The Chemistry Summary Sheet

Chemistry is the scientific study of **matter.**

ATOMIC STRUCTURE:

-an atom is composed of three fundamental particles: **proton, electron, neutron.**
-atom size mostly consists of space between these particles.
-isotopes are atoms with unequal numbers of protons and neutrons.
-protons:
-have a positive electric charge.
-are located in the nucleus.
- number of protons determines **atomic number** of element and its place on the Periodic Table of the Elements.
-number of protons and neutrons determines **atomic mass.**
-neutrons:
-have no electric charge.
-are located in the nucleus.
-number of protons and neutrons determines **atomic mass.**
-electrons:
-have a negative electric charge.
-orbit around nucleus at nearly the speed of light.

ATOMIC BONDS:

-result from the transfer and sharing of electrons in outer shells of atoms.
-ion:
-is an atom or molecule that has gained or lost one or more electrons, creating a positive or negative charge:
-**cations:** positively charged ions (lost electrons).
-**anions:** negatively charged ions (gained electrons).
-ionic bond:
-occurs when two distinct atoms or molecules transfer outer shell electrons.
- usually results in a crystal structure.
-creates bonds that are difficult to break.
-covalent bond:
-is chemical bonding between atoms or molecules that share pairs of electrons.
-creates stable atomic structures.
-forms compounds composed of many molecules.
-results in **strong bonds** within molecules.
-results in **weak bonds** between molecules.

MOLECULES:

-are two or more atoms bonded together.
-molecular formulas use element abbreviations and numbers:
-**O_2 =** two oxygen atoms bonded together.
-**CO_2 =** one carbon atom bonded with two oxygen atoms.
-**H_20 =** two hydrogen atoms bonded with one oxygen atom.

PERIODIC TABLE OF THE ELEMENTS:

-has chemical elements sorted by atomic number (number of protons in nucleus).
-arranged in horizontal rows called periods:
-atomic number increases from left to right.
-lightest elements are located in upper left of table.
-heaviest elements are located in lower right of table.
-arranged in vertical columns called groups:
-atoms in first group have one electron in outer shell (alkali metals).
-atoms in last group have eight electrons in outer shell (noble gases).
-elements within a group chemically behave in the same way..

REACTIONS:

-rearrange atoms and molecules.
-require making and breaking chemical bonds.
-most reactions require energy (activation energy) to begin.
-exothermic reactions release heat. In other words, the energy needed for the reaction to occur is less than the total energy released.
-endothermic reactions absorb heat. In other words, chemical reactions that requires an input of energy in the form of heat for it to proceed; the energy is absorbed from the surroundings by the reactants
-some can be fast (such as an explosion); some can be slow (such as rusting):
    -rate is affected by temperature, pressure, concentration, surface area, light.
-**compounds:**
    -created by reactions and bonding between elements.
    -difficult to separate into constituent elements.
    -have properties distinct and unique from constituent elements.
    -can be organic or inorganic (i.e., with or without carbon).
    -examples include water, salt, ammonia, sugar, and alcohol.
-**mixtures:**
    -created by a combination of elements and/or compounds.
    -formed without chemical reactions.
    -easy to separate into constituent components.
    -two different types:
        -heterogeneous mixtures: substances do not spread evenly.
        -homogeneous mixtures: substances spread evenly throughout.
    -examples include soil, concrete, and paint.
-**solutions:**
    -homogeneous mixtures with evenly mixed particles.
    -formed with two distinct parts:
        -solute: substance that dissolves in a liquid.
        -solvent: liquid in which substances dissolve.
    -examples include **salt water and vinegar**

The Mole

A mole is defined as the quantity of a substance that has the same number of particles as are found in 12.000 grams of carbon-12. This number, Avogadro's number, is 6.022×10^{23}.

Calculating Moles

Example 1: Determine the mass in grams of 1.00 mol of H_2SO_4.

First, look up the atomic masses for hydrogen, sulfur, and oxygen from the Periodic Table. The atomic mass is 1.008 for H; 32.06 for S; 16.00 for O.
The formula mass of H_2SO_4 is: $2(1.008) + 32.06 + 4(16.00) = 98.08$

Thus, one mole of H_2SO_4 has a mass of 98.08 grams.

Example 2: Determine the number of moles of CO2 in 454 grams.

First, look up the atomic masses for carbon and oxygen from the Periodic Table. The atomic mass of C is 12.01 and the atomic mass of O is 16.00. The formula mass of CO_2 is:

$12.01 + 2(16.00) = 44.01$

Thus, one mole of CO2 weights 44.01 grams. This relation provides a conversion factor to go from grams to moles. Using the factor 1 mol/44.01 g:

moles CO_2 = 454 g x 1 mol/44.01 g = 10.3 moles

Balancing Chemical Equations
Look at the equation and see which elements are not balanced. In this case, there are two oxygen atoms on the lefthand side of the equation and only one on the righthand side. Correct this by putting a coefficient of 2 in front of water:

$SnO_2 + H_2 \rightarrow Sn + 2\ H_2O$

This puts the hydrogen atoms out of balance. Now there are two hydrogen atoms on the left and four hydrogen atoms on the right. To get four hydrogen atoms on the right, add a coefficient of 2 for the hydrogen gas. Remember, coefficients are multipliers, so if we write 2 H_2O it denotes 2x2=4 hydrogen atoms and 2x1=2 oxygen atoms.

$SnO_2 + 2\ H_2 \rightarrow Sn + 2\ H_2O$

The equation is now balanced. Be sure to double-check your math! Each side of the equation has 1 atom of Sn, 2 atoms of O, and 4 atoms of H.

Do these NOW! Answers on the back

1. __NaCl + __BeF_2 ⟶ __NaF + __$BeCl_2$

2. __$FeCl_3$ + __$Be_3(PO_4)_2$ ⟶ __$BeCl_2$ + __$FePO_4$

3. __$AgNO_3$ + __LiOH ⟶ __AgOH + __$LiNO_3$

4. __CH_4 + __ O_2 ⟶ __C O_2 + __H_2O

5. __Mg + __Mn_2O_3 ⟶ __MgO + __Mn

Stoichiometry Lab: Vinegar and Baking Soda

Purpose: To predict the amount of Carbon Dioxide gas that should be produced in a chemical reaction; then calculate the % yield.

$$1CH_3COOH + 1NaHCO_3 \longrightarrow 1NaCH_3COO + 1H_2O + 1CO_2$$

Materials: Baking Soda ($NaHCO_3$), Vinegar (CH_3COOH), and 2 plastic cups, scale, thermometer.

Procedure: Find and record the mass of cup A. With cup A still on the scale, add approximately 3.0 g of baking soda to the cup. The mass does not have to be exact, as long as you carefully record your results.

Place cup B on the scale, weigh and record approximately 100.0 g of vinegar. The mass does not have to be exact, as long as you carefully record your results.
Slowly add vinegar to cup A until the reaction has stopped. DO NOT add all of the vinegar, just enough to complete the reaction. Reweigh and record both cup A and B. Calculate the mass of CO2 that escaped.

Data:

a. Mass of Cup A _____ g

b. Mass of Cup A and baking soda _____g

c. Calculate mass of baking soda (b - a) _____g

d. Mass of Cup B with vinegar _____g

e. Temperature of CH_3COOH in cup B _____C

f. Mass of Cup B after reaction _____g

g. Calculate mass of vinegar poured into Cup A (d – f)_____g

h. Mass of Cup A after reaction _____g

i. Temperature of Solution in cup A after reaction _____C

j. Calculate mass of product after reaction (h – a) _____g

k. Calculate baking soda + vinegar (c + g) _____g

l. Calculate mass of CO_2 lost (k - j) _____g

Discussion Questions

1. Using the mass of the $NaHCO_3$, calculate the mass of CO_2 you would expect.

Start by calculating the number of moles from the mass of $NaHCO_3$ you used.

Insert the number of moles into the balanced reaction equation. (Assume the CH_3COOH is not limiting)

$$1CH_3COOH + 1NaHCO_3 \longrightarrow 1NaCH_3COO + 1H_2O + 1CO_2$$

Now that you know the number of moles of CO_2 you should expect, convert that quantity back to grams

Grams of CO_2 to be produced _____g

2. How does this compare to the amount of CO_2 produced?

3. Calculate the percent yield.

$$\frac{\text{actual yield}}{\text{theoretical yield}} \times 100\ \% = \text{percent yield}$$

4. Calculate percent error.

$$\frac{\text{(actual yield - theoretical yield)}}{\text{theoretical yield}} \times 100\ \% = \text{percent error}$$

5. What are some possible sources of error that can contribute to your percent error?
What could be done to reduce the percent error?

6. Was this experiment exothermic or endothermic. What can you conclude about the reaction?

Answers:

1. 2 NaCl	+	1 BeF_2	$\longrightarrow$	2 NaF	+	1 $BeCl_2$
2. 2 $FeCl_3$	+	1 $Be_3(PO_4)_2$	$\longrightarrow$	3 $BeCl_2$	+	2 $FePO_4$
3. 1 $AgNO_3$	+	1 LiOH	$\longrightarrow$	1 AgOH	+	1 $LiNO_3$
4. 1 CH_4	+	2 O_2	$\longrightarrow$	1 C O_2	+	2 H_2O
5. 3 Mg	+	1 Mn_2O_3	$\longrightarrow$	3 MgO	+	2 Mn