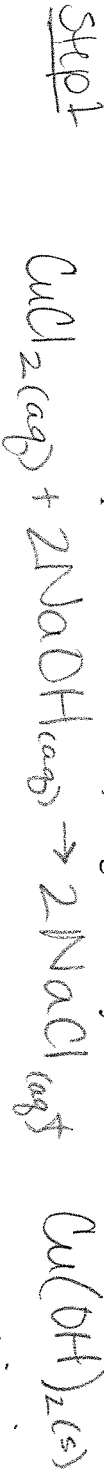


# Limiting Reactants Practice

Name: Andy

1. A sample of a solution containing 100 grams of copper (II) chloride is reacted with a solution containing 40 grams of sodium hydroxide.

a. Write the balanced chemical equation for the reaction, using the state symbols.



STEP 2 - moles we have of reactants

$$\frac{100\text{g CuCl}_2}{134.45\text{g/mol}} = 0.74\text{mol CuCl}_2$$

$$\frac{40\text{g NaOH}}{39.98\text{g/mol}} = 1\text{mol NaOH}$$

b. Determine the mass in grams of each product produced and the amount of the excess reactant that remains.

Product 1  $\text{Cu}(\text{OH})_2$  : Amount Produced 48.78g

Product 2  $\text{NaCl}$  : Amount Produced 55.85g

Excess Reactant  $\text{CuCl}_2$  : Amount Remaining 32.77g

STEP 3 - moles we need to react completely

$$\frac{0.74\text{mol CuCl}_2}{1\text{mol CuCl}_2} \times \frac{2\text{mol NaOH}}{1\text{mol CuCl}_2} = 1.48\text{mol NaOH}$$

← This # is greater than what we have, so...

NaOH is LR

STEP 4 & 5 Calculate mass of excess used + left over

STEP 5 
$$\frac{1\text{mol NaOH}}{2\text{mol NaOH}} \times \frac{1\text{mol CuCl}_2}{1\text{mol NaOH}} \times 134.45\text{g CuCl}_2 = 67.23\text{g CuCl}_2 \text{ used}$$

STEP 5 
$$100\text{g} - 67.23\text{g} = 32.77\text{g CuCl}_2 \text{ left over}$$

STEP 6 Calculate mass produced of products - USE LR!

$$\frac{1\text{mol NaOH}}{2\text{mol NaOH}} \times \frac{1\text{mol Cu}(\text{OH})_2}{1\text{mol NaOH}} \times 97.56\text{g Cu}(\text{OH})_2 = 48.78\text{g Cu}(\text{OH})_2$$

$$\frac{1\text{mol NaOH}}{2\text{mol NaOH}} \times \frac{2\text{mol NaCl}}{2\text{mol NaOH}} \times 55.85\text{g NaCl} = 55.85\text{g NaCl}$$

7.5 sig figs applied...

2. A sample of a solution containing 90 grams of iron (III) nitrate is reacted with a solution containing 20 grams of potassium hydroxide.

a. Write the balanced chemical equation for the reaction, using the state symbols.



step 2

$$90\text{g Fe}(\text{NO}_3)_3 \left| \begin{array}{l} \text{1 mol} \\ 241.86\text{g} \end{array} \right| = 0.37\text{ mol Fe}(\text{NO}_3)_3$$

$$20\text{g KOH} \left| \begin{array}{l} \text{1 mol} \\ 56.1\text{g} \end{array} \right| = 0.36\text{ mol KOH}$$

b. Determine the mass in grams of each product produced and the amount of the excess reactant that remains.

Product 1  $\text{Fe}(\text{OH})_3$  : Amount Produced 10.66g

Product 2  $\text{KNO}_3$  : Amount Produced 36.40g

Excess Reactant  $\text{Fe}(\text{NO}_3)_3$  : Amount Remaining 60.98g

step 3

$$3\text{mol KOH} \left| \begin{array}{l} \text{1 mol Fe}(\text{NO}_3)_3 \\ 3\text{mol KOH} \end{array} \right| = 0.12\text{ mol Fe}(\text{NO}_3)_3 \text{ needed, so KOH is LR}$$

step 4+5

$$0.12\text{ mol} \left| \begin{array}{l} 241.86\text{g} \\ \text{1 mol} \end{array} \right| = 29.02\text{g Fe}(\text{NO}_3)_3 \text{ given}$$

$$60.98\text{g Fe}(\text{NO}_3)_3 \text{ remaining}$$

$$0.36\text{ mol KOH} \left| \begin{array}{l} 3 \\ 3 \end{array} \right| 101.1\text{g} = 36.40\text{g}$$

3. Forty grams of magnesium is reacted with an excess of oxygen. How much oxygen is used in the reaction?

this allows us to skip a couple steps



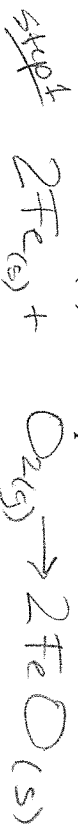
step 2+4  
step 4

$$40\text{g Mg} \left| \begin{array}{l} \text{1 mol Mg} \\ 24.3\text{g Mg} \end{array} \right| 1\text{ mol O}_2 \left| \begin{array}{l} 32\text{g O}_2 \\ 2\text{ mol Mg} \end{array} \right| 1\text{ mol O}_2$$

$$26.34\text{g O}_2$$

4. In a container, 100 grams of iron is combined with 100 grams of oxygen to form iron (II) oxide.

a. How much iron (II) oxide is produced?



step 2  $\frac{100\text{g Fe}}{55.85\text{g}} \left| \frac{1\text{mol}}{1} \right| = 1.79\text{mol Fe}$   $\frac{100\text{g O}_2}{32\text{g}} \left| \frac{1\text{mol}}{1} \right| = 3.13\text{mol O}_2$

*magic number*

step 3  $3.13\text{mol O}_2 \left| \frac{2\text{mol Fe}}{1\text{mol O}_2} \right| = 6.26\text{mol Fe}$   $\text{Fe is LR}$

step 4  $\frac{1.79\text{mol Fe}}{2\text{mol Fe}} \left| \frac{2\text{mol FeO}}{1\text{mol Fe}} \right| = 71.84\text{g}$   $= 128.59\text{g FeO produced}$

b. Which element is the limiting reactant? Fe

c. How much of the excess reactant does not react?

step 1 + 5  $\frac{1.79\text{mol Fe}}{2\text{mol Fe}} \left| \frac{1\text{mol O}_2}{2\text{mol Fe}} \right| = 0.4475\text{mol O}_2$   $\frac{100\text{g O}_2}{32\text{g}} = 3.125\text{mol O}_2$

$3.125\text{mol O}_2 - 0.4475\text{mol O}_2 = 2.6775\text{mol O}_2$

$2.6775\text{mol O}_2 \left| \frac{32\text{g}}{1\text{mol}} \right| = 85.68\text{g O}_2 \text{ left}$

5. Seventy grams of silver are allowed to react with 50 grams of bromine to form silver bromide, a compound found in eyeglass lenses.

a. How much silver bromide is produced?



$\frac{70\text{g Ag}}{107.87\text{g}} \left| \frac{1\text{mol}}{1} \right| = 0.65\text{mol Ag}$

$\frac{50\text{g Br}_2}{159.8\text{g}} \left| \frac{1\text{mol}}{1} \right| = 0.31\text{mol Br}_2$

*magic #*

$0.31\text{mol Br}_2 \left| \frac{2\text{mol Ag}}{1\text{mol Br}_2} \right| = 0.62\text{mol Ag needed}$  so  $\text{Br}_2 \text{ is LR}$

$0.31\text{mol Br}_2 \left| \frac{2\text{mol AgBr}}{1\text{mol Br}_2} \right| = 0.62\text{mol AgBr}$   $= 116.44\text{g AgBr}$

b. Which element is the limiting reactant? Br<sub>2</sub>

c. How much of the excess reactant does not react?

$0.31\text{mol Br}_2 \left| \frac{2\text{mol Ag}}{1\text{mol Br}_2} \right| = 0.62\text{mol Ag}$   $\frac{70\text{g}}{107.87\text{g}} = 0.65\text{mol Ag}$

$0.65\text{mol Ag} - 0.62\text{mol Ag} = 0.03\text{mol Ag}$

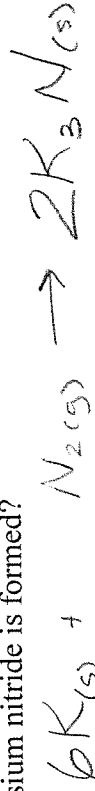
$0.03\text{mol Ag} \left| \frac{107.87\text{g}}{1\text{mol}} \right| = 3.24\text{g Ag left}$

$3.10\text{g Ag}$

*left*

6. In a container, 30 grams of potassium is combined with 25 grams of nitrogen and potassium nitride is formed.

a. How much potassium nitride is formed?



$$\frac{30g K}{39.1g/mol K} \times \frac{1 mol K}{1 mol K} = 0.78 mol K$$

K limits

$$0.78 mol K \left| \frac{1 mol K_3N}{6 mol K} \right| = 0.13 mol K_3N \text{ needed}$$

$$0.13 mol K_3N \left| \frac{1 mol K_3N}{131.3g} \right| = 34.138g K_3N \text{ produced}$$

b. What is the limiting reactant? K (potassium)

c. How much of the excess reactant remains?  
 $0.78 mol K \left| \frac{1 mol N_2}{28g N_2} \right| = 3.64g N_2 \text{ used}$   $25 - 3.64 = 21.36g$  left of  $N_2$

7. An experiment combines 1000 grams of sodium chloride with 2000 grams of barium phosphate.

a. Write a balanced equation for the reaction.



$$\text{step 2 } \frac{1000g NaCl}{55.85g/mol NaCl} = 17.91 mol NaCl \quad \left| \frac{1 mol Ba_3(PO_4)_2}{601.921g} \right| = 3.322 mol Ba_3(PO_4)_2$$

b. What is the limiting reactant? NaCl

$$\text{step 2 } \frac{17.91 mol NaCl}{6 mol NaCl} = 2.985 mol Ba_3(PO_4)_2 \text{ needed}$$

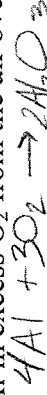
We are very not specific for water.

c. How much of the excess reactant remains?

$$\text{step 1 + 5 } 3.322 - 2.985 = 0.337 mol \quad \left| \frac{601.921g}{1 mol} \right| = 202.84g Ba_3(PO_4)_2 \text{ left}$$

for fun

8. **BONUS!** A chemist burns 160.0 g of Al in excess  $O_2$  from the air over a Bunsen burner to produce aluminum oxide,  $Al_2O_3$ .



a. Use the balanced equation to solve for how much aluminum oxide she could *theoretically* produce, given that the limiting reactant is Al.

$$\frac{160g Al}{26.98g/mol Al} \left| \frac{1 mol Al_2O_3}{4 mol Al} \right| = 101.96g \quad \left| \frac{1 mol Al_2O_3}{302.33g} \right| = 302.33g$$

b. She produces 260.0 g of solid aluminum oxide in the crucible. What is the percent yield of this experiment? (Just try it!!!! Think about what a percent is...)

$$\% \text{ yield} = \left( \frac{260g}{302.33g} \right) \times 100\% = 86\% \text{ (pretty good!)} \quad \text{(good!)} \quad \text{(pretty good!)}$$