Chemistry 104, Dr. Batterton
Help Sheet #2 – Review Material; Chapters 2, 3, 4, 8, and 11
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Nuggets: *Mole Calc (2.9); Balance Rxns (3.1, 3.2); Stoichiometric Calculations (4.1); Limiting Reagents (4.2); Percent Yield (4.3); Molarity (4.5); Electronegativity (8.7); Ideal Gas Law (11.3, 11.4)*

CHAPTER 2

MOLE CALCUATIONS: converting between grams, moles, atoms, molecules; none of these were on the handout from lecture but some of these are needed for reaction stoichiometry.

CHAPTER 3

BALANCING REACTIONS

CHAPTER 4

STOICHIOMETRY: Given a chemical reaction and the quantity of one of the reagents in the equation, be able to determine the quantities of all the other reagents in the reaction.

LIMITING REAGENTS: one reagent runs out first; this is the limiting reagent

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

actual yield = the actual amount obtained (given in the problem)
theoretical yield = calculated amount

MOLARITY – concentration of solutions; abbreviated as M (pronounced "molar")

$$\mathbf{M} = \frac{\mathbf{moles}_{solute}}{\mathbf{L}_{solution}}$$

Solute: The chemical that is dissolved into the solvent
Solvent: The liquid that the solute is dissolved into
Solution: Solvent + Solute

Dilution - this equation is only used with dilutions

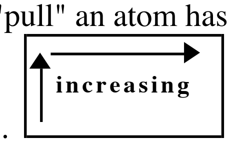
$$\mathbf{M_1 \times V_1 = M_2 \times V_2}$$

where M_1 and M_2 are the molarities of the initial and final solutions, respectively;
V_1 and V_2 are the volumes of the initial and final solutions, respectively; $V_2 = V_1$ + water added

CHAPTER 8

ELECTRONEGATIVITY (EN): The degree to which an atom can attract an e^- in a bond The greater the electronegativity, the greater the "pull" an atom has on an e^-.

Trend: Increases toward F.



BOND POLARITY: Greater ΔEN → the more polar, the more ionic, and the less covalent the bond is.

ΔEN = 0 → nonpolar bond (same atoms typically)

ΔEN > 0 → polar bond

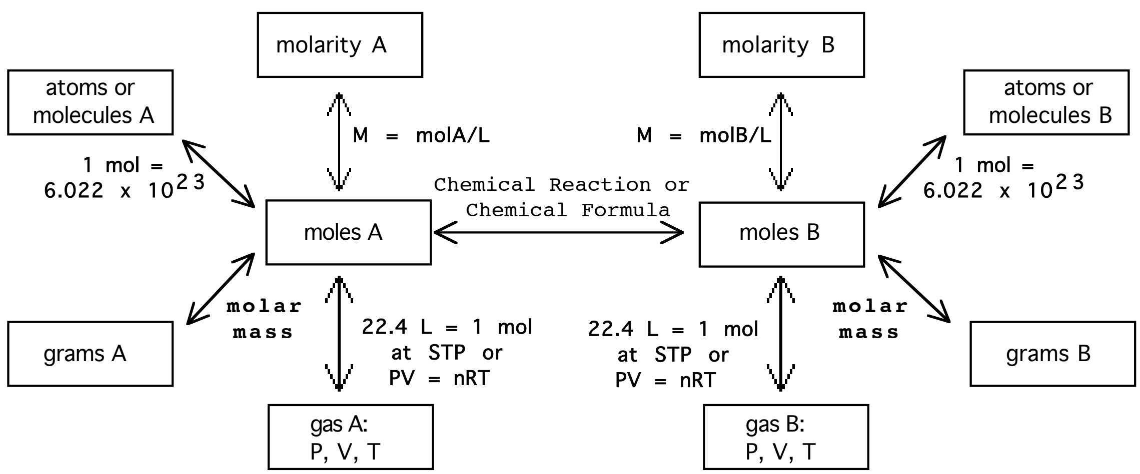
As the 2 atoms being compared get further apart on the Periodic Table, the ΔEN becomes greater

Polar bond: A bond in which the e^- are pulled closer to one of the atoms (ΔEN ≠ 0). A slightly positive charge resides on one atom and a slightly negative charge resides on the other atom. The polarity arrow points toward the negative side of the bond. (+⟶)

CHAPTER 11

Ideal Gas Law: PV = nRT

n = #moles; P in atm; V in L; T in K; $R = 0.0821 \frac{\text{L atm}}{\text{mol K}}$; 760 torr = 760 mm Hg = 1 atm



1. a. How many moles of carbon is present in 5.0g of CH_4O?

b. How many moles of oxygen is present in 15.0g of CH_3COOH?

2. Balance the following equations.

a. $Al(s) + O_2(g) \rightarrow Al_2O_3(s)$

b. $Mg(s) + SiO_2(s) \rightarrow MgO(s) + Si(s)$

c. C_5H_{12} is combusted: $C_5H_{12}(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

d. $CH_3OH(l) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

e. $C_6H_6(l) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

f. $Pb(NO_2)_2(aq) + KI(aq) \rightarrow PbI_2(s) + KNO_2(aq)$

g. $Ca(NO_3)_2(aq) + Na_3PO_4(aq) \rightarrow Ca_3(PO_4)_2(s) + NaNO_3(aq)$

h. $Al(OH)_3(s) + H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(s) + H_2O(l)$

i. $S_8(s) + F_2(g) \rightarrow SF_6(g)$

3. How many grams of oxygen gas (O_2) can be prepared from 24.0 g of H_2O_2? The reaction is

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

4. Given the reaction, $Fe_2O_3(s) + 3CO(g) \rightarrow 3CO_2(g) + 2Fe(s)$, and 25g Fe_2O_3 and 50g CO are reacted, answer the following questions.
a. Assuming 100% yield, how many grams of Fe can be produced?
b. Which is the limiting reagent?
c. If 14.5g Fe were recovered, what is the percent yield of the reaction?

5. Use the following reaction to answer the following questions

$$CH_4(g) + 4Cl_2(g) \rightarrow CCl_4(l) + 4HCl(g)$$

a. When 25.0g CH_4 and 100.0g Cl_2 are combined, how many grams of CCl_4 could be produced?
b. Which reactant is the limiting reagent?
c. If 40.0 grams of CCl_4 were recovered, what is the percent yield?

6. When 410 g HCl is dissolved in water to make 623 ml of solution, what is the molarity of the solution?

7. a. If a 0.5M $Na_3PO_4(aq)$ solution is prepared, what is the concentration of PO_4^{-3}? b. What is the concentration of Na^+?

8. How many grams of NaBr are needed to create a 100.ml solution of 0.010M NaBr?

9. Determine the Na^+ concentration when 2.75g of Na_2SO_4 is dissolved in 700ml H_2O?

10. Given the following balanced reaction

$$Pb(NO_3)_2(aq) + 2NaI(aq) \rightarrow PbI_2(s) + 2NaNO_3(aq)$$

a. When 6.624g $Pb(NO_3)_2$ (molar mass = 331.2g/mol) is mixed with 100ml of a 0.1M solution of NaI, how many grams of PbI_2 (molar mass = 461g/mol) can be prepared?
b. Which reactant is the limiting reagent?
c. If 1.15g of PbI_2 were recovered, what is the percent yield?

11. Small amounts of hydrogen gas can be prepared by reacting aluminum with hydrochloric acid:

$$2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(s) + 3H_2(g)$$

How many grams of Al are needed to prepare 2.50L H_2 gas at 1.01atm and 22.0˚C?

12. A mixture is of 15.0L NH_3 at 1.5atm and 20˚C is combined with 15.0g HCl.

$$NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$$

a. How many grams of $NH_4Cl(s)$ can be produced?
b. Which reactant is the limiting reagent?
c. If 18.5g NH_4Cl were recovered, what is the percent yield?

13. A way to produce diborane, B_2H_6, is to react sodium borohydride, $NaBH_4$, with phosphoric acid as shown in the reaction below. If 25.0 g of $NaBH_4$ (molar mass = 37.7g/mol) reacts with excess phosphoric acid, how many liters of B_2H_6 would be collected at 25 ˚C and 725 torr?

$$2NaBH_4(s) + H_3PO_4(aq) \rightarrow B_2H_6(g) + 2NaH_2PO_4(aq) + 2H_2(g)$$

14. In each set of bonds, determine which has the most polar bond?
a. O—F, Cl—F, F—F, N—F, C—F b. Si—Cl, P—Cl, S—Cl c. Se—F, Se—Cl, Se—Br

15. What is the concentration of a 0.25M Na_2SO_4 solution when 10.0ml of this solution is diluted to 75.0ml?

16. What is the concentration 25ml of 1.5M $Fe(NO_3)_3$ is diluted to 150ml?

17. How many ml of 5.0M KOH solution is needed to make 250ml of 0.60M KOH solution?

18. What is the concentration of a mixture of 250 ml of water and 100 ml of a 0.5 M NaOH solution?

ANSWERS

1. a. 0.16mol C b. 0.500mol O
2. a. $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$
   b. $2Mg(s) + SiO_2(s) \rightarrow 2MgO(s) + Si(s)$ c. $C_5H_{12}(g) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(g)$
   d. $2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$ e. $2C_6H_6(l) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(g)$
   f. $Pb(NO_2)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_2(aq)$
   g. $3Ca(NO_3)_2(aq) + 2Na_3PO_4(aq) \rightarrow Ca_3(PO_4)_2(s) + 6NaNO_3(aq)$
   h. $2Al(OH)_3(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(s) + 6H_2O(l)$ i. $S_8(s) + 24F_2(g) \rightarrow 8SF_6(g)$
3. 11.3 {24g H_2O_2 x [1mol H_2O_2/34g H_2O_2] x [1mol O_2/2mol H_2O_2] x [32g O_2/1mol O_2]}
4. a. 17.5g Fe {25g Fe_2O_3 can produce 17.5g Fe; 50g CO can produce 66.4g Fe → 17.5g Fe can be produced – the lesser amt}
   b. Fe_2O_3 {since Fe_2O_3 produces less Fe, Fe_2O_3 is the LR} c. 83% {14.5/17.5 x 100%}
5. a. 54.2 g CCl_4 {25g CH_4 x (1mol CH_4/16g CH_4) x (1mol CCl_4/1mol CH_4) x (153.8g CCl_4/1mol CCl_4) = 240.3g CCl_4
   100g Cl_2 x (1mol Cl_2/70.9g Cl_2) x (1mol CCl_4/4mol Cl_2) x (153.8g CCl_4/1mol CCl_4) = 54.2g CCl_4
   The smaller amount is the actual amount that can be produced; so 54.2 g CCl_4 can be produced.}
   b. Cl_2 {Since Cl_2 produced the smaller amount, it's the limiting reagent.}
   c. 73.8% {40.0/54.2 x 100%}
6. 18.0M {M = mol HCl/L; mol HCl = 410g HCl x [36.5g HCl/1mol HCl] = 11.23 mol HCl; M = 11.23 mol/ 0.623L}
7. a. $[PO_4^{-3}]$ = 0.5M b. $[Na^+]$ = 1.5M
8. 0.103g {1 x 10^{-2}M x 0.1L = 1 x 10^{-3}mol NaBr; 1 x 10^{-3}mol NaBr x [102.9g NaBr/1mol NaBr] = 0.103g NaBr}
9. 5.53 x 10^{-2} M {$[Na^+]$ = mol Na^+/L; 2.75g Na_2SO_4 x [1mol Na_2SO_4/142g Na_2SO_4] x [2mol Na^+/1mol Na_2SO_4] = 3.87 x 10^{-2} mol Na^+; $[Na^+]$ = 3.87 x 10^{-2} mol Na^+/0.7L}
10. a. 2.31 g {0.02 mol $Pb(NO_3)_2$ x [1mol PbI_2/1mol $Pb(NO_3)_2$] x [461g PbI_2/1mol PbI_2] = 9.22 g PbI_2; NaI: from M = mol/L solve for mol: (0.1L x 0.1M) = 0.01 mol NaI; 0.01 mol NaI x [1mol PbI_2/2mol NaI] x [461g PbI_2/1mol PbI_2] = 2.31 g PbI_2; smaller amount can be made}

b. NaI {the chemical the creates the smaller amount is the LR} c. 49.8% {1.15/2.31 x 100%}

11. 1.87g Al
12. a. 21.6g NH_4Cl {NH_3: PV = nRT and solve for n; n = [(1.5)(15)]/[(0.0821)(293)] = 0.935mol NH_3;
    0.935mol NH_3 x (1mol NH_4Cl/1mol NH_3) x (52.5g NH_4Cl/1mol NH_4Cl) = 49.09g NH_4Cl;
    HCl: 15g HCl x (1mol HCl/36.5g HCl) x (1mol NH_4Cl/1mol HCl) x (52.5g NH_4Cl/1mol NH_4Cl) = 21.58g NH_4Cl;
    smaller amount is how much can be produced}

b. HCl c. 85.7% {(18.5/21.6) x 100%}

13. 8.50L {mol A → gas B; find mol $NaBH_4(s)$: 25g $NaBH_4$x (1mol $NaBH_4$/37.7g $NaBH_4$) = 0.663mol $NaBH_4$;
    convert to total gasesous moles: 0.663mol $NaBH_4$ x (1mol B_2H_6/2mol $NaBH_4$) = 0.3315mol gas products;
    use PV = nRT to find V; V = nRT/P = (0.3315)(0.0821)(25+273)/[(725/760)] = 8.50L}
14. Most polar means greatest ΔEN: a. C—F b. Si—Cl c. Se—F
15. 0.033M {$M_1V_1 = M_2V_2$; (0.25)(10) = (x)(75); x = 0.033M}
16. 0.25M {$M_1V_1 = M_2V_2$; (1.5)(25) = (x)(150); x = 0.25M}
17. 30 ml of 5.0M stock solution; dilute to 250 ml with water. {$M_1V_1 = M_2V_2$; M_1 = 5.0, V_1 = ?, M_2 = 0.60M, V_2 = 250ml; (5)(x) = (0.60)(250) ® solve for x: x = 30ml}
18. 0.14M {$M_fV_f = M_iV_i$; solve for M_f: $M_f = M_iV_i/V_f$ where M_i = 0.5M, V_i = 100ml, V_f = 350ml ® M_f = [0.5 x 100]/(350) = 0.14M}