

The following activity is based on events that could actually happen within a company and shows how stoichiometry can be used. This can be a challenging activity but I know you can do this if you just stop and think about each problem and what you have already learned. If you need help Miss Klein is here to help you – klk02@mcsdk12.org or sign up for Remind by texting @kleinchem1 to 81010

Also – you can go to my website www.mchschem1.weebly.com and there you can find informational videos and example problems to help you.

ChemDetectives Inc: The Case of the Golden Drain

Prologue

John Doe has taken a position at GoldMaker Enterprises. The founder of GoldMaker Enterprises invented a way to make a better nugget using gold(III) hydroxide. Everyone else uses gold(III) chloride. To keep the process secret, GoldMaker Enterprises purchases gold(III) chloride and then reacts it with sodium hydroxide and their secret catalyst to make their own gold(III) hydroxide. John was recently hired to perform this reaction and isolate the gold(III) hydroxide. After about a month on the job, he was called into the boss's office for performance evaluation. He was very nervous as this was his first full-time position and he had never been called in for a meeting. You run a consulting company, called ChemDetectives Inc. You have received the case of John Doe. The transcript of his conversation with the founder of GoldMaker Enterprises is provided below. Analyze the performance of John Doe and provide a detailed report on the basis of this conversation.

Conversation Transcript (*important information in here!*)

Boss: Please sit down, John. I understand that you have been preparing our gold(III) hydroxide. Is that correct?

John: Yes, Sir. Is there a problem with the product?

Boss: No, the product is fine but our supply of gold(III) chloride has run low.

John: (nervously) Maybe that's because I'm working harder than the last person in this position.

Boss: (seriously) Maybe. John, please describe how you are making the gold(III) hydroxide.

John: I mix the sodium hydroxide with the gold(III) chloride and our catalyst, then let it settle for about an hour and remove the clear liquid from the top. Then I centrifuge the sludge. I remove the rest of the liquid; finally I let the material dry in the oven overnight.

Boss: That's not a very precise description. How much gold(III) chloride and how much sodium hydroxide do you mix?

John: The first time I used 280 grams of gold(III) chloride and 12 grams of sodium hydroxide.

Boss: Why did you use those amounts?

John: Those were the numbers I remember from my first day of work. But I only got about 24 gram of gold(III) hydroxide. I was told the yield was too low and that I should get more than 200 gram of

product. So, I increased the amount of all reagents by 10 times.

Boss: (in a surprised voice)

Everything?

John: (nervously) Yes.

Boss: Do you have a copy of the laboratory notebook for the reaction specification from your first day at work?

John: (sheepishly) No, I don't. It was easy to remember, so I didn't write it down.

Boss: (frowning) You must write down detailed notes on all reactions.

Boss: So you added 2800 grams of gold(III) chloride and 120 grams of sodium hydroxide?

John: That's right, (pleased with himself) and I got about 248 gram of gold(III) hydroxide, which is significantly higher than 200 gram.

Boss: And what happened to the liquid portion of each reaction?

John: I dumped it down the drain; since I had already isolated the product.

Boss: (heavy sigh) How many batches of product have you made?

John: Five batches a week for a month.

Boss: As you know gold is very expensive about \$43.61 per gram. And you made 20 batches. Is it true that you successfully finished your Chemistry I course?

John: Yes, I think I did really well in all my courses

Boss: (seriously) I am not sure that is correct. This meeting is over. I have a suspicion that something is not right, but I don't have the time to figure it out. I will hire ChemDetectives to investigate this matter. We will resume production only after we have their report. You may take the next 2 days as casual leave. Someone will get in touch with you, after we have seen the report from ChemDetectives.

Questions:

Section I: Background

1. What is the chemical formula for gold(III) hydroxide? What is the molar mass? (*remember find gold and find hydroxide and criss cross their charges – molar mass is on the periodic table*)
2. What is the chemical formula for gold(III) chloride? What is the molar mass?
3. What is the chemical formula for sodium hydroxide? What is the molar mass?

Section II: Stoichiometry. Show all work with units.

4. Write a balanced equation for the reaction of gold(III) chloride with sodium hydroxide to form gold(III) hydroxide and sodium chloride. (*you already have the formulas up above, now put them into an equation and balance them*)
5. Which reagent is limiting reactant in John's first reaction? How much gold (III) hydroxide can John make in the first reaction? (*Look back to the transcript and find out how much gold (III) chloride and sodium hydroxide John used in his first reaction. Do 2 different stoichiometry problems with those numbers going to grams of gold (III) hydroxide – the REACTANT that makes the least gold (III) hydroxide is the limiting reactant*)
6. What was the percent yield of John's first reaction? (*% yield = actual / theoretical *100*) (*theoretical is the amount of gold (III) hydroxide you can make from your limiting reactant in Question 5*)

7. Which reagent is limiting reactant in John's second reaction? How much gold (III) hydroxide can John make in the second reaction? (*Repeat what you did in Question 5 except with the starting amounts John used in the second reaction*)

Section III: Conclusion

8. What reactant was in excess in John's first reaction? How much of the excess reactant remained after the reaction was complete? (*Whatever reactant isn't the limiting reactant is in excess aka the excess reactant. For the second part of this question, take how much limiting reactant you started with and do a stoichiometry problem to grams of the excess reactant. This number is how much excess reactant you used in the lab. Subtract what you started with from what you used and that is how much excess reactant you have left over*)
9. What reactant was in excess in John's second reaction? How much of the excess reactant remained after the reaction was complete? (*Repeat everything from Question 8 except with the second reaction numbers*)
10. How much **total** excess reactant was wasted during John's experiments over **five weeks**? (Don't forget to include the amount from his very first reaction!) (*Use your brain and the answers from Questions 8 and 9*)

11. What happened to the excess reagent? (*read the manuscript*)

12. Did John cause a loss to the company? If yes, calculate the loss caused to the company.

- What was the percent composition of gold in the excess reactant?
(*percent composition = mass of gold / mass of excess reactant *100*)

- How many grams of gold were discarded with the excess reactant? (*use the percent composition*)

- How much money did the company lose because of John's mistake? (*use your answer above and the manuscript*)

13. Your service charge is 5% of the amount calculated in 12. How much did you earn for this investigation?

14. If John wanted to produce 200 g of $\text{Au}(\text{OH})_3$, how much AuCl_3 **should** he have used? (*stoichiometry problem*)

15. What is your recommendation about John to his employer?