Copper – Iron Stoichiometry

Limiting agents

Calculating yields

Weighing by difference

Quantitative transfer

Vacuum filtration

Calculation/significant figure
Learning Objectives (page 11)

• Use techniques of
  • quantitative transfer
  • weighing by difference
  • vacuum filtration
• Identify a limiting reagent by an experimental procedure
• Calculate the percent yield of a reaction
Weighing by Difference (page 15)

Two tasks:
Weigh ~ 7.000 g CuSO₄
Weigh ~ 2.000 g Fe

Questions:
How many digits after the point do you need to record?
What if you cannot weigh exactly 7.0000 g?
Carry out reaction...

• Dissolve CuSO₄ in deionized water
• Heat (but the solution should not be allowed to boil)
• Move the hot beaker to the hood (why?)
• Add Fe powder
• Allow the beaker to cool

What is the difference between Beaker C and D?

Hot glass looks like cold glass
After the reaction:
Vacuum Filtration Using a Crucible (page 14)

Crucible: handle it using only “finger cots” or Kim-Wipes no bare hands or gloves
After the Reaction: Questions to consider...

- Wash with 15 mL water. Why?
- Wash with 15 mL acetone 4 times. Why?
- Dry 10 minutes. Why?
- Get mass crucible + Cu
- Clean crucible with 6 M HCl

**Critical step: drying**

What is drying time is << 10 minutes?

Too much water remains, making the Cu weight artificially high

What is drying time is >> 10 minutes?

Cu will be oxidized to CuO, making the Cu weight artificially high
Things to Consider: limiting agent

• Your observations alone can determine what is limiting.
  • From your observations, you can choose the correct chemical equation.
  • How?
## Table of Uncertainty (see p 190)

<table>
<thead>
<tr>
<th>TYPE</th>
<th>VOLUME</th>
<th>UNCERTAINTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumetric Pipets</td>
<td>10 mL</td>
<td>± .04 mL</td>
</tr>
<tr>
<td></td>
<td>25 mL</td>
<td>± .06 mL</td>
</tr>
<tr>
<td>Mohr Pipets</td>
<td>10 mL</td>
<td>± .06 mL</td>
</tr>
<tr>
<td>Volumetric Flasks</td>
<td>100 mL</td>
<td>± .16 mL</td>
</tr>
<tr>
<td></td>
<td>250 mL</td>
<td>± .12 mL</td>
</tr>
<tr>
<td>Burets</td>
<td>50 mL</td>
<td>± .05 mL</td>
</tr>
<tr>
<td>Analytical Balances</td>
<td></td>
<td>± .0001 g</td>
</tr>
<tr>
<td>Pan Balances</td>
<td></td>
<td>± .01 g</td>
</tr>
<tr>
<td>Graduated cylinders</td>
<td>10 mL</td>
<td>± .2 mL</td>
</tr>
<tr>
<td>Graduated cylinders</td>
<td>100 mL</td>
<td>± 1 mL</td>
</tr>
</tbody>
</table>
Unit and significant figures

• **Units**: ALWAYS use it!

• **Significant figures**

**Rule 1**: always record data to the proper number of significant figures

a. Pipet, buret, and volumetric flasks: second place after the decimal (x).xx ml
   
   Balance: fourth place after the decimal: (x).xxxx g

b. Zeros: leading zeros----never significant. e.g.  0.0000000001
   
   captive zeros----always significant. e.g.  1.0000000001
   
   trailing zeros----significant **only** if the number contains a decimal point
   
   1,000,000 (?)
   
   1.000000 x 10^6
   
   1.000 x 10^6
   
   1.0 x 10^6
Rule 2: When numbers are multiplied or divided, the number of significant figures in the product or quotient cannot exceed that of the least precise number used in the calculation.

e.g. $1.0034 \text{ g } \times 2.0 \text{ g} = \boxed{2.0068} \text{ g} = 2.0 \text{ g}$

(calculation) (report)
Rule 3: In addition and subtraction, the sum or the difference cannot be stated to more places after the decimal than the term with the least number of places after the decimal.

e.g. 1.0 liter
+ 0.001 liter

1.001 liter

1.0 liter
Rule 4: When using logarithms, the significant figures are those in the mantissa (the figures after the decimal); the characteristic (figure before the decimal) indicates the placement of the decimal in the original number:

\[
\text{e.g. } \log(2731) = 3.4363
\]

Rule 5: The number of trials has infinite significant figures:

\[
\frac{15.05 + 14.98 + 15.01}{3} = 15.01 \text{ ml}
\]
Rounding off numbers

a. When the insignificant figure is less than halfway, round down.
b. When the insignificant figure is more than halfway, round up.
c. When the insignificant number is exactly halfway: round to the nearest even digit.

E.g., 43.440 → 43.4
        43.460 → 43.5
        43.450 ⇒ 43.4
        43.4501 ⇒ 43.5
        43.550 ⇒ 43.6
Review and Preview

- Review today’s lecture:
  - Read Lab 2 (pages 11-21 of Lab Manual)
- Preview next lecture (Gravimetric Determination of Calcium)
  - Read Lab 3 (pages 23-35)
  - Pre-Lab is due at the beginning of next lecture
  - Read Data Analysis on pages 169-178