(*) THIS IS WHAT I EXPECT YOU ARE ABLE TO DO ALREADY (*) REVIEW OF CHEM (Honors)

Chem I Review

Significant Digits and Exponential Notation

Your answer can only have as many significant digits in it as the least number of significant digits in the problem. Only look at the numbers that are given, do not include conversion factors (sig.digs are infinite for conversion factors) like 1000mL = 1 L.

Ex: (0.0004080)(160,000) = 65.28 Round answer to least number of significant digits = 65

0.000<u>4080</u> <u>160</u>,000

→ decimal point present (4 SD's) ← no decimal point present (2 SD's)

In exponential or scientific notation you move the decimal point so there is one non-zero digit in front. The exponent is the number of places you moved the decimal point. Numbers that are smaller than one have NEGATIVE exponent. Numbers that are larger than one have POSITIVE exponent.

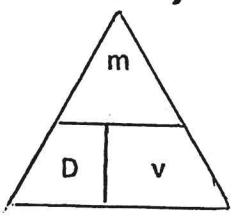
Ex: $0.0004080 = 4.080 \times 10^{-4}$ $160{,}000 = 1.6 \times 10^{5}$

YOUR TURN

Solve putting your answer in significant digits and exponential notation:

(0.000432000)(5,006,000)(40.003) =

Density = mass per unit volume or D= m/v



Cover the unit you are solving for. If they are above one another, divide. If they are on the same level, multiply

Mass = grams (g); Volume = mL or cm^3; Density = g/mL or g/cm^3

Ex: Find the density of an object with a mass of 42.60 g and a volume of 32.160 cm^3.

D = m/v = 42.60g /32.160 cm^3 = 1.324626866 g/cm^3 rounded to significant digits = 1.325 g/cm^3

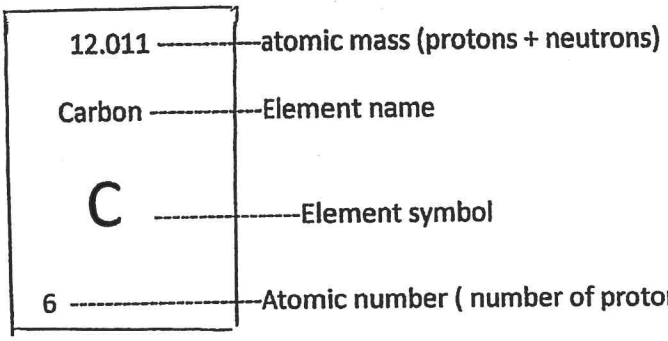
YOUR TURN

Calculate the mass of an object that has a density of 0.879 g/cm^3 and a volume of 25.0 cm^3.

Atomic Theory

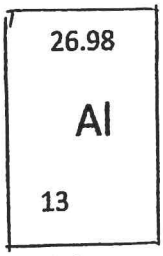
Atoms are the smallest unit of matter. They are composed of protons, neutrons and electrons, called subatomic particles. Protons and Neutrons are in the atom's nucleus. Electrons are outside of the nucleus in the electron cloud. Protons are positively charged. Neutrons have no charge. Electrons are negatively charged.

Protons and neutrons make up an atom's atomic mass. Protons are the atomic number of an element and cannot be changed without changing the identity of the element. Protons and electrons are equal if the atom is NOT charged.



To find the number of neutrons: Atomic mass – Atomic numbers = # of neutrons, rounded to a whole #

Ex: Calculate the number of subatomic particles present in an atom of aluminum.



13 protons, 13 electrons, 14 neutrons

If the atom has a charge, the number of protons and electrons are NOT equal and it is called an ION. Since protons cannot be changed it is the electrons that differ in an ion.

Ex: Calculate the number of subatomic particles in Al^{3+}

13 protons, 10 electrons, 14 neutrons

Isotopes are atoms with a varying number of neutrons.

YOUR TURN:

Calculate the number of subatomic particles in an atom of copper

Calculate the subatomic particles in O^{2-}

Electron Configurations and Dot Notations

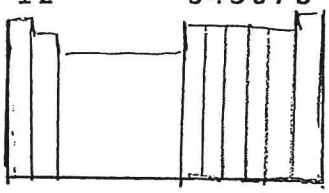
An electron configuration is a description of the electron cloud from the nucleus out. It includes energy levels (1-7), cloud shapes (sublevels: s,p,d,f) and the number of electrons in each sublevel.

Ex: the electron configuration for P

$1s^2 2s^2 2p^6 3s^2 3p^3$

The Noble Gas notation for P is $[Ne]3s^2 3p^3$

The dot notation shows the electrons in the highest energy level (called VALENCE electrons). Count 1 → 8, the high columns on the Periodic Table.



P has 5 valence electrons (2 e- per side of the symbol. Don't double them up until you have to: HUND's Rule)

Your Turn: Write the electron configuration and dot notation for sulfur, iron and the calcium ion. (electrons come out of the highest energy level first)

Writing Formulas

Use the sheet to find charges and then use subscripts to make the (+) and (-) charges cancel each other out. (+) charges are written first.

Ex: Calcium phosphate

Ca^{2+} PO_4^{3-} You need 3 Ca ions and 2 PO_4 ions to = 0 so, $Ca_3(PO_4)_2$

Your Turn: Write the formulas for

a. Aluminum nitrate
b. Lead (II) carbonate
c. Iron(III)oxide
d. Barium hydroxide

Writing molecular formulas- Prefixes like mono, di, tri, tetra, penta ... are used to tell how many of each atom are present in the compound. This is only when there are only 2 ELEMENTS total in the compound and BOTH are NONMETALS. Nonmetals are on the right side of the "staircase" on the Periodic Table. Metals are on the left. Metalloids, which count as nonmetals, lie on either side of the staircase.

Ex: Carbon dioxide means 2, so CO_2 Diphosphorous pentoxide P_2O_5

Your Turn: Carbon monoxide **Dichlorine heptoxide**

Writing Acid Formulas: Acids generally begin with H in their formulas. That's the ACID part of their name.

Hydro____ic acid Look for the ending IDE and add enough hydrogen atoms to cancel the charge.

Ex: hydrochloric acid Look for "chloride", which is Cl^{1-}, so only one H is needed. HCl is the formula.

_____ic acid. Look for the ending, ATE and add enough hydrogen atoms to cancel the charge.

Ex: Phosphoric acid. Look for "phosphate", which is PO_4^{3-} ,so you need 3 hydrogens to cancel the charge. H_3PO_4

_____ous acid. Look for the ending, ITE and add enough hydrogen atoms to cancel the charge.

Ex: Chlorous acid. Look for "chlorite", which is ClO_2^{1-}, so $HClO_2$. The charge on chlorine in this compound would be determined by assigning a +1 to hydrogen and a -2 to oxygen.

$$HClO_2$$

$+1 + x + 2(-2) = 0$ solve for x

YOUR TURN: Write the formulas for the following and determine the charge of the nonmetal (not oxygen) in each.

a. **Nitric acid**
b. **Sulfurous acid**
c. **Hydrophosphoric acid**

Naming Compounds

Use the negative ion (anion) to determine the charge on the positive ion (cation) if that element has multiple charges (you can tell if it does because it will have a Roman numeral beside the name on the ion chart or it will not be present on the chart)

Ex: Name Fe_2O_3

O has a -2 charge and there are 3 of them so 3(-2) = -6. Fe_2 then has to be = and opposite, so +6. There are 2 Fe's so each one is +6/2 = +3. Therefore the name is Iron (III) oxide.

Your Turn: Name

a- **$Al_2(CO_3)_3$**
b- **SiO_2**
c- **$NaHCO_3$**
d- **$(NH_4)_3PO_4$**
e- **H_2SO_4**

Percent Composition and Empirical Formulas

% composition is finding the % of each element in the compound by mass. Use atomic masses.

Ex: $Al_2(CO_3)_3 = 2(26.98) + 3(12.011) + 9(15.999) = 234.281$ g/mol

Al = 2(26.98)/ 234.281 x 100 = 23.03%

Your Turn: Calculate the % composition of calcium hydroxide

Empirical Formulas: Simplest ratio of elements in a compound (subscripts CANNOT be further simplified)

1- Divide each element by its own atomic mass
2- Divide through by the smallest answer you got in #1 to find subscripts

Ex: 78.1 g B, 21.9 g H

78.1 g B/ 10.81 g/mol = 7.22 mol B / 7.22 mol = 1

21.9 g H / 1.01 g/mol = 21.7 mol H / 7.22 mol = 3 Formula is: BH_3

YOUR TURN: 32.38 g Na, 22.65 g S, 44.99 g O

Molecular Formulas are multiples of empirical formulas. Use molar mass of empirical formula and divide it INTO the molecular mass of the molecular or true formula to find the number you multiply your subscripts by.

Ex: Molecular or True formulas for HO is 34 g/mol. HO = 1 + 16 = 17 g/mol. 34/17 =2 , so H_2O_2 is the molecular formula.

YOUR TURN: True molar mass of BH_3 = 42 g/mol. Calculate the molecular formula.

Covalent Molecules: Lewis Dot Diagrams or VSPER models

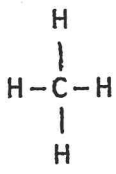
Determine the number of valence electrons for each element and get a total for the compound. The element that has the most places to bond (closest to 4 valence electrons) goes in the middle. Put the other elements around that one and connect each with a single bond to the center atom. Each bond

equals two valence electrons. Put molecules together, using dots for valence electrons that are left over from the bonds to try to get each atom 8 (OCTET RULE). Exceptions: Hydrogen and Boron

Ex: $CH_4 = 4 + 4(1) = 8$ valence electrons total.

-8

0



Used all 8 electrons in bonds

Shape: Tetrahedral

$CO_2 = 4 + 2(6) = 16$ valence electrons total.

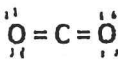
-4

12

O–C–O

Used 4 electrons in bonds

Need 16 more for each atom to get 8. Only have 12 left, so have to share some more.



Used 8 electrons in bonds

Need 8 more for Octet Rule.

Put 8 dots where they are needed. Shape: Linear.

Polarity: (+) and (-) ends of a molecule due to unequal sharing of electrons. Look for different elements on ends of molecule or unshared electrons on the center atom. CO_2 is nonpolar because both ends are the same and there are no unshared electrons on the center atom, Carbon.

Your Turn: Diagram, label shapes and polarities:

a. NH_3 **b. HCN** **c. CCl_4**

Writing and Balancing Equations

Due to the Law of Conservation of Mass, which states that matter cannot be created or destroyed, it simply changes form, the left side (REACTANTS) and the right side (PRODUCTS) of a chemical equation must have equal numbers of atoms of each element present. Use big numbers in front of the formulas, called COEFFICIENTS, to balance each element.

Ex: $PbCl_2 + Al \rightarrow Pb + AlCl_3$ Not balanced.

$3\ PbCl_2 + 2\ Al \rightarrow 3\ Pb + 2\ AlCl_3$ Balanced. Type of reaction: Single Displacement

Your Turn: Balance: $Fe_2O_3 + Cl_2 \rightarrow FeCl_3 + O_2$ **Identify the type of reaction.**

Types of Reactions:

Double Displacement: $CuCl + HBr \rightarrow CuBr + HCl$

Decomposition: $FeCO_3 \rightarrow FeO + CO_2$

Synthesis: $N_2 + H_2 \rightarrow NH_3$

Combustion: $CH_4 + O_2 \rightarrow CO_2 + H_2O$

Precipitate Reactions form a solid (s) or insoluble element or compound. Soluble compounds begin with alkali metals, NH_4^+ or end with NO_3^-, $C_2H_3O_2^-$, most Cl^- and SO_4^{2-}

Redox Reactions – something changes charge from reactant side to product side. All synthesis and single displacement reactions are redox reactions as well.

YOUR TURN: Write, balance and identify the type of reaction for each:

a. **Lithium sulfate is reacted with aluminum phosphate**

b. **Hydrogen gas is reacted with oxygen gas**

c. **Aluminum carbonate is decomposed**

d. **Lithium metal is placed in water**

e. **Ethane is burned in oxygen gas**

Net Ionic Equations

1- Write and balance the equation and determine the phase of each substance: soluble (aq), insoluble (s), gas (g) or liquid (l).
2- Anything that is (aq) breaks into its ions BY NAME
3- Anything that is EXACTLY the same on both sides of the arrow is a SPECTATOR ION and is cancelled out

Ex: Aluminum metal is added to a solution of copper (II) sulfate

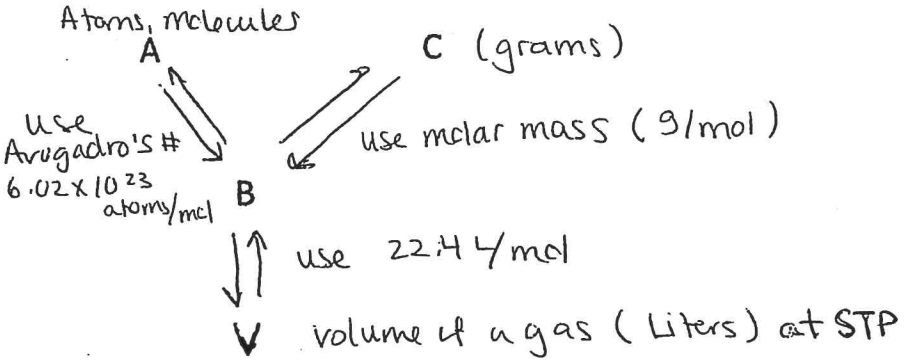
1- $2\ Al\ (s) + 3\ CuSO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3\ Cu\ (s)$
2- $2\ Al(s) + 3\ Cu^{2+} + 3\ SO_4^{2-} \rightarrow 2\ Al^{3+} + 3\ SO_4^{2-} + 3\ Cu(s)$
3- $2\ Al(s) + 3\ Cu^{2+} \rightarrow 2\ Al^{3+} + 3\ Cu(s)$

YOUR TURN: Write the net ionic equations for:

a. **Iron metal is added to a solution of sodium oxide (use iron(III))**

b. **Barium chloride solution is added to a solution of silver nitrate**

Molar Conversions



YOUR TURN: Convert 86 g of sulfuric acid to molecules

Convert 16.4 L of carbon dioxide gas to grams

Stoichiometry

1- Write and balance equations
2- Take whatever you are given and convert it to moles
3- Multiply the moles of the given by the coefficient of what you are solving for from your balanced equation and divide by the coefficient of your given
4- Multiply by molar mass for grams; 22.4 L/mol for volume of a gas; 6.02 x 10^{23} molecules /mol for molecules, atoms or formula units.

Ex: 25 g of sodium is reacted with aluminum chloride. What mass of aluminum should be produced?

1- $3\ Na + AlCl_3 \rightarrow 3\ NaCl + Al$

2- $\frac{25\text{ g Na}}{} \left| \frac{1\text{ mol Na}}{22.990\text{ g Na}} \right| \frac{1\text{ mol Al}}{3\text{ mol Na}} \left| \frac{26.98\text{ g Al}}{1\text{ mol Al}} \right. = 9.75\text{ g Al}$

Your Turn: 56 g of nitrogen gas are reacted with an excess of hydrogen. What mass of ammonia is produced?

Limiting Reactants: One reactant runs out before the other and the smaller amount is how much product is created. The one that produces the smaller amount is the reactant that limits the reaction. Identified by more than one given in the problem. Solve both problems for the same product.

Your Turn: 113 L of hydrogen gas are reacted with 64 L of oxygen gas. Which reactant limits the reaction? What mass of water is produced in this reaction?

Molarity= Moles of solute/Liter of solution, Concentration, M

Ex: What mass of sodium hydroxide is needed to make 450 mL of a 6 M solution?

$$\frac{0.450\ \text{L}}{} \left| \frac{6\ \text{mol NaOH}}{1\ \text{L}} \right| \frac{40\ \text{g NaOH}}{1\ \text{mol NaOH}} = 108\ \text{g NaOH}$$

Your Turn: Calculate the molarity of 623 mL of solution made using 45 g sodium chloride.

If more than one substance is in the problem, write and balance the equation first and use stoichiometry to calculate your answer.

Your Turn: What volume of a 0.48 M sodium hydroxide solution is needed to neutralize 15 mL of a 3.25 M sulfuric acid solution?