CHEMISTRY 1100/1110 Spring 09 Exam 1

USE PEN ONLY

___Key_____(PRINT) **_____**
LAST NAME, FIRST NAME **SECTION**

_____(RIN)

1. - 18_____(72pts)

4. _____(28pts)

_____(Total)

SHOW ALL WORK!

All essay questions must be answered with complete sentences. All calculations must be clearly shown the individual steps and with units and their cancellations in at least one step of the problem. Answers must be written with the proper number of significant figures. Only exams written in ink are eligible for a re-grade. Academic Integrity is expected of everyone and anyone caught cheating will receive an F in the course.

1-18._____ **_____**

Print Initials

(4pts for each question, all or nothing, fill in your answers for questions 1-18 with a Number 2 pencil on the Scantron Answer Sheet)

1. A compound is found to consist of 34.9% sodium, 16.4% boron and 48.6% oxygen.
Its simplest formula is

Molar Masses

B	**10.8 g/mol**
Na	**23.0 g/mol**
O	**16.0 g/mol**

(A) $NaBO_2$ (B) $NaBO_3$ (C) $Na_2B_4O_7$ (D) Na_3BO_3 (E) Na_3BO_4

2. A solution containing 70.0% HF by mass has a density of 1.25 g/mL. Its molarity, with respect to HF (Molar Mass: 20.0 g/mol) is

(A) 28.0 M (B) 35.5 M (C) 43.8 M (D) 84.3 M

3. Calcium chloride is used to melt ice and snow on roads and sidewalks and to remove water from organic liquids. Calculate the molarity of a solution prepared by diluting 165 mL of 0.688 M calcium chloride to 925.0 mL.

(A) 3.86 M (B) 0.743 M (C) 0.222 M (D) 0.123 M (E) 0.114 M

4. When 24.3 g of magnesium is burned in 32.0 g of oxygen, which reactant, if any, will be in excess? The product is MgO

Molar Masses

Mg	**24.3 g/mol**
O	**16.0 g/mol**

(A) O_2 (B) Mg (C) neither reactant (D) both reactants

5. Calculate *K* in terms of molar concentration for the reaction at a particular temperature

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

when the equilibrium concentrations are:
$N_2 = 0.060$ M, $H_2 = 0.040$ M, $NH_3 = 0.20$ M.

(A) 1.0×10^4 (B) 5.2×10^4 (C) 8.3×10^1 (D) 1.7×10^1

6. HCl is a strong acid. What is the pH of 300 mL of 0.0035 M HCl?

(A) 3.0 (B) 2.2 (C) 3.5 (D) 2.5

7. The oxidation numbers of P, S and Cl in $H_2PO_2^-$, H_2S, and $KClO_4$ are, respectively

(A) -1, -1, +3 (B) +1, -2, +7 (C) +1, +2, +7 (D) -1, -2, +7 (D) -1, -2, +3

8. A 20.0-mL sample of 0.30 *M* HBr is titrated with 0.15 *M* NaOH. What is the pH of the solution after 40.3 mL of NaOH have been added to the acid?

(A) 2.95 (B) 3.13 (C) 10.87 (D) 11.05 (E) 13.14

9. The percent by mass of oxygen in $Ca(NO_3)_2$ is

Atomic Molar Masses	
Ca	40.1 g·mol^{-1}
N	14.0 g·mol^{-1}
O	16.0 g·mol^{-1}

(A) $\frac{16.0}{70.1} \times 100$

(B) $\frac{96.0}{102.1} \times 100$

(C) $\frac{96.0}{164.1} \times 100$

(D) $\frac{48.0}{102.1} \times 100$

(E) $\frac{48.0}{164.1} \times 100$

10. The number of atoms in 9.0 g of aluminum is the same as the number of atoms in

Atomic Molar Masses	
Al	27.0 g·mol^{-1}
Mg	24.3 g·mol^{-1}

(A) 8.1 g of magnesium. (D) 18.0 g of magnesium.

(B) 9.0 g of magnesium. (E) 24.3 g of magnesium.

(C) 12.15 g of magnesium.

11. How many moles of pure NaOH must be used to prepare a 10 L of a solution that has a pH of 13?

(A) 1.0 (B) 0.10 (C) 0.010 (D) 0.0010

12. In the chemical reaction,

$$Zn_{(s)} + CuSO_{4(aq)} \rightarrow ZnSO_{4(aq)} + Cu_{(s)},$$

(A) metallic zinc is the reducing agent.

(B) metallic zinc in reduced.

(C) copper ion is oxidized.

(D) sulfate ion is the oxidizing agent.

13. In the process of oxidizing Fe^{2+} to Fe^{3+}, $Cr_2O_7^{2-}$ is reduced to Cr^{3+}. How many moles of Fe^{2+} are oxidized by one mole of $Cr_2O_7^{2-}$?

(A) 1 (B) 3 (C) 4 (D) 6

14. A 5.00 g sample of a metal reacts with 4.00 g of oxygen gas, O_2, to form an oxide with a formula MO. What is the atomic molar mass of the metal?

Atomic Molar Masses	
O	16.0 g·mol^{-1}

(A) 10.0 (B) 16.0 (C) <u>20.0</u> (D) 40.0 (E) 80.0

15. What is the molarity of a solution containing 11.7 g of NaCl in 400 mL of solution?

Molar Mass	
NaCl	58.5 g·mol^{-1}

(A) 0.0290 M (C) 2.92 M

(B) <u>0.500 M</u> (D) 5.00 M

16. The total concentration of ions in a 0.5 M Na_2SO_4 is

(A) 0.5 M (B) 1.0 M (C) <u>1.5 M</u> (D) 3.5 M

17. A 0.10 M C_6H_5COOH solution has a pH of 2.59. What is the K_a of this acid?

(A) 6.6×10^{-6} (C) 2.6×10^{-3}

(B) <u>6.6×10^{-5}</u> (D) 2.6×10^{-2}

18. Balance the net ionic equation for the reaction

$$? \text{ Al} + ? \text{ Cu}^{2+} \rightarrow ? \text{ Al}^{3+} + ? \text{ Cu}$$

using no fractional coefficients. The net charge on each side of the balanced equation is

(A) 0 (B) +2 (C) +3 (D) <u>+6</u> (E) +5

4._____ (28pts) _____

Print Initials

A. (7pts) One liter of a 0.100 M solution of HNO_3 would be neutralized by what volume of 0.400 M $Ba(OH)_2$?

HNO_3 is a strong acid so 1L of 0.100 M HNO_3 yields 0.100 M H_3O^+

Need 0.100 moles of OH^- so we need 0.0500 moles of $Ba(OH)_2$

$V[Ba(OH)_2]$ = 0.0500 moles / (0.400 moles/liter) = 0.125 L

B. (7pts) There are 3 isotopes of Mg (magnesium). Determine the average atomic mass.

Isotope	Mass (g/mole)	% Abundance
24	23.993	78.60
25	24.994	10.11
26	25.991	11.29

Av Mass Mg =

[(0.7860) (23.993) + (0.1011)(24.994) + (0.1129)(25.991)] = 24.32 g

(If you used the typo error mass of 24.320 g/mole for isotope 24 you would have gotten 24.58 g/mole and full credit.)

C. (7pts) A 6.16 g sample of CCl_4 reacted with excess oxidizing agent to form 3.64 g of $COCl_2$ as the only carbon-containing compound. What was the percentage yield of the process? CCl_4 (154 g/mole) $COCl_2$ (99 g/mole)

6.16 g CCl_4 (1 mole CCl_4/154 g CCl_4) = 4.00 x 10^{-2} mole CCl_4

100% yield gives 4.00 x 10^{-2} mole $COCl_2$ or 3.96 g $COCl_2$

(3.64 g/ 3.96 g) x 100% = 91.9%

(7pts) The following reaction takes place in acidic solution

$Cr_2O_7^{2-}$ (aq) + H_2SO_3 (aq) → Cr^{3+} (aq) + HSO_4^- (aq)

Break into two half-reactions and balance each half-reaction.

Oxidation ½ rxn **Reduction ½ rxn**

$H_2O + H_2SO_3$ (aq) → HSO_4^- (aq) + $3H^+$(aq) + $2e^-$ (oxidation)

(reduction) $6e^- + 14\ H^+$ (aq) + $Cr_2O_7^{2-}$ (aq) → 2 Cr^{3+} (aq) + 7 H_2O

Equations and Constants

$N_A = 6.022 \times 10^{23}$ $R = 8.314$ J/mol K $= 0.08206$ L atm/mol K

$m_e = 9.10939 \times 10^{-31}$ kg $c = 2.998 \times 10^{8}$ m/sec $h = 6.626 \times 10^{-34}$ J s

$R_{Rydberg} = 1.096776 \times 10^{7}\ m^{-1}$

1 atm = 760 mmHg = 760 torr = 1.01325 bar = 1.01325×10^{5} Pa

$PV = nRT$ $P_A = \chi_A P_{Total}$ $u_{rms} = \sqrt{\frac{3RT}{MM}}$

$q = mc\Delta T$ $\Delta E = q + w$ $dw = -pdV$ $\Delta H = \Delta E + P\Delta V$

$\Delta H^o_{rxn} = \Sigma m \Delta H^o_{f\,(products)} - \Sigma n \Delta H^o_{f\,(reactants)}$

$E = h\nu$ $c = \nu\lambda$

$\lambda = \frac{h}{mu}$ $p = \frac{h}{\lambda}$ $E_n = -(2.18 \times 10^{-18}\text{J})\ 1/n^2$ (Hydrogen Atom)

$KE(\text{electron}) = h\nu - \Phi$ $KE = \frac{1}{2}mu^2$

$\frac{1}{\lambda} = R_{Rydberg}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ (where $n_2 > n_1$)

$pH = -\log[H^+]$ $pOH = -\log[OH^-]$ $pH + pOH = 14$ $K_a \cdot K_b = K_w$

$K_w = 1.0 \times 10^{-14}$ (at 25°C) $M_1V_1 = M_2V_2$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$