**Chemistry A Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Period\_\_\_\_\_\_**

## Production of Sodium Carbonate

#### Discussion

Ernie Chiquita, owner and president of the BaNaNa Company, has decided to produce and sell sodium carbonate. Mr. Chiquita gave the task of finding a suitable process to Professor “Red” McIntosh. The research carried out by Professor McIntosh and his team uncovered two methods to prepare sodium carbonate. You have been given the task to analyze these plans, labeled A and B, and find out which process would produce the cheapest sodium carbonate.

In each plan certain by-products of the reactions, in addition to the sodium carbonate, will be sold for profit and certain chemicals will be recycled to help defray the cost of the reactants. Questions 1-7 are designed to help you gather the information necessary to make the decision as to which plan, A or B, would be the best to use.

The cost of chemicals used as reactants are given below:

|  |  |
| --- | --- |
| **Chemical Costs** | |
| carbon dioxide | $19.80/kg |
| ammonia | $13.20/kg |
| sodium chloride | $10.80/kg |
| calcium hydroxide | $13.20/kg |
| sodium hydroxide | $15.80/kg |
| hydrogen chloride | $ 8.25/kg |
| water | free |

The expected market price for the chemicals which will be sold for profit are:

|  |  |
| --- | --- |
| **Market Price for Products** | |
| ammonium chloride | $13.20/kG |
| calcium chloride | $14.30/kG |

#### Questions:

1. Write the balanced equations for each of the following:

* a) the production of ammonium bicarbonate
* b) the production of sodium bicarbonate
* c) the production of sodium carbonate
* d) the production of calcium chloride
* e) the production of sodium chloride

2. Given one mole each of carbon dioxide, ammonia, water, and sodium chloride, determine, for plan A, the following:

* a) the number of moles of carbon dioxide produced
* b) the number of moles of sodium carbonate produced
* c) the number of moles of water produced
* d) the number of moles of ammonium chloride produced
* e) the mass in grams of sodium carbonate produced
* f) the mass in grams of ammonium chloride produced

3. As you can see from plan A carbon dioxide is going to be recycled. Will there be enough produced to react with another mol of ammonia. If not, how many moles will have to be added on each successive cycle of the process, that is, how many moles will have to be added each time a mol of ammonia reacts?

4. What will be the minimum price that you will have to sell the sodium carbonate at in order to break even with plan A? (Hint: You will have to consider the total cost of the reactants on the second and successive cycles of the process and the price that you get for selling the ammonium chloride.)

5. Given one mol each of carbon dioxide, ammonia, sodium hydroxide, and hydrogen chloride determine, for plan B, the following:

* a) the number of moles of carbon dioxide produced.
* b) the number of moles of sodium carbonate produced.
* c) the number of moles of calcium chloride produced.
* d) the number of moles of ammonia produced.
* e) the number of moles of calcium hydroxide required.
* f) the mass in grams of sodium carbonate produced.
* g) the mass in grams of calcium chloride produced.
* h) the mass in grams of calcium hydroxide required.

6. As you can see from plan B both carbon dioxide and ammonia will be recycled. Will there be enough of each of these reactants to react with another mol of water. If not, how many mols will have to be added for each additional cycle of the process?

7. What will be the minimum price that you will have to sell the sodium carbonate at in order to break even with plan B? (Hint: You will have to consider the total cost of the reactants on the second and successive cycles of the process and the price that you will get for selling the calcium chloride.)

8. Which plan would you recommend? Why?

9. The purest grade of sodium carbonate is selling for about $21.80/kG. If your employer wanted to make at least $1.00 per kilogram profit, what would be the maximum production cost per kilogram that he could tolerate (heat, light, wages, salaries, taxes, etc.)