Spring 2024 CHM 2045 Exam 1 Review

The material covered is from chapters 1-4

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%

$\rightarrow M = X_A \cdot m_A + X_B \cdot m_B \cdots$

$35.45 = X_{35} \cdot 34.99 + X_{37} \cdot 36.99$

$* \; 1 = X_{35} + X_{37}$

$1 - X_{35} = X_{37}$

$35.45 = 34.99 \cdot X_{35} + 36.99(1 - X_{35})$

$35.45 = 34.99 X_{35} + 36.99 - 36.99 X_{35}$

$\frac{-1.54}{-2} = \frac{-2 X_{35}}{-2}$

$X_{35} = 0.77 \rightarrow 77\%$

$1 = 0.77 + X_{37}$

$-0.77 \quad -0.77$

$0.23 = X_{37}$

2) Fill in the missing information. Circle the compound that would have the most amount of moles in 10 grams of its compound.

	Name	Molecular Formula	Molecular Mass
a)	Vanadium (v) nitride: (+5, N^{-3})	V_3N_5	222.9 amu
b)	tin (iv) fluoride	SnF_4 ($1 \cdot x = +4$; $(-1)(4) = -4$) tin (iv) fluoride	194.7 amu
c)	Copper (ii) phosphate: (Cu^{2+}, PO_4^{3-})	$Cu_3(PO_4)_2$	380.6 amu
d)	ammonium dichromate	$(NH_4)_2Cr_2O_7$ ammonium dichromate	252.1 amu

$10g \cdot \frac{1 mol}{222.9 g}$ → smallest molar mass ⇓ largest moles

3) How many significant figures would the answer to (2.91 + 3.002)*62 have?

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

$(2.91 + 3.002) \times 62$ = 2 sig figs

5.91×62 → answer w/ 2 sig figs

addition/subtraction: least # places after the decimal

multiplication/division: least amount of sig figs

8.2×10^2 — 2 sig figs; 8.0×10^2 — 2 sig figs; 800 — 1 sig fig

Al^{3+} — SO_4^{2-}

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

$Al_2(SO_4)_3$

I. 0.241 mol Al^{3+}
II. 0.459 mol Al^{3+}
III. 0.987 mol $SO4^{2-}$
IV. 0.688 mol $SO4^{2-}$
V. $2.76*10^{23}$ atoms Al
VI. $5.47*10^{24}$ atoms Al
VII. $4.14*10^{23}$ atoms S
VIII. 6.3510^{25} atoms S
IX. $1.66 * 10^{24}$ atoms O
X. $9.32*10^{23}$ atoms O

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

$78.5\,g \cdot \frac{1\,mol\ Al_2(SO_4)_3}{342.15\ g\ Al_2(SO_4)_3} = 0.229\ mol\ Al_2(SO_4)_3$

$0.229\ mol\ Al_2(SO_4)_3 \cdot \frac{2\ mol\ Al^{3+}}{1\ mol\ Al_2(SO_4)_3} = 0.459\ mol\ Al^{3+}$

$.459\ mol\ Al^{3+} \cdot \frac{6.022\times10^{23}\ atoms\ Al^{3+}}{1\ mol\ Al^{3+}} = 2.76\times10^{23}\ atoms\ Al^{3+}$

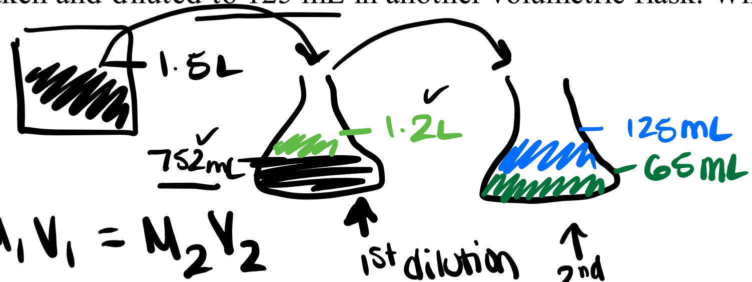
$\cdot \frac{3\ mol\ SO_4^{2-}}{1\ mol\ Al_2(SO_4)} = 0.687\ mol\ SO_4^{2-}$

$.687\ mol\ SO_4^{2-} \cdot \frac{1\ mol\ S}{1\ mol\ SO_4^{2-}} \cdot \frac{6.022\times10^{23}\ atoms\ S}{1\ mol\ S} = 4.14\times10^{23}$

$.687\ mol\ SO_4^{2-} \cdot \frac{4\ mol\ O}{1\ mol\ SO_4} \cdot 6.022\times10^{23}\ atoms = 1.66\times10^{24}$ atoms O

5) 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



$M_1V_1 = M_2V_2$

★ make sure volume units match ★

$M_1 = 8.2\,M$ $\quad V_2 = 1.2\,L$

$V_1 = 752\,mL = .752\,L$ $\quad M_2 = x$

$\frac{8.2\,M\,(.752\,L)}{1.2\,L} = \frac{x\,(1.2\,L)}{1.2\,L}$

$5.139\,M = x = M_2$

$M_2 = 5.139\,M$ $\quad M_3 = x$

$V_2 = 65\,mL$ $\quad V_3 = 125\,mL$

$5.139\,M\,(65\,mL) = 125\,mL \cdot x$

$x = 2.67\,M$

$x = 2.7\,M$

6) Write the ① balanced molecular, ② complete ionic, and ③ net ionic equations for the combination of silver nitrate and sodium chromate. Label the spectator ions (if there are any). What is the ④ sum of moles in the net ionic equation?

① $2AgNO_3(aq) + Na_2CrO_4(aq) \rightarrow Ag_2CrO_4(s) + 2NaNO_3(aq)$

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

③ $2Ag^+(aq) + CrO_4^{2-}(aq) \rightarrow Ag_2CrO_4(s)$

④ $2+1+1 = 4$

7) What is 2.59 in^2/mL in m^2/gal?

a) 52.7 m^2/gal
b) 6.32 m^2/gal
c) 2.84 m^2/gal
d) 249 m^2/gal
e) 4.35 m^2/gal

1 in = 2.54 cm 3.785 L = 1 gal
10^2 cm = 1 m 1 L = 10^3 mL

$$\frac{2.59\ in^2}{mL} \cdot \left(\frac{2.54\ cm}{1\ in}\right)^2 \cdot \left(\frac{1\ m}{10^2\ cm}\right)^2 \cdot \frac{10^3\ mL}{1 L} \cdot \frac{3.785 L}{1\ gal} =$$

$$\frac{2.59\ in^2}{mL} \cdot \frac{6.4516\ cm^2}{1\ in^2} \cdot \frac{1\ m^2}{10^4\ cm^2} \cdot \frac{10^3\ mL}{1 L} \cdot \frac{3.785 L}{1\ gal} = 6.32\ m^2/gal$$

8) Given 2.68 M of strontium phosphate, what are the mols of oxygen in 689 mL?

a) 9.81 mol
b) 1.84 mol
c) 2.43 mol
d) 14.7 mol
e) 7.78 mol

Sr^{2+} PO_4^{3-} → $Sr_3(PO_4)_2$

$$\frac{2.68\ mol\ Sr_3(PO_4)_2}{L} \cdot .689\ L = 1.84652\ mol\ Sr_3(PO_4)_2$$

$$1.84652\ mol\ Sr_3(PO_4)_2 \cdot \frac{8\ mol\ O}{1\ mol\ Sr_3(PO_4)_2} = 14.7\ mol\ O$$

9) 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
S = 32.07
O = 16 (4) = 64 +

136.15 g/mol $CaSO_4$

172.17 g/mol − 136.15 g/mol = 36.02 g/mol

$\frac{36.02 \text{ g/mol}}{18.02 \text{ g/mol } H_2O} = 2$

10) 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 $Ca(OH)_2$?

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

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

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

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

$.2325 \text{ mol } V(OH)_5 \cdot \frac{135.944 g}{mol} = 31.6 g$

11) Using the question 10's chemical reaction, how many mL are left over of the excess reactant?

f) 30mL
g) 90mL
h) 512mL
i) 26mL
j) 410mL

Initial: $.2427 \text{ mol } V(OH)_5 \cdot \frac{2 \text{ mol } VCl_5}{2 \text{ mol } V(OH)_5} = 0.2427 \text{ mol } VCl_5$

Used: $.2325 \text{ mol } V(OH)_5 \cdot \frac{2 \text{ mol } VCl_5}{2 \text{ mol } V(OH)_5} = 0.2325 \text{ mol } VCl_5$

left over

left over + used = initial

.2427 mol − 0.2325 mol = left over

= 0.0102 mol VCl_5 left over

$0.0102 \text{ mol } VCl_5 \cdot \frac{1 L}{0.389 \text{ mol } VCl_5} = .0262 L$

= 26.2 mL

12) Using the information from question 10, if 18.4g of $V(OH)_5$ was produced during the experiment, what is the percent yield?

- a) 58.2%
- b) 24.7%
- c) 52.2%
- d) 171.7%
- e) 71.8%

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

theoretical → based on calculation

$$\% \text{ yield} = \frac{18.4g}{31.6g} \times 100\%$$

$= 58.2\%$

13) Balance and identify the type of reaction, [redacted], oxidizing agent, and reducing agent of each equation:

OIL +++
RIG ---

$N_2O_5 \rightarrow NO_2 + O_2$ decomposition (1 reactant → 2 products)

$2N_2O_5 \rightarrow 4NO_2 + O_2$

N: +5(2) = +10
O: (−2)5 = −10
−10 + X·2 = 0 (charge)

N: +4
O: −2(2) = −4

O: 0

*N: +5 → +4 more negative reduced OA
O: −2 → −2
→ −2 → 0 more +++ oxidized RA

RA & OA = N_2O_5

$S_8 + F_2 \rightarrow SF_4$

$S_8 + 16F_2 \rightarrow 8SF_4$ combination reaction (2 reactants → 1 product)

0 0 S: +4
F: −1(4)

S: 0 → +4 +++ oxidized → RA
F: 0 → −1 ---- reduced → OA

RA: S_8
OA: F_2

$CsI + Cl_2 \rightarrow CsCl + I_2$

$2CsI + Cl_2 \rightarrow 2CsCl + I_2$ Single Displacement

Cs: +1 Cl: 0 Cs: +1 I: 0
I: −1 Cl: −1

OA = Cl_2
RA = CsI

Cl: 0 → −1 ---- reduced OA
I: −1 → 0 +++ oxidized RA

% yields

% yield = actual / theoretical × 100

14. Use the following reactions:

Reaction	% yields
$A_2B + 2C \rightarrow 2AC + B_2$	84%
$B_2 + DE_2 \rightarrow DB_2 + E_2$	46%

2.44 moles

If 2.44 moles of E_2 was produced, how many moles of C did we start with?

started rxn 2

a. 10.9 moles C
b. 6.31 moles C
c. 12.6 moles C
d. 0.91 moles C
e. 3.26 moles C

2.44 moles actually produced

① $\frac{2.44 \text{ mol } E_2}{x} = .46x$

$\frac{2.44 \text{ mol}}{.46} = \frac{.46x}{.46}$

$5.3043 \text{ mol } E_2 = x$

② $5.3043 \text{ mol } E_2 \cdot \frac{1 \text{ mol } B_2}{1 \text{ mol } E_2} = 5.3043 \text{ mol } B_2$ = actual of rxn 1

③ $\frac{5.3043 \text{ mol } B_2}{T} = .84$

$T = 6.3146 \text{ mol } B_2$ theoretically

④ $6.3146 \text{ mol } B_2 \cdot \frac{2 \text{ mol } C}{1 \text{ mol } B_2} = 12.6 \text{ mol } C$

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

180.096 g/mol

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

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

C: $\frac{m_C}{m_T} = \frac{12 \text{ g/mol} \cdot 6}{180.096} \times 100\% = 39.97\% \sim 40\%$

H: $\frac{12 \times 1.008}{180.096} \times 100\% = 6.7\%$

O: $\frac{16 \text{ g/mol} \cdot 6}{180.096} \times 100\% = 53.3\%$

16. How many neutrons, protons, and electrons does $^{130}Te^{2-}$ have?

If charge = 0, # p = # e

-2 - 2 more e than p

#52 ↑ #protons

52p +2 = 54e⁻

a. 130 protons, 130 neutrons, 130 electrons
b. 52 protons, 130 neutrons, 52 electrons
c. 52 protons, 52 neutrons, 52 electrons
d. 52 protons, 78 neutrons, 54 electrons
e. 54 protons, 78 neutrons, 54 electrons

130 (mass number) = # neutrons + # protons → 130 - 52 = 78 neutrons

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

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

→ equivalence point

① find amount of mol reactant you know
② convert to the one you don't (mol to mol)
③ any final conversions

① $\frac{.8291 \text{ mol HCl}}{L} \cdot .07259L$ ② $= 0.0602 \text{ mol HCl} \cdot \frac{1 \text{ mol } Sr(OH)_2}{2 \text{ mol HCl}} = 0.030 \text{ mol } Sr(OH)_2$

③ $.030 \text{ mol } Sr(OH)_2 \cdot \frac{1L}{.6143 \text{ mol } Sr(OH)_2} = 0.04899L \cdot \frac{10^3}{1L} = 48.99 \text{ mL}$

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

$2M + 3S \rightarrow M_2S_3$

1.62g M

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

$\frac{1.62 \text{ g M}}{0.0599 \text{ mol M}} = 27.05 \text{ g/mol}$ ✓ Al

aluminum sulfide

$m_{Al} = 26.98$

19) If 26.13g of CO_2 and 14.25g of H_2O were produced from a combustion reaction, what is the empirical formula for the C_xH_y molecule burned?

a) CH_4
b) C_4H_6
c) C_2H_4
d) C_4H_{10}
e) C_3H_8

2

$C_xH_y + O_2 \rightarrow CO_2 + H_2O$ (C goes to CO_2; H goes to H_2O)

$26.13 g\ CO_2 \cdot \frac{1 mol\ CO_2}{44 g\ CO_2} \cdot \frac{1 mol\ C}{1 mol\ CO_2} = 0.59386\ mol\ C$

$14.25 g\ H_2O \cdot \frac{1 mol\ H_2O}{18 g\ H_2O} \cdot \frac{2 mol\ H}{1 mol\ H_2O} = 1.58333\ mol\ H$

$\frac{.59386\ mol\ C}{.59386\ mol\ C} = 1\ mol\ C$ ×3 → 3

$\frac{1.5833\ mol\ H}{.59386} = 2.667\ mol\ H$ ×3 – 7.998 → 8

C_3H_8

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; $C_6H_{12}O_6$

assume 100g

$40 g\ C \cdot \frac{1 mol\ C}{12 g\ C} = \frac{3.33\ mol\ C}{3.33}$ C_1

$6.71 g\ H \cdot \frac{1 mol\ H}{1.008 g\ H} = \frac{6.6567\ mol\ H}{3.33}$ H_2

$53.3 g\ O \cdot \frac{1 mol\ O}{16 g\ O} = \frac{3.33\ mol\ O}{3.33}$ O_1

empirical: CH_2O $M_e = 30.016 g$

$\frac{240.24}{30.016} = 8 \rightarrow C_8H_{16}O_8$ (molecular

★ $[Na^+]$ → $\frac{mol}{L}$

204.3 mL of 0.534 M Na_3PO_4

414.1 mL of 1.12 M Na_2S

$Na_3PO_4 + Na_2S \rightarrow X$

Question from HW

① total mol_{Na} = $Na^+ mol_{Na_3PO_4}$ + $Na^+ mol_{Na_2S}$

$\frac{0.534 \text{ mol } Na_3PO_4}{L} \cdot .2043 L \cdot \frac{3 \text{ mol Na}}{1 \text{ mol } Na_3PO_4} = 0.3273 \text{ mol Na}$

$\frac{1.12 \text{ Mol } Na_2S}{L} \cdot .4141 L \cdot \frac{2 \text{ mol Na}}{Na_2S} = 0.9276 \text{ mol Na}$

$= 1.2549 \text{ mol } Na^+$

② volume

total V = $V_{Na_3PO_4} + V_{Na_2S}$

.2043L .4141L

$= 0.6184 L$

③ concentration

$= \frac{1.2549 \text{ mol } Na^+}{0.6184 \text{ L}}$

$= 2.03 \text{ M } Na^+$

Ox. number

halide, group 2A

$SnF_4 + 2CaSO_4 \rightarrow Sn(SO_4)_2 + 2CaF_2$

- SnF_4: +4, (−1)4
- $CaSO_4$: +2, +6, (−2)4 → −8
- $Sn(SO_4)_2$: +4, +6, −2
- CaF_2: +2, −1

$x + -4 = 0$
$x = +4$

$+2 + x + (-2 \cdot 4) = 0$
$+2 + x \quad -8$
$x = +6$

* group 1A → +1
  2A → +2

* transition metals change
  Ag → +1
  Zn → +2
  Cu → +1

* non metals
  O → −2
  F → −1 (all halides group 7A)
  N → −3