

SMOKIN' CUPCAKES

Reviewing the principles of Chemistry 1 at Billings Senior High School

In this lab, you will react potassium nitrate with sucrose (sugar) to produce an excessive amount of smoke made of carbon dioxide, water vapor and nitrogen gas.

Your challenge is to develop a recipe to create a “smoking cupcake” that produces more smoke than the other team’s “cupcake”. They are called “cupcakes” because the mixed chemicals have a consistency similar to cake batter and if you pour them into a muffin pan, they look like cupcakes. But don’t be fooled, these are definitely not your grandma’s cupcakes - these things are “Smokin’ Cupcakes!”

This inquiry experiment (inquiry means that you will develop and discover the outcome) is meant to challenge you with the principles learned in Chemistry 1. You are not, in any way, allowed to use the internet to help you with this challenge.

Background Information:

Reaction rates are an important topic in AP Chemistry which we will learn in detail at a later time. There are several things that affect the rate of reaction including: ideal ratio of reactants and surface area. As you work through the procedure in this lab, be sure to keep these two factors in mind because they will affect the rate of reaction and the outcome of this experiment.

Safety Concerns:

- Heating the substances can cause them to react, producing flames and smoke. Do not overheat and be vigilant at all times.
- If substances begin to smoke, move them to the fume hood and turn on the fan immediately - do not set the hot can/beaker down as it will burn the tabletop in the hood.
- Do not light smoke cakes indoors - we will test the smoke cakes outside.
- The “Cupcakes” are NOT edible. Do not eat anything in this lab.

Supplies:

- *Sugar (sucrose)
- *Potassium nitrate
- 150ml Beakers for measuring (need 2)
- Stovetop
- Non-Stick Pan
- Spatula
- Muffin Tin
- Cupcake Baking Cups (or aluminum foil pressed into the muffin tin)
- Aluminum foil
- Dixie Cup
- Balance
- Magnesium strip (10 cm)

- Data collection instruments (you will have to determine what you need for this)

**measure these very carefully using your AP Chemistry balance at your lab station*

Pre-Lab:

Calculating your ratio

1. Write the balanced chemical equation for the following:
 - Potassium nitrate reacts with sugar ($C_{12}H_{22}O_{11}$) to produce potassium carbonate, carbon dioxide, water and nitrogen gas.
 - i. (hint: Balanced chemical equation will have 48 moles of Potassium Nitrate and ?? moles of Potassium Carbonate, ?? moles of carbon dioxide, and 55 moles of water, and ?? moles Nitrogen gas)
2. Determine the molar ratio of reactants you will use in your recipe. Write a list of how many moles of each reactant you will need.
3. Convert the moles of reactants to grams. This is your recipe for making the ideal smokin' cupcake if you had unlimited supplies.
4. For this lab, you may not use more than 100 grams of reactants total (mass of all reactants cannot exceed 100 grams). Using molar ratio and percent composition, calculate how many grams of potassium nitrate and how many grams of sugar you will use.
5. How many grams of potassium carbonate will be produced when you react to your calculated reactants (from question 4)?
6. Record the amount (g) of each reactant and share your calculations and numbers with Mr. Beals before continuing. ****You must have Mr. Beals sign off on your numbers before proceeding.**

Procedure

-Note: *We will all burn our smoke cakes outside to see which team has calculated the best ratio and has used the most accurate lab skills.*

1. Wear goggles and apron
2. Measure the sugar and potassium nitrate in the small beakers
3. Get the mass of your empty Cupcake Paper Cup (or aluminum foil).
4. Mr. Beals will cook your cakes with you on the stovetop. (More info on lab day)
5. Remove the sugar from the heat once it has melted and is the consistency of caramel.
6. Pour the melted mixture into a Cupcake Paper Cup (or aluminum foil).
7. Cut a 10cm strip of magnesium. Place the magnesium metal into the cake (like a birthday candle) to use as a fuse. Allow to cool.
8. Get the mass of your full Cupcake Paper Cup (or aluminum foil) with the magnesium 'candle'. Record the total mass of 'cake' that is in your cup by subtracting the initial mass of the cup.
9. Make a name tag with a small strip of paper (with team members names) to attach to your fuse so we know which is yours.
10. Clean supplies (see next steps for cleaning)

Cleanup

1. Clean the beaker and stir rod with water. Scrub until all residue is completely removed. Rinse thoroughly. Dry and return to the lab supply station.
2. Clean the cooking pan with water and soap. Scrub thoroughly.
3. Clean up all lab supplies.
4. Clean lab table tops with Lab Table Cleaner

Data/Observations

In AP Chemistry, you need to be able to identify dependent and independent variables in data sets and use them to graph and interpret what the data means. This is practice for those skills:

1. You will need to develop scientific ways to collect data on the following to determine how well one recipe burned compared to another:
 - Recall **"DRY MIX"**
 - **Dependent Responding Y-axis**
 - **Manipulated Independent X-axis**
 - Identify and record the following:
 - **Dependent Variable:**
 - **Independent Variable:**
2. Collect data in the same manner for each group (you will have data tables for every group's "cake" so you can compare at the end).
3. ~~Create a graph to visually represent the variable. For the Independent variable, find out how much potassium nitrate each group used and whether or not they did anything to increase or decrease surface area and plot one of those against the dependent variable.~~
 - ~~○ Recall **"DRY MIX"**~~
 - ~~■ **Dependent Responding Y-axis**~~
 - ~~■ **Manipulated Independent X-axis**~~

Post-Lab Questions:

1. AP FRQ (Free Response Question) Practice : Use critical thinking and complete sentences:
 - Technically speaking, if we all used the same stoichiometric process then every "cake" should have burned at the same rate and produced the same amount of smoke - most likely this did not happen. Explain why there were differences in smoke production and burn rate.
(Use scientific thinking and words. Relate your answer back to your prior knowledge of chemistry)

Conclusion:

~~No conclusion needed for this lab. Smile.~~

(Skip the following for this year)

Ratios for experiment

Use the ratio assigned to you to calculate the mass of each reactant needed
ratios

| Number | Sucrose | Potassium Nitrate |
|---------------|----------------|--------------------------|
| 1 | 1 | 9 |
| 2 | 2 | 8 |
| 3 | 3 | 7 |
| 4 | 4 | 6 |
| 5 | 5 | 5 |
| 6 | 6 | 4 |
| 7 | 7 | 3 |
| 8 | 8 | 2 |
| 9 | 9 | 1 |