

Chemistry 1142

Spring 2013

Exam 3a

Name: _____

Take a deep breath, and relax! First, answer the questions you know how to do and then work on the more difficult problems. Don't forget to show all your work, so I can give you as much credit as possible.

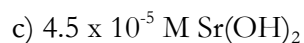
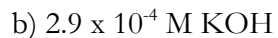
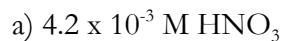
Good Luck!

Andy



Show all work to receive credit. Be sure to include units, and express answers to the correct number of significant figures / decimal places.

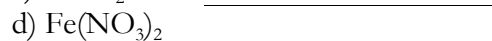
Q1. [10 pts.] Calculate the pH of the following aqueous solutions at 25 °C. Show *all* work to receive credit!



Q2. [12 pts.] State the Arrhenius, Brønsted, and Lewis definitions of an acid and a base:

Theory	Acid	Base
Arrhenius		
Brønsted		
Lewis		

Q3. [10 pts.] Predict whether the following salts are acidic, basic, or neutral:



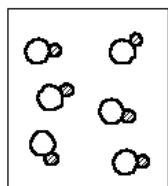
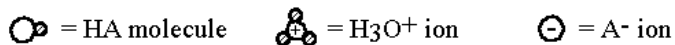
Q4. [10 pts.] Write the chemical reactions corresponding to K_{a1} and K_{a2} for carbonic acid, H_2CO_3 .

Q5. [15 pts.] Barbituric acid, $HC_4H_3N_2O_3$, is used to prepare various barbiturate drugs (used as sedatives). Calculate the concentrations of hydronium ion and barbiturate ion in a 0.25 M solution of the acid. The value of K_a is 9.8×10^{-5} .

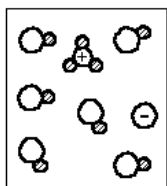
Q6. [5 pts.] Which of the following diagrams represents a snapshot of a very small portion of a beaker containing a weak acid, HA, dissolved in water? (Circle the best response.)



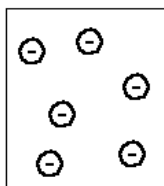
Note that the solvent molecules (i.e., H_2O) are not shown for clarity.



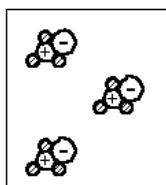
(a)



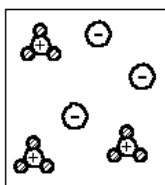
(b)



(c)



(d)



(e)

Q7. [12 pts.] Calculate the molar solubility of silver carbonate in an aqueous solution of 0.10 M sodium carbonate. $K_{\text{sp}}(\text{Ag}_2\text{CO}_3) = 8.1 \times 10^{-12}$.

Q8. [12 pts.] Solutions of lead(II) nitrate and sodium iodide are mixed together in a test-tube. Upon mixing, $[\text{Pb}^{2+}] = 2.4 \times 10^{-3} \text{ M}$ and $[\text{I}^-] = 1.8 \times 10^{-2} \text{ M}$. Will a precipitate of lead(II) iodide form? $K_{\text{sp}}(\text{PbI}_2) = 1.4 \times 10^{-8}$. *Show all work.*

Q9. [14pts.] A buffer is prepared by adding 45.0 mL of 0.18 M NaF to 35.0 mL of 0.12 M HF. What is the pH of the final solution? K_{a} for HF is 6.8×10^{-4} .

BONUS Questions. Circle the best response:

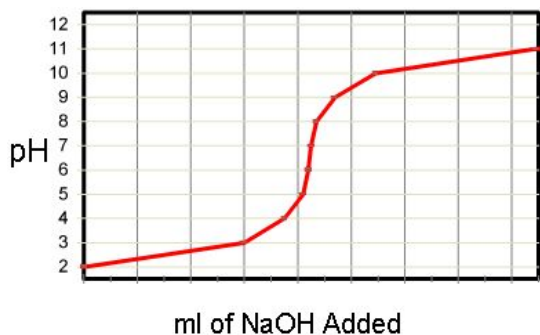
Q. Given three separate solutions containing equal concentrations of formic acid ($K_a = 1.7 \times 10^{-4}$), phenol ($K_a = 1.3 \times 10^{-10}$), and acetic acid ($K_a = 1.8 \times 10^{-5}$), select the response below that has the acids arranged in order of increasing percent dissociation at equilibrium.

- a) formic < phenol < acetic b) formic < acetic < phenol c) acetic < formic < phenol
d) phenol < acetic < formic e) No response is correct.

Q. Why is it necessary to take the acid-base properties of water into account when computing the hydronium ion concentration of very dilute solutions of strong acids?

- a) The hydroxide ion produced from the dissociation of water reacts with most of the hydronium ion produced from the acid.
b) The dissociation constant for water is larger in dilute rather than in concentrated solutions of acids.
c) The acids do not dissociate completely in dilute solutions.
d) The amount of hydronium ion produced by the dissociation of water is significant compared to that produced by the acid.
e) The conjugate base of the strong acid reacts with the hydroxide ion produced from the dissociation of water.

Q. Given the following pH titration curve, which acid-base indicator should be used to determine the end-point?



Indicator	Color		pH Range*
	In Acid	In Base	
Thymol blue	Red	Yellow	1.2–2.8
Bromophenol blue	Yellow	Bluish purple	3.0–4.6
Methyl orange	Orange	Yellow	3.1–4.4
Methyl red	Red	Yellow	4.2–6.3
Chlorophenol blue	Yellow	Red	4.8–6.4
Bromothymol blue	Yellow	Blue	6.0–7.6
Cresol red	Yellow	Red	7.2–8.8
Phenolphthalein	Colorless	Reddish pink	8.3–10.0

*The pH range is defined as the range over which the indicator changes from the acid color to the base color.

- a) Thymol blue b) Methyl orange c) Bromothymol blue d) Phenolphthalein

Useful Information

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

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

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1.0 \times 10^{-14} \text{ at } 25^\circ\text{C}.$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+]$$

$$K_a K_b = K_w$$

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

$$\text{pH} + \text{pOH} = 14.00 \text{ (at } 25^\circ\text{C)}$$

$$R = 8.3145 \text{ J/mol}\cdot\text{K} = 0.08206 \text{ L}\cdot\text{atm/mol}\cdot\text{K}$$

$$M_1 V_1 = M_2 V_2$$

Periodic Table of the Elements

IA	IIA											IIIA	IVA	VA	VIA	VIIA	VIIIA	
1	2											13	14	15	16	17	18	
1 H 1.01																		2 He 4.00
3 Li 6.94	4 Be 9.01											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 101.07	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	71 Lu 174.97	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 207.20	83 Bi 208.98	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 [285]	114 [285]	115 [289]	116 [289]	117 [293]	118 [293]	
		* 57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04			
		** 89 Ac [227]	90 Th 232.04	91 Pa 231.04	92 U 238.03	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]			