

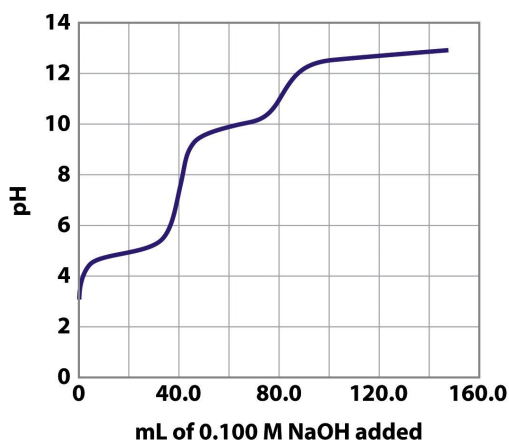
Exam III – Chapters 15 & 16

Important information

Some K_a values:

Acetic acid (CH_3COOH)	1.8×10^{-5}
Nitrous acid (HNO_2)	4.5×10^{-4}
Hypochlorous acid (HOCl)	3.0×10^{-8}
Hydrocyanic acid (HCN)	4.9×10^{-10}
Ammonia (NH_3)	5.6×10^{-10}
Methylamine (CH_3NH_2)	2.7×10^{-11}

1. (8 pts) The following graph represents the titration of a diprotic acid, H_2A^+ , with 0.100 M NaOH.



Problem 15-43 Chemistry, 5/e
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- a. Write the reaction of the diprotic acid, H_2A^+ in water including all steps.

 - b. Indicate on the graph with the letter B where you have 50% HA and 50% A^- .

 - c. Indicate with the letter C on the graph where you have 100% HA.
2. (6 pts) Which of the following titrations results in an acidic solution at the equivalence point?
- a. CH_3COOH titrated with NaOH
 - b. KF titrated with KOH
 - c. HCl titrated with NaOH
 - d. $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ titrated with HCl

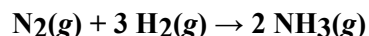
3. (6 pts) What is the pH of a buffer system made by dissolving 10.70 grams of ammonium chloride and 20.0 mL of 12.0 M ammonia in enough water to make a 1.000 L solution? (*Show work for partial credit*)
- 9.18
 - 9.26
 - 9.33
 - 11.03
4. (6 pts) What is the magnitude of change when 0.005 moles of hydrochloric acid is added 0.100 L of a buffer solution that is 0.100 M in acetic acid and 0.100 M in potassium acetate? (*Show work for partial credit*)
- 0.00
 - 0.20
 - 0.48
 - 1.30
5. (6 pts) What is the pH at the equivalence point of a weak base-strong acid titration if 20.00 mL of sodium hypochlorite, NaOCl, requires 28.30 mL of 0.50 M HCl? (*Show work for partial credit*)
- 0.30
 - 3.18
 - 3.76
 - 4.03

6. (6 pts) Write the chemical equation for the dissolution of silver carbonate in water. Then write the K_{sp} expression for this salt.

Chemical Equation: _____ K_{sp} = _____

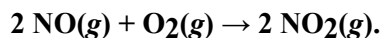
7. (6 pts) What is the silver ion concentration for a saturated solution of silver carbonate if the K_{sp} for silver carbonate is 8.4×10^{-12} ? (*Show work for partial credit*)
- 1.28×10^{-4} M
 - 2.56×10^{-4} M
 - 4.06×10^{-4} M
 - 2.90×10^{-6} M

8. (6 pts) Calculate the K_{sp} for silver sulfate if the solubility of Ag_2SO_4 in pure water is 4.5 g/L. (*Show work for partial credit*)
- 2.1×10^{-4}
 - 4.2×10^{-4}
 - 1.2×10^{-5}
 - 3.0×10^{-6}
9. (6 pts) In which of the following solutions would solid $PbCl_2$ be expected to be the least soluble at $25^\circ C$?
- 0.1 M $CaCl_2$
 - 0.1 M HCl
 - 0.1 M $NaCl$
 - 0.1 M KNO_3
10. (6 pts) For which process is the sign of ΔS negative in the system?
- $2 H_2(g) + O_2(g) \rightarrow 2 H_2O(g)$
 - $2 H_2O(l) + 2 K(s) \rightarrow 2 K^+(aq) + 2 OH^-(aq) + H_2(g)$
 - $H_2O(s) \rightarrow H_2O(g)$
 - $H_2O(l) \rightarrow H_2O(g)$
11. (6 pts) $\Delta S^\circ = -198.7 \text{ J/K}$ for the reaction shown below. Calculate S° for $NH_3(g)$. (*Show work for partial credit*)



	Species	$S^\circ, \text{ J/(K}\cdot\text{mol)}$
a. 61.7 J/K·mol	N ₂ (g)	191.5
b. 123.4 J/K·mol	H ₂ (g)	130.6
c. 192.3 J/K·mol	NH ₃ (g)	?
d. 384.6 J/K·mol		

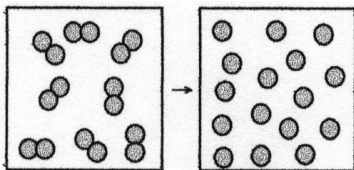
12. (6 pts) For a process to be at equilibrium, it is necessary that
- $\Delta S_{sys} = \Delta S_{surr}$.
 - $\Delta S_{sys} = -\Delta S_{surr}$.
 - $\Delta S_{sys} = 0$.
 - $\Delta S_{sys} = 0$ and $\Delta S_{surr} = 0$.
13. (6 pts) Calculate the standard free energy change at $25^\circ C$ for the reaction: (*Show work for partial credit*)



	Species	$\Delta H^\circ_f, \text{ kJ/mol}$	$S^\circ, \text{ J/(K}\cdot\text{mol)}$
a. -4.69 kJ	NO (g)	90.25	210.8
b. -70.48 kJ	O ₂ (g)	0.00	205.1
c. -157.82 kJ	NO ₂ (g)	33.18	240.1
d. -532.57 kJ			

14. (6 pts) At 25°C, $\Delta G^\circ = -198 \text{ kJ}$ for the reaction, $\text{NO}(g) + \text{O}_3(g) \rightleftharpoons \text{NO}_2(g) + \text{O}_2(g)$. Calculate ΔG under the following conditions: the partial pressure of NO is $1.0 \times 10^{-6} \text{ atm}$, O_3 is $1.0 \times 10^{-7} \text{ atm}$, NO_2 is $3.0 \times 10^{-6} \text{ atm}$, O_2 is 0.20 atm .). (Show work for partial credit)
- 159 kJ
 - 167 kJ
 - 198 kJ
 - 236 kJ

15. (8 pts) The figure below represents the nonspontaneous reaction $\text{O}_2(g) \rightarrow 2 \text{O}(g)$. What are the signs (+ or -) of ΔH , ΔS , and ΔG for this process?



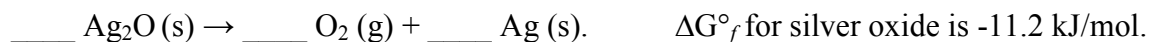
ΔH _____

ΔS _____

ΔG _____

Is the value for K less than (<), greater than (>), or equal to (=) 1? _____

16. (6 pts) Calculate K for the decomposition of silver oxide into oxygen gas and silver metal represented by the following *unbalanced* equation:



Extra credit:

- (2 pts) Which pair of ions can be separated by the addition of sulfide ion?

- Ag^+ and Cu^{2+}
- Cu^{2+} and Bi^{3+}
- Ca^{2+} and Ba^{2+}
- Pb^{2+} and Ca^{2+}

- (3 pts) Indicate all chemical species present in a beaker containing a solution of 0.100 M HF and 0.100 M KF.