Chapter 4

1. Explain the law of conservation of mass.

*mass before / after a reaction must be equal*

2. What mass of product is produced in the following reaction?

\[ 2 \text{ grams } \text{H}_2 + 3 \text{ grams } \text{Cl}_2 \rightarrow 5 \text{ grams } \text{HCl} \]

3. Complete the chart.

<table>
<thead>
<tr>
<th>Subatomic Particle</th>
<th>Charge</th>
<th>Size</th>
<th>Location in Atom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton</td>
<td>+</td>
<td>Same size</td>
<td>nucleus</td>
</tr>
<tr>
<td>Neutron</td>
<td>$\neq$</td>
<td>$&gt;\text{ electron}$</td>
<td>nucleus</td>
</tr>
<tr>
<td>Electron</td>
<td>-</td>
<td>VERY small</td>
<td>orbitals</td>
</tr>
</tbody>
</table>

4. Which subatomic particle makes up most of an atom's mass?

*protons* *neutrons*

5. Most of an atom's volume is really what?

*empty space*

6. Define isotope and give an example.

*atom w/ same # of protons but a different # of neutrons* *C-12 and C-13*

7. Why is the atomic mass of a given element usually NOT listed on the periodic table as a whole number?

*average of all the isotopes*

8. What particle does the atomic number listed on the periodic table represent, and where does this particle reside?

*protons* *in nucleus*
9. Write the equation that relates the mass # to the number of protons and neutrons in the nucleus of an atom.

\[ \text{mass} \# = \text{protons} + \text{neutrons} \]

10. Calculate the number of protons, neutrons and electrons in a atom of Potassium, K?

\[ \text{K} = 39 \quad \text{P} = 19, \quad E = 19, \quad N = 39 - 19 = 20 \]

11. What is the atomic mass and the atomic number of lead, Pb?

\[ \text{atomic mass} = 207.2 \quad \text{atomic \#} = 82 \]

12. Which atom has a great atomic mass: Silver or Arsenic?

\[ \text{Silver} \]

13. Which element on the periodic table has the atomic number of 17?

\[ \text{Potassium} \]

14. Which of the following are isotopes of each other? (Circle all that apply)

\[ \text{Ca-40} \quad \text{Cr-50} \quad \text{Cr-53} \quad \text{Cu-63} \quad \text{Fe-56} \]

15. What is the atomic mass of an atom that has 30 neutrons and 25 protons?

\[ \text{mass} = 30 + 25 = 55 \]

Chapter 5

16. Fill in the orbital diagram below for Tungsten and then write the full electron configuration below.

W: \( 74 = 74 \) Arrows

\[
\begin{array}{cccccccccccccccc}
\text{1s} & \text{2s} & \text{2p} & \text{3s} & \text{3p} & \text{4s} & \text{3d} & \text{4p} & \text{5s} & \text{4d} & \text{5p} & \text{6s} & \text{5d} & \text{6p} & \text{7s} \\
\uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow \\
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
\end{array}
\]
17. Which of the following is an incorrect orbital diagram? Why?
   a.  
   \[
   \begin{array}{ccc}
   1s & 2s & 2p \\
   \end{array}
   \]
   b.  
   \[
   \begin{array}{ccc}
   1s & 2s & 2p \\
   \end{array}
   \]
   c.  
   \[
   \begin{array}{ccc}
   1s & \uparrow & \uparrow \\
   2s & \uparrow & \downarrow \\
   2p & \uparrow & \downarrow \\
   \end{array}
   \]
   d.  
   \[
   \begin{array}{ccc}
   1s & 2s & 2p \\
   \end{array}
   \]
   must fill in the same direction first

18. Write the unabbreviated electron configuration for the following atoms:
   a) Helium \[ \text{He}^2 \]
   b) Oxygen \[ 1s^2 2s^2 2p^4 \]
   c) Aluminum \[ 1s^2 2s^2 2p^6 3s^2 3p^1 \]
   d) Neon

19. Write the abbreviated electron configuration for the following atoms:
   a) Silver \[ [Kr] 5s^2 4d^9 \]
   b) Copper \[ [Ar] 4s^2 3d^9 \]
   c) Tungsten \[ [Xe] 6s^2 4f^{14} 5d^4 \]
   d) Titanium \[ [Ar] 4s^2 3d^2 \]

20. Define ground state.
   * Lowest energy level an electron can occupy

   * When an electron jumps to a higher energy level
22. How do atoms jump from ground state to excited state and back?
   * given energy

23. Which atomic particle changes energy states?
   * electrons

24. Label the number total number of electrons at each energy level for each elements below:
   MAGNESIUM
   ARGON
   ZINC

- which of the above is also an alkaline earth metal? magnesium
- which of the above is unreactive? argon

Chapter 6

25. Define period.
   * horizontal row on periodic table

26. Define group. What is another name for group?
   * vertical column on periodic table
   * family

27. Define electronegativity. How is it used to determine bonds?
   * how well atoms attract electrons

28. Define atomic radius.
   * size of an atom

29. Define ionization energy.
   * energy needed to remove an electron from an atom
30. Label the following on the attached periodic table (at the end of SG):

1) Atomic radius trend
2) Electronegativity trend
3) Ionization energy trend
4) Alkali metals
5) Alkaline earth metals
6) Halogens
7) Noble gases
8) Actinides
9) Lanthanides
10) Metals
11) Nonmetals
12) Metalloids

31. COMPLETE THE CHART – for certain properties, just write high or low

<table>
<thead>
<tr>
<th>CONDUCTIVITY</th>
<th>METALS</th>
<th>METALLOIDS</th>
<th>NONMETALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUSTER</td>
<td>HIGH</td>
<td>MID</td>
<td>LOW</td>
</tr>
<tr>
<td>BRITTLE</td>
<td>LOW</td>
<td>MID</td>
<td>HIGH/MID</td>
</tr>
<tr>
<td>MALLEABLE</td>
<td>HIGH</td>
<td>MID</td>
<td>LOW</td>
</tr>
<tr>
<td>PHASE OF MATTER</td>
<td>SOLID</td>
<td>SOLID</td>
<td>GLASS</td>
</tr>
<tr>
<td>Location on periodic table</td>
<td>LEFT OF STAIRCASE</td>
<td>ON STAIRCASE</td>
<td>RIGHT OF STAIRCASE</td>
</tr>
<tr>
<td>Example elements</td>
<td>Zn, Cu, Au</td>
<td>B, Si, Sb</td>
<td>Cl, O, P</td>
</tr>
</tbody>
</table>

Chapter 7 & 8

32. How is an ion different from an atom?

*has a charge

33. Define cation and give an example.

*positive ion (more protons than electrons) Mg$^{2+}$

34. Define anion and give an example.

*negative ion (more electrons than protons) O$^{2-}$

35. Compare and contrast ionic and covalent bonds.

**Ionic**

*metal + nonmetals *
charges!

**Covalent**

*nonmetal + nonmetal *
no charges – prefixes

36. How many electrons are shared in a covalent bond?

*two!

37. Define octet rule. Which family on the period table has a complete octet and thus does not react to form compounds?

*atoms want 8 valence electrons
*Group 8 - Noble Gases
38. Define valence electron. *electrons in outer energy level (equal to group #)

39. How many valence electrons do the following atoms have:
   a) Magnesium 2
   b) Bromine 7
   c) Calcium 2
   d) Phosphorous 5

40. The electron configuration of oxygen is 1s² 2s² 2p⁴. How many more electrons does oxygen need to satisfy the octet rule?
   *two*

Chapter 9

41. Name the following ionic compounds.
   a) Al(SO₄)₂ aluminum sulfate
   b) PbF₄ lead (IV) fluoride
   c) KBr₂ potassium bromide
   d) Ca(OH)₂ calcium hydroxide
   e) Mg(NO₂)₂ magnesium nitrite

42. Write the formula for the following ionic compounds.
   a) Magnesium chloride ²⁺ Mg²⁺ ³⁻ ClO₃⁻ → Mg(ClO₃)₂
   b) Potassium cyanide ¹⁺ K⁺ ⁻ CN⁻ → KCN
   c) Tin (IV) chloride ⁴⁺ Sn⁴⁺ ⁻ Cl⁻ → SnCl₄
   d) Zinc nitrate ²⁺ Zn²⁺ ₃⁻ NO₃⁻ → Zn(NO₃)₂
   e) Calcium chloride ²⁺ Ca²⁺ ⁻ ClO₂⁻ → Ca(ClO₂)₂
43. Name the following covalent (in other words molecular) compounds.
   a) \( \text{As}_3\text{P}_5 \) triarsenic pentaphosphide
   b) \( \text{IF}_7 \) iodine heptafluoride
   c) \( \text{NO}_2 \) nitrogen dioxide
   d) \( \text{CO} \) carbon monoxide
   e) \( \text{SiCl}_4 \) silicon tetrachloride

44. Write the formula for the following covalent (molecular) compounds.
   a) dinitrogen pentoxide \( \text{N}_2\text{O}_5 \)
   b) carbon monoxide \( \text{CO} \)
   c) trisulfur difluoride \( \text{S}_3\text{F}_2 \)
   d) triarsenic pentanitride \( \text{As}_3\text{N}_5 \)
   e) dihydrogen monoxide \( \text{H}_2\text{O} \)

**Chapter 10**

45. Circle the subscripts in the following chemical formula.
   \[ \text{K}_2\text{SO}_4 \]

46. What information does a subscript reveal and how would changing a subscript in a chemical formula change the chemical it represents?
   * Subscript tells you how many atoms of each substance are present in a compound
   * It would change the substance completely

47. Define molar mass.
   * The mass of 1 mole of a substance
48. Calculate the molar mass of the following:

a) \( \text{Au} = 196.97 \)

b) \( \text{H}_2\text{O} = 2(1.01) + 1(16.00) = 18.02 \)

c) \( \text{Mg}(\text{MnO}_4)_2 = 1(24.31) + 2(54.94) + 8(16.00) = 262.19 \)

d) \( \text{CH}_3\text{CH}_2\text{COOH} = 3(12.01) + 6(1.01) + 2(16.00) = 74.09 \)

49. Define molecular formula.

* equal to empirical formula or a whole multiple of it (subscripts can be reduced)

50. Define empirical formula.

* when all the subscripts are reduced

51. What is the empirical formula for \( \text{C}_6\text{H}_{12} \)?

\( \text{CH}_2 \)

52. What is the empirical formula for \( \text{C}_11\text{H}_{22}\text{O}_{11} \)?

\( \text{CH}_2\text{O} \)

53. Calculate the percent composition of each element in the following compounds:

a) potassium cyanide, \( \text{KCN} \)

molar mass = \( 1(39.10) + 1(12.01) + 1(14.01) = 65.12 \)

\( \frac{39.10}{65.12} \times 100 = 60.04\% \)

\( \frac{12.01}{65.12} \times 100 = 18.44\% \)

\( \frac{14.01}{65.12} \times 100 = 21.81\% \)

b) butane, \( \text{C}_4\text{H}_{10} \)

molar mass = \( 4(12.01) + 10(1.01) = 58.14 \)

\( \frac{4(12.01)}{58.14} \times 100 = 82.03\% \)

\( \frac{10(1.01)}{58.14} \times 100 = 17.17\% \)
54. Find the empirical formula of a compound that is 63.52% iron and 36.48% sulfur.

\[
\frac{63.52 \text{ g Fe}}{1 \text{ mol Fe}} \times \frac{1 \text{ mol Fe}}{55.85 \text{ g Fe}} = \frac{1.14}{1.14} = 1
\]

FeS

55. Calculate the empirical formula of a compound containing 1.0 g K, 0.70 g Cr, and 0.82 g of O.

\[
\frac{1.0 \text{ g K}}{39.10 \text{ g K}} = \frac{0.026}{0.013} = 2
\]

\[
\frac{0.82 \text{ g O}}{16.00 \text{ g O}} = \frac{0.051}{0.013} = 4
\]

\[
\frac{0.70 \text{ g Cr}}{52.00 \text{ g Cr}} = \frac{0.13}{0.013} = 1
\]

K₂CrO₄

56. A white powder is analyzed and found to have an empirical formula of P₂O₅. The compound has a molar mass of 283.88 g/mol. What is the compound's molecular formula?

\[
\text{molar mass } P₂O₅ = 2(30.97) + 5(16.00) = 141.94
\]

\[
\frac{283.88}{141.94} = 2
\]

\[
P₂O₅ \rightarrow \text{P}₂\text{O}_{10}
\]

57. A compound with the empirical formula CH₄O was found to have a molar mass of approximately 192 g/mol. What is the molecular formula of the compound?

\[
\text{molar mass } CH₄O = 1(12.01) + 4(1.01) + 1(16.00) = 32.05
\]

\[
\frac{192}{32.05} \approx 6
\]

\[
6\text{(CH}_4\text{O)} \rightarrow \text{C}_{6}\text{H}_{24}\text{O}_{6}
\]

58. How many atoms are there in a mole of gold?

\[
* 6.02 \times 10^{23} \text{ atoms}
\]

59. Convert 3.5 moles of nickel into atoms.

\[
3.5 \text{ mol Ni} \times \frac{6.02 \times 10^{23} \text{ atoms Ni}}{1 \text{ mol Ni}} = 2.11 \times 10^{24} \text{ atoms Ni}
\]

60. How many moles are in 1.20 \times 10^{24} atoms of Zinc?

\[
\frac{1.20 \times 10^{24} \text{ atoms Zn}}{6.02 \times 10^{23} \text{ atoms Zn}} \times \frac{1 \text{ mol Zn}}{1 \text{ mol Zn}} = 1.99 \text{ mol Zn}
\]
61. What is the mass of 5 moles of \( \text{C}_6\text{H}_12\text{O}_6 \), glucose?

\[
\frac{5 \text{ mol C}_6\text{H}_12\text{O}_6}{1 \text{ mol C}_6\text{H}_12\text{O}_6} \times 180.18 \text{ g C}_6\text{H}_12\text{O}_6 = 900.90 \text{ g C}_6\text{H}_12\text{O}_6
\]

62. How many grams are in 3 moles of HCl, hydrochloric acid?

\[
\frac{3 \text{ mol HCl}}{1 \text{ mol HCl}} \times 36.46 \text{ g HCl} = 109.38 \text{ g HCl}
\]

63. How many moles are in 1 gram sample of gold?

\[
\frac{1 \text{ g Au}}{196.97 \text{ g Au}} \times 1 \text{ mol Au} = 0.0051 \text{ mol Au}
\]

*SKIP*

64. A scientist has a sample of magnesium that has a mass of 5 grams. How many atoms of magnesium does the scientist have?

\[
\frac{5 \text{ g Mg}}{24.31 \text{ g Mg}} \times 6.02 \times 10^{23} \text{ atoms Mg} = 1.24 \times 10^{23} \text{ atoms Mg}
\]

Chapter 11 & 12

65. Define product.

*produced in a chemical reaction (on right of \( \rightarrow \))*

66. Define reactant.

*present at the beginning of a reaction (on left of \( \rightarrow \))*

67. Label the products and reactants in the following chemical reactions:

- \( \text{H}_2 (g) + \text{O}_2 (g) \rightarrow \text{H}_2\text{O} (l) \)

- Copper sulfate (aq) + iron (s) \( \rightarrow \) iron sulfate (aq) + copper (s)
\[
\text{H}_2\text{O} + \text{CO}_2 + \text{light} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2
\]

**Reactants**

**Products**

68. What is changed when balancing a chemical equation?

* COEFFICIENTS

69. Identify the type of reaction and balance:

a) \(2 \text{ Al} + 6 \text{ NaOH} \rightarrow 2 \text{ Na}_3\text{AlO}_3 + 3 \text{ H}_2\)  

b) \(_\text{C}_1\text{2H}_{22}\text{O}_{11} + 1\text{6} \text{ O}_2 \rightarrow 1\text{6} \text{ CO}_2 + 11 \text{ H}_2\text{O}\)

c) \(_\text{Ca} + _\text{H}_2\text{SO}_4 \rightarrow _\text{CaSO}_4 + _\text{H}_2 \sqrt{AB}\)

d) \(_\text{CaCl}_2 + _\text{Na}_2\text{CO}_3 \rightarrow 2 \text{ NaCl} + _\text{CaCO}_3\)

70. Predict the products and balance these chemical reactions:

a) \(_\text{Cu(NO}_3)_2 + 2 \text{ K} \rightarrow 2 \text{ KNO}_3 + _\text{Cu}\)

b) \(_\text{SiF}_4 + 4 \text{ NaOH} \rightarrow _\text{Si(OH)}_4 + 4 \text{ NaF}\)

c) \(_\text{MnO}_2 + 4 \text{ K} \rightarrow 2 \text{ K}_2\text{O} + _\text{Mn}\)

d) \(2 \text{ K} + _\text{Cl}_2 \rightarrow 2 \text{ KCl}\)

e) \(_\text{C}_2\text{H}_8 + 4 \text{O}_2 \rightarrow 2 \text{ CO}_2 + 4 \text{H}_2\text{O}\)

71. Define limiting reactant.

* limiting reactant gets used up first in a Reaction (produces less product)
72. Define excess reactant.

*Excess reactant will be left over after a reaction (produces more product)*

73. \( \text{Mg(OH)}_2 + 2 \text{HCl} \rightarrow \text{MgCl}_2 + 2 \text{H}_2\text{O} \)

If the reaction begins with 25.44g of \( \text{Mg(OH)}_2 \), what mass of \( \text{H}_2\text{O} \) is produced from the reaction?

\[
\begin{align*}
25.44 \text{g Mg(OH)}_2 &\quad 1 \text{ mol Mg(OH)}_2 &\quad 2 \text{ mol H}_2\text{O} &\quad 18.02 \text{ g H}_2\text{O} \\
58.33 \text{g Mg(OH)}_2 &\quad 1 \text{ mol Mg(OH)}_2 &\quad 1 \text{ mol H}_2\text{O} &\quad 15.72 \text{ g H}_2\text{O}
\end{align*}
\]

74. \( 6 \text{Li} + \text{Ca}_3(\text{PO}_4)_2 \rightarrow 2 \text{Li}_3\text{PO}_4 + 3 \text{Ca} \)

If the reaction above produced 84.3 grams of calcium, what mass of lithium was used to start the reaction?

\[
\begin{align*}
84.3 \text{ g Ca} &\quad 1 \text{ mol Ca} &\quad 6 \text{ mol Li} &\quad 0.94 \text{ g Li} \\
40.08 \text{ g Ca} &\quad 3 \text{ mol Ca} &\quad 1 \text{ mol Li} &\quad 29.19 \text{ g Li}
\end{align*}
\]

75. \( \text{Ba}_3(\text{PO}_4)_2 + 6 \text{KCl} \rightarrow 3 \text{BaCl}_2 + 2 \text{K}_3\text{PO}_4 \)

The above reaction begins with 3.71 g of \( \text{Ba}_3(\text{PO}_4)_2 \) and 3.71 g of \( \text{KCl} \). What is the limiting reactant?

What is the excess reactant?

\[
\begin{align*}
3.71 \text{ g Ba}_3(\text{PO}_4)_2 &\quad 1 \text{ mol Ba}_3(\text{PO}_4)_2 &\quad 3 \text{ mol BaCl}_2 &\quad 208.23 \text{ g BaCl}_2 \\
0.97 \text{ g Ba}_3(\text{PO}_4)_2 &\quad 1 \text{ mol Ba}_3(\text{PO}_4)_2 &\quad 1 \text{ mol BaCl}_2 &\quad 0.23 \text{ g BaCl}_2 \\
3.71 \text{ g KCl} &\quad 1 \text{ mol KCl} &\quad 3 \text{ mol BaCl}_2 &\quad 74.55 \text{ g KCl} \\
1.02 \text{ g KCl} &\quad 1 \text{ mol KCl} &\quad 1 \text{ mol BaCl}_2 &\quad 0.18 \text{ g KCl}
\end{align*}
\]

76. \( 2 \text{N}_2\text{H}_4 + \text{N}_2\text{O}_4 \rightarrow 3 \text{N}_2 + 4 \text{H}_2\text{O} \)

The above reaction begins with 153.89 g of \( \text{N}_2\text{H}_4 \) and 542.92 g of \( \text{N}_2\text{O}_4 \). What is the limiting reactant? If the reaction actually produces 190.4g of \( \text{N}_2 \), what is the percent yield?

\[
\text{on next page!}
\]
77. \[ 2 \text{Na} + \text{Cl}_2 \rightarrow 2 \text{NaCl} \]

If 17 grams of Na and 17 grams of Cl\(_2\) react, what mass of NaCl will be made?

\[ \frac{17 \text{g Na}}{22.99 \text{g Na}} = \frac{1 \text{mol Na}}{2 \text{mol Na}} = \frac{58.44 \text{g NaCl}}{1 \text{mol NaCl}} = 43.21 \text{g NaCl} \]

\[ \frac{17 \text{g Cl}_2}{70.90 \text{g Cl}_2} = \frac{1 \text{mol Cl}_2}{1 \text{mol Cl}_2} = \frac{58.44 \text{g NaCl}}{1 \text{mol NaCl}} = 28.02 \text{g NaCl} \]

\[ \frac{153.89 \text{g N}_2\text{H}_4}{42.04 \text{g N}_2\text{H}_4} = \frac{1 \text{mol N}_2\text{H}_4}{2 \text{mol N}_2\text{H}_4} = \frac{3 \text{mol N}_2}{1 \text{mol N}_2} = 201.75 \text{g N}_2 \]

\[ \frac{542.92 \text{g N}_2\text{O}_4}{92.02 \text{g N}_2\text{O}_4} = \frac{1 \text{mol N}_2\text{O}_4}{1 \text{mol N}_2\text{O}_4} = \frac{3 \text{mol N}_2}{1 \text{mol N}_2} = 495.96 \text{g N}_2 \]

Limiting Reactant = N\(_2\)H\(_4\)

\[ \% \text{ Yield} = \frac{190.4}{201.75} \times 100 = 94.37\% \]

Page 13
### Periodic Table of the Elements

**Electric Charge:**
- **Positive:** Near the top of the table (Alkali Metals).
- **Negative:** Near the bottom of the table (Halogens).

**Atomic Radius:**
- **Increases** from top to bottom and from left to right.

**Electronegativity/ Ionization Energy:**
- **Increases** from top to bottom and from left to right.

**Groups:**
- **Alkali Metals:** Left side (Alkali Metals).
- **Transition Metals:** Center of the table.
- **Halogens:** Bottom right (Halogens).

**Periods:**
- **Increases** from top to bottom.

**Subgroups:**
- **A1:** Far left (Alkali Metals).
- **A2:** Second row from the left (Alkali Alkaline Earths).
- **A3:** Third row from the left (Alkali Alkaline Earths).
- **A4:** Fourth row from the left (Transition Metals).
- **A5:** Fifth row from the left (Transition Metals).
- **A6:** Sixth row from the left (Transition Metals).
- **A7:** Seventh row from the left (Transition Metals).

**Electronegativity Range:**
- **Increases** from top to bottom and from left to right.

**Ionization Energy Range:**
- **Increases** from top to bottom and from left to right.

**Atomic Radius Range:**
- **Increases** from top to bottom and from left to right.