N_A = 6.022 x 10^{23}

1. How many protons, neutrons and electrons are found in an ion of the isotope $^{34}S^{2-}$

      16 protons   **18** neutrons   **18** electrons

2. Define:

    Isotopes: **Two atoms that have the same atomic number (same number of protons) but different numbers of neutrons (and thus different mass numbers).**

    Allotropes: **Two different molecular forms of an element. Example: O_2 and O_3**

3. Elements in the same **group** of the periodic table tend to have similar properties.

4. Give formulas for the following:

    ammonium phosphate: $(NH_4)_3PO_4$ boron trichloride: BCl_3

    disulfur decafluoride: S_2F_{10} potassium sulfate: K_2SO_4

5. Name the following:

    $MgCl_2$: magnesium chloride S_2O_3 : disulfur trioxide

    Na_2SO_3 : sodium sulfite $AlBr_3$: aluminum bromide

6. Identify the following compounds as covalent or ionic:

    C_2H_6 **covalent** or ionic S_2Cl_4 **covalent** or ionic

    $Mg(NO_3)_2$ covalent or **ionic** NH_4ClO_4 covalent or **ionic**

7. How many atoms of hydrogen are found in 8.40 mol N_2H_4?

$$8.40 \text{ mol } N_2H_4 \ \times \frac{4 \text{ mol H}}{1 \text{ mol } N_2H_4} \times \frac{6.022 \times 10^{23} \text{ H atoms}}{1 \text{ mol H}} = 2.02 \times 10^{25} \text{ H atoms}$$

8. Balance the following reaction:

   1 $Al_2(SO_3)_3$ + 6 HCl → 2 $AlCl_3$ + 3 SO_2 + 3 H_2O

   The first "1" need not be shown.

8. Copper (Cu) has two isotopes. Their masses are:

   ^{63}Cu = 62.93 aum ^{65}Cu = 64.93 amu

   Which isotope is present in greater abundance?   **^{63}Cu** or ^{65}Cu

   The molar mass of Cu on the periodic table is 63.55 amu. This is much closer to the atomic mass of Cu-63, so Cu-63 must be in greater abundance.

9. Consider the reaction of butane with oxygen:

   2 C_4H_{10} + 13 O_2 → 8 CO_2 + 10 H_2O

   If 5.6 mol C_4H_{10} are reacted with excess oxygen, what amount (in moles) of H_2O can be formed?

   $$5.6 \text{ mol } C_4H_{10} \ \times \frac{10 \text{ mol } H_2O}{2 \text{ mol } C_4H_{10}} = 28 \text{ mol } H_2O$$

10. Why do we use "moles" to describe chemical amounts?

    The mole concept allows us to relate atomic and molecular scale properties to the bulk, measureable scale. It allows us to infer things about how molecules act by measuring compounds on the human scale.

11. What is the molar mass of $(NH_4)_2SO_3$?   **116.13 g/mol**

12. Well mixed, filtered salt water represents:

                    element   compound   pure substance

                homogeneous mixture   heterogeneous mixture

Long Answer Questions: You MUST Show All Work

Some molar masses: $MgSO_4$: 120.36 g/mol Fe_2O_3: 159.69 g/mol

Na_2SO_4: 142.04 g/mol

13. Calculate the percent composition of oxygen in $MgSO_4$.

$$\%Mg = \frac{\text{mass O}}{\text{mass MgSO4}} \times 100 = \frac{4 \times 16.00 \text{ g/mol}}{120.36 \text{ g/mol}} \times 100 = 53.17\%$$

14. What is the weight of one gallon of gasoline (in pounds)?

$$1 \text{ gal} \times \frac{3.785 \text{ L}}{1 \text{ gal}} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times \frac{1 \text{ cm}^3}{1 \text{ mL}} \times \frac{0.72 \text{ g}}{1 \text{ cm}^3} \times \frac{1 \text{ pound}}{454 \text{ g}} = 6.0 \text{ pounds}$$

> Density = 0.72 g/cm³
> 1 gallon = 3.785 L
> 1 pound = 454 g

15. A **43.09** gram sample of a hydrate of **Na_2SO_4** was heated thoroughly in a porcelain crucible, until its weight remained constant. After heating, **22.82** grams of the anhydrous compound remained. What is the formula of the compound?

The key is to determine the number of waters of hydration per Na_2SO_4 unit.

$$\text{hydration number} = \frac{\# H_2O \text{ molecules}}{Na_2SO_4} = \frac{\text{mol } H_2O}{\text{mol } Na_2SO_4}$$

Mass loss upon heating = mass H_2O = 43.09 g – 22.82 g = 20.27 g H_2O

Mass of sample after heating = mass of anhydrous Na_2SO_4 = 22.82 g Na_2SO_4

$$\text{mol } H_2O = \frac{20.27 \text{ g } H_2O}{18.02 \text{ g } H_2O} = 1.125 \text{ mol } H_2O$$

$$\text{mol } Na_2SO_4 = \frac{22.82 \text{ g } Na_2SO_4}{142.04 \text{ g } Na_2SO_4} = 0.1607 \text{ mol } Na_2SO_4$$

$$\text{hydration } \# = \frac{1.125 \text{ mol } H_2O}{0.1607 \text{ mol } Na_2SO_4} = 7$$

Formula = $Na_2SO_4 \cdot 7H_2O$

16. A compound is found to contain **43.64% phosphorus** and **56.35 %** **oxygen** by weight. What is the empirical formula?
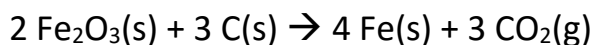
$$\text{mol P} = 43.64 \text{ g P} \times \frac{1 \text{ mol P}}{30.97 \text{ g P}} = 1.409 \text{ mol P}$$

$$\text{mol O} = 56.35 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 3.521 \text{ mol O}$$

$$\text{ratio of atoms} = \frac{3.521 \text{ mol O}}{1.409 \text{ mol P}} = 2.50 = 2\frac{1}{2} = \frac{5 \text{ O}}{2 \text{ P}}$$
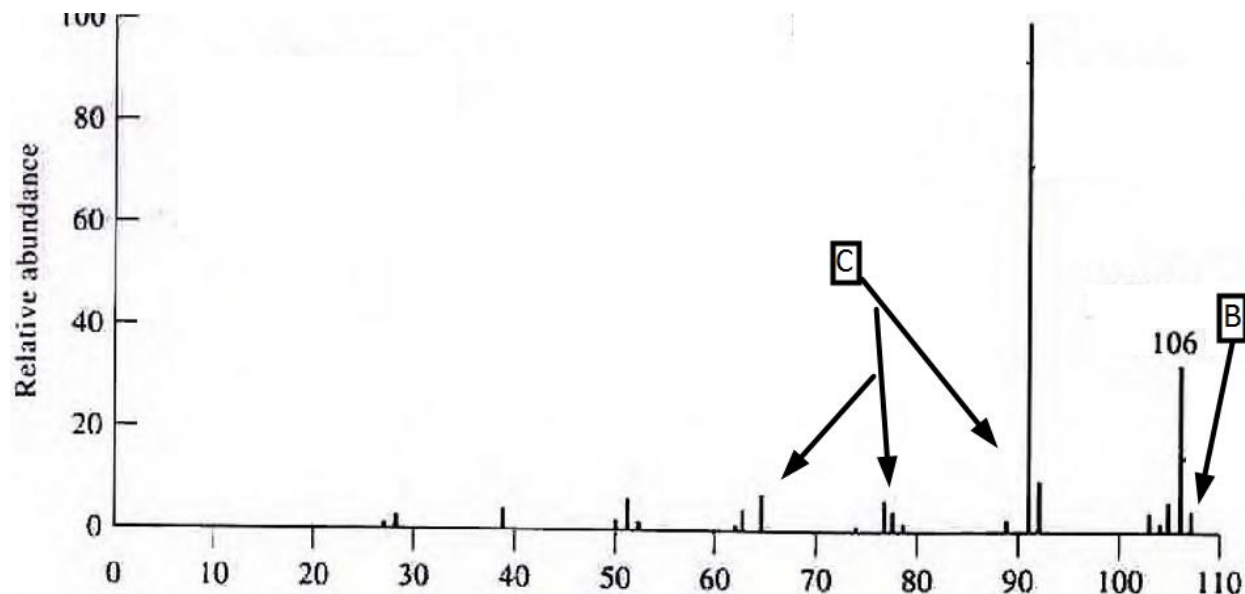
Empirical Formula = P_2O_5

17. Metallic iron is made by the reaction of iron oxide with carbon:

$$2 \text{ Fe}_2\text{O}_3(s) + 3 \text{ C}(s) \rightarrow 4 \text{ Fe}(s) + 3 \text{ CO}_2(g)$$

If one pound (454 g) Fe_2O_3 are reacted with excess C, what mass of CO_2 is formed?

$$454 \text{ g Fe}_2\text{O}_3 \times \frac{1 \text{ mol Fe}_2\text{O}_3}{159.69 \text{ g Fe}_2\text{O}_3} \times \frac{3 \text{ mol CO}_2}{2 \text{ mol Fe}_2\text{O}_3} \times \frac{44.01 \text{ gCO}_2}{1 \text{ mol CO}_2} = 188 \text{ g CO}_2$$

18. A compound is found to have the empirical formula C_4H_5. It's mass spectrum is below.

a. What is the molecular formula of the compound? C_8H_{10}

b. What leads to the peak labeled "B"? Give a one-sentence general description.

Some molecules of C_8H_{10} contain heavier isotopes of H or C.

c. What leads to the peak labeled "C"? Describe in one or two sentences. You are looking for the general cause, not the specific chemical entity.

Some of the molecules decompose and fragment into smaller pieces during the experiment, and show up smaller, lighter species.