Final Exam General Chemistry I (CHEM 201) Form A 12/10/18 8 am MWF Dr. Hahn Exam # _____

Name Key (print) Name _____ (sign)

Please show work for partial credit on the Long Answers and in some of the Short Answer Questions. (2 pts print & sign)

Avogadro's number = 6.022×10^{23} = 1 mole = Formula Weight or Atomic Weight, Molarity (M) = # moles solute /Liter solution, mole = grams / formula weight or atomic weight, $^{o}C + 273.15 = K$

760 mm Hg = 1 atm, $PV = nRT$, $R = 0.08206$ (L atm)/(mol K), $P_1V_1 / P_2V_2 = T_1 / T_2$

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (No Partial Credit for MC) (3 pts per question, 27 pts pts total)

1) How many oxygen atoms are there in one formula unit of $Al_2(SO_4)_3$? 1) A

A) 12 B) 3 C) 4 D) 7

2) We generally report a measurement by recording all of the certain digits plus ____ uncertain digit(s). 2) A

A) one B) two C) no D) three

3) What is the specific heat capacity (S) of zinc if it requires 146J (q) to raise the temperature of 15 grams of zinc by 25°C (ΔT) ? (q = S * mass * Δ T) 3) A

$146 = (S)(15g)(25°C)$

$S = (146)/(15)(25)$

A) 0.39 J/g°C B) 2.5 J/g°C C) 0.60 J/g°C D) none of these

4) Chlorous acid, $HClO_2$, contains what percent hydrogen by mass? (FW = 68.46) 4) D

A) 1.92% B) 23.4% C) 25.0% D) 1.47%

5) Express 0.000779 in scientific notation. 5) A

A) 7.79×10^{-4} B) 7.79×10^{4} C) 7.79×10^{2} D) 779×10^{-6}

6) Consider the following process: 6) C

	ΔH (kJ/mol)
$3B \rightarrow 2C + D$ $B \rightarrow C + 2C$	- 125
$A \rightarrow 2B$	300
$D \rightarrow E + A$	-350

Calculate ΔH for: $B \rightarrow E + 2C$ -175

A) 525 kJ/mol B) 325 kJ/mol C) -175 kJ/mol D) none of these

7) Which of the following ions will form an insoluble sulfate ? 7) B

A) K^+ B) Ca^{2+} C) S^{-2} D) Cl^{-1}

FW= 48.49

8) The empirical formula of a group of compounds is CHCl. Lindane, a powerful insecticide, is a member of this group. The molar mass of lindane is 290.8 g/mol. How many atoms of carbon does a molecule of lindane contain? 8) B

A) 3 B) 6 C) 2 D) 4

9) Which metals form cations with varying positive charges? 9) B

A) Group 1 metals
B) transition metals
C) Group 2 metals
D) Group 3 metals

Part II: Short Answers (38 pts) Show work on all questions for partial and full credit even on questions which do not specify.

1. Given the following list of chemical formulas, circle all which are covalent compounds (8 pts total, 1 pt each)

Na_2O CO_2 Sr_3P_2 Ba_3N_2 NO_2 Li_2S PCl_3 $CaCl_2$

2. For the following, write out the formula for the neutral compound. Explain or show work for charges on elements and explain how you came up with the formula. (6 pts)

Ba & NO_3^- $Ba(NO_3)_2$

Gp. 2 +2

Ba^{+2} NO_3^-

3. Complete and balance the following reaction. (note solubility) (8 pts, 3 pts each blank, 2 pt balance)

$2\,AgNO_3 + Na_2SO_4 \rightarrow$ $Ag_2SO_4(s)$ + $2\,NaNO_3(aq)$

4. Give the oxidation state in the following reagents. Explain or show work for each. (6 pts, 2 pt each)

a. O_2 Zero element b. O in BaO -2 Gp. 6 $-8 = -2$ c N in NO_2 $+4$ $N + 2(-2) = \text{zero}$ $N = +4$

5 Set up the solution to the following by filling in the blank with the letter of the numbers. Do not actually fill in the equation or solve for the answer. For a gas at (A) 273.5 K, (B) 2.7 Liter, at (C) 1.05 atm if the temperature is raised to (D) 300.2 K at (E) 1.5 Liter, what is the (F) new pressure ? (if completing problem, you would be using the equation: $P_1V_1 / P_2V_2 = T_1 / T_2$) (6 pts, 1 pt each blank)

$P_1 =$ C 1.05 atm $V_1 =$ B 2.7 $T_1 =$ A 273.5 K $P_2 =$ F ? $V_2 =$ E 1.5 l $T_2 =$ D 300.2 K

6 For the reaction shown complete the following equation for $\Delta H°_{rxn}$ for this reaction **by filling in the blank with the letters**. (4 pts, 1 pt each blank)

$$\Delta H° = \sum n_p \Delta H°_f(\text{products}) - \sum n_r \Delta H°_f(\text{reactants})$$

$NaNO_3(s) + H_2SO_4(l) \Rightarrow NaHSO_4(s) + HNO_3(g)$

(A) $\Delta H°_f[NaNO_3(s)] = -467.8$ kJ/mol; (B) $\Delta H°_f[NaHSO_4(s)] = -1125.5$ kJ/mol;

(C) $\Delta H°_f[H_2SO_4(l)] = -814.0$ kJ/mol; (D) $\Delta H°_f[HNO_3(g)] = -135.1$ kJ/mol.

$\Delta H°_{rxn} = \{\Delta H°_f$ B $] + \Delta H°_f$ D $]\} - \{(\Delta H°_f$ A $) + (\Delta H°_f$ C $)\}$

Part III: Long Answer (35 pts) Show work for partial credit and full credit even on questions which do not specify. Avogadro's number = 6.022×10^{23} = 1 mole = Formula Weight or Atomic Weight, Molarity (M) = # moles solute / Liter solution, mole = grams / formula weight or atomic weight

1. Given the following reaction, complete the following.(23 pts)

$3\ SrCl_2\ (aq) + 2\ Li_3PO_4\ (aq) \rightarrow Sr_3(PO_4)_2\ (s) + 6\ LiCl\ (aq)$

a. If you start the reaction with 35.2 grams of $SrCl_2$, how many grams of $Sr_3(PO_4)_2$ (s) will you make? (14 pts) {FW = 158.52 g/mol [$SrCl_2$] FW = 452.40 g/mol [$Sr_3(PO_4)_2$]}

$$35.2\ g\ SrCl_2 \times \frac{1\ mol\ SrCl_2}{158.52\ g\ SrCl_2} \times \frac{1\ mol\ Sr_3(PO_4)_2}{3\ mol\ SrCl_2} \times \frac{452.4\ g\ Sr_3(PO_4)_2}{1\ mol\ Sr_3(PO_4)_2} = 33.5\ g\ Sr_3(PO_4)_2$$

b. How many atoms of phosphorus (P) in $Sr_3(PO_4)_2$ will you make ? (5 pts)

$$35.2\ g\ SrCl_2 \times \frac{1\ mol\ SrCl_2}{158.52\ g\ SrCl_2} \times \frac{1\ mol\ Sr_3(PO_4)_2}{3\ mol\ SrCl_2} \times \frac{2\ mol\ P}{1\ mol\ Sr_3(PO_4)_2} \times \frac{6.022 \times 10^{23}}{1\ mol} = 8.91 \times 10^{2}\ atoms$$

c. If you do the reaction with 6 moles of $SrCl_2$ & 2 moles of Li_3PO_4, which is the **limiting reagent** ?

[($SrCl_2$) or ((Li_3PO_4))] (circle one) (4 pts)

2a. If you have 239.4 grams of NH_4Cl (FW = 53.50 g/mol) , how many moles is that ? Show work. (6 pts)

$$239.4\ g\ NH_4Cl \times \frac{1\ mol\ NH_4Cl}{53.50\ g\ NH_4Cl} = 4.475\ mol\ NH_4Cl$$

b. If you dissolve that amount to make up 582.2 mL of solution, what is the molarity ? (show work) (6 pts)

$$582.2\ mL \times \frac{1\ L\ Soln.}{1000\ mL} = 0.5822\ L$$

$$\frac{4.475\ mol\ NH_4Cl}{0.5822\ L} = 7.686\ M$$

Final Exam General Chemistry I (CHEM 201) Form B 12/10/18 8 am MWF Dr. Hahn Exam # _____

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760 mm Hg = 1 atm, $PV = nRT$, $R = 0.08206$ (L atm)/(mol K), $P_1V_1 / P_2V_2 = T_1 / T_2$ pink

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (No Partial Credit for MC) (3 pts per question, 27 pts pts total)

1) Consider the following process: 1) B

	ΔH (kJ/mol)
$3B \rightarrow 2C + D$	- 125
$A \rightarrow 2B$	300
$D \rightarrow E + A$	-350

Calculate ΔH for: $B \rightarrow E + 2C$

A) 525 kJ/mol (B) -175 kJ/mol C) 325 kJ/mol D) none of these

2) Which metals form cations with varying positive charges? 2) B

A) Group 2 metals (B) transition metals

C) Group 3 metals D) Group 1 metals

3) What is the specific heat capacity (S) of zinc if it requires 146J (q) to raise the temperature of 15 grams of zinc by 25°C (ΔT) ? ($q = S * mass * \Delta T$) 3) A

(A) 0.39 J/g°C B) 0.60 J/g°C C) 2.5 J/g°C D) none of these

4) Express 0.000779 in scientific notation. 4) D

A) 779×10^{-6} B) 7.79×10^{2} C) 7.79×10^{4} (D) 7.79×10^{-4}

5) The empirical formula of a group of compounds is CHCl. Lindane, a powerful insecticide, is a member of this group. The molar mass of lindane is 290.8 g/mol. How many atoms of carbon does a molecule of lindane contain? FW = 48.47 5) D

A) 2 B) 3 C) 4 (D) 6

6) How many oxygen atoms are there in one formula unit of $Al_2(SO_4)_3$? 6) A

(A) 12 B) 4 C) 7 D) 3

7) Which of the following ions will form an insoluble sulfate ? 7) A

(A) Ca^{2+} B) Cl^{-1} C) S^{-2} D) K^{+}

8) We generally report a measurement by recording all of the certain digits plus ____ uncertain digit(s). 8) B

A) three (B) one C) no D) two

9) Chlorous acid, $HClO_2$, contains what percent hydrogen by mass? 9) B

A) 25.0% (B) 1.47% C) 1.92% D) 23.4%

FW = 68.46

Part II: Short Answers (38 pts) Show work on all questions for partial and full credit even on questions which do not specify.

1. Given the following list of chemical formulas, circle all which are ionic compounds (8 pts total, 1 pt each)

NO_2 Li_2S PCl_3 $CaCl_2$ Na_2O CO_2 Sr_3P_2 Ba_3N_2

2. For the following, write out the formula for the neutral compound. Explain or show work for charges on elements and explain how you came up with the formula. (6 pts)

Ca & PO_4^{-3} $Ca_3(PO_4)_2$ Ca gp. 2 (+2) Ca^{+2} / PO_4^{-3}

3. Complete and balance the following reaction. (note solubility) (8 pts, 3 pts each blank, 2 pt balance)

$3\ Li_2CO_3 + 2\ AlCl_3 \rightarrow$ 6 $LiCl$ + $Al_2(CO_3)_3$

4. Give the oxidation state in the following reagents. Explain or show work for each. (6 pts, 2 pt each)

a. N_2 Zero element

b. N in Ba_3N_2 -3 gp. 5 − 8 = −3

c S in SO_4^{-2} $+6$ $5 + 4(-2) = -2$ $5 = -2 + 8 = +6$

5 Set up the solution to the following by filling in the blank with the letter of the numbers. Do not actually fill in the equation or solve for the answer. For a gas at (A) 380 K, (B) 1.35 Liter, at (C) 0.987 atm if the temperature is raised to (D) 300.2 K at (E) 1.01 atm, what is the (F) new volume ? (if completing problem, you would be using the equation: $P_1V_1 / P_2V_2 = T_1 / T_2$) (6 pts, 1 pt each blank)

P_1 = C 0.987 atm V_1 = B 1.35 l T_1 = A 380k P_2 = E 1.01 atm V_2 = F ? T_2 = D 300.2 K

6 For the reaction shown complete the following equation for $\Delta H°_{rxn}$ for this reaction **by filling in the blank with the letters**. (4 pts, 1 pt each blank)

$$\Delta H° = \sum n_p \Delta H°_f (\text{products}) - \sum n_r \Delta H°_f (\text{reactants})$$

$NaHSO_4(s) + HNO_3(g) \rightarrow NaNO_3(s) + H_2SO_4(l)$

(A) $\Delta H°_f[NaNO_3(s)] = -467.8$ kJ/mol; (B) $\Delta H°_f[NaHSO_4(s)] = -1125.5$ kJ/mol;

(C) $\Delta H°_f[H_2SO_4(l)] = -814.0$ kJ/mol; (D) $\Delta H°_f[HNO_3(g)] = -135.1$ kJ/mol.

$\Delta H°_{rxn} = \{\Delta H°_f$ A $]+ \Delta H°_f$ C $]\} - \{(\Delta H°_f$ B $) + (\Delta H°_f$ D $)\}$

Part III: Long Answer (35 pts) Show work for partial credit and full credit even on questions which do not specify. Avogadro's number = 6.022×10^{23} = 1 mole = Formula Weight or Atomic Weight, Molarity (M) = # moles solute / Liter solution, mole = grams / formula weight or atomic weight

1. Given the following reaction, complete the following.(23 pts)

$4\ Fe\ (s) + 3\ O_2\ (g) \rightarrow 2\ Fe_2O_3\ (s)$

a. If you start the reaction with 35.2 grams of Fe(s), how many grams of Fe_2O_3 (s) will you make ? (14 pts) [FW Fe = 55.85 g/mol] [FW Fe_2O_3 = 159.70 g/mol]

$$35.2\text{ g Fe} \times \frac{1\text{ mol Fe}}{55.85\text{ g Fe}} \times \frac{2\text{ mol } Fe_2O_3}{4\text{ mol Fe}} \times \frac{159.70\text{ g}}{1\text{ mol } Fe_2O_3} = 50.3\text{ g } Fe_2O_3$$

b. How many atoms of iron (Fe) in Fe_2O_3 will you make ? (5 pts)

$$35.2\text{ g Fe} \times \frac{1\text{ mol Fe}}{55.85\text{ g Fe}} \times \frac{2\text{ mol } Fe_2O_3}{4\text{ mol Fe}} \times \frac{2\text{ mol Fe}}{1\text{ mol } Fe_2O_3} \times \frac{6.022 \times 10^{23}\text{ Fe atoms}}{1\text{ mol Fe}} =$$

3.80×10^{23} atoms Fe

c. If you do the reaction with 2 moles of reagent Fe , and 6 moles of reagent O_2, which is the limiting reagent ?

[(Fe) or (O_2)] (circle one) (4 pts)

2a. If you have 78.2 grams of NH_4Cl , (FW = 53.50 g/mol) how many moles is that ? Show work. (6 pts)

$$78.2\text{ g } NH_4Cl \times \frac{1\text{ mol } NH_4Cl}{53.50\text{ g } NH_4Cl} = 1.46\text{ mol } NH_4Cl$$

a. If you dissolve that amount to make up 899.25 mL of solution, what is the molarity ? (show work) (6 pts)

$$899.25\text{ ml} \times \frac{1\text{ l}}{1000\text{ ml}} = 0.89925$$

$$1.46\text{ mol} / 0.89925\text{ l} = 1.62\text{ M}$$