Review

Significant Digits

- <u>Significant Digits</u>: the digits we know for certain or precisely **plus** an estimated digit which accounts for errors
- <u>GENERAL RULES AND DEALING WITH ZEROS</u>
  - All digits 1-9 count as a significant digit
  - Leading zeros are <u>NOT</u> significant digits

    0.07206 — 4 sig. figs.

    020113 — 5 sig. figs.

  - Trailing zeros (to the right of the decimal) <u>DO</u> count as significant digits

    0.020800 — 5 sig. figs

    900 — 3 sig. figs.

  - <u>ONLY</u> round to the answer to correct significant digits when the entire problem is solved
  - Significant digits is your <u>very last</u> step in completing all calculations
- <u>ADDITION AND SUBTRACTION RULES</u>
  - Out of all the numbers being added/subtracted, the number that has the least amount of decimal places (ie. least precise) is the number that determines the significant digits for the record answer
  - When adding/subtracting, the significant digits are determined only by the number of decimal places

```
  627.1
+ 659    ← least precise
+  27.25
---------
 1313.35
```

correct sig figs ⇒ 1313

```
  536.1  ← least precise
-  64.039
---------
  472.061
```

correct sig. figs ⇒ 472.1

or 4.721×10^2

Review

- **MULTIPLICATION AND DIVISION RULES**
  - Count the number of significant digits in all the numbers that are being multiplied/divided
  - The number with the least amount of significant digits (ie. least precise value) is the significant digits the answer is record too

$(27.1) \times (2.3) = 62.33 \Rightarrow$ correct sig. figs

3 sig. figs　　2 sig. figs

62 or 6.2×10^1

$32.09 \div 2.75 = 11.669... \Rightarrow$ correct sig. figs

4 sig. figs　　3 sig. figs

11.7 or 1.17×10^1

- **EXACT NUMBER AND CONSTANTS**
  - Exact numbers (ie. 800 people) are counted and defined numbers, so they are not considered when determining the significant digits of the answer, even if the number was used in the calculations

The above rule also applied to pre-determined constants, such as those that appear on the formula sheet

Chemical Formulas and Names

- Need to memorize the formulas for the following elements:
  - H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2, P_4, S_8
  - All other atoms are monotomic (travel as one)

Review

Binary Compounds

- Name the metal first (elements found on the left side of the staircase line on periodic table)
- Name the non-metal last, giving an "ide" ending to the non-metal. Non-metals are found on the right side of the staircase line on the periodic table
- Use the prefix below when necessary
  - mono – 1 (often not used)
  - di - 2
  - tri - 3
  - tetra - 4
  - penta - 5
  - hexa - 6
  - poly – many
- Examples

$NaCl$ sodium chloride
CO_2 carbon dioxide
CO carbon monoxide
$AlBr_3$ aluminum bromide

calcium oxide CaO
copper (II) chloride $CuCl_2$
silicon dioxide SiO_2

Ionic Compounds

- Positive ions (cations) are usually metals
  - sodium ion Na^+
  - zinc ion Zn^{2+}
- Negative ions (anions) are non-metals
  - chlorine Cl^-
  - sulphide ion S^{2-}
  - simple anions end in "ide"

Review

- Complex (or polyatomic) ions are a group of atoms that act as a unit, carrying either a positive or negative charge

ammonium	NH_4^+
hydroxide ion	OH^-
cyanide ion	CN^-

  - Complex anions usually have a "ate" or "ite' ending

sulphate ion	SO_4^{2-}
sulphite ion	SO_3^{2-}
nitrate ion	NO_3^-
nitrite ion	NO_2^-

  - Do not need to memorize these complex ions, found in the data book
- Naming and formulas
  - Write/name the positive ion first and the negative ion last
  - Balance the positive charges and the negative charges because compounds are electrically neutral with no charge
  - Examples
    1. Write the chemical formula and name the compound formed between aluminum and sulphur.

       Al_2S_3

       aluminum sulphide
    2. Write the chemical formula and name the compound formed between the ammonium ion (NH_4^+) and the phosphate ion (PO_4^{3-}).

       $(NH_4)_3PO_4$

       ammonium phosphate

Review

Chemical Reactions and Equations

Chemical Equations

- Substances reacting (reactants) are written on the left side of an arrow
- Substance produced (products) are written on the right side of an arrow
- The brackets following each substance represent the phase
  - (g) - gas phase
  - (l) - liquid phase
  - (s) - solid phase
  - (aq) - aqueous/in water solution
- Example

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$$

reactants — product

Types of Reactions

- Simple Composition or Formation
  - Two elements combine to form a compound

$$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$$

- Simple Decomposition
  - A compound decomposes into two elements

$$2HgO_{(s)} \rightarrow 2Hg_{(l)} + O_{2(g)}$$

- Single Replacement
  - An element and a compound react to form a different element and compound

$$Zn_{(s)} + Cu(NO_3)_{2(aq)} \rightarrow Zn(NO_3)_{2(aq)} + Cu_{(s)}$$

- Double Replacement
  - Two compounds react to form two new compounds

$$HCl_{(aq)} + NaOH \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

- Combustion
  - A hydrocarbon reacts with oxygen gas to from carbon dioxide gas and water vapour

$$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$$

Balanced Equations

- All atoms are conserved; for every type of atom on the reactant side, there must be an equal number on the product side
- Coefficients are the numbers out in front of each element/compound that must be written in to balance the equation
- Example: Write out the balance reaction for the combustion of propane ($C_3H_{8(g)}$).

$$C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(g)}$$

Stoichiometry

Molecular Molar Mass (Molar Mass)

- The molar mass is simply the sum of the masses of all atoms found in a mole of molecules (measured in grams)
  - 1 mole = 6.02×10^{23} molecules
- Molar mass is recorded as two decimal places because the atomic masses on the period table are to two decimal places

- Example: What is the molar mass of carbon dioxide?

CO_2

C: 12.01 g/mol × 1 mol

+ O: 16.00 g/mol × 2 mol

44.01 g/mol

Moles and Mass

- Molar mass is a weight, measured in grams/mol
- Moles is a specific number of particles/molecules (measured in mol)
- Molecules is how many particles/molecules there are in total (no units)
- Formula

m=Mn where m is the mass of substance (grams -g)
M is the molar mass of the substance (g/mol)
n is the amount of moles (mol)

- Example: How many moles are in 5.56g of chlorine gas?

Cl_2

M = 35.45 g/mol × 2 mol

M = 70.90 g/mol

$m = Mn$

$\frac{m}{M} = n$

$\frac{5.56g}{70.90 g/mol} = n$ → **0.0784 mol = n**

Stoichiometry

- Need to use a balanced reaction to determine the amount of a product produced or the amount of reactant required
    - "want over have"
    - comparison of the number of moles
    - need to consider the coefficients in the balance reaction

Review

- Examples:
  1. What mass of fluorine gas is required to produce 2.20×10^2 g of hydrogen fluoride?

$M = 2 \times 19.00 = 38.00$

$M = 1.01 + 19.00 = 20.01$

Step 1: $F_{2(g)} + H_{2(g)} \longrightarrow 2HF_{(g)}$

? $\quad 2.20 \times 10^2$ g

Step 2: Find # of moles $\quad n = \frac{m}{M} = \frac{2.20 \times 10^2 g}{20.01 g/mol} = 10.9945$ mol

Step 3: "want over have" ratio

$$n_{F_2} = \left(\frac{1}{2}\right)(10.9945 mol) = 5.49725 mol$$

Step 4: Convert moles into mass

$m_F = nM = (5.49725 mol)($

$\boxed{m_F = 209 g}$

  2. Iron reacts with oxygen to produce rust (iron(III) oxide). If 6.0g of your car (which is iron) has rusted, find the mass of iron(III) oxide produced?

$M = 55.85$ g/mol

$M = 2 \times 55.85 + 3 \times 16.00 = 159.70$ g/mol

Step 1: $2Fe_{(s)} + \frac{3}{2}O_{2(g)} \longrightarrow Fe_2O_{3(s)}$

6.0g $\quad$?

Step 2: $n = \frac{m}{M} = \frac{6.0 g}{55.85 g/mol} = 0.107$ mol

Step 3:

$$n_{Fe_2O_3} = \left(\frac{1}{2}\right) 0.107 mol = 0.0537 mol$$

Step 4: $m_{Fe_2O_3} = nM = (0.0537 mol)(159.70 g/mol)$

$\boxed{m_{Fe_2O_3} = 8.6 g}$