How Can We Make Chalk? student activity sheet

Purpose:
As a new hire for a major chemical manufacturer, you are in charge of an efficiency analysis for the production of calcium carbonate (also known as chalk). Your group is to determine the best method for making chalk with the lowest cost. In order to do this, you will need to determine the possible reactions that will produce calcium carbonate from the possible reactants listed below. You will need to determine the cost of these possible reactants and you will need to perform the reactions at least twice in order to determine the percent yield for each reaction. Prior to performing any experiments, your group will submit a short report to your boss. This report must contain the following:

Pre-lab proposal report (Each group will need two copies, one to turn in and one to use in the lab.)

- List of the balanced equations for all possible reactions that can be performed in order to produce calcium carbonate from the available reactants listed under "possible reactions" below. These reactions must be written as balanced equations.
- List of cost per gram of reactant for each of the possible reactants. Assume you will purchase the solid and lab grade for each of the reactants. Use the manufacturer cost data provided by your teacher.
- A procedure you will follow in order to perform these reactions. You will be given only 50.0 ml of 0.5 M solutions of your two reactants to use. You will need to specify in your procedure the volume of each of these solutions that you will use. Consider that you may need to perform several trials from that 50 ml sample.
- Conclude this report by stating the reaction you would most like to perform and an explanation of why this reaction is your choice.

Possible reactants:

1. calcium acetate monohydrate
2. calcium chloride anhydrous
3. calcium nitrate tetrahydrate
4. ammonium carbonate anhydrous
5. sodium carbonate anhydrous
6. potassium carbonate anhydrous

Your boss will review your report and approve your reaction. Next, you will need to create a data table to record all the data you collect and calculate as you perform your experiments. You will receive your reactants when this data table has been approved. Perform your experiment until you believe your results are repeatable and consistent. As a class, we want to perform all possible reactions so we can share the data. It may be necessary to assign your group a different reaction than the one you selected. This will not affect your final report as we will all use the data generated by each group in the class.

Final report

Each group will turn in a final report, which will include the following.

- The balanced equation for the reaction that you performed
- The procedure used to perform your reaction. Turn in the initialed original procedure as well as an edited version with any changes you made while performing the lab.
- The calculations used to determine the actual yield, theoretical yield, and the percent yield for your reaction.
- The cost per gram to make chalk using your procedure
- Two data tables. The original table with all data and calculated values for the reaction your group performed. The second data table includes the actual yield, theoretical yield, and percent yield reported by every group in your class. All data contains proper significant digits and units.
- Thorough analysis of class data to determine the most cost effective reaction to produce chalk.
- A summary of at least three possible errors and ways to improve the experiment next time.

Important deadlines:

- Two copies of the pre-lab proposal report due _____
- Final report due _____

Your job performance will be evaluated using the rubrics included in these pages.

Table 1: Table of reactants and costs

Reactant	Supplier	Cost / mass ($/g)	Cost /1 gram ($)	Cost/ mole ($)
Calcium chloride	Fisher	7.65 / 100 g	0.0765	6.89
Calcium acetate	Fisher	15.50 /500 g	0.031	4.90
Calcium nitrate	Fisher	12.45 / 500 g	0.0249	4.09
Ammonium carbonate	Fisher	15.70 /500 g	0.0314	3.01
Sodium carbonate	Fisher	5.95 / 500 g	0.0116	1.23
Potassium carbonate	Fisher	12.75/ 500 g	0.0255	3.52

Table 3 : Solutions for "Let's Make Chalk" lab

Reactant	Mass (g)	Volume solution(ml)
Ammonium carbonate	9.609	200
Potassium carbonate	13.821	200
Sodium carbonate	10.599	200
Calcium chloride	14.702	200
Calcium nitrate	23.616	200
Calcium acetate	17.619	200

"Let's Make Chalk" lab rubrics

Pre-lab report

5	4	3	2	1
Lists all possible balanced reactions	Lists 90% of all possible balanced reactions	Lists 80% of all possible balanced reactions	Lists 70% of all possible balanced reactions	Lists 60% of all possible balanced reactions
Lists correct costs for 1 g of all possible reactants	80% of the costs are correct	60% of costs are correct	50% of the costs are correct	The costs are missing or incorrect
Procedure contains proper names and sizes of equipment and amounts for reactants	Procedure missing proper names and sizes of equipment or amounts for reactants for a few items	Procedure missing proper names and sizes of equipment or amounts for reactants throughout	Procedure missing proper names and sizes of equipment and amounts for reactants	Procedure missing names of equipment and reactants
Procedure is logical, easy to follow, and includes all necessary steps	Procedure is incomplete or slightly difficult to follow	Procedure is incomplete and slightly difficult to follow	Procedure is incomplete and difficult to follow	Procedure is confusing to follow
Pre-lab report was submitted on time, typed or written neatly in ink	Submitted on time, but not neat	Submitted 1 day late, neat	Submitted 1 day late and not neat	Submitted 2 days late
2 copies of the data table typed or neatly drawn in ink, ready to hold all data collected as well as calculated answers	Missing places for a few pieces of information or missing a second copy of data table	Data table holds all data, but not neatly drawn	Data table not neat and missing places for pieces of data	Not turned in prior to lab day

Final report rubric

5	4	3	2	1
The procedure used to test these reactions. Both the original and the edited final draft.	Original procedure turned in and final procedure contains most changes.	Original procedure not turned in, but final procedure contains most changes.	Final procedure is not complete or updated.	No final procedure turned in.
The calculations for the actual yield, theoretical yield, and % yield for the reaction. Contains the balanced equation for the reaction.	Calculations missing one of the following: balanced equation, yield calculations, or % yield calculations.	Calculations missing 2 of the following: balanced equation, yield calculations, or % yield calculations.	Calculations missing 3 of the following: balanced equation, yield calculations, or % yield calculations.	Calculations not present or not able to be followed.
The calculation to determine the cost per gram of chalk produced for the reaction.	Calculation of cost contains a small error.	Calculation of cost contains more than one error.	Calculation of cost is not clearly presented.	Calculation of cost not present.
Original data table and class data table containing all data and calculated results. Includes units and sig digs.	Original data table is missing some data. Class data table is included.	Original data table is included, but the class data table is missing.	Both data tables are missing data.	Data tables are missing.
Correct and thorough explanation of the most cost effective method to produce chalk.	Incomplete but correct explanation of the most cost effective method to produce chalk.	Complete, but incorrect explanation of the most cost effective method to produce chalk.	Explanation is neither correct nor complete.	No analysis presented.
A summary of possible errors and ways to improve the experiment next time.	A few errors are listed without relating them to the final results.	Errors are listed without ways to improve the experiment.	Errors are not mentioned, but ways to improve the experiment are.	Neither errors nor possible improvements are mentioned.