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 =
$$6.022 \times 10^{23}$$
 units/mol $32.00^{\circ}F = 0.000^{\circ}C = 273.15K$
Density of Water = $1.000^{g}/_{mL}$
 $R = 0.08206$ L*atm/mol*K = 8.314 J/mol*K
PV=nRT
 $\Delta T_{fp/bp} = k_{fp/bp}$ *m*i
For water, $k_{fp} = -1.86$ °C/m; $k_{bp} = 0.52$ °C/m
 $P_1 = X_1P_1$ °
 $\Pi = MRTi$
 $C_1V_1 = C_2V_2$
Quadratic formula:
 $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{\sqrt{b^2 - 4ac}}$

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

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

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
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K	Ca	Sc	Ti	\mathbf{V}	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
K 39.098	Ca 40.078	Sc 44.956	Ti 47.88	V 50.942	Cr 51.996	Mn 54.938	F'e 55.847	Co 58.933	Ni 58.69	Cu 63.546	Zn 65.39	Ga 69.723	Ge 72.61	As 74.922	Se 78.96	Br 79.904	Kr 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 Sr	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 Rb	38 Sr	39 Y	47.88 40 Zr	50.942 41 Nb	51.996 42 Mo	54.938 43 Tc	55.847 44 Ru	58.933 45 Rh	58.69 46 Pd	63.546 47 Ag	65.39 48 Cd	69.723 49 In	72.61 50 Sn	51 Sb	78.96 52 Te	79.904 53 I	54 Xe
39.098 37 Rb 85.468	40.078 38 Sr 87.62	44.956 39 Y 88.906	47.88 40 Zr 91.224	50.942 41 Nb 92.906	51.996 42 Mo 95.94	54.938 43 Tc (98)	55.847 44 Ru 101.07	58.933 45 Rh 102.91	58.69 46 Pd 106.42	63.546 47 Ag 107.87	65.39 48 Cd 112.41 80	69.723 49 In 114.82	72.61 50 Sn 118.71	74.922 51 Sb 121.76	78.96 52 Te 127.60	79.904 53 I 126.90	83.80 54 Xe 131.29
39.098 37 Rb 85.468 55	40.078 38 Sr 87.62 56	44.956 39 Y 88.906 57	47.88 40 Zr 91.224 72	50.942 41 Nb 92.906 73	51.996 42 Mo 95.94 74	54.938 43 Tc (98) 75	55.847 44 Ru 101.07 76	58.933 45 Rh 102.91 77	58.69 46 Pd 106.42 78	63.546 47 Ag 107.87 79	65.39 48 Cd 112.41	69.723 49 In 114.82 81	72.61 50 Sn 118.71 82	74.922 51 Sb 121.76 83	78.96 52 Te 127.60 84	79.904 53 I 126.90 85	83.80 54 Xe 131.29 86
39.098 37 Rb 85.468 55 Cs	40.078 38 Sr 87.62 56 Ba	39 Y 88.906 57 La	47.88 40 Zr 91.224 72 Hf	50.942 41 Nb 92.906 73 Ta	51.996 42 Mo 95.94 74 W	54.938 43 Tc (98) 75 Re	55.847 44 Ru 101.07 76 Os	58.933 45 Rh 102.91 77 Ir	58.69 46 Pd 106.42 78 Pt	63.546 47 Ag 107.87 79 Au	65.39 48 Cd 112.41 80 Hg	69.723 49 In 114.82 81 Tl	72.61 50 Sn 118.71 82 Pb	74.922 51 Sb 121.76 83 Bi	78.96 52 Te 127.60 84 Po	79.904 53 I 126.90 85 At	83.80 54 Xe 131.29 86 Rn
39.098 37 Rb 85.468 55 Cs 132.91	40.078 38 Sr 87.62 56 Ba 137.33	44.956 39 Y 88.906 57 La 138.91	47.88 40 Zr 91.224 72 Hf 178.49	50.942 41 Nb 92.906 73 Ta 180.95	51.996 42 Mo 95.94 74 W 183.84	54.938 43 Tc (98) 75 Re 186.21	55.847 44 Ru 101.07 76 Os 190.23	58.933 45 Rh 102.91 77 Ir 192.22	58.69 46 Pd 106.42 78 Pt 195.08	63.546 47 Ag 107.87 79 Au 196.97	65.39 48 Cd 112.41 80 Hg 200.59	69.723 49 In 114.82 81 Tl	72.61 50 Sn 118.71 82 Pb 207.2	74.922 51 Sb 121.76 83 Bi	78.96 52 Te 127.60 84 Po (209)	79.904 53 I 126.90 85 At	83.80 54 Xe 131.29 86 Rn

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	U	Np	Pu	Am	Cm	Bk	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):

$[H_3O^+]$	[OH ⁻]	pН	рОН	Acidic, Basic or Neutral?
	2.91x10 ⁻⁹			
		8.723		

Conjugate Acid	K _a @25°C	Conjugate Base	K _b @25°С
$H_2PO_3^{-1}$			3.45x10 ⁻⁸
	1.23x10 ⁻⁴	C ₆ H ₅ CO ₂ ⁻¹ (benzoate ion)	

2. A labmate has prepared a chlorite/chlorous acid buffer solution at pH=2.00, but does not write much information down in a lab notebook. You know that the concentration of the buffer is 1.25M and pK_b=12.05 for ClO₂⁻¹(aq). Is the concentration of conjugate acid higher in this buffer or is the concentration of conjugate base in this buffer higher? Over what pH range would chlorite/chlorous acid make an effective buffer? Explain your answers. (10pts)

3. What is the concentration of lead(II) ions {Atomic # = 82} in a saturated solution of lead(II) phosphate? $\{K_{sp} = 7.97x10^{-43}\}\ (10pts)$

4. How many milliliters of 0.448M HClO₄(aq) must be added to 25.00mL of 0.591M NaOH(aq) to reach the equivalence point? What is the pH of this solution at the equivalence point? Explain. (10pts)

5. You have prepared a buffer solution by combining 0.316mols of nitrous acid (HNO₂, $K_a = 4.6 \times 10^{-4}$) and 0.385mols of sodium nitrite in enough water to make 500.0mL of solution. What is the pH of this buffer solution? (10pts)

6. What is the expected pH of a 0.784M aqueous solution of methyl amine? $\{K_b(CH_3NH_2) = 4.97x10^{-4}\}$ (14pts)

7. What is the K_a of a weak acid if 500.0mL of a solution containing 0.229mol of the base and 0.216mol of its conjugate acid has a pH of 7.482? Over what pH range would this conjugate acid/conjugate base pair make an effective buffer? (14pts)

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- 8. You have titrated 25.00mL of 0.773M phosphorous 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?

 $\{K_{a1}(H_3PO_3) = 2.42x10^{-2}, K_{a2} = 2.89x10^{-7}, K_{a3} = 1.96x10^{-11}\}\$ (18pts)

9. You have titrated 25.00mL of an unknown sulfurous acid {H₂SO₃(aq), pK_{a1}=1.770, pK_{a2}=7.201} solution to the second equivalence point with 41.64mL of 0.637M potassium hydroxide. Sketch the titration curve and label all equivalence points and all sulfurous acid-based species in solution in all portions of the curve. What is the concentration of the unknown sulfurous acid solution? How many milliliters were required to reach the *first* equivalence point in this titration? (18pts)