Chem 210 – Exam 3a *Name:* _____
Spring 2009

Chemistry 210 Exam 3

Be sure to put your name on each page. This page can be removed from your exam so that you will have a Periodic Table handy throughout the exam, it does not need to be turned in. Show all your work for problems which require any sort of calculation, no credit will be given for answers without work shown. If you have shown a significant amount of work or multiple drawings for a problem, draw a box around what you consider your final answer.

Avogadro's Number = 6.022×10^{23} $^{\text{units}}/_{\text{mol}}$
$32.00^{\circ}F = 0.000^{\circ}C = 273.15K$
Density of Water = $1.000\ ^{g}/_{mL}$
$R = 0.08206\ ^{L \cdot atm}/_{mol \cdot K} = 8.314\ ^{J}/_{mol \cdot K}$
$PV=nRT$
$\Delta T_{fp/bp} = k_{fp/bp} \cdot m \cdot i$
For water: $k_{fp} = -1.86\ ^{^{\circ}C}/_{m}$
$k_{bp} = 0.512\ ^{^{\circ}C}/_{m}$
$P_1 = X_1 P_1^{\circ}$
$\Pi = MRTi$
$C_1V_1 = C_2V_2$

Quadratic formula:

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

Integrated Rate Laws:

$\ln[A]_t = -kt + \ln[A]_o$
$1/[A]_t = kt + 1/[A]_o$
$[A]_t = -kt + [A]_o$

$k = Ae^{-Ea/RT}$

$$\ln(k) = \left(\frac{-E_a}{R}\right)\left(\frac{1}{T}\right) + \ln(A)$$

$$\ln\left(\frac{k_1}{k_2}\right) = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$pH = pK_a + \log\left(\frac{[\text{conjugate base}]}{[\text{conjugate acid}]}\right)$$

$E_{cell} = E^{\circ}_{cell} - {}^{RT}/_{nF}\ ln Q$
$E^{\circ}_{cell} = {}^{RT}/_{nF}\ ln K^{\circ}$
$K^{\circ} = e^{\wedge}({}^{nF}/_{RT}\ E^{\circ}_{cell})$
$F = 96485\ ^{J}/_{V \cdot mol\ of\ electrons}$
$\Delta G^{\circ} = \Delta H^{\circ}_{system} - T\Delta S^{\circ}_{system}$
$\Delta G^{\circ} = -nFE^{\circ}_{cell} = -RT ln K^{\circ}$
$\Delta G = \Delta G^{\circ} + RT ln Q$
$F = 96485\ ^{C}/_{mol\ electrons}$
$1A = 1\ C / sec$

1 **H** 1.0079																	2 **He** 4.0026
3 **Li** 6.941	4 **Be** 9.0122											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305											13 **Al** 26.982	14 **Si** 28.086	15 **P** 30.974	16 **S** 32.066	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.88	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.847	27 **Co** 58.933	28 **Ni** 58.69	29 **Cu** 63.546	30 **Zn** 65.39	31 **Ga** 69.723	32 **Ge** 72.61	33 **As** 74.922	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.80
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.03	89 **Ac** 227.03	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 (269)	111 (272)	112 (277)		114		116		

58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.94	70 **Yb** 173.04	71 **Lu** 174.97
90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (258)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

Score

1. Complete each row of the following tables for aqueous solutions at 25ºC (4pts per box):

$[H_3O^+]$	$[OH^-]$	pH	pOH	Acidic, Basic or Neutral?
$6.81x10^{-8}$				
			4.993	

Conjugate Acid	K_a @25ºC	Conjugate Base	K_b @25ºC
H_3O^+			$1.0x10^{-14}$
	$6.2x10^{-8}$	SO_3^{2-}	

2. Explain why each of the following ***does not*** result in an effective buffer? (15pts)

1.24mol NH_4NO_3(aq) + 0.03mol NH_3(aq)

0.38mol HI(aq) + 0.38mol NaI(aq)

1.28mol Na_2CO_3(aq) + 0.64mol NaOH(aq)

3. How much 0.461M NaOH(aq) must be added to 25.00mL of 0.399M HCl(aq) to reach the equivalence point? What is the pH of this solution at the equivalence point? (10pts)

Score

4. Describe how you would prepare 1.00L of a 1.00M buffer at pH 6.70. You have the following reagents available: Nitrous acid (HNO_2, $K_a = 7.2x10^{-4}$), Hydrosulfuric acid (H_2S, $K_a = 1.1x10^{-7}$), Boric acid (H_3BO_3, $K_a = 5.8x10^{-10}$), NaOH(s), distilled/deionized water. (15pts)

5. What is the K_b of a base if 500.0mL of a solution containing 0.261 mol of the base and 0.216 mol of its conjugate acid has a pH of 5.761? Over what pH range would this conjugate acid/ conjugate base pair make an effective buffer? (12pts)

6. You are going to use a titration to determine the concentration of an unknown selenic acid solution (H_2SeO_4, $pK_a = -7$). The base you have chosen to use is 1.031M sodium hydroxide.
   a. Write out the chemical equations for the step-wise deprotonation/neutralization of selenic acid and the overall/net chemical reaction. (6pts)

   b. Sketch the titration curve you would expect for this titration, labeling all equivalence points and selenic acid-based species present in each portion of the curve. (5pts)

Score

(#6 continued...)

c. Someone left your pH probe laying on the bench and it has dried out. After a short search, you have found the following three visual indicators: Thymolphthalein (TP, endpoint pH range = 9.5-10.5); Bromothymol Blue (BTB, endpoint pH range = 6.0-7.5); 2,4-dinitrophenol (DNP, endpoint pH range = 2.8-4.0). Which of these visual indicators would be useful in your titration? Explain your choices. (10pts)

d. As you are about to start your titration, a package arrives with a new pH probe, so you decide to use the pH probe to monitor your titration. You find that 50.00mL of selenic acid requires 46.93mL of sodium hydroxide to reach the second equivalence point. What is the concentration of the selenic acid solution? (10pts)

e. How much sodium hydroxide solution was required to reach the first equivalence point in part "d"? Explain your answer. (4pts)

7. Which solution has a higher concentration of silver(I) ions? Explain your answer. (15pts)

Saturated silver(I) chloride, $K_{sp}(AgCl) = 1.77x10^{-10}$

Saturated silver(I) phosphate, $K_{sp}(Ag_3PO_4) = 8.89x10^{-17}$

Score