## **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.

$$\begin{split} &\text{Avogadro's Number} = 6.022 \text{x} 10^{23 \text{ units}}/_{\text{mol}} \\ &32.00^{\circ}\text{F} = 0.000^{\circ}\text{C} = 273.15 \text{K} \\ &\text{Density of Water} = 1.000^{\text{g}}/_{\text{mL}} \\ &\text{R} = 0.08206^{\frac{1}{\text{c-atm}}}/_{\text{mol-K}} = 8.314^{\frac{1}{3}}/_{\text{mol-K}} \\ &\text{PV=nRT} \\ &\Delta T_{fp/bp} = k_{fp/bp} \bullet \text{m} \bullet \text{i} \\ &\text{For water, } k_{fp} = -1.86^{\circ\text{C}}/_{\text{m}} \text{ ; } k_{bp} = 0.52^{\circ\text{C}}/_{\text{m}} \\ &P_1 = X_1 P_1^{\circ} \\ &P = cRTi \\ &C_1 V_1 = C_2 V_2 \\ &\text{Quadratic formula:} \\ &x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \end{split}$$

$$\begin{split} &\text{Integrated Rate Laws:} \\ &0^{\text{th}} \text{ order } \quad [A]_t = -kt + [A]_o \\ &1^{\text{st}} \text{ order } \quad \ln[A]_t = -kt + \ln[A]_o \\ &2^{\text{nd}} \text{ order } \quad 1/[A]_t = kt + 1/[A]_o \\ &k = Ae^{-Ea/RT} \\ &\ln(k) = \left(\frac{-E_a}{R}\right) \left(\frac{1}{T}\right) + \ln(A) \\ &\ln\left(\frac{k_1}{k_2}\right) = \frac{E_a}{R} \left(\frac{1}{T_2} - \frac{1}{T_1}\right) \\ &pH = pK_a + \log\left(\frac{[\text{conjugate base}]}{[\text{conjugate acid}]}\right) \end{split}$$

$$\begin{split} E_{cell} &= E^{\text{o}}_{cell} - {^{RT}}/_{nF} \ln Q \\ E^{\text{o}}_{cell} &= {^{RT}}/_{nF} \ln K^{\text{o}} \\ K^{\text{o}} &= e^{\text{o}}({^{nF}}/_{RT} E^{\text{o}}_{cell}) \\ F &= 96485 \, {^{J}}/_{V^{\text{+}mol of electrons}} \\ \Delta G^{\text{o}} &= \Delta H^{\text{o}}_{system} - T\Delta S^{\text{o}}_{system} \\ \Delta G^{\text{o}} &= -nFE^{\text{o}}_{cell} = -RT \ln K^{\text{o}} \\ \Delta G &= \Delta G^{\text{o}} + RT \ln Q \\ F &= 96485 \, {^{C}}/_{mol \, electrons} \\ 1A &= 1 \, C \, / \, sec \end{split}$$

1																	2
H																	He
1.0079																	4.0026
3	4											5	6	7	8	9	10
Li	Be											В	C	N	0	F	Ne
6.941	9.0122											10.811	12.011	14.007	15.999	18.998	20.180
11	12											13	14	15	16	17	18
Na	Mg											Al	Si	P	S	Cl	Ar
22.990	24.305											26.982	28.086	30.974	32.066	35.453	39.948
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	$\sim$	~			~		_	~	~	~		$\sim$	~		~	_	W.7
K	Ca	Sc	Ti	$\mathbf{V}$	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
<b>K</b> 39.098	<b>Ca</b> 40.078	<b>Sc</b> 44.956	<b>Ti</b> 47.88	<b>V</b> 50.942	<b>Cr</b> 51.996	<b>Mn</b> 54.938	F'e 55.847	<b>Co</b> 58.933	<b>Ni</b> 58.69	<b>Cu</b> 63.546	<b>Zn</b> 65.39	<b>Ga</b> 69.723	<b>Ge</b> 72.61	<b>As</b> 74.922	<b>Se</b> 78.96	<b>Br</b> 79.904	<b>Kr</b> 83.80
				•													1
39.098	40.078	44.956	47.88	50.942	51.996	54.938	55.847	58.933	58.69	63.546	65.39	69.723	72.61	74.922	78.96	79.904	83.80
39.098	38 <b>Sr</b>	44.956 39	47.88	50.942	51.996 42	54.938	55.847 44	58.933 45	58.69 46	63.546	65.39 48	69.723 49	72.61 50	74.922 51	78.96 52	79.904 53	83.80 54
39.098 37 <b>Rb</b>	38 <b>Sr</b>	39 <b>Y</b>	47.88 40 <b>Zr</b>	50.942 41 <b>Nb</b>	51.996 42 <b>Mo</b>	54.938 43 <b>Tc</b>	55.847 44 <b>Ru</b>	58.933 45 <b>Rh</b>	58.69 46 <b>Pd</b>	63.546 47 <b>Ag</b>	65.39 48 <b>Cd</b>	69.723 49 <b>In</b>	72.61 50 <b>Sn</b>	51 <b>Sb</b>	78.96 52 <b>Te</b>	79.904 53 <b>I</b>	83.80 54 <b>Xe</b>
39.098 37 <b>Rb</b> 85.468	40.078 38 <b>Sr</b> 87.62	44.956 39 <b>Y</b> 88.906	47.88 40 <b>Zr</b> 91.224	50.942 41 <b>Nb</b> 92.906	51.996 42 <b>Mo</b> 95.94	54.938 43 <b>Tc</b> (98)	55.847 44 <b>Ru</b> 101.07	58.933 45 <b>Rh</b> 102.91	58.69 46 <b>Pd</b> 106.42	63.546 47 <b>Ag</b> 107.87	65.39 48 <b>Cd</b> 112.41 80	69.723 49 <b>In</b> 114.82	72.61 50 <b>Sn</b> 118.71	74.922 51 <b>Sb</b> 121.76	78.96 52 <b>Te</b> 127.60	79.904 53 <b>I</b> 126.90	83.80 54 <b>Xe</b> 131.29
39.098 37 <b>Rb</b> 85.468 55	40.078 38 <b>Sr</b> 87.62 56	44.956 39 <b>Y</b> 88.906 57	47.88 40 <b>Zr</b> 91.224 72	50.942 41 <b>Nb</b> 92.906 73	51.996 42 <b>Mo</b> 95.94 74	54.938 43 <b>Tc</b> (98) 75	55.847 44 <b>Ru</b> 101.07 76	58.933 45 <b>Rh</b> 102.91 77	58.69 46 <b>Pd</b> 106.42 78	63.546 47 <b>Ag</b> 107.87 79	65.39 48 <b>Cd</b> 112.41	69.723 49 <b>In</b> 114.82 81	72.61 50 <b>Sn</b> 118.71 82	74.922 51 <b>Sb</b> 121.76 83	78.96 52 <b>Te</b> 127.60 84	79.904 53 <b>I</b> 126.90 85	83.80 54 <b>Xe</b> 131.29 86
39.098 37 <b>Rb</b> 85.468 55 <b>Cs</b>	40.078 38 Sr 87.62 56 Ba	39 <b>Y</b> 88.906 57 <b>La</b>	47.88 40 <b>Zr</b> 91.224 72 <b>Hf</b>	50.942 41 <b>Nb</b> 92.906 73 <b>Ta</b>	51.996 42 <b>Mo</b> 95.94 74 <b>W</b>	54.938 43 <b>Tc</b> (98) 75 <b>Re</b>	55.847 44 <b>Ru</b> 101.07 76 <b>Os</b>	58.933 45 <b>Rh</b> 102.91 77 <b>Ir</b>	58.69 46 <b>Pd</b> 106.42 78 <b>Pt</b>	63.546 47 <b>Ag</b> 107.87 79 <b>Au</b>	65.39 48 <b>Cd</b> 112.41 80 <b>Hg</b>	69.723 49 <b>In</b> 114.82 81 <b>Tl</b>	72.61 50 <b>Sn</b> 118.71 82 <b>Pb</b>	74.922 51 <b>Sb</b> 121.76 83 <b>Bi</b>	78.96 52 <b>Te</b> 127.60 84 <b>Po</b>	79.904 53 <b>I</b> 126.90 85 <b>At</b>	83.80 54 <b>Xe</b> 131.29 86 <b>Rn</b>
39.098 37 <b>Rb</b> 85.468 55 <b>Cs</b> 132.91	40.078 38 Sr 87.62 56 Ba 137.33	44.956 39 <b>Y</b> 88.906 57 <b>La</b> 138.91	47.88 40 <b>Zr</b> 91.224 72 <b>Hf</b> 178.49	50.942 41 <b>Nb</b> 92.906 73 <b>Ta</b> 180.95	51.996 42 <b>Mo</b> 95.94 74 <b>W</b> 183.84	54.938 43 <b>Tc</b> (98) 75 <b>Re</b> 186.21	55.847 44 <b>Ru</b> 101.07 76 <b>Os</b> 190.23	58.933 45 <b>Rh</b> 102.91 77 <b>Ir</b> 192.22	58.69 46 <b>Pd</b> 106.42 78 <b>Pt</b> 195.08	63.546 47 <b>Ag</b> 107.87 79 <b>Au</b> 196.97	65.39 48 <b>Cd</b> 112.41 80 <b>Hg</b> 200.59	69.723 49 <b>In</b> 114.82 81 <b>Tl</b>	72.61 50 <b>Sn</b> 118.71 82 <b>Pb</b> 207.2	74.922 51 <b>Sb</b> 121.76 83 <b>Bi</b>	78.96 52 <b>Te</b> 127.60 84 <b>Po</b> (209)	79.904 53 <b>I</b> 126.90 85 <b>At</b>	83.80 54 <b>Xe</b> 131.29 86 <b>Rn</b>

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

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

$[\mathbf{H_3O}^+]$	[OH <sup>-</sup> ]	pН	рОН	Acidic, Basic or Neutral?
5.37x10 <sup>-6</sup>				
			4.183	

Conjugate Acid	K <sub>a</sub> @25°C	<b>Conjugate Base</b>	К <sub>b</sub> @25°С
H <sub>2</sub> PO <sub>3</sub>			5.13x10 <sup>-8</sup>
	1.58x10 <sup>-11</sup>	Te <sup>2-</sup>	

2. Explain why each of the following *does not* result in an effective buffer? (15pts)  $0.38 \text{mol HClO}_4(\text{aq}) + 0.38 \text{mol NaClO}_4(\text{aq})$ 

1.28mol  $K_2$ HPO<sub>3</sub>(aq) + 1.28mol HClO<sub>4</sub>(aq)

 $1.24 mol\ Na_2SO_3(aq) + 0.03 mol\ NaHSO_3(aq)$ 

3. How much 1.183M KOH(aq) must be added to 25.00mL of 1.262M HCl(aq) to reach the equivalence point? (14pts)

4. You have dissolved 11.338g of sodium fluoride in enough water to make 300.0mL of solution. What is the expected pH of this solution? {  $K_b(F) = 1.52 \times 10^{-11}$  } (15pts)

5. What is the expected pH of a buffer prepared by dissolving 13.537g of selenous acid and 14.661g of sodium hydrogen selenite in enough water to make 150.00mL of solution?  $\{K_a(H_2SeO_3) = 2.43x10^{-8}\}$  (18pts)

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- 6. What is the K<sub>a</sub> of an acid if 250.0mL of a solution containing 0.318 mol of the acid and 0.393 mol of its conjugate base has a pH of 9.357? Over what pH range would this conjugate acid/ conjugate base pair make an effective buffer? (20pts)

7. You have titrated 25.00mL of 0.773M sulfurous acid solution with an unknown sodium hydroxide solution. You reach the second equivalence point when 44.17mL of base is added. What is the concentration of the original stock sodium hydroxide solution? What is the expected pH of the sulfurous acid solution before the titration begins?  $\{K_{a1}(H_2SO_3) = 1.68 \times 10^{-2}, K_{a2}(H_2SO_3) = 6.42 \times 10^{-8}\}$  (20pts)