

NOTE: Your final exam will be multiple choice.

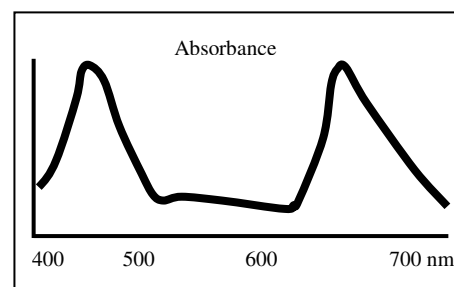
Experiment 8: Acids, Bases, Salts, and Buffers

- Find the pH of a 0.10 M OCl^- solution. K_a of HOCl is 3.0×10^{-8} .
10.26
- Find the pH of a buffer that is 0.150 M lactic acid ($\text{HC}_3\text{H}_5\text{O}_3$, "HLc") and 0.130 M sodium lactate ($\text{NaC}_3\text{H}_5\text{O}_3$, "NaLc"). K_a for HLc = 1.4×10^{-4} .
3.79
- Why acid & base solutions often test more acidic than expected in lab?
 CO_2 gas from the air dissolves into the solution to generate weak carbonic acid, H_2CO_3 .
- Can an aqueous mixture of HCl/NaCl be used as a buffer? **NO**
Can an aqueous mixture of $\text{HC}_2\text{H}_3\text{O}_2/\text{NaC}_2\text{H}_3\text{O}_2$ be used as a buffer? **YES**
- Calculate the pH of the solution formed after 25 mL of a 0.10 M NaOH solution is added to 100 mL 0.10 M HOCl solution.
7.05

Experiment 9: Beer's Law and Allura Red

$A = -\log T = \epsilon bc$, where b = pathlength
 c = concentration

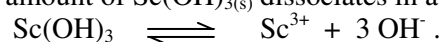
The absorbance spectrum of a green dye used in KoolAid® is shown:



- A student wishes to determine the amount of dye in a KoolAid® solution of unknown concentration. At what wavelength should the student conduct the absorbance experiments?
450 nm because the dye absorbs strongly
- The slope of a Beer's Law plot (absorbance vs. concentration) taken at a particular wavelength in a cell with pathlength = 1.25 cm was found to be $(3.25 \text{ absorbance units}) / (1.0 \times 10^{-4} \text{ M})$. What is the value of ϵ , the extinction coefficient?
26000 absorbance units/cm·M
- What is the concentration of KoolAid® with an absorbance of 0.1625 in a 1.05 cm pathlength cell?
 $6.0 \times 10^{-6} \text{ M}$

Experiment 10: Solubility Product Constant, K_{sp} , by Titration

Scandium hydroxide, $\text{Sc}(\text{OH})_3$, is quite insoluble in water. If we neglect any complex ion formation, a small amount of $\text{Sc}(\text{OH})_{3(s)}$ dissociates in a saturated solution according to the expression:



The solubility product constant, K_{sp} , for the dissociation is 4.2×10^{-18} at 25°C . $K_{sp} = [\text{Sc}^{3+}][\text{OH}^-]^3$

- Express $[\text{Sc}^{3+}]$ in terms of $[\text{OH}^-]$ only.
 $[\text{Sc}^{3+}] = 1/3[\text{OH}^-]$
- What is $[\text{OH}^-]$ in a saturated solution at 25°C ?
 $6.0 \times 10^{-5} \text{ M}$

A student titrates a saturated solution of a metal-hydroxide salt that dissociates according to the equilibrium:
 $M(OH)_3 \rightleftharpoons M^{3+} + 3 OH^-$. $K_{sp} = [M^{3+}][OH^-]^3$

11. If 50.0 mL of the saturated solution is neutralized by an average of 10.6 mL of 0.125 M HCl, $[OH^-]$ is 0.0265 M. What is the value of K_{sp} for this salt? Recall that $[OH^-] = 3[M^{3+}]$.
 $1.67 \times 10^{-7} M$

Experiment 11: Spectroscopic Determination of K_{eq}

Two reactants, A and B react in a one-to-one ratio to form an equilibrium mixture with the product, C. C absorbs 560 nm light with a molar extinction coefficient of 6400 L/mol·cm.

4.00 mL of a $1.25 \times 10^{-4} M$ solution of A are mixed with 6.00 mL of a $1.25 \times 10^{-4} M$ solution of B.

12. What is the initial concentration of A in the mixture (prior to equilibrium)?
 $5.00 \times 10^{-5} M$
13. What is the initial concentration of B in the mixture (prior to equilibrium)?
 $7.50 \times 10^{-5} M$

The mixture of A and B comes to equilibrium. The percent transmittance, %T, is measured at 65.5% in a 1.1 cm cell.

14. What is the absorbance, A? $A = -\log T = \epsilon bc$
0.183

15. What is the concentration of C in mol/L in the equilibrium mixture?
 $2.61 \times 10^{-5} M$

16. What is the value of the equilibrium constant, K_{eq} ? $A + B \rightleftharpoons C$ $K_{eq} = \frac{[Product]^{coefficient} \times \dots}{[Reactant]^{coefficient} \times \dots}$

	A	B	C
Initial concentrations?			
Change in each concentration?			
Final concentrations?			

$K_{eq} = 2.22 \times 10^4$

Experiment 12: Kinetics

The reaction between A^- and B^- was investigated: $A^- + B^- \rightarrow C^{2-}$. For the given concentrations of A^- and B^- , the following rate data were collected. $Rate = k[A^-]^m[B^-]^n$.

The order of reaction, m, with respect to A^- is found to be 2; with respect to B^- , n is found to be 3.

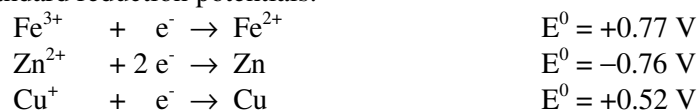
17. Using the data for run 1, calculate the value of k, the rate constant (don't worry about units).

1.25×10^7

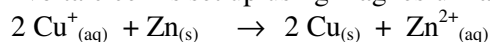
Run	$[A^-], M$	$[B^-], M$	Rate, M/s
1	2.00×10^{-3}	2.00×10^{-3}	4.00×10^{-7}

Experiment 13: Solubility Product Constant, K_{sp} , by Electrochemistry

Standard reduction potentials:



A voltaic cell is set up using magnesium and silver and the following reaction occurs:



18. What is the standard cell potential, E° ?

+1.28 V

19. If the Zn^{2+} concentration is 0.050 M and the Cu^{+} concentration is 0.025 M, what is the cell potential, E ?

+1.22 V
$$E = E^{\circ} - \left(\frac{0.0591 \text{ V}}{n} \right) \log Q$$

A second cell is set up according to the equation: $2 \text{Fe}^{3+}_{(\text{aq})} + \text{Zn}_{(\text{s})} \rightarrow 2 \text{Fe}^{2+}_{(\text{aq})} + \text{Zn}^{2+}_{(\text{aq})}$

20. What is the value of the equilibrium constant, K , under standard conditions?

5.98×10^{51}
$$E^{\circ} = \left(\frac{0.0591 \text{ V}}{n} \right) \log K$$

Experiment 14: Vitamic C Determination by Redox

A new vitamin drink, Vito-Aide, is coming to market, and it is your job to ensure that every 20.0 g serving contains at least 35% of the US RDA of vitamin C (ascorbic acid, 176.1 g/mol; RDA 60 mg/day).

Using a 5.00×10^{-3} M DCP solution, you perform multiple redox titrations. On average, you find that one serving (20.0 g) of Vito-Aide requires 25.12 mL of DCP solution.

21. What is 35% of the US RDA for vitamin C?

21 mg

22. How many milligrams of vitamin C are in each 20.0 g serving of Vito-Aide (1 mol DCP is required for every mol vitamin C)?

22.1 mg

23. On one of your titrations, you fail to reach the endpoint by adding too little DCP. How will this affect your calculated amount of vitamin C in the sample?

Too low

1
1A

18
8A

1 H Hydrogen 1.008	2 He Helium 4.003											13 3A	14 4A	15 5A	16 6A	17 7A	
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.30	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.84	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.95	43 Tc Technetium 97.91	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3	57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0	
87 Fr Francium 223	88 Ra Radium 226	89 Ac Actinium 227	104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 263	107 Bh Bohrium 262	108 Hs Hassium 265	109 Mt Meitnerium 266	110 Ds Darmstadtium 269	111 Uuu Ununium 272	112 Uub Ununbium 277	113	114 Uuq Ununquadium 289	115	116 Uuh Ununhexium 289	117	118 Uuo Ununoctium 293

Lanthanides

58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium 237	94 Pu Plutonium 244	95 Am Americium 243	96 Cm Curium 247	97 Bk Berkelium 247	98 Cf Californium 251	99 Es Einsteinium 252	100 Fm Fermium 257	101 Md Mendelevium 258	102 No Nobelium 259	103 Lr Lawrencium 262

Actinides