Lecture 36: Reactions 3

Read: BLB 3.6–3.7
HW: BLB 3:57,64,73,79
Sup Rxns 1–11

Know:
• stoichiometry calculations
• limiting reagents
• theoretical yield vs actual yield

Check out the grad-u-lator on the Chem110 website

Review chemical nomenclature (e.g., BST #5, Lecture 8 ...); & memorize those strong acids & bases (BLB Table 4.2)

Bonus deadline for BST #10: Net ionic equations, Thurs, April 16;
FINAL SKILL CHECK TEST DEADLINE: MONDAY, APRIL 27

Missed Exam 1, 2 or 3 due to illness? Make-up Exam: Monday, April 20 @ 6:30, 105 Wartik. Covers material from Exams 1–3, multiple choice. You must sign up by downloading & completing the request form & giving it to me: deadline to sign up is April 15. (info under “Exam Schedule” on Chem110 website)

Need help?? Get help!! TAs in CRC (211 Whitmore) and SI—hours on Chem 110 website; my office hours (Mon 12:30-2 & Tues 10:30-12 in 324 Chem Bldg [or 326 Chem])

Final Exam: MONDAY, May 4, 12:20 pm
Problem solving

• write the balanced equation

• note **what you know** and **what you need to know**

• think logically about how you can get from known to unknown—what connections are there?

• is the answer reasonable?

• **PRACTICE PROBLEMS!!!!** Practice, practice, practice…

• **show all work!!!** & use units!!!!
Example:
One common component of antacids is aluminum hydroxide. If an upset stomach contains 155 mL of 0.175 M HCl, what mass of aluminum hydroxide is required to completely neutralize the acid? MW of aluminum hydroxide is 78 g/mol.
Limiting reagents

• *must* start with a *balanced reaction*

• when reactant mixed in *unbalanced proportions*, some reactants are left over (the ones *in excess*)

*limiting reagent*: the reactant that is *completely consumed* in a reaction (i.e., used up first); *determines the amount of product possible*

• *be sure to test all reactants!!!*
Limiting reactants
(the ham sandwich)

- making a ham sandwich analogous to a chemical reaction

\[ 2 \text{ Bd}_{(s)} + 1 \text{ Ch}_{(s)} + 2 \text{ Hm}_{(s)} \rightarrow 1 \text{ Bd}_2\text{ChHm}_2(\text{yum})_{s} \]

(bread) (cheese) (ham) (sandwich)

**reactants**

**product**

**reactants**

**products possible**

10 slices of bread

8 slices of cheese

25 slices of ham

limiting reagent is

left-overs
Example:
13.88 mg Li is allowed to react with 68.05 mg F₂. Which reactant is the limiting reagent, and which is in excess? How much of the excess reagent remains after the reaction goes to completion? What is the expected yield (theoretical yield) of LiF?

\[
2 \text{ Li}(s) + F_2(g) \rightarrow 2 \text{ LiF}(s)
\]

MW 6.9 g/mol 38 g/mol 25.9 g/mol
13.88 mg 68.05 mg ???

limiting reagent?
Percent yield

*theoretical yield*: the yield of product that results when the limiting reagent is completely

*actual yield*: the yield you *actually* get in the real world

*percent yield*:

\[
\% \text{ yield} = \left( \frac{\text{actual yield}}{\text{theoretical yield}} \right) \times 100
\]

**NOTE**: if you get a % yield >100% something is wrong, you’ve just created matter!??!!

*previous example con’t.*
When you react Li with $\text{F}_2$ in lab, you get 45.76 mg. What is your percent yield?
Titrations

• **goal:** find concentration of *unknown solution*

  e.g., unknown concentration of HCl

• react unknown solution with solution with known concentration (a **standard solution**)  

  e.g., known concentration of NaOH

• find equivalence point or end-point (using an **indicator**)

  e.g., how much NaOH needed to neutralize HCl?

\[ M_1V_1 = M_2V_2 \]
Titration example

A flask contains an unknown amount of \( H_3PO_4 \). This solution is titrated with 0.101 M NaOH. It takes 23.35 mL of NaOH solution to complete the reaction. If there were 12.52 mL of \( H_3PO_4 \) originally in the flask, what was the concentration of the unknown \( H_3PO_4 \) solution?

net ionic eqn:

\[
H_3PO_4 + NaOH \rightarrow Na_3PO_4 + H_2O
\]

<table>
<thead>
<tr>
<th>volume</th>
<th>12.52 mL</th>
<th>23.35 mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>[]</td>
<td>???</td>
<td>0.101 M</td>
</tr>
</tbody>
</table>
Before next class:

**Read:**  BLB 4.6 & 10.5  
**HW:**  BLB 4:81a,b,83,87; 10:28,55,57; 18:26,61  
 Sup Rxns 12–18

**Know:**
• solution stoichiometry
• reactions in the gas phase

**Answers:**
p. 3: 0.705 g Al(OH)$_3$
p. 6: Li is LR; 29.83 mg excess F$_2$; 52.10 mg LiF produced
p. 7: 87.8% yield
p. 9: 0.0628 M