limiting reactant & percent yield

CheMistry: http://genest.weebly.com

Stop in for help every day at lunch and Tues, Weds., &Thurs after school!

After-hours question? Email me at home: eagenest@madison.k12.wi.us

Name KEY

Period

1. (Circle answers). You calculate the theoretical yield by converting the amount of *each* of the (reactants / products) into the amount of *just one* of the (reactants / products).

2. The reactant that gives the least product is called the LIMITING REACTANT

3. The formula for finding percent yield is: $\%YIELD = \frac{\text{ACTUAL YIELD}}{\text{THEORETICAL YIELD}} \times 100$

The balanced reaction we used in lab:
$2\ Al_{(s)} + 2\ KOH_{(aq)} + 4\ H_2SO_{4(aq)} + 22\ H_2O_{(l)} \rightarrow 2\ KAl(SO_4)_2{\cdot}12H_2O_{(s)} + 3\ H_{2(g)}$

4. Using a periodic table and ***the information above***, fill in these conversion factors:

FROM PER. TABLE: 39.10 + 16.00 + 1.01 ← 1 mole of potassium hydroxide = 56.11 grams

FROM THE REACTION ⟶ 4 mole of H_2SO_4 = 3 moles of H_2

2 mole of Al = 2 moles of $KAl(SO_4)_2{\cdot}12H_2O$

K: 1×(39.10) = 39.10
Al: 1×(26.98) = 26.98
S: 2×(32.06) = 64.12
O: 20×(16) = 320.00
H: 24×(1.01) = 24.24
= 474.44 g/mol

→ 1 mole of $KAl(SO_4)_2{\cdot}12H_2O$ = 474.44 grams $KAl(SO_4)_2{\cdot}12H_2O$

5. In a perfect world, if you react 808 moles of H_2SO_4 in the above reaction how many moles of H_2 will you get?

$808 \text{ mol } H_2SO_4 \times \frac{3 \text{ mol } H_2}{4 \text{ mol } H_2SO_4} = 606 \text{ mol } H_2$

6. In the real world, Bobby Brown does the above reaction with 808 moles of H_2SO_4 and he only gets 501 moles of H_2. What was Mr. Brown's % yield?

$808 \text{ mol } H_2SO_4 \times \left(\frac{3 \text{ mol } H_2}{4 \text{ mol } H_2SO_4}\right) = 606 \text{ mol } H_2 \text{ theoretical}$

$\boxed{\% = \frac{501 \text{ mol } H_2}{606 \text{ mol } H_2} = 82.7\%}$

7. If Mr. Brown tries the experiment again, 123 grams of aluminum and 123 grams of KOH and more than enough of the other reactants, ANSWER: ~~KOH~~ KOH is LIMITING

a. which will be the limiting reactant?

#1 $123 \text{ g Al} \times \left(\frac{1 \text{ mol Al}}{26.98 \text{ g Al}}\right)\left(\frac{2 \text{ mol ALUM}}{2 \text{ mol Al}}\right)\left(\frac{474 \text{ g ALUM}}{1 \text{ mol ALUM}}\right) = 2160 \text{ grams ALUM}$

#2 $123 \text{ g KOH} \times \left(\frac{1 \text{ mol KOH}}{56.11 \text{ g KOH}}\right)\left(\frac{2 \text{ mol ALUM}}{2 \text{ mol KOH}}\right)\left(\frac{474 \text{ g ALUM}}{1 \text{ mol ALUM}}\right) = 1040 \text{ g ALUM}$

b. How many grams of $KAl(SO_4)_2{\cdot}12H_2O$ will be his theoretical yield?

Answer 1040 grams ALUM

c. If he only gets 208 g of $KAl(SO_4)_2{\cdot}12H_2O$, what was his % yield?

$\% \text{ yield} = \frac{208 \text{ g ALUM}}{1040 \text{ g ALUM}} \times 100 = 20.0\%$

8. Calculate the answer writing both number and correct UNIT.

$$\left(\frac{4\ grams\ Zn}{7\ mL\ Zn}\right) x \left(\frac{3\ \cancel{mL\ H_2O}}{1\ \cancel{mL\ Zn}}\right) x \left(\frac{5\ \cancel{mL\ Zn}}{2\ \cancel{mL\ H_2O}}\right) = \quad 4\ \frac{grams}{mL}$$

"ALUM"

The balanced reaction we used ~~in lab~~:

$$2\ Al_{(s)} + 2\ KOH_{(aq)} + 4\ H_2SO_{4(aq)} + 22\ H_2O_{(l)} \rightarrow 2\ \boxed{KAl(SO_4)_2{\cdot}12H_2O_{(s)}} + 3\ \boxed{H_{2(g)}}$$

474 g/mol

9. In a perfect world, if you react 40.8 grams of Al in the above reaction how many moles of $KAl(SO_4)_2{\cdot}12H_2O$ will you get?

$$40.8\ g\ Al \times \left(\frac{1\ mol\ Al}{26.98\ g\ Al}\right) \times \left(\frac{2\ mol\ ALUM}{2\ mol\ Al}\right) = 1.51\ moles\ \text{"ALUM"}$$

10. In the real world you attempt the above reaction with 40.8 grams of Al and you only get 680. grams of [redacted] of $KAl(SO_4)_2{\cdot}12H_2O$

a. What was your % yield?

THEORETICAL YIELD $= 1.51\ mol\ ALUM \times \left(\frac{474\ g\ ALUM}{1\ mol\ ALUM}\right) = 717\ g\ ALUM$

$$\%\ yield = \frac{680\ g\ ALUM}{717\ g\ ALUM} \times 100 = 94.8\%$$

b. List three things that might have caused your yield to be so low:

- spilled chemicals?
- incomplete reaction
- OLD/DIRTY REACTANTS
- accident during measuring

11. If you try the above reaction again, using 3.00 grams of aluminum and 16.5 grams of KOH and more than enough of the other reactants, ANSWER: the limiting reactant is ALUMINUM

a. which will be the limiting reactant?*

$$\#1 \quad \frac{3.00\ g\ Al}{1} \times \left(\frac{1\ mol\ Al}{26.98\ g\ Al}\right) \times \left(\frac{2\ mol\ ALUM}{2\ mol\ Al}\right) \times \left(\frac{474\ g\ ALUM}{1\ mol\ ALUM}\right) = 52.8\ g\ \text{"ALUM"}$$

$$\#2 \quad \frac{16.5\ g\ KOH}{1} \times \left(\frac{mol\ KOH}{g\ KOH}\right) \times \left(\frac{mol\ ALUM}{mol\ KOH}\right) \times \left(\frac{g\ ALUM}{mol\ ALUM}\right) = 139\ g\ ALUM$$

b. How many grams of $KAl(SO_4)_2{\cdot}12H_2O$ will be your theoretical yield?**

Answer: 52.8 g ALUM

c. If you only get 30.6 g of $KAl(SO_4)_2{\cdot}12H_2O$, what was your % yield?

$$\%\ yield = \frac{30.6\ g\ ALUM}{52.8\ g\ ALUM} \times 100 = 58.0\%$$

*Strategy: Try converting grams of the first reactant into grams of product, Then do the same for the second reactant. The limiting reactant will be whichever reactant gives the least product

**Strategy: Do a conversion, using the grams of your limiting reactant as the starting point and trying to finish up in grams of your product.