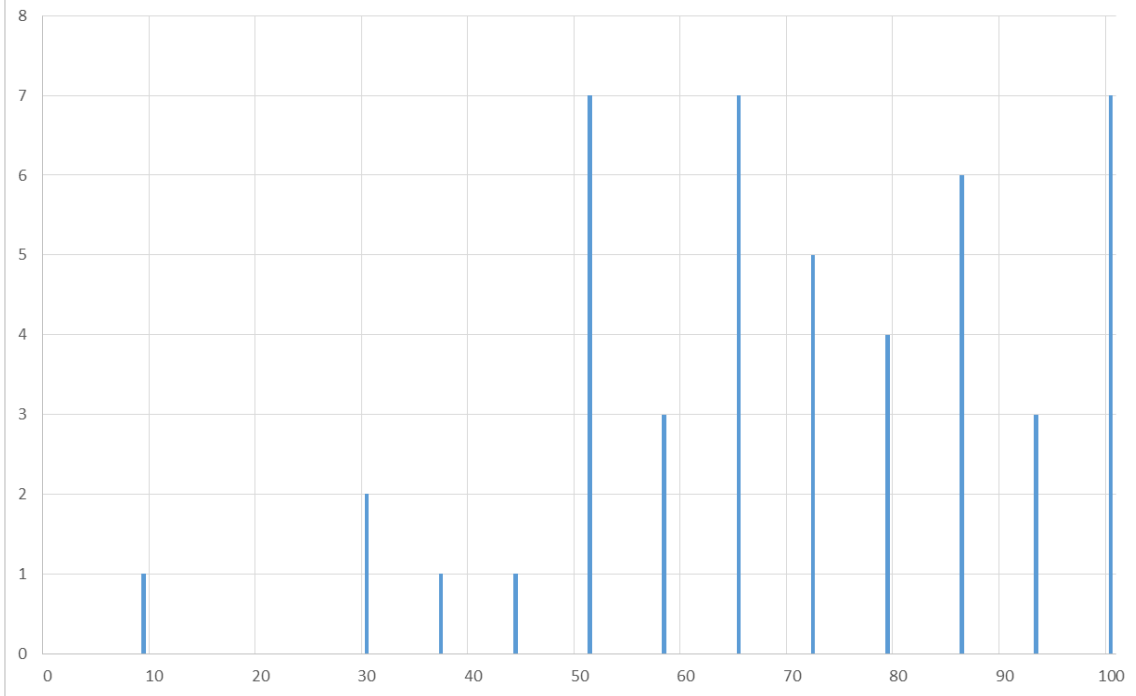


Chem 253 Exam 3 – November 30, 2016
15 Questions, 7 points each for question 1-14
2 points for answering question 15 correctly

DO NOT OPEN THIS EXAM UNTIL YOU ARE INSTRUCTED TO DO SO

- Please print your name on the scantron
Last Name, First Name -- That's all that's needed
- Sit in every other seat as instructed
- Books & Bags in the front of the room.
- No text entry calculators.
- Use the exams as scratch paper.
- Keep the exams when you are done.
- Turn in the scantrons.

Chem 253 2016 Exam 3, avg = 70.4, std dev = 21.7



CLASS Chem253 2016

TEST Exam 3

DATE _____

SCANTRON

ITEM ANALYSIS-

QUESTIONS 1-25

FORM NO. 9702

REORDER ONLY
www.ScantronStore.com

Number of wrong responses

FORMS SCORED	CLASS AVERAGE	ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
46	9.6		4	10	17	10	11	19	24	31	15	11	6	11	11	20	0	0	0	0	0	0	0	0	0	0	0

PASS 1

CUSTOMER SERVICE 1-800-SCANTRON

FEED THIS DIRECTION

© SCANTRON CORPORATION 2011. ALL RIGHTS RESERVED

EW-9702.2-12

Table 13-1 Values of $\alpha_{Y^{4-}}$ for EDTA at 20°C and $\mu = 0.10$ M

pH	$\alpha_{Y^{4-}}$
0	1.3×10^{-23}
1	1.9×10^{-18}
2	3.3×10^{-14}
3	2.6×10^{-11}
4	3.8×10^{-9}
5	3.7×10^{-7}
6	2.3×10^{-5}
7	5.0×10^{-4}
8	5.6×10^{-3}
9	5.4×10^{-2}
10	0.36
11	0.85
12	0.98
13	1.00
14	1.00

Table 13-2 Formation constants for metal-EDTA complexes

Ion	$\log K_f$	Ion	$\log K_f$	Ion	$\log K_f$
Li ⁺	2.79	Mn ³⁺	25.3 (25°C)	Ce ³⁺	15.98
Na ⁺	1.66	Fe ³⁺	25.1	Pr ³⁺	16.40
K ⁺	0.8	Co ³⁺	41.4 (25°C)	Nd ³⁺	16.61
Be ²⁺	9.2	Zr ⁴⁺	29.5	Pm ³⁺	17.0
Mg ²⁺	8.79	Hf ⁴⁺	29.5 ($\mu = 0.2$)	Sm ³⁺	17.14
Ca ²⁺	10.69	VO ²⁺	18.8	Eu ³⁺	17.35
Sr ²⁺	8.73	VO ₂ ⁺	15.55	Gd ³⁺	17.37
Ba ²⁺	7.86	Ag ⁺	7.32	Tb ³⁺	17.93
Ra ²⁺	7.1	Tl ⁺	6.54	Dy ³⁺	18.30
Sc ³⁺	23.1	Pd ²⁺	18.5 (25°C, $\mu = 0.2$)	Ho ³⁺	18.62
Y ³⁺	18.09	Zn ²⁺	16.50	Er ³⁺	18.85
La ³⁺	15.50	Cd ²⁺	16.46	Tm ³⁺	19.32
V ²⁺	12.7	Hg ₂ ²⁺	21.7	Yb ³⁺	19.51
Cr ²⁺	13.6	Sn ²⁺	18.3 ($\mu = 0$)	Lu ³⁺	19.83
Mn ²⁺	13.87	Pb ²⁺	18.04	Am ³⁺	17.8 (25°C)
Fe ²⁺	14.32	Al ³⁺	16.3	Cm ³⁺	18.1 (25°C)
Co ²⁺	16.31	Ga ³⁺	20.3	Bk ³⁺	18.5 (25°C)
Ni ²⁺	18.62	In ³⁺	25.0	Cf ³⁺	18.7 (25°C)
Cu ²⁺	18.80	Tl ³⁺	37.8 ($\mu = 1.0$)	Th ⁴⁺	23.2
Ti ³⁺	21.3 (25°C)	Bi ³⁺	27.8	U ⁴⁺	25.8
V ³⁺	26.0			Np ⁴⁺	24.6 (25°C, $\mu = 1.0$)
Cr ³⁺	23.4				

Table 14-1 Ordered redox potentials

Oxidizing agent	Reducing agent	E° (V)
F ₂ (g) + 2e ⁻ ⇌ 2F ⁻		2.890
O ₃ (g) + 2H ⁺ + 2e ⁻ ⇌ O ₂ (g) + H ₂ O		2.075
⋮		
MnO ₄ ⁻ + 8H ⁺ + 5e ⁻ ⇌ Mn ²⁺ + 4H ₂ O		1.507
⋮		
Ag ⁺ + e ⁻ ⇌ Ag(s)		0.799
⋮		
Cu ²⁺ + 2e ⁻ ⇌ Cu(s)		0.339
⋮		
2H ⁺ + 2e ⁻ ⇌ H ₂ (g)		0.000
⋮		
Cd ²⁺ + 2e ⁻ ⇌ Cd(s)		-0.402
⋮		
K ⁺ + e ⁻ ⇌ K(s)		-2.936
Li ⁺ + e ⁻ ⇌ Li(s)		-3.040

1] What is the fraction of EDTA in the Y⁴⁻ form at pH 8.00? ¹

- a) 0.44
- b) 2.6×10^{-11}
- c) 2.3×10^{-5}
- d) 5.6×10^{-3}
- e) 1.00

2] What is the conditional formation constant of CaEDTA²⁻ at pH 10.00? ²

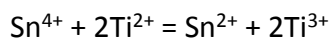
- a) 1.8e10
- b) 10.69
- c) 32
- d) 4.9e-10
- e) 1.6e6

3] The fraction of free metal in the following equilibrium can be expressed as: ³



- a) $\alpha_m = \frac{[M]}{1 + \beta}$
- b) $\alpha_m = \frac{[M]}{1 + \beta[L]}$
- c) $\alpha_m = \frac{1}{1 + \beta[L]}$
- d) $\alpha_m = \frac{1}{1 + \beta[L] + \beta[L]^2}$
- e) $\alpha_m = \frac{1}{1 + \beta}$

4] 18.00 mL of 0.125 M Sn⁴⁺ is titrated with 0.100 M Ti²⁺ in the following reaction:



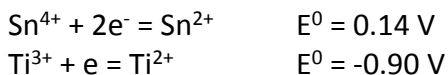
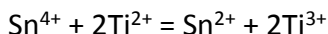
What is the added volume of titrant required to reach the equivalence point? ⁴

- a) 45.0 mL
- b) 22.5 mL
- c) 90.0 mL
- d) 120.0 mL
- e) 12.5 mL

5] Which of the following is true at the equivalence point of problem 4? ⁵

- a) $[\text{Sn}^{4+}] = [\text{Ti}^{2+}]$ & $[\text{Sn}^{2+}] = [\text{Ti}^{3+}]$
- b) $[\text{Sn}^{4+}] = [\text{Ti}^{2+}] = [\text{Sn}^{2+}] = [\text{Ti}^{3+}]$
- c) $4[\text{Sn}^{4+}] = 2[\text{Ti}^{2+}]$ & $2[\text{Sn}^{2+}] = 3[\text{Ti}^{3+}]$
- d) $2[\text{Sn}^{4+}] = [\text{Ti}^{2+}]$ & $2[\text{Sn}^{2+}] = [\text{Ti}^{3+}]$
- e) $[\text{Sn}^{4+}] = 2[\text{Ti}^{2+}]$ & $[\text{Sn}^{2+}] = 2[\text{Ti}^{3+}]$

6] What is the E_{cell} if $[\text{Sn}^{4+}] = 0$, $[\text{Sn}^{2+}] = 1.1 \text{ mM}$, $[\text{Ti}^{2+}] = 0.55 \text{ mM}$ and $[\text{Ti}^{3+}] = 0.55 \text{ mM}$? Assume that the indicator electrode is Pt reference electrode is the S.H.E. ⁶



- a) +0.45 V
- b) -0.90 V
- c) +0.11 V
- d) +1.6 V
- e) -0.67 V

7] What is the K_{sp} of AgCl given the following? ⁷



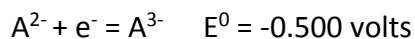
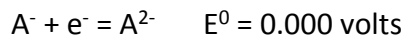
Note that $2.303RT/nF = 0.0592 \text{ V}$.

- a] $6.22e-10$
- b] $4.61e-8$
- c] $8.31e-12$
- d] $2.97e-6$
- e] $1.79e-10$

8] A solution of 50.0-mL of $1.00 \times 10^{-3} \text{ M NiCl}_2(\text{aq})$ is titrated with $1.00 \times 10^{-3} \text{ M EDTA}$ in a solution of 0.100 M NH_3 at pH 11.00. What is pNi if 25.0-mL of the titrant solution is added? Note that $\alpha_{\text{Ni}^{2+}} = 1.34 \times 10^{-4}$ at 0.100 M NH_3 . ⁸

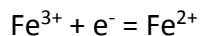
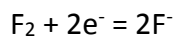
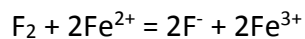
- a) 7.350
- b) 8.442
- c) 5.311
- d) 10.673
- e) 11.995

9] Which of the following species is the strongest oxidizing agent? ⁹



- a) A^-
- b) A
- c) A^{2-}
- d) A^{3-}
- e) e^-

10] What is E^0_{cell} for the reaction below? ¹⁰



$$E^0_{\text{red}} = 2.890 \text{ V}$$

$$E^0_{\text{red}} = 0.771 \text{ V}$$

- a) -2.119 V b) -1.348 V c) 1.348 V d) 0.655 V e) 2.119 V

11] A visible absorption analysis was conducted on a red dye ($\lambda_{\text{max}} = 566 \text{ nm}$). A 1.00 mM standard solution of that dye yields an absorption of 0.455. The absorption in 0.00 mM of that dye is 0.00. An unknown solution of that dye gives an absorption of 0.522. What is the concentration of that red dye in the unknown? ¹¹

- a) 2.31 mM
- b) 0.76 mM
- c) 1.56 mM
- d) 1.15 mM
- e) 0.98 mM

12] A solution of Pb^{2+} analysis in drinking water was conducted by UV absorbance spectroscopy. In the first run a sample of Pb^{2+} gave an absorbance of 0.400. In a second run that sample had the concentration of Pb^{2+} increased by 1.00 ppm and its measured absorbance is now 0.700. What is the concentration of Pb^{2+} in the sample? ¹²

- a) 2.76 ppm
- b) 1.00 ppm
- c) 1.33 ppm
- d) 0.89 ppm
- e) 1.09 ppm

13] A pH electrode responded with a voltage of 0.227 V in a standardized pH 7.000 solution. What is the pH of an unknown if that pH electrode responds with a voltage of 0.363 V? ¹³

- a) 6.551
- b) 2.244
- c) 4.702
- d) 7.824
- e) 5.669

14] The sensitivity in a calibration curve is best expressed as ¹⁴

- a) x-int
- b) y-int
- c) linear range
- d) dynamic range
- e) slope

15] My Chem 254 Lab Section Meets

- a) Mornings at 8:30 am Sec 01
- b) Afternoons at 2:30 pm Sec 02
- c) Evenings at 6:30 pm Sec 03
- d) I am not in a lab this semester

Answers

¹ d

² a: $K_f' = 0.36 \cdot 10^{10.69} = 1.8 \cdot 10^{-10}$

³ c

⁴ a: $18.00 \text{ mL} \cdot 0.125 \text{ M Sn}^{4+} \cdot (2 \text{ mol Ti}^{2+} / \text{mol Sn}^{4+}) \cdot 1 / 0.100 \text{ M Ti}^{2+} = 45.0 \text{ mL}$

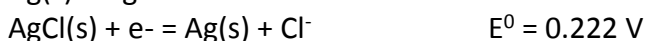
⁵ d

⁶ b) only $\text{Ti}^{2+}/\text{Ti}^{3+}$ governs the electrode potential

$$E = -0.90 \text{ V} + 0.0592 \log 0.55/0.55 = -0.90$$

⁷ e) rxn: $\text{AgCl(s)} = \text{Ag}^+ + \text{Cl}^-$

add the following



$$E_{\text{cell}} = 0.222 - 0.799 \text{ V} = -0.577 \text{ V}$$

$$\Delta G = -RT \ln K_{\text{sp}} = -nFE$$

$$K_{\text{sp}} = 10^{(-0.577/0.0592)} = 1.79 \cdot 10^{-10}$$

⁸ a) Initial mol $\text{Ni}^{2+} = 50.0\text{-mL} \cdot 1.00 \cdot 10^{-3} \text{ M} = 0.0500 \text{ mmol}$
Added mol EDTA = $25.0\text{-mL} \cdot 1.00 \cdot 10^{-3} \text{ M} = 0.0250 \text{ mmol}$

$$\text{Excess Ni}^{2+} = 0.0500 - 0.0250 \text{ mmol} = 0.0250 \text{ mmol}$$

$$C_{\text{Ni}^{2+}} = 0.0250 \text{ mmol} / 75.0\text{-mL} = 3.33 \cdot 10^{-4} \text{ M}$$

$$\text{Free } [\text{Ni}^{2+}] = \alpha_{\text{Ni}^{2+}} C_{\text{Ni}^{2+}} = 1.34 \cdot 10^{-4} \cdot 3.33 \cdot 10^{-4} = 4.47 \cdot 10^{-8} \text{ M}$$

$$\text{pNi} = 7.350$$

⁹ b) A

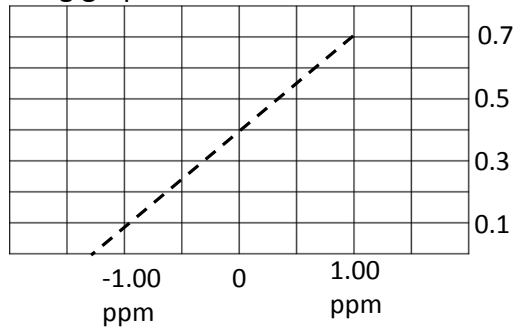
¹⁰ e) $E_{\text{cell}} = E_{\text{cath}} - E_{\text{anod}} = 2.890 - 0.771 = \mathbf{2.119 \text{ V}}$

¹¹ d) $A = \text{ebc} \cdot 0.455 = \text{eb}(1.00 \text{ mM}) \quad \text{eb} = 0.455 \quad \text{Au} = 0.522 = 0.455 \cdot \text{c} \quad \text{c} = 1.15 \text{ mM}$

¹² The slope of the standard addition curve is $0.700 - 0.400 / 1.000 \text{ ppm} = 0.300$

Line is $y = 0.300x + 0.400$ find x-int
 $0 = 0.300x + 0.400$ $x = -1.33$ ppm

Using graph:



¹³ $E = \text{const.} - 0.0592 \text{ pH}$ $0.227 = \text{const.} - 0.0592 * 7.000$ $\text{const.} = 0.6414$
 $0.363 = 0.6414 - 0.0592 \text{ pH}$ $\text{pH} = 4.702$

¹⁴ e: slope