

Vasquez High School -- AP Chemistry -- Exam #3 -- Chapter 3 -- 90 points

Read the stories **carefully**. Everything you need to do them is in the stories. Be NEAT, clear and complete in your presentations. Read what you wrote BEFORE turning it in. Good luck; see you in 2106.

- 1a) Despite seemingly endless arguments between management and labor, the mining and production met its quotas. Throughout the summer and into the fall of 2106, United Americas' mine #11 refined the largest amount of thorium ever produced since the Martian colonies were opened in 2057. Everyone at the facility knew that all parties concerned had to meet quotas for anyone to get paid.

You were the staff chemist. You were the one responsible for seeing that the yields were up to the proper levels and calculating amounts of raw materials needed and products refined. It was you who learned how to refine the thorium oxide, ThO_3 , by pumping in hot, pressurized hydrogen gas, thus yielding the pure, rare, and highly valued heavy metal. One handsome by-product was the steam being ejected into the Martian atmosphere leading one day, perhaps, to the widespread terraforming of the entire Martian surface. Should this occur one day, you would be famous...

As you lazily dreamt of future fame, your manager stormed in and yelled, "Okay, P-H-D, get back to work! Get me that balanced reaction right now!" Stirred from your reverie, you picked up your pencil and wrote...

- 1b) He looked at the formula approvingly. "Very good. Now we have poured 2.63×10^4 kg thorium oxide into the reaction chamber this morning. How many moles is that?" (thorium has a mass of 232 g/mol)

- 1c) "Yes, that's right. Okay, now what I have to know is how many kg of hydrogen gas we will need to pump in to completely react with that much ThO_3 . And be quick about it!"

- 1d) "Lastly, the big boss needs a minimum 92.5% yield on the thorium metal produced. The investors are very demanding and if they don't get it, heads are going to roll. And if I lose mine, you'll lose yours. So tell me, what's the mass of the minimum yield that will satisfy these greedy investors?"

- 2) In the school for the miners' children, professor Beryllium Berkeley is demonstrating the reaction between potassium permanganate, KMnO_4 , and glycerol, $\text{C}_3\text{H}_5(\text{OH})_3$. "Now kids, I am getting a bit forgetful in my old age and cannot remember how many mL of glycerol I need to react with this 10.0 g KMnO_4 . You're going to have to help me...now, I do remember the mole ratio is 7-to-2...and the density of glycerol is 1.26 g/mL. Can anyone help me?" (K = 39.1 g/mol and Mn = 54.9 g/mol)
- 3) Back in New Angeles, on the latest hit HoloV show, "Making Glad," the lead character Ms. Black is preparing for the combustion of rhamnose monohydrate, a sugar with the formula $\text{C}_6\text{H}_{12}\text{O}_5 \cdot \text{H}_2\text{O}$ in pure oxygen. She carefully measures out 150.0 g of the sugar and realizes that she has oxygen in excess. She asks her friend, "How many grams of carbon dioxide will I get if all of this sugar burns?" Well, before her friend can answer, you say... (don't forget, the monohydrate is part of the formula)
- 4) Your associate in the lab, G. Eyemaduntz, wishes to make barium uranate, BaUO_3 , in order to facilitate a better yield of thorium. The substance conveniently works as a catalyst to lower the amount of energy needed to produce the thorium. He starts with 500 g of barium oxide, BaO , and 750 g of uranium. He asks you, "What can I expect as a theoretical yield of the uranate? What is the limiting reagent?"
- He showed you the balanced reaction -----> $\text{BaO} + \text{O}_2 + \text{U} \implies \text{BaUO}_3$
 What do you answer? (Ba = 137 g/mol and U = 238 g/mol)

- 5) After finally appeasing your manager's surly demands, you hearken back to simpler times when all you had to do was calculate things like "How many oxygen atoms would one find in 250.0 g of sulfuric acid, H_2SO_4 ?"
- 6) But maybe the crowning achievement of your semi-illustrious career was to produce the 50.0 kg of nitrous oxide, N_2O (laughing gas), needed for the governor's re-election party of 2072. Merely by thermally decomposing ammonium nitrate (NH_4NO_3), into it and water vapor, you gave everyone the laugh of a lifetime. You couldn't remember right now, but how much of the ammonium nitrate did you need?
- 7) And oh yeah, the time you needed to analyse the percentage composition of thorionic acid, H_2ThO_2 ...but that was merely child's play for you then...yeah, those were the days, huh...
- 8) And what about the calculation you had to do on your interview for this chemist job...now what was it...oh yeah, "A compound is found to be 68.63% iodine (mass = 126.9 g/mol) and 31.37% thorium. What is its empirical formula?"