Name: _____

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:
0^{th} order $[A]_t = -kt + [A]_o$
1^{st} order $\ln[A]_t = -kt + \ln[A]_o$
2^{nd} order $1/[A]_t = kt + 1/[A]_o$

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

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

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

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

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

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

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1. Complete each row of the following tables for aqueous solutions at 25ºC (5pts per box):

$[H_3O^+]$	$[OH^-]$	pH	pOH	Acidic, Basic or Neutral?
	$4.69x10^{-5}$			
		11.093		

Conjugate Acid	K_a @25ºC	Conjugate Base	K_b @25ºC
HNO_2			$2.5x10^{-11}$
	$1.2x10^{-2}$	SO_4^{2-}	

2. A labmate has prepared an acetic acid/acetate buffer solution at pH=5.15, but does not write much information down in a lab notebook. You know that the concentration of the buffer is 0.85M and pK_b=9.25 for $C_2H_3O_2^{-1}$(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 acetic acid/acetate make an effective buffer? Explain your answers. (8pts)

3. What is the expected pH of a 0.628M aqueous solution of sodium fluoride? {$K_b(F^{-1})=1.47x10^{-11}$} (10pts)

Score

4. You have prepared a buffer solution by combining 0.492mols of formic acid (HCO_2H, $K_a = 1.77x10^{-4}$) and 0.385mols of sodium formate in enough water to make 600.0mL of solution. What is the expected pH of this buffer solution? (10pts)

5. How much 0.187M HBr(aq) must be added to 15.00mL of 0.207M NaOH(aq) to reach the equivalence point? What is the expected pH of this solution at the equivalence point? Explain. (10pts)

6. What is the K_a of a weak acid if 500.0mL of a solution containing 0.134mol of its conjugate base and 0.162mol of the acid has a pH of 4.992? Over what pH range would this conjugate acid/ conjugate base pair make an effective buffer? (10pts)

Score

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For questions 7-11: You are going to use a titration to determine the concentration of an unknown selenous acid solution (H_2SeO_3, $pK_{a1} = 2.62$, $pK_{a2} = 8.32$). The base you have chosen to use is 0.648M potassium hydroxide.

7. Write out the chemical equations for the step-wise deprotonation/neutralization of selenous acid and the overall/net chemical reaction. (8pts)

8. You titrate 20.00mL of the unknown selenous acid solution to the second equivalence point with 31.83mL of potassium hydroxide solution. What is the concentration of the unknown selenous acid solution? (10pts)

9. What is the expected pH of the selenous acid solution before the titration begins? (10pts)

Score

10. Sketch the titration curve you would expect for this titration, labeling all equivalence points and selenous acid-based species present in each portion of the curve. Wherever reasonable, include pH values. (10pts)

11. You will have to repeat this titration regularly as part of your job and would like to use a visual indicator in the future. You have the following indicators available: Methyl Red (MR, endpoint range = 4.4-6.2), Brilliant Yellow (BY, endpoint range = 6.6-7.8), Thymol Blue (TB, endpoint range = 8.0-9.6). Which of these visual indicators would be useful in your titration? Explain your choice(s) and any assumptions. (8pts)

Score