Fall 2023 CHM 2045 Exam 1 Review

The material covered is from chapters 1-5

1. The two most abundant isotopes of chlorine are ^{35}Cl (34.99 amu) and ^{37}Cl (36.99 amu). What are their percent abundances? (Hint: Use value from periodic table)

a) ^{35}Cl is 37%; ^{37}Cl is 63%
b) ^{35}Cl is 23%; ^{37}Cl is 77%
c) ^{35}Cl is 77%; ^{37}Cl is 23%
d) ^{35}Cl is 63%; ^{37}Cl is 37%
e) ^{35}Cl is 50%; ^{37}Cl is 50%

2. Given the name of the compound, write its molecular formula.

a) Vanadium (v) nitride: V_3N_5
b) Iron (i) nitrate: $FeNO_3$
c) Tin (iv) fluoride: SnF_4
d) Copper (ii) phosphate: $Cu_3(PO_4)_2$
e) Ammonium dichromate: $(NH_4)_2Cr_2O_7$

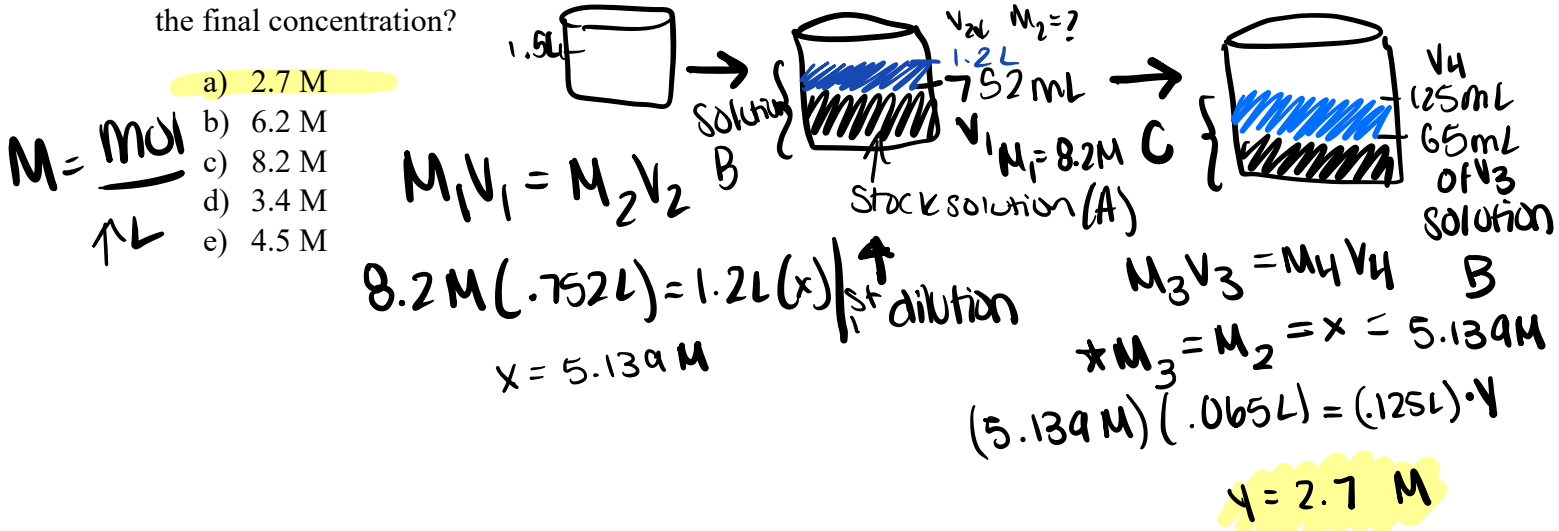
3. What are the moles of each ion and the number of each atom in 78.5 g of aluminum sulfate?

I.	0.241 mol Al^{3+}	V.	$2.76*10^{23}$ atoms Al	IX.	$1.66*10^{24}$ atoms O
II.	0.459 mol Al^{3+}	VI.	$5.47*10^{24}$ atoms Al	X.	$9.32*10^{23}$ atoms O
III.	0.987 mol SO_4^{2-}	VII.	$4.14*10^{23}$ atoms S		
IV.	0.688 mol SO_4^{2-}	VIII.	6.3510^{25} atoms S		

a) II, IV, V, VII, IX
b) I, III, VI, VIII, X
c) I, II, IV, VI, VIII, X
d) II, III, V, VII, IX
e) None of the above

4. You have a concentrated stock solution of HCl. The concentration is 8.2 M and there is 1.5 L of stock solution. 752 mL of stock solution are taken and diluted to 1.2 L in a volumetric flask. 65 mL of this new solution are taken and diluted to 125 mL in another volumetric flask. What is the final concentration?

a) 2.7 M
b) 6.2 M
c) 8.2 M
d) 3.4 M
e) 4.5 M



★Temperature always has to be in Kelvin for gas laws

5. In an experiment, 25.0 mL of a gas with a pressure of 1.00 atm is contained in a balloon at 25.00°C. The balloon's temperature is adjusted until the pressure is 0.75 atm at a volume of 31.1 mL. What is the final temperature of the gas under the new conditions?

a) 278°C
b) 5°C
c) 23°C
d) 273°C

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{(25mL)(1atm)}{298.15K} = \frac{(.75atm)(31.1mL)}{X} \cdot X \cdot \frac{298.15K}{25mL \cdot 1atm}$

$X = 278\ K \rightarrow 278K - 273.15 = 5°C$

6. Write the balanced molecular and net ionic equations for the combination of silver nitrate and sodium chromate.

$Na^+ \ CrO_4^{2-} \Rightarrow Na_2CrO_4$

$Ag^+ \ NO_3^- \Rightarrow AgNO_3$

$Na_2CrO_4(aq) + 2AgNO_3(aq) \rightarrow 2NaNO_3(aq) + Ag_2CrO_4(s)$

$2Na^+(aq) + CrO_4^{2-}(aq) + 2Ag^+(aq) + 2NO_3^-(aq) \rightarrow 2Na^+(aq) + 2NO_3^-(aq) + Ag_2CrO_4(s)$

$CrO_4^{2-}(aq) + 2Ag^+(aq) \rightarrow Ag_2CrO_4(aq)$

7. Given 2.68 M of strontium phosphate, what are the mols of phosphate ion in 689 mL?

a) 9.81 mol
b) 3.69 mol
c) 7.78 mol
d) 2.43 mol
e) 6.75 mol

$Sr^{2+} \ PO_4^{3-} \rightarrow Sr_3(PO_4)_2$

$\frac{2.68\ mol\ Sr_3(PO_4)_2}{1L} \cdot .689L \cdot \frac{2\ mol\ PO_4^{3-}}{1\ mol\ Sr_3(PO_4)_2} = 3.69\ mol\ PO_4^{3-}$

8. Gypsum is a common hydrate salt. It has the general formula $CaSO_4 \cdot xH_2O$. If the molar mass of gypsum is 172.17 g/mol, what is x?

a) 1
b) 2
c) 3
d) 4
e) 5

Ca → 40.08 | 40.08
S → 32.07 | 32.07
O → (16) 4 = 64 | +

136.15 g/mol

172.17 − 136.15 = 36.02 g/mol

$H_2O \rightarrow \sim 18$

$\frac{36.02}{18.02} = \sim 2$

9. What is the mass of CO_2 if 8.2g of nonene (C_9H_{18}) and 20g of O_2 are combusted? And which is the limiting reactant?

a) Nonene, 23g
b) O_2, 16g
c) Nonene, 25g
d) O_2, 18g
e) O_2, 27g

$2(C_9H_{18} + O_2 \rightarrow 9CO_2 + 9H_2O)$

9C 18H
$\frac{27}{2}O$

9C 18H
180 + 90 = 270

$2\ C_9H_{18} + 27O_2 \rightarrow 18\ CO_2 + 18\ H_2O$

$8.2g\ C_9H_{18} \cdot \frac{1\ mol\ C_9H_{18}}{126g\ C_9H_{18}} \cdot \frac{18\ mol\ CO_2}{2\ mol\ C_9H_{18}} = 0.5857\ mol\ CO_2$

LR

★ $20g\ O_2 \cdot \frac{1\ mol\ O_2}{32g\ O_2} \cdot \frac{18\ mol\ CO_2}{27\ mol\ O_2} = 0.4167\ mol\ CO_2$

$.416 \text{ mol } CO_2 \cdot \frac{44 \text{ g } CO_2}{1 \text{ mol}} = 18.3 \text{ g } CO_2$ produced

n molar mass d P

10. Consider 2.00 moles of Argon, an ideal gas, at a density of 5.00 g/L and a pressure of 2.00 atm. What is the closest value to the temperature (in K) of this gas?

a. 172 K
b. 273 K
c. 304 K
d. 195 K

$d = \frac{MP}{RT}$ (d = density)

$\frac{x \cdot 5.00 \text{ g/L}}{5 \text{ g/L}} = \frac{(39.95 \text{ g/mol})(2 \text{ atm})}{(0.08206 \frac{\text{L atm}}{\text{K mol}}) \cdot x \text{ K}}$

$x = 195 \text{ K}$

11. What is the mass of $V(OH)_5$ formed when 624 mL of 0.389 M VCl_5 reacts with 893 mL of 0.651 M of $Ca(OH)_2$?

$2\ VCl_5 + 5\ Ca(OH)_2 \rightarrow 2\ V(OH)_5 + 5\ CaCl_2$

a. 30.6g
b. 98.2g
c. 33.0g
d. 74.6g
e. 31.6g

LR

$\frac{.389 \text{ mol } VCl_5}{1 \text{ L}} \cdot .624 \text{ L} = 0.2427 \text{ mol } VCl_5 \cdot \frac{2 \text{ mol } V(OH)_5}{2 \text{ mol } VCl_5} = 0.2427 \text{ mol } V(OH)_5$

$\frac{.651 \text{ mol } Ca(OH)_2}{1 \text{ L}} \cdot .893 \text{ L} = 0.581 \text{ mol } Ca(OH)_2 \cdot \frac{2 \text{ mol } V(OH)_5}{5 \text{ mol } Ca(OH)_2} = 0.2325 \text{ mol } V(OH)_5$

$.2325 \text{ mol } V(OH)_5 \cdot \frac{135.949 \text{ g } V(OH)_5}{1 \text{ mol } V(OH)_5} = 31.6 \text{ g}$

12. Using the question 11's chemical reaction, how many mL are left over of the excess reagant?

a. 30mL
b. 90mL
c. 512mL
d. 26mL
e. 410mL

$.2325 \text{ mol } V(OH)_5 \cdot \frac{2 \text{ mol } VCl_5}{2 \text{ mol } V(OH)_5} = .2325 \text{ mol } VCl_5 \text{ used}$

$.2427 \text{ mol } VCl_5 \text{ initial} - .2325 \text{ mol } VCl_5 \text{ used} = .0102 \text{ mol } VCl_5 \text{ left over}$

$.0102 \text{ mol} \cdot \frac{1 \text{ L}}{.389 \text{ mol}} = .0262 \text{ L} = 26.2 \text{ mL}$

13. Balance and identify the type of reaction, oxidizing agent, and reducing agent of each equation:

OIL RIG OA RA

$2\ N_2O_5 \rightarrow NO_2 + O_2$

$4\ 2N\ \ 4\ 2xN$
$10\ 5O\ \ 8\ 8xO + 2O$

$2\ N_2O_5 \rightarrow 4\ NO_2 + O_2$

N: +5 → +4 reduced
O: −2 → 0 oxidized

N_2O_5 is RA & OA
Decomposition

$S_8 + F_2 \rightarrow SF_4$

S: 0 → +4 oxidized
F: 0 → −1 reduced

S_8 = RA
F_2 = OA
Combination

$CsI + Cl_2 \rightarrow CsCl + I_2$

I: −1 → 0 oxidized
Cl: 0 → −1 reduced

CsI = RA
Cl_2 = OA
Single displacement

$Fe_3O_4 + 4H_2 \rightarrow 3Fe + 4H_2O$

14. Given the reaction $Fe_3O_4 + H_2 \rightarrow Fe + H_2O$, if 0.250g H_2 makes 1.49 g of H_2O, what is the percent yield?

a. 52.3%
b. 66.7%
c. 95.2%
d. 12.4%
e. 75.3%

Actual yield

$.250\,g\,H_2 \cdot \frac{1\,mol\,H_2}{2.0\,g\,H_2} \cdot \frac{4\,mol\,H_2O}{4\,mol\,H_2} \cdot \frac{18.0\,g}{1\,mol\,H_2O}$

$= 2.25\,g\,H_2O$

$\%\,yield = \frac{theoretical}{actual}$

$= \frac{1.49\,g}{2.25\,g} \times 100\% = 66.7\%$

15. Given $7.13*10^{19}$ Ca atoms, what is the mass of calcium in grams?

a. $5.23*10^{-3}$
b. $6.35*10^{-3}$
c. $4.74*10^{-3}$
d. $9.24*10^{-3}$
e. $4.93*10^{-3}$

$7.13\times10^{19}\,Ca\,atom \cdot \frac{1\,mol\,Ca}{6.022\times10^{23}\,atoms} \cdot \frac{40.08\,g}{1\,mol}$

$= 0.004745\,g\,Ca = 4.74\times10^{-3}$

16. Given 1 mol, what is the mass percent of each element in $C_6H_{12}O_6$?

I. 60% C
II. 40% C
III. 6.7% H
IV. 8.4% H
V. 31.6 % O
VI. 53.3% O

180.096

a. I, IV, VI
b. II, IV, VI
c. I, IV, V
d. II, III, VI
e. II, IV, V

$C: \frac{6\times12}{180.096} \times 100\% = 39.97\% \approx 40\%$

$H: \frac{12\times1.008}{180.096} = 6.7\%$

$O: \frac{6(16)}{180.096} = 53.3\%$

17. What volume of 0.6143 M of strontium hydroxide would neutralize 72.59 mL of a 0.8291 M solution of hydrochloric acid?

$Sr(OH)_2$ HCl

$Sr(OH)_2 + 2HCl \rightarrow 2H_2O + SrCl_2$

a. 62.43mL
b. 48.99mL
c. 75.12mL
d. 36.25mL
e. 95.13mL

$\frac{.8291\,mol\,HCl}{L} \cdot .07259\,L = 0.0601\,mol\,HCl \cdot \frac{1\,mol\,Sr(OH)_2}{2\,mol\,HCl} = 0.03\,mol\,Sr(OH)_2$

$.03\,mol\,Sr(OH)_2 \cdot \frac{1\,L}{.643\,mol\,Sr(OH)_2} = 48.99\,mL$

18. An unknown metal M reacts with sulfur to make M_2S_3. If 1.62g of M reacts with 2.88g of sulfur, what is M and the name of M_2S_3?

a. V; vanadium (iii) sulfide
b. Fe; iron (iii) sulfide
c. Au; gold (iii) sulfide
d. Al; aluminum sulfide
e. Cr; chromium (iii) sulfide

$2M + 3S \rightarrow M_2S_3$

1.62 g M

$2.88\,g\,S \cdot \frac{1\,mol\,S}{32.06\,g\,S} \cdot \frac{2\,mol\,M}{3\,mol\,S} = 0.0599\,mol\,M$

$\frac{1.62\,g}{0.0599\,mol} = 27.05$

$+3\ \ -2$

M_2S_3

$\rightarrow Al^{3+}$ $(M = 26.98\,g/mol)$

19. Balance the equation and identify the oxidation numbers, oxidizing agent, and reducing agent for the combustion of C_7H_{14}.

$C_7H_{14} + \frac{21}{2}O_2 \rightarrow 7H_2O + 7CO_2$; 14H: 70 + 140 = 210

$2C_7H_{14} + 21O_2 \rightarrow 14CO_2 + 14H_2O$

C: −2 → +4 oxidized C_7H_{14} = reducing agent

O: 0 → −2 reduced O_2 = oxidizing agent

20. What is the empirical formula of a compound that is 40% C, 6.71% H, and 53.3% O? What is the molecular formula given that the molar mass is 240.24 g/mol?

a. CH_2O; $C_9H_{18}O_9$
b. C_2HO; $C_{16}H_8O_8$
c. CH_2O; $C_8H_{16}O_8$
d. CHO_2; $C_9H_9O_{18}$
e. CH_2O; $C_6H_{12}O_6$

$40\,g\,C \cdot \frac{1\,mol\,C}{12\,g} = \frac{3.33\,mol\,C}{3.33} \rightarrow 1$

$0.71\,g\,H \cdot \frac{1\,mol\,H}{1.008\,g} = \frac{6.6567\,mol\,H}{3.33} \rightarrow 2$

$53.3\,g\,O \cdot \frac{1\,mol\,O}{16\,g\,O} = \frac{3.33\,mol\,O}{3.33} \rightarrow 1$

empirical: CH_2O

12g + 2.016g + 16 = 30.16 g/mol

$\frac{240.24\,g/mol}{30.16\,g/mol} = 8$

21. Consider the following reaction in a closed reaction flask:

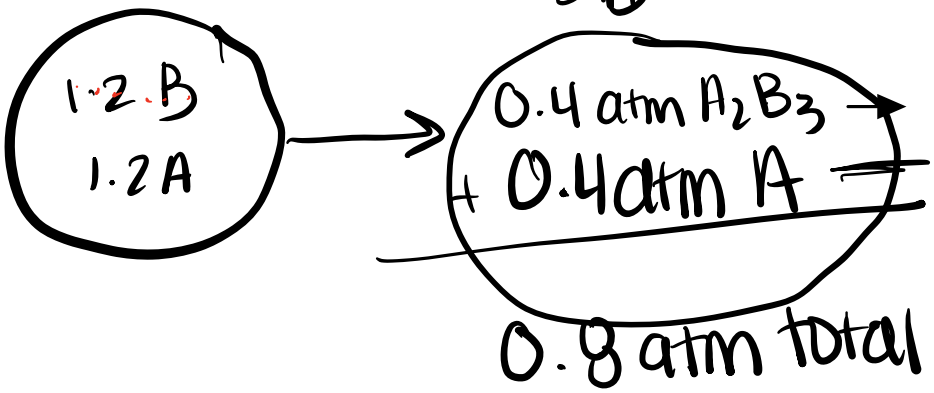
$$2\,A_{(g)} + 3\,B_{(g)} \rightarrow A_2B_{3\,(g)}$$

If 1.20 atm of gas A is allowed to react with 1.20 atm of gas B, and the reaction goes to completion at constant temperature and volume, what is the total pressure (in atm) in the reaction flask at the end of the reaction?

a. 0.4 atm
b. 0.8 atm
c. 1.2 atm
d. 2.4 atm

$1.2\,atm\,A \cdot \frac{1\,mol\,A_2B_3}{2\,mol\,A} = 0.6\,atm\,A_2B_3$

LR: $1.2\,atm\,B \cdot \frac{1\,A_2B_3}{3\,B} = 0.4\,atm\,A_2B_3 \cdot \frac{2\,A}{1\,A_2B_3} = 0.8\,atm\,A$



0.8 atm A used

$1.2_{atm\,A\,initial} - 0.8_{atm\,A\,used} = 0.4_{atm\,A\,left\,over}$