Chapter 1-3 Quick Review

Chem 1A

Significant Figure Gems

- All non-zero digits are significant.  123456789
- Interior zeros are significant.  103400709
- Trailing zeros after a decimal point are significant.  123456.0000
- Leading zeros are NOT significant.  000.00012569
- Zeros at the end of a number without a written decimal point are ambiguous  1230000???

Multiplying and Dividing: Same as the measurement with the fewest number of significant figures.

\[ 1 \times 0.887 \times 38.723 \div 12.27 = 3 \] (NOT 2.799291......)

Adding and Subtracting: Same number of decimal places as the measurement with the fewest number of decimal places.

\[ 1 + 0.887 \times 38.723 \div 12.27 = 4 \] (NOT 3.799291......)

To add and subtract numbers with exponents, the exponent must be (made) the same (otherwise you don’t know where the decimal place is)
COMBINED MATH OPERATIONS

• When doing different math operations on measurements:
  ▪ Follow the standard order of operations.
  ▪ Identify the significant figures for any intermediate answer, then do the remaining steps.
  ▪ Round only at the end

  ▪ For Logarithms: Mind the mantissa
    ▪ Log (3.000) = 0.4774 4 sig figs (because 3.000 has 4 SFs)
    ▪ Log (3.00) = 0.477 3 sig figs (because 3.00 has 3 SFs)
  ▪ Antilogs: # of sig figs comes from mantissa
    ▪ Antilog (5.89) = 10^{5.89} = 7.8 \times 10^5 2 sig figs

EXACT NUMBERS & UNCERTAINTY

Exact numbers:
  ▪ Items you can count
  ▪ Sometimes by definition (2.54 cm/in, 12 in/ft)
  ▪ From integer values in equations (ex. radius (r=d/2))
  ▪ Exact or exactly implies an infinite number of sig figs
  ▪ If we use an exact number in a calculation, we don’t consider it when we determine the number of sig figs

• Uncertainty vs. error in measurements
  ▪ Uncertainty ± 1 unit of the last digit (the estimated digit)
  ▪ Error in measurement is how far our experimental value is from the true/theoretical/accepted value:
    \[
    \text{accepted value - experimental value} \div \text{accepted value} \times 100\%
    \]
POLYATOMIC IONS - LEARN THESE

<table>
<thead>
<tr>
<th>Ions with -1 charge</th>
<th>hydroxide</th>
<th>cyanide</th>
<th>thiocyanate</th>
<th>acetate</th>
<th>permanganate</th>
<th>bicarbonate</th>
</tr>
</thead>
<tbody>
<tr>
<td>perchlorate</td>
<td>ClO₄⁻¹</td>
<td>CN⁻¹</td>
<td>SCN⁻¹</td>
<td>C₂H₃O₂⁻¹</td>
<td>MnO₄⁻¹</td>
<td>HCO₃⁻¹</td>
</tr>
<tr>
<td>chlorate</td>
<td>ClO₃⁻¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chlorite</td>
<td>ClO₂⁻¹</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hypochlorite</td>
<td>ClO⁻¹</td>
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<td></td>
</tr>
<tr>
<td>perbromate</td>
<td>BrO₄⁻¹</td>
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<tr>
<td>bromate</td>
<td>BrO₃⁻¹</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bromite</td>
<td>BrO₂⁻¹</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>hypobromite</td>
<td>BrO⁻¹</td>
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<td></td>
</tr>
<tr>
<td>periodate</td>
<td>IO₄⁻¹</td>
<td></td>
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</tr>
<tr>
<td>iodate</td>
<td>IO₃⁻¹</td>
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<td></td>
</tr>
<tr>
<td>iodite</td>
<td>IO₂⁻¹</td>
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</tr>
<tr>
<td>hypiodite</td>
<td>IO⁻¹</td>
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<tr>
<td>nitrate</td>
<td>NO₃⁻¹</td>
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<td></td>
</tr>
<tr>
<td>nitrite</td>
<td>NO₂⁻¹</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ions with -2 charge</th>
<th>carbonate</th>
<th>sulfate</th>
<th>sulfite</th>
<th>chromate</th>
<th>dichromate</th>
<th>oxalate</th>
<th>peroxide</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO₃⁻²</td>
<td>SO₄⁻²</td>
<td>SO₃⁻²</td>
<td>CrO₄⁻²</td>
<td>Cr₂O₇⁻²</td>
<td>C₂O₄⁻²</td>
<td>O₂⁻²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ions with +1 charge</th>
<th>phosphate</th>
<th>phosphite</th>
<th>ammonium ion</th>
<th>hydronium ion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PO₄⁻³</td>
<td>PO₃⁻³</td>
<td>NH₄⁺</td>
<td>H₃O⁺</td>
</tr>
</tbody>
</table>

The most productive method of committing these ions to memory is first memorize the ones that have the “ate” ending. This is the most common ending.
Chemical reactions involve rearrangement and exchange of atoms to produce new molecules.

1. **Synthesis (aka formation or combination)**
   - \( \text{A} + \text{B} \rightarrow \text{AB} \)

2. **Decomposition (aka falling apart)**
   - \( \text{AB} \rightarrow \text{A} + \text{B} \)

3. **Single Displacement (or single replacement)**
   - \( \text{AB} + \text{C} \rightarrow \text{AC} + \text{B} \)

4. **Double Displacement (or double replacement)**
   - \( \text{AB} + \text{CD} \rightarrow \text{AD} + \text{CB} \)

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### Finding an Empirical Formula from Experimental Data

1. Convert the percentages to grams
2. Convert grams to moles [use molar masses]
3. Write a mole ratio formula w/moles as subscripts.
4. Divide all by smallest number of moles.
5. Multiply all mole ratios by whole number to make all whole numbers, if necessary.
   - If ratio is 0.5, multiply by 2; if 0.33 or 0.67, multiply all by 3, etc
6. Convert empirical to molecular formula using:
   - \( \frac{\text{Molar mass}_{\text{compound}}}{\text{Empirical formula mass}} \) to find number to use to multiply empirical formula subscripts
PERCENTS: COMPOSITION, YIELD AND ERROR

**Mass %:** Percentage of each element in compound by mass
Can be determined from either:
- The formula of the compound.
- The experimental mass analysis of the compound.
The percentages may not always total exactly 100%
Can use as conversion factor

\[
\text{Percentage} = \frac{\text{mass of element } X \text{ in } 1 \text{ mol}}{\text{mass of } 1 \text{ mol of the compound}} \times 100\%
\]

**% Yield or Error:**

\[
\text{Percentage} = \frac{\text{accepted or theoretical value} - \text{experimental value}}{\text{accepted or theoretical value}} \times 100\%
\]

WRITING BALANCED CHEMICAL EQUATIONS

1. Write a skeletal equation for the reactants and products
2. Balance the charges in each formula: Use charges for each ion to adjust subscripts to make formulas neutral
3. Balance equation using coefficients to give the same number and kind of each atom on each side
   a) Count the number of atoms of each element on each side of the equation (polyatomic ions may often be counted as if they are one “element”).
   b) Pick an element to balance.
      • If an element is found in only one compound on both sides, balance it first. Do metals before non-metals.
      • Leave free elements until last. Balance free elements by adjusting the coefficient where it is a free element.
**MASS → MOLES → MASS CONVERSION**

- The ultimate solution map for all your problems!
- Can also branch out to atoms or molecules

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**What Is the Limiting Reactant and Theoretical Yield When 0.552 Moles of Al React with 0.887 Moles of Cl₂?**

\[ 2 \text{Al}(s) + 3 \text{Cl}_2(g) \rightarrow 2 \text{AlCl}_3 \]

**Solution Map:**

| Given: | 0.552 mol Al, 0.887 mol Cl₂ |
| Find:  | mol AlCl₃ |

**Solution:**

- **Limiting Reactant**
  
  \[
  \frac{0.552\text{ mol Al}}{2\text{ mol Al}} \times \frac{2\text{ mol AlCl}_3}{2\text{ mol Al}} = 0.552\text{ mol AlCl}_3
  \]

- **Theoretical Yield**
  
  \[
  \frac{0.877\text{ mol Cl}_2}{3\text{ mol Cl}_2} = 0.5847\text{ mol AlCl}_3
  \]
FOR THURSDAY

• Bring Scantron form (50 answers/side), #2 pencil and calculator for exam
• MC homework due
• PreLab for purity of a hydrate lab
• 7-Up lab worksheets due next Tues