

Exam Four
Chm 205 (Dr. Mattson)
30 March 2009

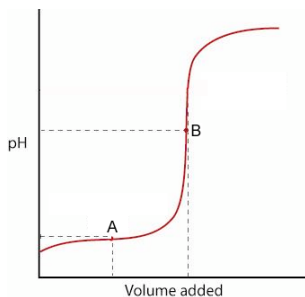
Academic Integrity Pledge:

In keeping with Creighton University's ideals and with the Academic Integrity Code adopted by the College of Arts and Sciences, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.

Signature:

Instructions: Show all work whenever a calculation is required! You will receive credit for how you worked each problem as well as for the correct answer. If you need more space, you may use the back of your periodic table — Write: "See PT" in box and then attach the periodic table. **BOX YOUR ANSWERS!** Write legibly.

1. The titration of 30.00 mL 0.1400 M HA ($K_a = 2.5 \times 10^{-4}$) with 0.1100 M NaOH is shown at right.

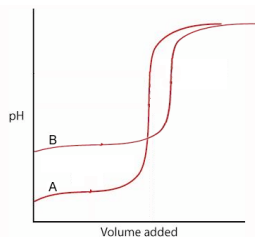


- (a) (4 pts) What is the volume of OH^- added at the equivalence point?

- (b) (4 pts) What is the pH of Point A?

- (c) (2 pts) What is the pH of Point B? <7 $= 7$ >7

2. (6 pts) Two acids were titrated with the same NaOH solution yielding Curves A and B.

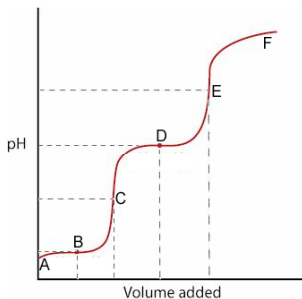


The two acids were from the following list:

- (a) $\text{HC}_2\text{H}_3\text{O}_2$, $K_a = 1.8 \times 10^{-5}$ (b) HCl
 (c) $\text{HC}_3\text{H}_3\text{O}_3$, $K_a = 2.8 \times 10^{-3}$ (d) H_2SO_3

- (a) Circle the acid that explains Titration Curve A
 (b) Draw a box around the acid that explains Titration Curve B
 (c) Which acid has a larger concentration: A or B

3. Consider the titration plot shown for H_2A ($K_{a1} = 4.3 \times 10^{-3}$ and $K_{a2} = 5.7 \times 10^{-8}$)



- (a) (2 pts) What information would you need in order to

determine the pH at Point A, before any OH^- has been added? (Only 1 answer)

- A. Concentration of H_2A and HA^-
 B. $\text{p}K_{a1}$
 C. Concentration of H_2A and K_{a1}
 D. Volume OH^- at equivalence point, K_b for HA^-

- (b) (4 pts) What is the pH at Point B?

- (c) (4 pts) What is the pH at Point C?

- (d) (4 pts) What is the pH at point D?

- (e) (5 pts) Circle all of the values you would need in order to determine the pH at point E.

- Volume of H_2A originally used. Value of K_{a1}
 Volume of NaOH added Value of K_{a2}
 Original concentration of H_2A

- (f) (2 pts) To determine pH at Point F, one would need all of the following except

- Original $[\text{H}_2\text{A}]$ Original $[\text{OH}^-]$
 Value of K_{a2} Volume of H_2A used
 Volume of NaOH added

4. (5 pts) If a saturated solution of Ag_2CO_3 in water has a $[\text{Ag}^+] = 2.56 \times 10^{-4} \text{ M}$, what is the value of K_{sp} for Ag_2CO_3 ?

5. Calculate the molar solubility of PbCrO_4 ($K_{\text{sp}} = 2.8 \times 10^{-13}$) in

(a) (5 pts) pure water

(b) (5 pts) a solution that is 1.0×10^{-3} M K_2CrO_4 .

6. (2 pts) Which of these fluoride salts has the largest molar solubility?



7. (5 pts) Will a precipitate form if 1.0 mmol of Na_2SO_4 is added to 500.0 mL of a solution that is 0.0050 M $\text{Pb}(\text{NO}_3)_2$? [PbSO_4 $K_{\text{sp}} = 1.8 \times 10^{-8}$]

8(a) (5 pts) What is the pH of a saturated solution of $\text{Ca}(\text{OH})_2$? [$K_{\text{sp}} = 4.7 \times 10^{-7}$]

(b) (4 pts) What will happen to the *equilibrium* [Ca^{+2}] if each of the following is done?

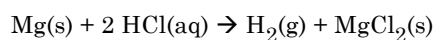
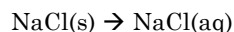
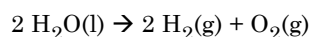
add OH^- : [Ca^{+2}] Increase Decrease No change

add H_3O^+ : [Ca^{+2}] Increase Decrease No change

add H_2O : [Ca^{+2}] Increase Decrease No change

add $\text{Ca}(\text{OH})_2(\text{s})$: [Ca^{+2}] Increase Decrease No chg

9. (5 pts) Circle each of the following processes for which $\Delta G^\circ < 0$? (Hint: Recall what the "o" means)



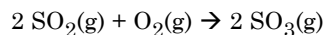
10. (5 pts) Circle each of the following processes for which $\Delta S < 0$?

Freezing of water

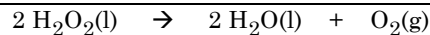
Boiling of water

Combustion of coal to produce CO_2 and H_2O

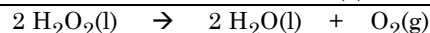
Dissolving of sugar in hot water



11(a) (5 pts) Use the data provided on the data sheet to calculate ΔS° for the reaction: UNITS!



(b) (5 pts) Use the data provided on the data sheet to calculate ΔH° for the reaction in (a): UNITS!



(c) (2 pts) This reaction is:

A. spontaneous at low temperature only

B. spontaneous at high temperature only

C. always spontaneous D. never spontaneous

(d) (4 pts) Calculate ΔG°

(e) (4 pts) Calculate K_p

12 (2 pts) At equilibrium,

(A) $\Delta G^\circ = \Delta G$

(B) $\Delta G^\circ = 0$

(C) $\Delta G = 0$

(D) $\Delta G^\circ = -R T \ln Q$

Print your name in the box.

Name: (only if you answer yes below): _____

Work to be graded on this sheet?

YES: If you have done work to be graded on this sheet, you must submit it with your exam and include your name above. Do not clip it to the exam — simply hand them in together.

NO: If there is nothing to grade on this sheet, simply return it to the pile next to the exams.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.01																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											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	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 97	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	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															

$$\Delta G^{\circ} = -R T \ln K$$

$$R = 8.314 \text{ J/mol K}$$

$$\Delta G = \Delta H - T\Delta S$$

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

$$\Delta G = \Delta G^{\circ} + R T \ln Q$$

	ΔH_f° (kJ/mol)	ΔG_f° (kJ/mol)	S° (J/mol K)
H ₂ O(l)	-285.8	-237.2	69.9
H ₂ O ₂ (l)	-187.8	-120.4	110
O ₂ (g)	0	0	205

Answers:

1. (a) 38.18 m; (b) 3.60; (c) pH > 7

2. (a) Circle (c) $\text{HC}_3\text{H}_3\text{O}_3$, $K_a = 2.8 \times 10^{-3}$; (b) Draw a box around (a) $\text{HC}_2\text{H}_3\text{O}_2$, $K_a = 1.8 \times 10^{-5}$; (c) B

3. (a) C; (b) pH = 2.37; (c) pH = 4.81; (d) pH = 7.24

(e) Circle all values except "Value of K_{a1} "; (f) (One would need all of the values except Value of K_{a2})

4. $K_{sp} = 8.4 \times 10^{-12}$

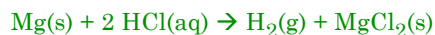
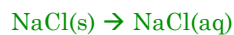
5. (a) 5.3×10^{-7} ; (b) 2.8×10^{-10}

6. BaF_2

7. $Q_{sp} = 1.0 \times 10^{-5}$ therefore a precipitate forms

8(a) 11.99; (b) Decrease, Increase, No change, No change

9. Circled choices:



10. Circled choices:

Freezing of water



11(a) $\Delta S^\circ = 124.8 \text{ J/K}$

(b) $\Delta H^\circ = -196 \text{ kJ}$

(c) This reaction is always spontaneous.

(d) $\Delta G^\circ = -233 \text{ kJ}$

(e) (4) Calculate $K_p = 7 \times 10^{+40}$

12 (2 pts) At equilibrium, $\Delta G = 0$