

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} units/mol

$32.00^\circ\text{F} = 0.000^\circ\text{C} = 273.15\text{K}$

Density of Water = $1.000^{\text{g}}/\text{mL}$

$R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K} = 8.314 \text{ J}/\text{mol}\cdot\text{K}$

$PV = nRT$

$\Delta T_{\text{fp/bp}} = k_{\text{fp/bp}} \cdot m \cdot i$

For water: $k_{\text{fp}} = -1.86^\circ\text{C}/m$
 $k_{\text{bp}} = 0.512^\circ\text{C}/m$

$P_1 = X_1 P_1^\circ$

$\Pi = MRTi$

$C_1 V_1 = C_2 V_2$

Quadratic formula:

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

Integrated Rate Laws:

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

$$1/[A]_t = kt + 1/[A]_o$$

$$[A]_t = -kt + [A]_o$$

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

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

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

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

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{RT}{nF} \ln Q$$

$$E_{\text{cell}}^\circ = \frac{RT}{nF} \ln K^\circ$$

$$K^\circ = e^{(nF/RT) E_{\text{cell}}^\circ}$$

$$F = 96485 \text{ J}/\text{V}\cdot\text{mol of electrons}$$

$$\Delta G^\circ = \Delta H^\circ_{\text{system}} - T\Delta S^\circ_{\text{system}}$$

$$\Delta G^\circ = -nFE_{\text{cell}}^\circ = -RT \ln K^\circ$$

$$\Delta G = \Delta G^\circ + RT \ln Q$$

$$F = 96485 \text{ C}/\text{mol electrons}$$

$$1A = 1C / \text{sec}$$

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							

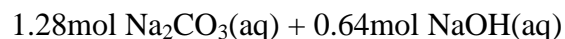
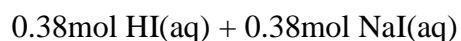
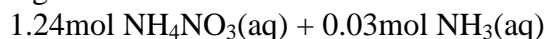
58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.94	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)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

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

$[\text{H}_3\text{O}^+]$	$[\text{OH}^-]$	pH	pOH	Acidic, Basic or Neutral?
6.81×10^{-8}				
			4.993	

Conjugate Acid	K_a @ 25°C	Conjugate Base	K_b @ 25°C
H_3O^+			1.0×10^{-14}
	6.2×10^{-8}	SO_3^{2-}	

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



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)

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 , $K_a = 7.2 \times 10^{-4}$), Hydrosulfuric acid (H_2S , $K_a = 1.1 \times 10^{-7}$), Boric acid (H_3BO_3 , $K_a = 5.8 \times 10^{-10}$), 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 , $\text{p}K_a = -7$). The base you have chosen to use is 1.031M sodium hydroxide.
- Write out the chemical equations for the step-wise deprotonation/neutralization of selenic acid and the overall/net chemical reaction. (6pts)
 - 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)

(#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, $K_{sp}(\text{AgCl}) = 1.77 \times 10^{-10}$
Saturated silver(I) phosphate, $K_{sp}(\text{Ag}_3\text{PO}_4) = 8.89 \times 10^{-17}$