The following problems sets are compiled from B. A. Averill and P. Eldredge, *General Chemistry: Principles, Patterns, and Applications*. License: CC BY-NC-SA. Source: Open Textbook Library.

Reading: Averill 1.1-1.7; 7.1; 3.1, 3.3-3.4;

1. **Atomic symbols practice**

*Averill Chapter 1, Section 6, Conceptual Problem 5*

Give the symbol \( ^ax \) for these elements, all of which exist as a single isotope:

- a. beryllium
- b. ruthenium
- c. phosphorus
- d. aluminum
- e. cesium
- f. praseodymium
- g. cobalt
- h. yttrium
- i. arsenic

2. **Isotopes and average atomic mass**

*Averill Chapter 1, Section 6, Numerical Problem 5*

Copper, an excellent conductor of heat, has two isotopes: \(^{63}\text{Cu}\) and \(^{65}\text{Cu}\). Use the following information to calculate the average atomic mass of copper:

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Percent Abundance (%)</th>
<th>Atomic mass (amu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^{63}\text{Cu})</td>
<td>69.09</td>
<td>62.9298</td>
</tr>
<tr>
<td>(^{65}\text{Cu})</td>
<td>30.92</td>
<td>64.9278</td>
</tr>
</tbody>
</table>

3. **Isotopes and average atomic mass**

*Averill Chapter 1, Section 6, Numerical Problem 10*

Complete the following table:

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Number of protons</th>
<th>Number of neutrons</th>
<th>Number of electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^{57}\text{Fe})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(^{40}\text{X})</td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>(^{36}\text{S})</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Molecular mass/molar mass
Averill Chapter 3, Section 1, Numerical Problem 3

Calculate the molecular mass or formula mass (molar mass) of each compound:

a. V₂O₄ (vanadium(IV) oxide)
b. CaSiO₃ (calcium silicate)
c. BiOCl (bismuth oxychloride)
d. CH₃COOH (acetic acid)
e. Ag₂SO₄ (silver sulfate)
f. Na₂CO₃ (sodium carbonate)
g. (CH₃)₂CHOH (isopropyl alcohol)

5. Grams to moles
Averill Chapter 3, Section 1, Numerical Problem 8

Calculate the number of moles in 5.00X10²g of each substance. How many molecules or formula units are present in each sample?

a. CaO (lime)
b. CaCO₃ (chalk)
c. C₁₂H₂₂O₁₁ (sucrose/cane sugar)
d. NaOCl (bleach)
e. CO₂ (dry ice)

6. Moles, molecules, and molar mass
Averill Chapter 3, Section 1, Numerical Problem 16

Decide whether each statement is true or false and explain your reasoning.

a. There are more molecules in 0.5 mol of Cl₂ than in 0.5 mol of H₂.
b. One mole of H₂ has 6.022x10²³ hydrogen atoms.
c. The molecular mass of H₂O is 18.0 amu.
d. The formula mass of benzene is 78 amu.

7. Balancing reactions
Averill Chapter 3, Section 3, Numerical Problem 2

Balance each chemical equation.

a. Be(s) + O₂(g) → BeO(s)
b. N₂O(g) + H₂O(l) → HNO₂(aq)
c. Na(s) + H₂O(l) → NaOH(aq) + H₂(g)
d. CaO(s) + HCl(aq) → CaCl₂(aq) + H₂O(l)
e. CH₃NH₂(g) + O₂(g) → H₂O(g) + CO₂(g) + N₂(g)
f. Fe(s) + H₂SO₄(aq) → FeSO₄(aq) + H₂(g)
8. Writing balanced equations and finding limiting reagents

*Averill Chapter 3, Section 4, Numerical Problem 12*

Write a balanced chemical equation for each reaction and then determine which reactant is in excess.

a. 2.46 g barium(s) plus 3.89 g bromine(I) in water to give barium bromide
b. 1.44 g bromine(I) plus 2.42 g potassium iodide(s) in water to give potassium bromide and iodine
c. 1.852 g of Zn metal plus 3.62 g of sulfuric acid in water to give zinc sulfate and hydrogen gas
d. 0.247 g of iron metal reacts with 0.924 g of silver acetate in water to give iron(II) acetate and silver metal
e. 3.142 g of ammonium phosphate reacts with 1.648 g of barium hydroxide in water to give ammonium hydroxide and barium phosphate

9. Determining the yield of a reaction

*Averill Chapter 3, Section 4, Numerical Problem 25*

Aniline (C₆H₅NH₂) can be produced from chlorobenzene (C₆H₅Cl) via the following reaction:

\[
C₆H₅Cl(l) + 2NH₃(g) \rightarrow C₆H₅NH₂(l) + NH₄Cl(s)
\]

Assume that 20.0 g of chlorobenzene at 92% purity is mixed with 8.30 g of ammonia.

a. Which is the limiting reactant?
b. Which reactant is present in excess?
c. What is the theoretical yield of ammonium chloride in grams?
d. If 4.78 g of NH₄Cl was recovered, what was the percent yield?
e. Derive a general expression for the theoretical yield of ammonium chloride in terms of grams of chlorobenzene reactant, if ammonia is present in excess.