Exam 3A
Chem 1142
Spring 2017

Name:_____

MULTIPLE CHOICE. [3 pts ea.] Record the best response on the scantron sheet. [**45 pts total.**]

Assume all solutions are aqueous and at a temperature of 25 °C, unless stated otherwise.

Q1. Which version of the exam do you have?
a) 3A
b) 3B

Q2. For the chemical equilibrium:
$HCOOH(aq) + HCO_3^-(aq) \rightleftharpoons H_2CO_3(aq) + HCOO^-(aq)$
a conjugate acid-base pair would be:
a) HCOOH & H_2CO_3
b) HCOOH & HCO_3^-
c) HCOOH & $HCOO^-$
d) H_2CO_3 & HCOOH

Q3. What is the concentration of $[OH^-]$ in a solution which has $[H^+] = 2.5 \times 10^{-10}$ M?
a) 2.5×10^{-10} M
b) 3.0×10^{-5} M
c) 1.6×10^{-5} M
d) 4.0×10^{-5} M

Q4. What is the pH of a solution with $[OH^-] = 1.4 \times 10^{-9}$ M?
a) 8.85
b) 5.15
c) 1.40
d) 9.95

Q5. What is the pOH of 0.30 M $Ba(OH)_2(aq)$?
a) 0.52
b) 1.52
c) 0.22
d) 0.60

Q6. Which of the following acids will have the lowest pH at a concentration of 0.10 M?
HF, $K_a = 7.1 \times 10^{-4}$ **HCO_2H**, $K_a = 1.7 \times 10^{-4}$ **CH_3CO_2H**, $K_a = 1.8 \times 10^{-5}$

a) HF
b) HCO_2H
c) CH_3CO_2H
d) All three acids will have the same pH

Q7. The base dissociation constant (K_b) for CH_3NH_2 is 4.4×10^{-4}. Which of the following is the correct conjugate acid and its K_a?

a) CH_3NH^+ $K_a = 2.3 \times 10^{-4}$
b) CH_3NH^+ $K_a = 2.3 \times 10^{-11}$
c) $CH_3NH_3^+$ $K_a = 2.3 \times 10^{-4}$
d) $CH_3NH_3^+$ $K_a = 2.3 \times 10^{-11}$

Q8. Predict which of the following salts will be acidic:
a) $AlCl_3$
b) KNO_3
c) $Ba(C_2H_3O_2)_2$
d) $LiNO_2$

Q9. A Lewis acid is a(n):
a) H^+ donor
b) electron acceptor
c) OH^- ion producer
d) reducing agent

Q10. Formic acid, HCOOH, can form a buffer when combined with:
a) HCOOLi
b) H_2CO_3
c) NH_3
d) CH_3COONa

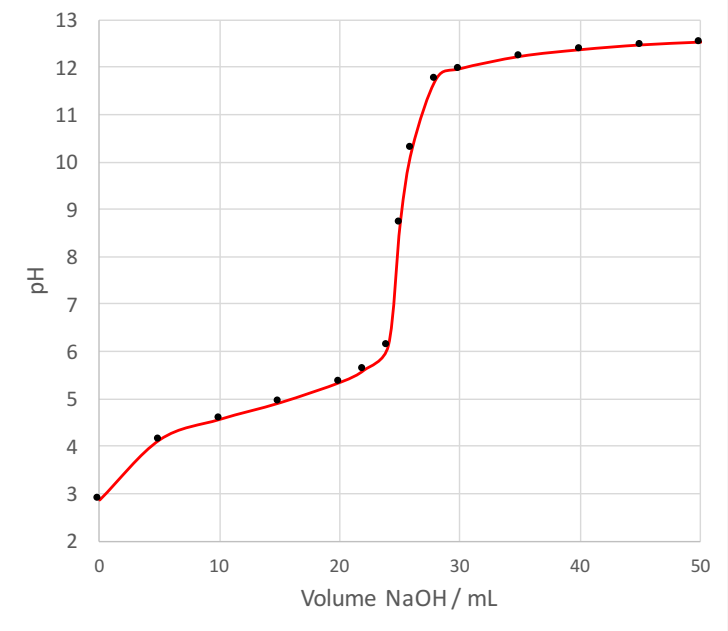
Q11. What pH is required to ensure the ratio of $[NH_3]/[NH_4^+]$ is 100?
Note: K_a $(NH_4^+) = 1.8 \times 10^{-5}$?
a) 3.74
b) 6.74
c) 9.74
d) 10.74

Q12. Which is the correct mathematical expression for K_{sp} $(Mg_3(PO_4)_2)$?
a) $[Mg^{2+}][PO_4^{3-}]$
b) $[Mg_3^{2+}][2PO_4^{3-}]$
c) $[Mg]^2[PO_4]^3$
d) $[Mg^{2+}]^3[PO_4^{3-}]^2$

Q13. The molar solubility of CaF_2 is 2.2×10^{-4} M. What is K_{sp} equal to?
a) 4.3×10^{-11}
b) 4.8×10^{-8}
c) 1.1×10^{-11}
d) 2.2×10^{-4}

Q14. If Q_{sp} for an ionic compound in solution is greater than K_{sp}, what will happen?
a) Nothing—the solution is saturated
b) More solute can dissolve—the solution is un-saturated
c) Solute will precipitate—the solution is super-saturated
d) The solution will cool down until $Q_{sp} = K_{sp}$

Q15. What would be the best pH indicator to use in the titration of CH_3CO_2H vs. NaOH? Its titration curve is given below:



The choice of indicators are:

	Color		
Indicator	**In Acid**	**In Base**	**pH Range**
Methyl orange	Orange	Yellow	3.1 – 4.4
Methyl red	Red	Yellow	4.2 – 6.3
Cresol red	Yellow	Red	6.2 – 8.8
Alizarin	Yellow	Red	10.1 – 12

a) Methyl orange
b) Methyl red
c) Cresol red
d) Alizarin

Short Response.

Show ALL work to receive credit.

Q16. [10 pts.] (a) Show how to, and then calculate, the pH of 0.040 M $HNO_3(aq)$.

(b) Show how to, and then calculate, the pH of 0.040 M $Ba(OH)_2(aq)$

(c) Calculate the concentration of OH^- ions in the solution described in part (a).

Q17. [15 pts.] Calculate the pOH and pH of 0.25 M NH_3. K_b (NH_3) = 1.8×10^{-5}. Show all work, including a properly labelled ICE chart, as well as the correct chemical equation for the K_b reaction.

Q18. [15 pts.] (a) Using the Henderson-Hasselbalch equation, calculate the pH of a solution that is 0.50 M in $CH_3CO_2H(aq)$ as well as 0.30 M in $CH_3CO_2Na(aq)$. Note: K_a (CH_3CO_2H) = 1.8×10^{-5}.

(b) Calculate the new pH of 250-mL of the solution described in part (a) to which 5.0 mL of 3.0 M $HNO_3(aq)$ has been added. Comment on your final result. Be sure to show all relevant chemical equations, and clearly show your work using an ICE chart.

Q19. [15 pts.] (a) Write out the chemical equation for the reaction corresponding to $K_{sp}(Ag_2SO_4)$.

(b) Using an ICE chart, calculate the molar solubility of silver sulfate (Ag_2SO_4) in water, given that $K_{sp} = 1.4 \times 10^{-5}$.

(c) Calculate the molar solubility of silver sulfate in 1.35 M $Na_2SO_4(aq)$. Be sure to show all relevant chemical equations, and clearly show your work using an ICE chart. Comment on your final result.

"This is a lovely old song that tells of a young woman who leaves her cottage, and goes off to work. She arrives at her destination, and places some solid NH_4HS in a flask containing 0.50 atm of ammonia, and attempts to determine the pressures of ammonia and hydrogen sulfide when equilibrium is reached."

Useful Information

Periodic Table of the Elements

IA	IIA											IIIA	IVA	VA	VIA	VIIA	VIIIA
1																	*18*
1 H 1.008	*2*											*13*	*14*	*15*	*16*	*17*	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [98]	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.60	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba* 137.3	71 Lu 175.0	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po [210]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra** [226]	103 Lr [262]	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [265]	109 Mt [268]	110 [269]	111 [272]	112 [277]	113	114 [285]	115	116 [289]	117	118 [293]

*	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm [145]	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.50	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0
**	89 Ac [227]	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]

$N_A = 6.022 \times 10^{23}\ \text{mol}^{-1}$

$$R = 8.3145\frac{\text{J}}{\text{mol}\cdot\text{K}} = 0.08206\frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}} \qquad M_1V_1 = M_2V_2$$

$\text{pH} = -\log_{10}[\text{H}^+]$ $\qquad$ $\text{pH} + \text{pOH} = 14.00\ (25\ ^\circ\text{C})$

$K_w = 1.0 \times 10^{-14}\ (25\ ^\circ\text{C})$ $\qquad$ $K_a \cdot K_b = K_w$

$$\text{pH} = \text{p}K_a + \log\frac{[\text{Base}]}{[\text{Acid}]}$$

$K_p = K_c(RT)^{\Delta n_g}$

Given: $ax^2 + bx + c = 0$, then $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$