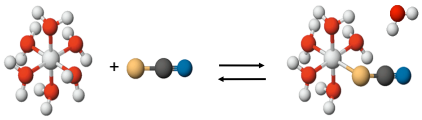
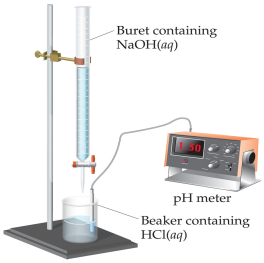
Chemistry 223 Exam I Review
Chapters 12, 13 and 14





Chemistry 223
Professor Michael Russell

Last update: 7/6/26

MAR

Midterm I

Chapters 12, 13, 14

- *Bring:* **calculator**, pencil, **"Acid Base Titrations" lab**, **Exam Prep Worksheet I, "Titration Weak Acids" printed lab**
- 12 multiple choice questions, 4 short answer questions, ~90 minutes in length
- Returned following lab period with "summary sheet" ***Good luck with your studying!***

Let's start the review!

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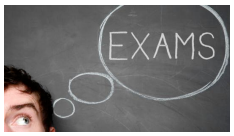
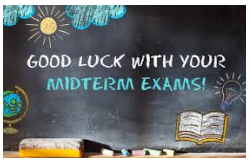


L1: Mon, 4/26 1:10 PM, AC 2501
L2: Wed, 4/28 1:10 PM, AC 2501

Check with instructor to ensure correct dates and times!



Calculate the standard entropy change for the following reaction:

$CCl_4(l) + O_2(g) \rightarrow CO_2(g) + 2\ Cl_2(g)$

* $S°[CCl_4(l)] = 214.39$ J/K • mol
* $S°[CO_2(g)] = 213.74$ J/K • mol
* $S°[O_2(g)] = 205.07$ J/K • mol
* $S°[Cl_2(g)] = 223.08$ J/K • mol

A. -17.36 J/K
B. +17.36 J/K
C. +240.44 J/K
D. -25.78 J/K
E. 42

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Calculate $\Delta G_{rxn}°$ for the following reaction:

$CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(g)$

* $\Delta G_f°[CO_2(g)] = -394.4$ kJ/mol
* $\Delta G_f°[CH_4(g)] = -50.8$ kJ/mol
* $\Delta G_f°[H_2O(g)] = -228.6$ kJ/mol

A. 572.2 kJ/mol•rxn
B. -673.7 kJ/mol•rxn
C. -572.2 kJ/mol•rxn
D. -436.4 kJ/mol•rxn
E. -800.8 kJ/mol•rxn

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Given the following information, calculate $\Delta G°$ for the reaction below at 25 °C:

$Mg(s) + 1/2\ O_2(g) \rightarrow MgO(s)$

$\Delta H° = -601.24$ kJ/mol•rxn
$\Delta S° = -108.36$ J/K•rxn

A. 664.5 kJ/mol•rxn
B. -568.9 kJ/mol•rxn
C. 31700 kJ/mol•rxn
D. -528.3 kJ/mol•rxn
E. 42

MAR

A reaction has a $\Delta H°$ which is ***positive*** and a $\Delta S°$ which is ***positive***. What can be said about the reaction spontaneity at different temperatures?

A. product favored at all temperatures
B. product favored only at high temperature
C. product favored only at low temperature
D. not product favored at any temperature

MAR

Calculate ΔG° at 25 °C for: **$2\ H_2O_2(l) \rightarrow 2\ H_2O(l) + O_2(g)$**

	ΔH°(kJ/mol)	**S°(J/K • mol)**
$H_2O_2(l)$	-187.8	109.6
$H_2O(l)$	-285.8	69.9
$O_2(g)$	-----	205.1

A. -157.9 kJ/mol•rxn
B. -192.3 kJ/mol•rxn
C. -37700 kJ/mol•rxn
D. -233.5 kJ/mol•rxn
E. 42

MAR

A reaction has ΔH = -96.0 kJ/mol and ΔS = -12.6 J/K•mol. If the temperature is increased slowly, at what temperature will this reaction become nonspontaneous?

A. It will never be spontaneous
B. 7162 °C
C. 762 K
D. 7620 K
E. It will always be spontaneous

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Barium sulfite is poorly soluble in water with a K_{sp} value of 8.0×10^{-7}. What is ΔG° at 25 °C?

A. 15.1 kJ/mol•rxn
B. 34.8 kJ/mol•rxn
C. -34.8 kJ/mol•rxn
D. 343 kJ/mol•rxn
E. 42

MAR

We place 0.010 mol of $N_2O_4(g)$ in a 2.0 L flask at 200 °C. After reaching equilibrium, $[N_2O_4] = 0.0038$ M. Calculate K_c for the following reaction:

$N_2O_4\ (g) \rightleftharpoons 2\ NO_2(g)$

A. 1600
B. 1.5×10^{-3}
C. 6.1×10^{-4}
D. 8.8×10^{-6}
E. -3.1×10^{-3}

MAR

Given the following two equilibria:

$NiCO_3(s) \rightleftharpoons Ni^{2+}(aq) + CO_3^{2-}(aq)$ **$K_1 = 6.6 \times 10^{-9}$**

$HCO_3^-(aq) + H_2O(l) \rightleftharpoons CO_3^{2-}(aq) + H_3O^+(aq)$ **$K_2 = 4.8 \times 10^{-11}$**

calculate the equilibrium constant for the following reaction:

$NiCO_3(s) + H_3O^+(aq) \rightleftharpoons Ni^{2+}(aq) + HCO_3^-(aq) + H_2O(l)$

A. 7.3×10^{-3}
B. 3.2×10^{-19}
C. 140
D. 1.8×10^{-9}
E. 1100

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$\Delta H^o = -18.8$ kJ, $K_c = 10.5$, for:

$2\ CH_2Cl_2(g) \rightleftharpoons CH_4(g) + CCl_4(g)$

If the temperature on the equilibrium system is suddenly decreased, the value of K_c:

A. increases
B. decreases
C. remains the same

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You add 0.535 g of NaOH (MM = 40.0 g mol^{-1}) to 100.0 mL of water at 25 °C. What is $[H_3O^+]$ in this solution?

A. 0.134 M
B. 7.48×10^{-14} M
C. 1.34×10^{13} M
D. 6.87×10^{-12} M

MAR

Considering only H_2S ($K_a = 1 \times 10^{-7}$) and HCN ($K_a = 4 \times 10^{-10}$), predict in which direction the following equilibrium lies:

$$HCN(aq) + HS^-(aq) \rightleftharpoons CN^-(aq) + H_2S(aq)$$

A. equilibrium lies to the left
B. equilibrium lies to the right
C. equilibrium is perfectly balanced left and right
D. cannot be determined

MAR

What is $[H_3O^+]$ in a 0.10 M solution of HCN at 25 °C? (K_a for HCN = 4.0×10^{-10})

A. 1.6×10^{-9} M
B. 6.3×10^{-6} M
C. 2.0×10^{-5} M
D. 4.0×10^{-11} M
E. 0.10 M

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In a 0.15 M solution of Na_2CO_3, what are $[H_3O^+]$, $[OH^-]$ and the pH? K_b for CO_3^{2-} is 2.1×10^{-4}.

	$[H_3O^+]$	$[OH^-]$	pH
A.	5.6×10^{-3}	1.8×10^{-12}	5.61
B.	1.8×10^{-12}	5.6×10^{-3}	11.75
C.	5.6×10^{-3}	1.8×10^{-12}	11.75
D.	1.8×10^{-12}	5.6×10^{-3}	5.61

MAR

Place the following acids in order of increasing acid strength.

(a) Anilinium ion, $pK_a = 4.60$
(b) Benzilic acid, $pK_a = 3.09$
(c) Chloroacetic acid, $pK_a = 2.98$
(d) Dibromophenol, $pK_a = 8.06$

A. a, b, c, d
B. d, c, b, a
C. c, b, a, d
D. d, a, b, c
E. a, c, d, c

MAR

You have a solution of NH_4Cl. What effect will addition of NH_3 have on the pH of the solution?

A. increase pH
B. no effect
C. decrease pH
D. cannot tell from information given

MAR

You have a solution of NH_4Cl. What effect will addition of NaCl have on the pH of the solution?

A. increase pH
B. no effect
C. decrease pH
D. cannot tell from information given

MAR

Which choice would be an ideal buffer solution?

A. 0.20 M HCN and 0.10 M KCN
B. 0.20 M HCl and 0.10 M KOH
C. 0.20 M CH_3CO_2H and 0.10 M HCO_2H
D. 0.10 HCl and 0.010 M KCl
E. 0.10 M CH_3OH and 0.10 M NaOH

MAR

What is the pH of a buffer that is composed of 0.20 M NH_4Cl and 0.20 M NH_3? (K_a for NH_4^+ = 5.6×10^{-10})

A. 4.85
B. 5.65
C. 7.00
D. 9.25
E. 10.05

MAR

What is the pH of a buffer that is composed of 0.20 M NH_4Cl and 0.50 M NH_3? (K_a for NH_4^+ = 5.6×10^{-10})

A. 4.75
B. 5.65
C. 7.00
D. 9.25
E. 9.65

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What volume of 0.10 M sodium acetate must be added to 100. mL of 0.10 M acetic acid (K_a = 1.8×10^{-5}) to have a pH of 4.00?

A. 100. mL
B. 50. mL
C. 36 mL
D. 18 mL
E. 9.0 mL

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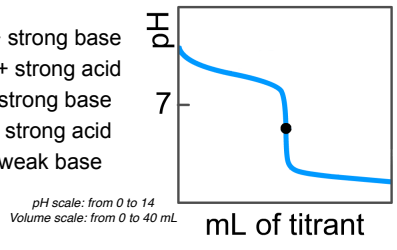
What type of titration does the graph below represent?

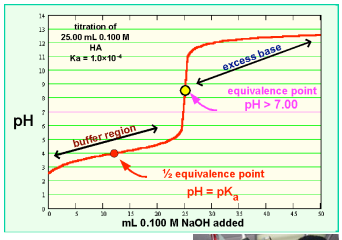
A. strong acid + strong base
B. strong base + strong acid
C. weak acid + strong base
D. weak base + strong acid
E. weak acid + weak base



pH scale: from 0 to 14
Volume scale: from 0 to 40 mL

MAR

End of Review - *good luck with your studying!*



Need more practice?

- *Practice Problem Sets (Companion and online)*
- *Concept Guides (Companion and online)*
- *Chapter Guides (online)*
- *End of Chapter Problems in Textbook (every other question has answer at end)*

Good luck with your studying!

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