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Chemistry Workbook

By no means could we prepare a workbook that would have an example of each type of problem faced in the chemistry classroom or on the UIL Science Test. What we have attempted to do is to give you some basic examples of problem types along with their solutions. From these basics you may have to apply one or two types of problem-solving strategies to solve a specific chemistry problem. Many of the UIL Science problems involve two or more steps to solve. Familiarizing yourself with these problems will increase your success on the test. Good luck on the UIL Science Test and good luck in your endeavors in science.

Helpful Chemistry Reminders:

- **Become familiar with the periodic table**. It is your friend on the chemistry portion of the UIL test.
- Read through the question and mark what they are asking you for.
- Always start with a balanced chemical equation.
- **Remember how important the mole is.** When in doubt, convert to moles. All comparisons in chemistry involve moles, so get comfortable converting back and forth.
- Mole ratios in balanced chemical equations are extremely important in calculations.
- Look at the units in the answer to a problem. Many times knowing this will give you the method you need to use in order to solve the problem. For example, if the units on the answer are mol/L, then look to divide moles by liters in order to solve your problem.
- Become very familiar with the UIL formula cheat-sheet. This will remind you of the things you don't have to memorize and the ones you do.
- Yes, you will have to **memorize** a number of things like the following:
    1. Polyatomic ions and their charges (chemistry *FlipCards* pg 34)*
    2. Ground state electron configurations (pg 20)
    3. Periodic Chart trends: ionic radius, atomic radius, electronegativity, ionization energy (pg 21)
    4. Radioactive Decay summary (pg 28)
    5. Review formula writing (pg 37-40)
    6. List of diatomic elements (pg 41)
    7. Strong acids and strong bases list (pg 85)
    8. Formulas not found on the UIL Formula cheat-sheet but found in the chemistry *FlipCards*

Don't try to cram all of this into an evening study session. Use the workbook and the *FlipCards* throughout the school year in class not only to improve your UIL Science Test scores, but more importantly, to improve your scores in chemistry and physics. Individualize both your workbook and *FlipCards* by adding to and modifying them as you see fit. Good luck this year in both school and UIL Academic competition.

*The rest of the page reference numbers also indicate pages from the Chemistry *FlipCards* published by Hexco Academics

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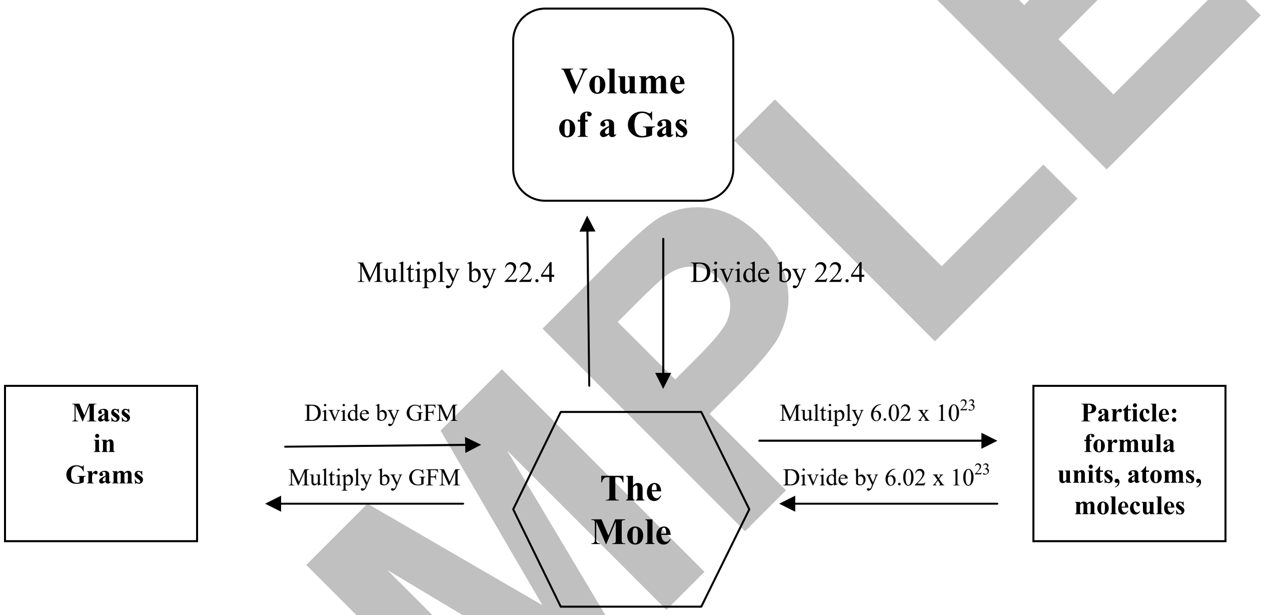
The Mole

The Mole

The mole is essential in chemistry for measurement of chemicals, establishing ratios, and comparing reactions. When in doubt, convert to moles!!

The chart below is helpful in learning conversions at first. Just follow the arrows from what you are given.


Volume of a Gas
Multiply by 22.4
Divide by 22.4
Mass in Grams
Divide by GFM
Multiply by GFM
The Mole
Multiply 6.02 x 10^{23}
Divide by 6.02 x 10^{23}
Particle: formula units, atoms, molecules

Moles to Particles

Given moles and converting to atoms, formula units and molecules, multiply the quantity in moles by Avogadro's Number (6.0 x 10^{23}). Remember Dimensional Analysis!!

Example: 7.50 moles of Carbon would be equal to ________ atoms.

(7.50 ~~mol C~~ **/** 1) (6.02 x 10^{23} atoms C **/** 1 ~~mol C~~) = **4.52 x 10^{24} atoms C**

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Stoichiometry

Stoichiometry and Chemical Equations; What it tells us

Stoichiometry relates quantity of reactants and products. It depends on a balanced chemical equation. A balanced chemical equation gives us the relationships between participating components of the equation. These ratios can be used to calculate moles of each reactant to moles of product. Once molar ratios are known, we can relate mass relationships, and if a gas, volume relationships.

Example: The balanced chemical equation tells me what?

$2\ H_2\ (g)\ +\ O_2\ (g) \rightarrow\ 2\ H_2O\ (g)$

1. 2 mole hydrogen gas reacts with 1 mole oxygen gas to yield 2 mole of water vapor.
2. 2 molecules of hydrogen gas react with 1 molecule of oxygen gas to form 2 molecules of water.
3. At STP, 2 volumes of hydrogen gas react with 1 volume of oxygen gas to yield 2 volumes of water vapor.

Practice:

39. Given the reaction, explain all relationships that exist.
$Fe\ (s)\ +\ O_2\ (g) \rightarrow\ Fe_2O_3\ (s)$

40. Given the chemical equation below, explain all relationships that you can derive.
$NaOH\ (aq)\ +\ HCl\ (aq) \rightarrow\ NaCl\ (aq)\ +\ H_2O\ (l)$

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Solutions

Henry's Law

The solubility of a gas in solution is directly proportional to the pressure of the gas above the liquid. Solubility is usually measured in g/L. Pressure doesn't matter as long as it is the same across the equal sign.

$S_1 \mathbf{/} P_1 = S_2 \mathbf{/} P_2$

S = solubility in g/L
P = pressure (unit may vary)

Example: Originally there is 45.6 g of a gas dissolved in a 5.00×10^2 mL sample of solution at 2.50 atm. How much does the solubility change when the pressure is reduced to 1.50 atm?

Formula: $(45.6 \text{ g} \mathbf{/} .500 \text{ L}) = 91.2 \text{ g/L}$ original solubility at 2.50 atm
$(91.2 \text{ g/L} \mathbf{/} 2.50 \text{ atm}) = (\mathbf{S_2} \mathbf{/} 1.50 \text{ atm})$
$S_2 = (91.2 \text{ g/L} \times 1.5 \text{ atm} \mathbf{/} 2.5 \text{ atm}) = 54.72 \text{ g/L}$

Change in Solubility:

91.2 g/L - 54.72 g/L = 36.48 g/L decrease in solubility

Practice:

74. A liquid can dissolve 3.20 mol of NaCl / L at 760 mm Hg. What pressure would be necessary to dissolve 5.20 mol **/** L of NaCl?

Pressure = ____

75. Calculate the change in solubility as a 250 mL solution containing 35.0 g of solute at 3.25 atm loses pressure and achieves equilibrium at 1.00 atm of pressure.

Solubility Change = ____

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Calculating Molarity of a Weak Acid or Base Using Titration

Steps:

1. Balance equation showing neutralization of acid or base.
2. Calculate moles of strong acid or base used in titration to achieve neutralization.
3. Use mole ratio in balanced equation to calculate moles of unknown solution neutralized.
4. Calculate the molarity of unknown by dividing moles of unknown neutralized by liters of unknown found in the original problem.

Example: What is the molarity of HCl if 27.0 mL of a .50 M NaOH is used to neutralize 75.0 mL?

Balance: NaOH + HCl → NaCl + H_2O
Moles: (.50 mol/liter NaOH **/** 1) = (x mol NaOH **/** .027 L NaOH) = .0135 mol NaOH used

Mole unknown neutralized:
(.0135 ~~mol NaOH~~ **/** 1) (1 mol HCl **/** 1 ~~mol NaOH~~) = .0135 mol HCl
Calculate Molarity: x M HCl = .0135 mol HCl **/** .075 L **= .18 M HCl**

Practice:

118. How many mL of a .035 M HCl solution would it take to neutralize 50.0 mL of a .050 M NaOH solution?

mL of HCl = ____

119. How many mL of a .040M HCl solution could you neutralize with 42.0 mL of a .025 M NaOH solution?

mL of HCl to neutralize = ____

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