not?	

Three of the reactions that you should have done in the lab are listed below:

Chemicals	Reactants	Yield	Products
Chemical A with Chemical 3	$\text{NaHCO}_3 + \text{C}_6\text{H}_8\text{O}_7 + \text{H}_2\text{O}$	→	$\text{CO}_2 + 3 \text{H}_2\text{O} + \text{NaC}_6\text{H}_5\text{O}_7$
Chemical B with Chemical 2	$\text{NaHCO}_3 + \text{CH}_3\text{COOH}$	→	$\text{H}_2\text{O} + \text{CO}_2 + \text{NaCH}_3\text{COO}$
Chemical C with Chemical 1	$\text{Zn} + 2\text{HCl}$	→	$\text{ZnCl}_2 + \text{H}_2$

Chemical A = Alka-Seltzer

Chemical B = Baking Soda

Chemical C = Zinc

Chemical 1 = Water

Chemical 2 = Vinegar

Chemical 3 = Hydrochloric Acid

**Questions:**

1. Does each chemical equation satisfy the law of conservation of matter? Explain.

2. Label each chemical equation as endothermic or exothermic and explain why:

Chemical Reaction	Endothermic or Exothermic	Explanation

3. What did you learn about rockets from this lab?

4. Would you ever consider a career as a rocket scientist? Why or Why not?