

ZIP LOCK BAG REACTIONS

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This was one of the first problems developed for testing. It is a variation of a GEMS activity (Lawrence Hall of Science) and concerns chemical reactions, acids and bases, and heat. There are no major hazards in this activity, but safety glasses and gloves are required,

This problem was used in an academic competition where teams of students worked to solve the problem and then presented their results to a team of evaluators.

The factors that the evaluators looked for were first outlined by this author. That material was sent to outside evaluators, in the field, to criticize and modify. The comments and modifications were reviewed, corrections were made, and the modified material was again sent out for review and further modification. It should be noted, that the process of evaluating active assessment-type questions is a process that takes time and the input of several people. The goal is to try to develop a more objective evaluation that identifies the knowledge of the students working on the problem. The final answer is only a small part of this type of problem solving.

Most practical exams, administered in a small department setting, are evaluated in a somewhat subjective manner and the same criteria are not uniformly applied to all the students or teams working on the problem. This is not necessarily a result of favoritism toward certain students, although it may play a role, but rather a result of limited time for evaluation, different evaluators, or just a cursory scan of results where the evaluator concentrated mainly on the answer.

Another consideration is that all points are **positive points**, that is, students or teams get points added for each correct part of the solution to the problem. The author believes this produces more of a positive feedback to the student/team.

ZIP-LOCK BAG REACTIONS

Materials:

- 2 bottles labeled #1 and #2, containing powders
- phenol red aqueous solution
- empty vial
- water
- tablespoon measure
- zip-lock bags
- 4 safety glasses and 4 pairs of gloves
- paper towels
- drip pan

One of the bottles contains calcium chloride, and the other contains sodium bicarbonate (baking soda).

NOTE: All students must wear safety glasses and gloves during experimentation.

Task:

Using the materials supplied above, you have **20 minutes** to determine which numbered bottle contains calcium chloride and which one contains sodium bicarbonate.

You must explain how you determined your conclusions in a **5-minute presentation** to the judges, using chemical notation if appropriate.

- 1) Place 1 tablespoon of each powder in a zip-lock bag. Fill vial about **1/2 inch** high with phenol red solution. Being careful not to spill any of phenol red solution, place the vial in an upright position into the bag of powders and seal the bag tightly. Once the bag is sealed, spill the phenol red solution into the powders.
- 2) Record your observations, and determine why they occurred.
- 3) Repeat the procedure with any variation of the components.
- 4) Identify which bottle contains the calcium chloride and which one contains the sodium bicarbonate.
- 5) Which component is responsible for each of the observed results?
- 6) Explain why you came to that conclusion.

Zip Lock Bag Reactions SCORING WORKSHEET

TOTAL of 500 points for the entire activity

Results of Task (120 points)

The results that should be observed are described along with each combination. A **team can achieve a maximum of 120 points for this section regardless of the number of combinations they produce.**

* Phenol red solution is pink or red when mixed with a basic solution. It turns yellow when with an acid solution.

Combinations of Substances and Observed Results	Possible Points	Points Achieved
1) Calcium chloride plus sodium bicarbonate plus water will react to form a gas	20 pts	
2) Calcium chloride plus sodium bicarbonate plus phenol red will react to form a gas and change to yellow.	20 pts	
3) Sodium bicarbonate mixed with phenol red will be red with no change in temperature or gas production.	20 pts	
4) Sodium bicarbonate dissolves in water with no change in temperature or gas production.	20 pts	
5) Calcium chloride reacts with water to produce heat.	20 pts	
6) Calcium chloride mixed with phenol red may not show a distinguishable	20 pts	
Total Points	120 pts (max)	

Explanation/Presentation (340 points)

Explanation of Observed Results	Possible Points	Points Achieved
1) Identification of both compounds (<i>Calcium chloride and sodium bicarbonate</i>)	40 pts	
• Writing the formula for Calcium chloride as CaCl_2	10 pts	
• Writing the formula for Sodium bicarbonate as NaHCO_3	30 pts	
2) Proper explanation of an indicator	10 pts	
• Proper use of the term <i>acid</i>	10 pts	
• Proper use of the term <i>base</i>	10 pts	
• Description of the reactive properties of phenol red	10 pts	
3) Explanation of why heat evolves	10 pts	
• Proper use of the term <i>exothermic</i>	10 pts	
• The mention of breaking bonds and forming new bonds	10 pts	
4) Explanation of gas production (also accept term bubbles)	30 pts	
• The proper identification of the gas as CO_2	20 pts	
5) Indication that carbonic acid breaks down to form water and carbon dioxide	20 pts	
• Writing the equation for the breakdown as $\text{H}_2\text{CO}_3 \rightarrow \text{H}_2\text{O} + \text{CO}_2$	20 pts	
• Explanation describing the instability of carbonic acid	10 pts	
6) Properly writing the equation for the chemical reaction that occurs between calcium chloride and sodium bicarbonate as either:	40 pts	
$\text{CaCl}_2 + 2 \text{NaHCO}_3 \rightarrow 2 \text{NaCl} + \text{CaCO}_3 + \text{H}_2\text{CO}_3$		
AND		
$\text{H}_2\text{CO}_3 \rightarrow \text{H}_2\text{O} + \text{CO}_2$		
OR		
$\text{CaCl}_2 + 2 \text{NaHCO}_3 \rightarrow 2 \text{NaCl} + \text{CaCO}_3 + \text{H}_2\text{O} + \text{CO}_2$		
*If only the first equation of the top pair is given, award 20 pts.		
• If the equation is properly balanced	20 pts	
• If students indicate CO_2 is a gas with \uparrow or (g) notation (written as $\text{CO}_2\uparrow$ or $\text{CO}_{2(g)}$)	10 pts	
Total Points		

Quality of Presentation (40 points)

Participation and Presentation

For all team members actively participating in the presentation.	20 pts max
Use of general public speaking skills such as voice projection, Eye contact, proper grammar, etc.	20 pts max
Total Points	40 pts

TOTAL POINTS FOR PROBLEM (500 max)