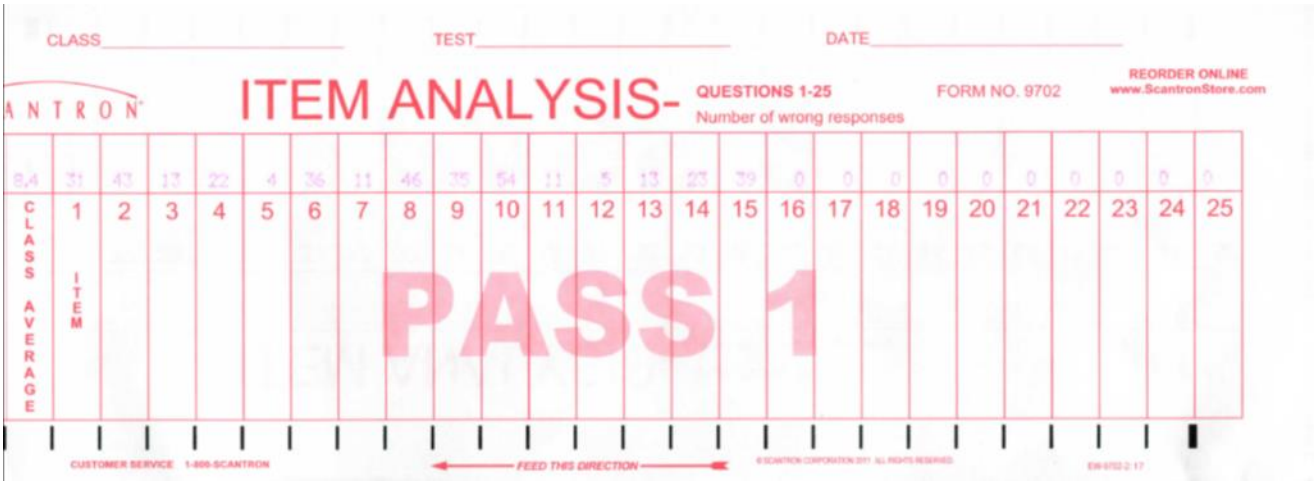
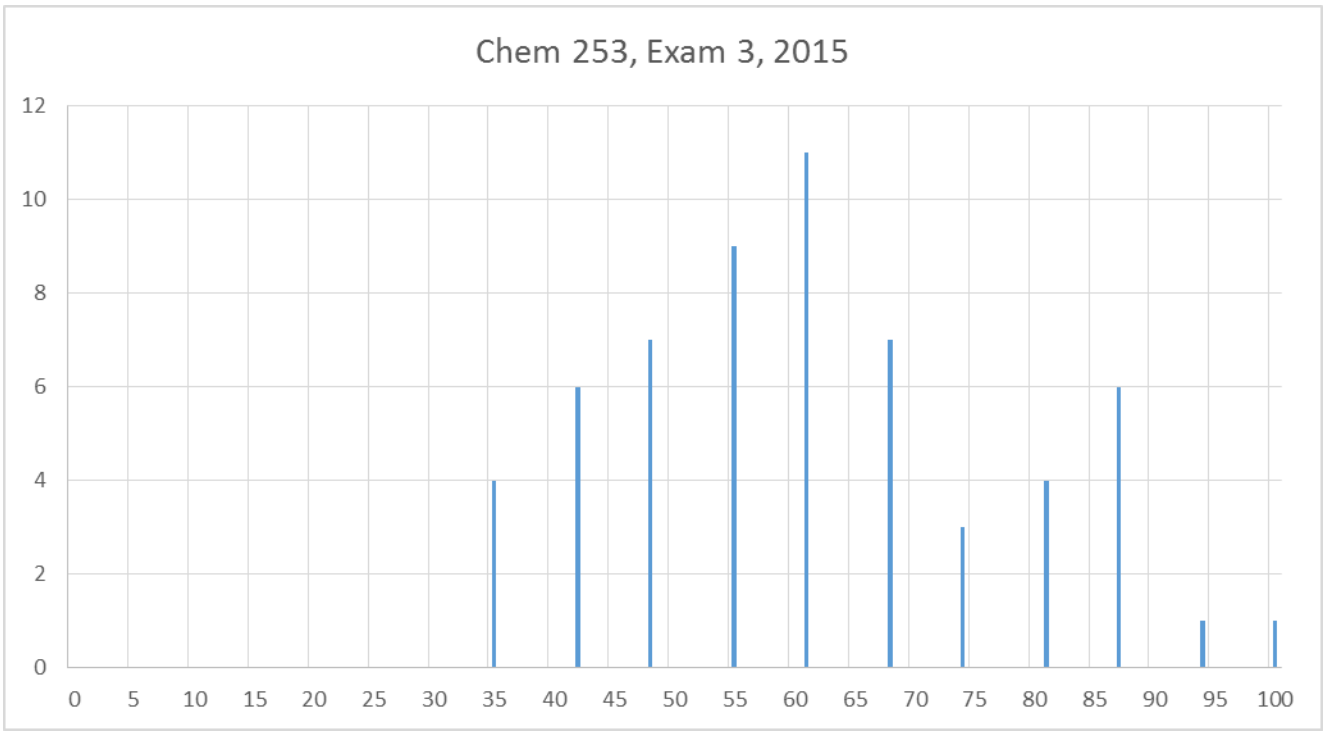
Exam 3 – Chem 253 – December 2, 2015
16 Questions, 6.5 points each for question 1-15
2.5 points for answering question 16 correctly



Frequency



Grade

Average = 61 Std.Dev. = 16

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			Er^{3+}	18.85
La^{3+}	15.50	Zn^{2+}	16.50	Tm^{3+}	19.32
V^{2+}	12.7	Cd^{2+}	16.46	Yb^{3+}	19.51
Cr^{2+}	13.6	Hg^{2+}	21.7	Lu^{3+}	19.83
Mn^{2+}	13.87	Sn^{2+}	18.3 ($\mu = 0$)	Am^{3+}	17.8 (25°C)
Fe^{2+}	14.32	Pb^{2+}	18.04	Cm^{3+}	18.1 (25°C)
Co^{2+}	16.31	Al^{3+}	16.3	Bk^{3+}	18.5 (25°C)
Ni^{2+}	18.62	Ga^{3+}	20.3	Cf^{3+}	18.7 (25°C)
Cu^{2+}	18.80	In^{3+}	25.0	Th^{4+}	23.2
Ti^{3+}	21.3 (25°C)	Tl^{3+}	37.8 ($\mu = 1.0$)	U^{4+}	25.8
V^{3+}	26.0	Bi^{3+}	27.8	Np^{4+}	24.6 (25°C, $\mu = 1.0$)
Cr^{3+}	23.4				

APPENDIX I

Formation Constants*

Reacting ions	log β_1	log β_2	log β_3	log β_4	log β_5	log β_6	Temperature (°C)	Ionic strength (μ, M)
Ammonia, NH_3								
Ag^+	3.31	7.23					25	0
Cd^{2+}	2.51	4.47	5.77	6.56			30	0
Co^{2+}	1.99	3.50	4.43	5.07	5.13	4.39	30	0
Cu^{2+}	3.99	7.33	10.06	12.03			30	0
Hg^{2+}	8.8	17.5	18.50	19.28			22	2
Ni^{2+}	2.67	4.79	6.40	7.47	8.10	8.01	30	0
Zn^{2+}	2.18	4.43	6.74	8.70			30	0

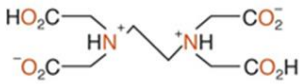
1] The relationship between transmittance and absorbance is

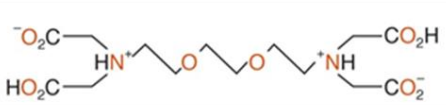
a) $T = -\log A$
b) $A = -\log(T)$
c) $A = -\log(T_o/T)$
d) $T = -\log(A_o/A)$
e) $T = -\log(A/A_o)$

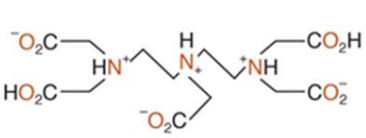
2] Absorbances at λ = 546 nm were measured for a sample (A = 0.332) and that sample with a 0.050 mM analyte (A = 0.488). What is the concentration of analyte?

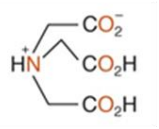
a) 0.072 mM
b) 0.120 mM
c) 0.040 mM
d) 0.211 mM
e) 0.106 mM

3] The structure of EDTA is

A 

C 

B 

D 

4] What is the concentration of Ca^{2+} if we dissolved 0.100 M CaY^{2-} at pH 7.00?

a) 7.4×10^{-6} M
b) 9.9×10^{-6} M
c) 9.4×10^{-5} M
d) 6.5×10^{-5} M
e) 8.3×10^{-5} M

5] Which of the following allows the calculation of α_M for Ag^+ in 0.100 M NH_3 at pH 6.50?

a) $\alpha_M = \frac{1}{1+\beta_1[NH_3]+\beta_2[NH_3]^2}$

b) $\frac{1}{\alpha_M} = 1 + \frac{\beta_2\beta_1}{[H^+]^2}$

c) $\alpha_M = \frac{1+\beta_1[NH_3]+\beta_2[NH_3]^2}{1}$

d) $\alpha_M = \frac{1+\beta_1[NH_3]}{1}$

e) $\frac{1}{\alpha_M} = 1 + \frac{1}{\beta_2\beta_1[NH_3]^2}$

6] Which of the following species is the strongest reducing agent?

	$\Delta E_o'$ (volts)
$NAD^+ + 2H^+ + 2\ e^- \longrightarrow NADH + H^+$	-0.320
$OAA + 2H^+ + 2\ e^- \longrightarrow$ malate	-0.166
fumarate $+ 2H^+ + 2\ e^- \rightarrow$ succinate	+0.031
$1/2\ O_2 + 2H^+ + 2\ e^- \longrightarrow H_2O$	+0.816

a) H_2O
b) NAD^+
c) H^+
d) NADH
e) O_2

7] A pH electrode responded with a voltage of 0.433 V in a standardized pH 4.01 solution. What is the pH of an unknown if that pH electrode responds with a voltage of 0.257V?

a) 7.44
b) 6.21
c) 6.98
d) 8.45
e) 9.11

8] What is the cell potential between a Pt electrode and SCE when 5.00 mL of 0.0100 M Fe^{3+} is added to 5.00 mL of 0.0100 M Sn^{2+}?

$Fe^{3+} + e^- = Fe^{2+}$ $\quad E^0 = 0.77$ V

$Sn^{4+} + 2e^- = Sn^{2+}$ $\quad E^0 = 0.14$ V

a) 0.14 - E_{SCE}
b) 0.77 - E_{SCE}
c) 0.14 + E_{SCE}
d) 0.91 + E_{SCE}
e) 0.23 - E_{SCE}

9] What is the cell potential between a Pt electrode and SCE when 5.00 mL of 0.0100 M Fe^{3+} is added to 1.25 mL of 0.0100 M Sn^{2+}?

a) 0.14 - E_{SCE}
b) 0.42 + E_{SCE}
c) 0.14 + E_{SCE}
d) 0.77 - E_{SCE}
e) 0.85 - E_{SCE}

10] At the equivalence point which of the following is true?

a) $[Fe^{3+}] = 2\,[Sn^{2+}]$
b) $2\,[Fe^{3+}] = [Sn^{2+}]$
c) $[Fe^{3+}] = [Sn^{2+}]^{1/2}$
d) $[Fe^{3+}] = 2\,[Sn^{4+}]$
e) $2\,[Fe^{3+}] = [Sn^{4+}]$

11] Oxidations take place at the

a) reference electrode
b) anode
c) cathode
d) galvanic
e) voltaic

12] The purpose of a reference electrode is to …..

a) to prevent mixing of the electrolyte solution.	b) to provide a means of ionic transport between the anode and cathode	c) to enable the reductive process at the anode.	d) to provide a stable potential in which an electrode reaction can be compared to known redox reaction.	e) to provide a stable source of current.

13] It is advantageous to conduct EDTA titrations of metal ions in

a) acidic pH's to assist metal ion hydrolysis
b) basic pH's to prevent metal ion hydrolysis
c) basic pH's to maximize Y^{4-} fraction
d) basic pH's to minimize Y^{4-} fraction
e) acidic pH's to maximize Y^{4-} fraction

14] When considering separation column length (L) and resolution (Rs) in chromatography which of the following is true?

a) Longer columns increase resolution where $Rs \propto L^{1/2}$
b) A longer column is always better.
c) Longer columns increase resolution where $L \propto Rs$
d) Longer columns increase resolution where $Rs \propto L^{2}$
e) Longer columns increase resolution where $L \propto Rs^{2/3}$

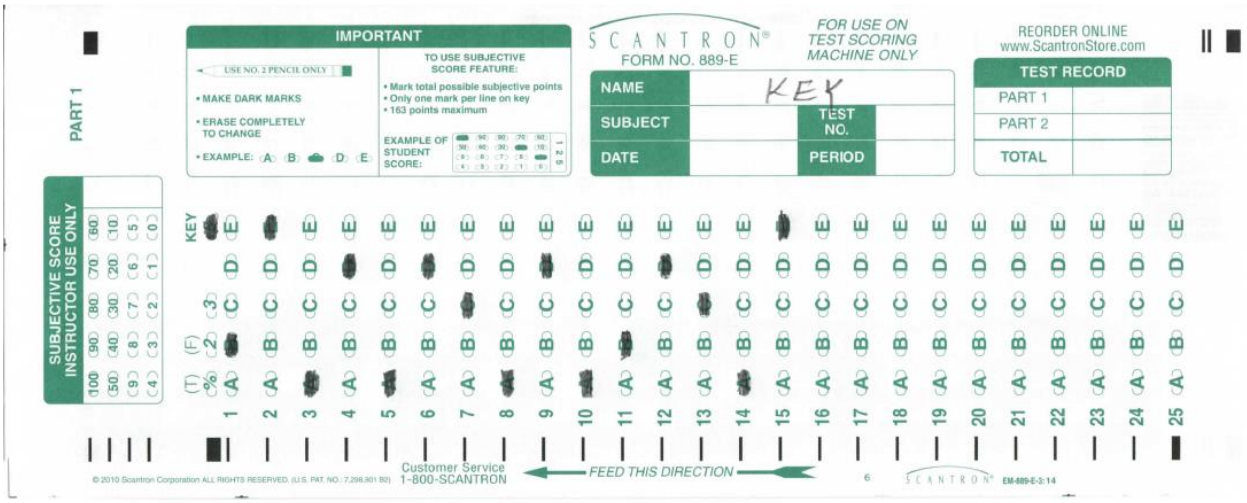
15] When considering mobile phase flow rate which is true?

a) Faster mobile phase flow rate is always better.
b) Slower mobile phase flow rate is always better.
c) Faster flow rate will decrease band spreading due to mass transfer effects.
d) Slower flow rate will decrease band spreading due to longitudinal diffusion.
e) Slower flow rate will decrease band spreading due to mass transfer effects.

16] 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



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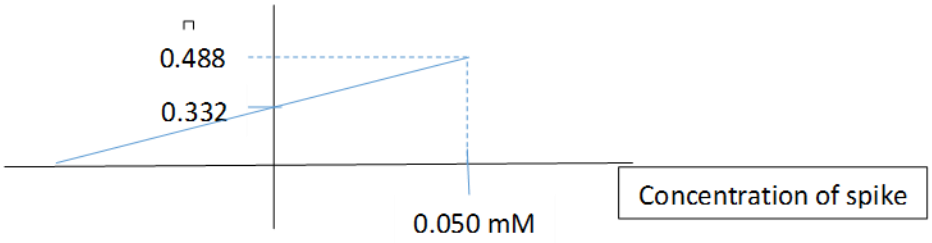

Find x-int. y = {(0.488-0.332)/0.050}x + 0.332

x-int = 0.106 mM

4] What is the concentration of Ca^{2+} if we dissolved 0.100 M CaY^{2-} at pH 7.00?

α_{Y4-} at pH = 5.0e-4 $K_f' = 5.0e\text{-}4(10^{10.69}) = 2.4e7$

CaY^{2-} =	Ca^{2+} +	EDTA
0.100 M	0	0
-x	+x	+x

$2.4e7 = (0.100 - x)/x^2 = \cong 0.100 / x^2$

x = 6.5e-5 M

7] A pH electrode responded with a voltage of 0.433 V in a standardized pH 4.01 solution. What is the pH of an unknown if that pH electrode responds with a voltage of 0.257V?

$E = const - 0.0592pH$ $0.433 = const - 0.0592(4.01)$ const = 0.670

$0.257 = 0.670 - 0.0592pH$ pH = 6.98

8] What is the cell potential between a Pt electrode and SCE when 5.00 mL of 0.0100 M Fe^{3+} is added to 5.00 mL of 0.0100 M Sn^{2+}?

$Fe^{3+} + e^- = Fe^{2+}$ $E^0 = 0.77$ V

$Sn^{4+} + 2e^- = Sn^{2+}$ $E^0 = 0.14$ V

5.00 mL (0.0100 M Fe^{3+}) = 0.0500 mmol Fe^{3+}

5.00 mL (0.0100 M Sn^{2+}) = 0.0500 mmol Sn^{2+}

Redox Rxn:	$2Fe^{3+}$	+ Sn^{2+} =	$2Fe^{2+}$	+ Sn^{4+}
	0.0500	0.0500 mmol	0	0
	-2*0.0250	-0.0250	+2*0.0250	+0.0250 mmol
	0	0.0250	0.0500	0.0250 mmol

The Pt electrode will be governed by the Sn^{2+}/Sn^{4+} ratio in the Nernst Eqn.

$E = 0.14 - 0.0592 \log [Sn^{2+}]/[Sn^{4+}] = 0.14 - 0.0592 \log (1) = 0.14$

$E_{cell} = 0.14 - E_{SCE}$

9] What is the cell potential between a Pt electrode and SCE when 5.00 mL of 0.0100 M Fe^{3+} is added to 1.25 mL of 0.0100 M Sn^{2+}?

5.00 mL (0.0100 M Fe^{3+}) = 0.0500 mmol Fe^{3+}

1.25 mL (0.0100 M Sn^{2+}) = 0.0125 mmol Sn^{2+}

Redox Rxn:	$2Fe^{3+}$	+ Sn^{2+} =	$2Fe^{2+}$	+ Sn^{4+}
	0.0500	0.01250 mmol	0	0
	-2*0.0125	-0.0125	+2*0.0125	+0.0125 mmol
	0.0250	0.00	0.0250	0.0125 mmol

The Pt electrode will be governed by the Fe^{2+}/Fe^{3+} ratio in the Nernst Eqn.

$E = 0.77 - 0.0592 \log [Fe^{2+}]/[Fe^{3+}] = 0.77 - 0.0592 \log (1) = 0.77$

$E_{cell} = 0.77 - E_{SCE}$