If Beyonce were reacting 3.6 moles of nitrogen gas with 1.0 moles of hydrogen to form N_2H_4, which would be the limiting reactant?
Start by writing a balanced reaction equation on your answer sheet. Then follow the STRATEGY.

Don't write on this sheet please, write on your answer sheet.

If Carrie Brownstein were reacting 1234 g of chlorine gas with 1234 g of aluminum to form aluminum chloride, which would be the limiting reactant?
Start by writing a balanced reaction equation on your answer sheet. Then follow the STRATEGY.

Don't write on this sheet please, write on your answer sheet.

WARMUP Practicing Tuesday's Lesson: How to find which reactant is the limiting reactant.

Strategy: Convert each reactant into moles or grams of *PRODUCT*. The smaller product must be what really happens.

$N_2 + 2\,H_2 \rightarrow N_2H_4$

$3.6 \text{ moles } N_2 \times \left(\frac{1 \text{ mole } N_2H_4}{1 \text{ mole } N_2}\right) = 3.6 \text{ moles } N_2H_4$ (CAN'T BE TRUE)

$1.0 \text{ moles } H_2 \times \left(\frac{1 \text{ mole } N_2H_4}{2 \text{ moles } H_2}\right) = 0.5 \text{ moles } N_2H_4$ TRUE LIMITING

Final answer: The limiting reactant is HYDROGEN

$2Al + 3Cl_2 \rightarrow 2\,AlCl_3$

$1234 \text{ g } Al \times \left(\frac{1 \text{ mol } Al}{26.98 \text{ g } Al}\right) \times \left(\frac{2 \text{ mol } AlCl_3}{2 \text{ mol } Al}\right) \times \left(\frac{133.33 \text{ g } AlCl_3}{1 \text{ mol } AlCl_3}\right) = 6098 \text{ g } AlCl_3$

$1234 \text{ g } Cl_2 \times \left(\frac{1 \text{ mol } Cl_2}{70.9 \text{ g } Cl_2}\right) \times \left(\frac{2 \text{ mol } AlCl_3}{3 \text{ mol } Cl_2}\right) \times \left(\frac{133.33 \text{ g } AlCl_3}{1 \text{ mol } AlCl_3}\right) = 1547 \text{ g } AlCl_3$

Final answer: The limiting reactant is CHLORINE

2. Magnesium sulfate, $MgSO_4$, decomposes when heated to produce magnesium sulfide and oxygen gas. If 6.32 grams of $MgSO_4$ were heated in a test tube, what mass of oxygen gas should be released?

$MgSO_4 \longrightarrow MgS + 2O_2$

$6.32\,g\ MgSO_4 \times \left(\frac{1\ mol\ MgSO_4}{120.37\,g\ MgSO_4}\right) \times \left(\frac{2\ mol\ O_2}{1\ mol\ MgSO_4}\right) \times \left(\frac{32.00\,g\ O_2}{1\ mol\ O_2}\right) = 3.36\,g\ O_2$

3. What mass of CO was used up in the reaction with an excess of oxygen gas if 24.7 g of carbon dioxide is formed? $2\ CO + O_2 \rightarrow 2\ CO_2$

$24.7\,g\ CO_2 \times \left(\frac{1\ mol\ CO_2}{44.01\,g\ CO_2}\right) \times \left(\frac{2\ mol\ CO}{2\ mol\ CO_2}\right) \times \left(\frac{28.01\,g\ CO}{1\ mol\ CO}\right) = 15.7\,g\ CO$

[redacted]

4. Fill in this data table to organize your data from above.

empty crucible mass 51.0 grams	volume for one squirt 1.5 mL
crucible with dried salt 52.99 grams	concentration of the brine $\frac{365\,g}{1270\,mL}$ g/mL
number of squirts 5 squirts	

5. Calculate what mass of dry salt she *should* have? (Set up your calculation in a single line if possible, like we did in class--it will make the next part *much* easier to solve.Hint: The lonely number here is number of squirts. The goal is grams of salt.)

$5\ squirts \times \left(\frac{1.5\ mL}{1\ squirt}\right) \times \left(\frac{365\,g\ salt}{1270\,mL\ salt}\right) = 2.2\ grams\ salt$

The number calculated here is a □actual yield ☒theoretical yield

6. Based on her scale readings, how many grams of salt did she actually recover?

full crucible minus empty crucible gives actual yield:

$52.99\,g - 51.0\,g = 1.99\,g$

The number calculated here is a □actual yield □theoretical yield

7. Calculate Dr Lopez's percent yield using the formula in your notes.

$\%\,yield = \frac{1.99\ grams}{2.2\ grams} \times 100$ $\%\,yield = 90.4\%$

Name _____

Period _____

Write balanced chemical equations for the following reactions.

19. Sodium oxide reacts with water to form sodium hydroxide.

$Na_2O + H_2O \rightarrow 2NaOH$

20. Iron metal reacts with water to form Fe_3O_4 and hydrogen gas.

$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

21. Aluminum bromide reacts with chlorine gas to produce aluminum chloride and liquid bromine.

$2AlBr_3 + 3Cl_2 \rightarrow 2AlCl_3 + 3Br_2$

22. Nitric acid (HNO_3) reacts with barium hydroxide to produce barium nitrate and water.

$2HNO_3 + Ba(OH)_2 \rightarrow Ba(NO_3)_2 + 2HOH$

23. Calcium sulfite decomposes when heated to form calcium oxide and sulfur dioxide.

$CaSO_3 \rightarrow CaO + SO_2$

Reaction Terminology

Theoretical yield is a calculated answer. Start with the lovely number and calculate how much product should form.

Actual yield is a measured answer, sometimes weighed on a scale.

Percent yield = Actual yield divided by theoretical yield times one hundred

Limiting reactant is the reactant you run out of. (It's "the truth".)

Excess reactant is the reactant that is left over.

Applying the Model

1. Tin (II) chloride, $SnCl_2$, reacts with oxygen gas to produce tin (II) oxide and chlorine dioxide. If 0.750 moles of O_2 were consumed using this chemical reaction, what mass of tin (II) oxide would be produced?

THEORETICAL YIELD — a calculation made using coefficients and the periodic table

ACTUAL YIELD - a measured yield you find in the laboratory

PERCENT YIELD - $\%\text{yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$

STOICHIOMETRY — the science of counting molecules

ANSWER

Name_____

Period_____

Learning goals for this Test

A. Retrovirus Sheet
   a. If you know moles of one substance, convert to moles of another.
   b. Predict how many grams of salt will remain in a dried crucible
   c. Analyze whether an error will make your result too high or too low

B. Brewers Sheet
   a. % Yield
   b. change pictures of molecules into moles or into grams (class notes)

C. Earhart Sheet
   a. atoms to grams
   b. moles to grams

D. Kayaker Sheet
   a. Use the coefficients as conversion factors for grams to grams(3 step) and moles to moles (1 step) conversions.

E. First Lady Sheet
   a. Theoretical Yield
   b. Percent Yield

F. JLawrence Sheet
   a. Know how to calculate the things we learned in this unit *using real lab data.*

G. Katherine Hepburn Sheet

2. From this sheet you should focus on finding which reactant is the limiting reactant. Do this by using the strategy we used in class [illegible]

Vocabulary to understand, remember, and use correctly

- Stoichiometry
- Stoichiometric mole ratio
- Theoretical yield
- Actual yield
- Percent yield
- Limiting reactant

1. Suppose 8.61 g of zinc was allowed to react with 1.61 g HCl gas to produce zinc chloride and hydrogen gas.

   a. What is the balanced equation?

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

   b. Which reactant is limiting? The strategy – convert both reactants to the same arbitrarily-chosen product.

HCl must be limiting:

$$8.61\,g\,Zn \times \left(\frac{1\ mol\ Zn}{65.38\,g\,Zn}\right) \times \left(\frac{1\ mol\ H_2}{1\ mol\ Zn}\right) = 0.13\ mol\ H_2$$

$$1.61\,g\,HCl \times \left(\frac{1\ mol\ HCl}{36.46\,g\,HCl}\right) \times \left(\frac{1\ mol\ H_2}{2\ mol\ HCl}\right) = 0.022\ mol\ H_2$$

   c. According to the grams of ZnCl2 you calculated in (b) for the Limiting Reactant what mass of zinc chloride would be the Theoretical Yield?

$$8.61\,g\,Zn \times \left(\frac{1\ mol\ Zn}{65.38\,g\,Zn}\right) \times \left(\frac{1\ mol\ ZnCl_2}{1\ mol\ Zn}\right) \times \left(\frac{136.28\,g\ ZnCl_2}{1\ mol\ ZnCl_2}\right) = 17.9\,g\ ZnCl_2$$

   d. Suppose that you actually recovered 1.56 g of zinc chloride. What is your percent yield?

$$\frac{1.56\,g\ ZnCl_2}{17.9\,g\ ZnCl_2} \times 100 = 8.71\%$$

2. Determine the mass of carbon dioxide that should be produced in the reaction between 3.74 g of carbon and excess O_2. What is the % yield if 11.34 g of CO_2 is recovered?

$$C + O_2 \rightarrow CO_2 \quad \text{(already balanced)}$$

$$3.74\,g\,C \times \left(\frac{1\ mol\ C}{12.01\,g\,C}\right) \times \left(\frac{1\ mol\ CO_2}{1\ mol\ C}\right) \times \left(\frac{44.01\,g\ CO_2}{1\ mol\ CO_2}\right) = 13.7\,g\,CO_2$$

$$\%\ yield = \frac{11.34\,g}{13.7\,g} \times 100 = 82.8\%$$

3. If 2222 grams of potassium chloride are reacted with 2222 grams of oxygen, which reactant will be the limiting reactant?

$$2KCl + 3O_2 \longrightarrow 2KClO_3$$

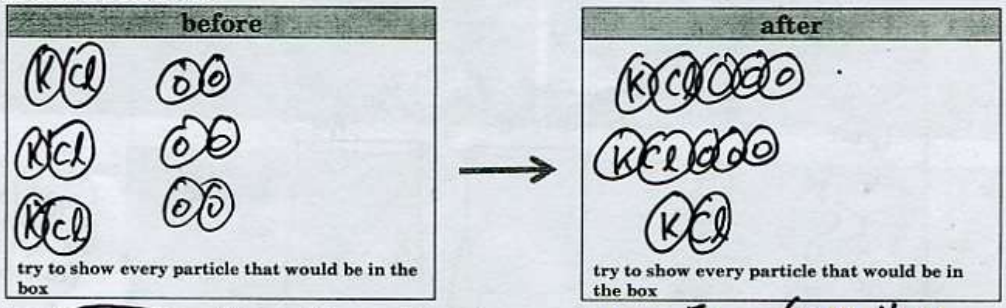
$$2222\,g\,KCl \times \left(\frac{1\ mol\ KCl}{74.55\,g\,KCl}\right) \times \left(\frac{2\ mol\ KClO_3}{2\ mol\ KCl}\right) = 29.81\ mol\ KClO_3$$

$$2222\,g\,O_2 \times \left(\frac{1\ mol\ O_2}{32.00\,g\,O_2}\right) \times \left(\frac{2\ mol\ KClO_3}{3\ mol\ O_2}\right) = 46.29\ mol\ KClO_3$$

Answer: KCl is the limiting reactant

4. If 3 molecules of KCl and 3 molecules of O2 are placed in a square tank and are allowed to react by the same reaction shown in the previous problem, draw what would be in the tank before the reaction and after:

Visual solution:



FIRST find the balanced rxn: $4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

5. Determine the mass of water vapor you would expect to form **(and the percent yield)** in a reaction between 15.8 g of NH_3 and excess oxygen to produce water and nitric oxide (NO). The mass of water actually formed is 21.8 g.

FIND the grams of water that form:

$$15.8\text{ g } NH_3 \times \left(\frac{1\text{ mol } NH_3}{17.04\text{ g } NH_3}\right)\left(\frac{6\text{ mol } H_2O}{4\text{ mol } NH_3}\right) \times \left(\frac{18.02\text{ g } H_2O}{1\text{ mol } H_2O}\right) = 25.1\text{ g } H_2O$$

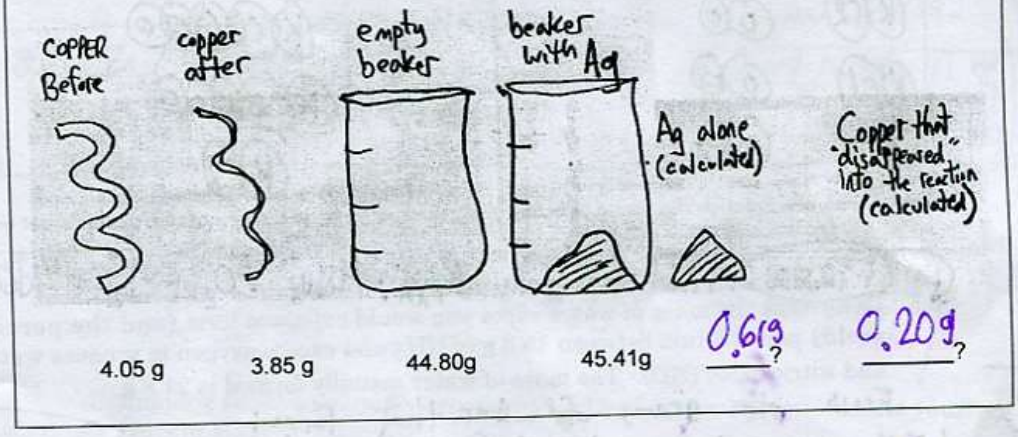
Answer

Percent yield is

$$\%\text{yield} = \frac{21.8\text{g}}{25.1\text{g}} \times 100 = 86.9\%$$

A balanced reaction and data from last week's lab sheet:

$$2AgNO_3 + Cu \longrightarrow 2Ag + Cu(NO_3)_2$$



6. Based on the numbers in the first four pictures fill in the last two blanks above.

7. How many grams of copper reacted?

0.20 grams Cu

8. How many grams of silver *should* have formed? (This is the Theoretical Yield. Find it using the periodic table, the reaction coefficients, and a calculator)

$$0.20\,g\,Cu \times \left(\frac{1\ mol\ Cu}{63.55\,g\,Cu}\right) \times \left(\frac{2\ mol\ Ag}{1\ mol\ Cu}\right) \times \left(\frac{107.87\ grams\ Ag}{1\ mol\ Ag}\right) = 0.68\,g\,Ag$$

9. How many grams of silver *did* form? (This is the ACTUAL Yield of silver. Found by simply weighing the prodcut)

0.61g formed

10. Calculate the percent yield using the formula $\%yield = \frac{\frac{actual\ yield}{theoretical\ yield}}{} \times 100$

$$\frac{0.61g}{0.68g} \times 100 = 90\%$$