

# CHEM 6BL PRACTICE FINAL EXAM

## IMPORTANT STUDY RECOMMENDATIONS

In order to be best prepared for your upcoming final exam, which covers experiments 4A-6, make sure you review the following items:

- Pre- and postlab questions
- Lecture notes and exercises included in the lecture notes
- Important lab calculations from your lab reports
- Important background information and concepts covered in the lab manual
- The practice exam provided in the next pages of this document (contains the answer key in addition to all the extra pages that would be provided in a normal exam).

## EXAM REVIEW SESSION(S)

TBA by instructor/TA

## EXAM COURSE POLICIES

Please review the exam course policies, including all exam dates in the course syllabus. Your final exam will be given on the last day/time of lecture on **WEEK 10**. **VERY IMPORTANT: No other final exam will be administered** in this laboratory class on the week of final exams.

As specified in the syllabus, several lab sections may be scheduled to take their exam in an overflow exam room (section assignment/location TBA by instructor/TA).

**CHEM 6BL Practice Final Exam**  
**FORM A**  
**University of California, San Diego**

**Please complete and sign**

I pledge that I have not used any unauthorized material on this exam. In addition, I have not provided anyone with unauthorized assistance.

\_\_\_\_\_  
Full Name (printed)

UCSD ID#: \_\_\_\_\_

\_\_\_\_\_  
Name (signature)

\_\_\_\_\_  
Lab Section #

\_\_\_\_\_  
TA Name

**DIRECTIONS**

**BEFORE THE START THE EXAM**

- You must use a **#2 lead pencil** (*not* a pen!). Only materials allowed on your desk in addition to the exam materials provided by the instructor: pencils, erasers, a non-graphing, non-programmable calculator, your **UCSD ID** (required!!!!!!)
- **SCANTRON INFO REQUIRED FOR YOUR TEST TO BE SCORED CORRECTLY: you must blacken the circle for "TEST FORM" ⒸAⓃ!** Your test will not be rescored if you enter the wrong test form letter!!!
- **SCANTRON INFO REQUIRED FOR YOUR TEST TO BE SCORED:** Write your **student ID #** into the boxes below the "ID NUMBER" field with the last digit in the last box. Next, darken the bubbles in the corresponding ID fields. Note: **"A" = "1"**
- **SCANTRON INFO REQUIRED:** Write your **Full Name** and **Lab Section #** (in *Hour/Day*)

**DURING THE EXAM**

- Use **only SIDE 1** of the Scantron® sheet. When you have selected your answer, blacken the corresponding space on the answer sheet
- Any question for which more than one response has been blackened (i.e. "overvoting") **will not be counted**

**AT THE END OF THE EXAM**

- VERIFY THAT YOUR STATEMENT OF ACADEMIC INTEGRITY IS SIGNED (on top of this page)
- You **will not** be allowed to take your examination booklet with you when you leave the testing room. **TURN IN YOUR SCANTRON AND THIS EXAM**

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**DO NOT TURN THIS PAGE UNTIL YOU ARE  
INSTRUCTED TO DO SO!!!!!!!!!!**

***KEEP YOUR EXAM COVERED AT ALL TIMES!!!!!!***

(150 points)

Section #: \_\_\_ TA: \_\_\_\_\_

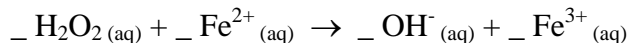
Select the letter corresponding to the best answer for each question. Once you have selected your answer, blacken the corresponding space on your Scantron sheet.

"Short" Questions (7 points each):

- In a "Beer's Law" (absorbance vs. concentration) plot, the slope of the line of the "standard" points is equal to:  
a)  $\epsilon$                       b)  $b$                       c)  $\epsilon \times b$                       d)  $1/c$                       e)  $1/\epsilon$
- In the  $K_{sp}$  formula for  $\text{AgCl}_{(s)}$ , why does the concentration of  $\text{AgCl}_{(s)}$  not matter?  
a) Because  $\text{AgCl}_{(s)}$  is the product and it is solid, so it drops out of the  $K_{eq}$  formula  
b) Because  $\text{AgCl}_{(s)}$  is the reactant and it is solid, so it drops out of the  $K_{eq}$  formula  
c) Because being a solid,  $\text{AgCl}_{(s)}$  does not have a "concentration"  
d) a & c  
e) b & c
- If the absorbance of a  $\text{Cr}^{3+}$  complex is 0.479, what is its % transmittance?  
a) 3.01%                      b) 33.2%                      c) 0.332%                      d) 0.0301%                      e) 52.1%
- Using your knowledge of salt solubility chemistry, which of the following metal ions is the only one that will be precipitated by  $\text{S}^{2-}$  even in strongly acidic (aqueous) conditions?  
a)  $\text{Cr}^{3+}$                       b)  $\text{Mn}^{2+}$                       c)  $\text{Ni}^{2+}$                       d)  $\text{Sn}^{4+}$                       e)  $\text{Fe}^{3+}$
- Green light has a wavelength of about 525 nm, yellow light has a wavelength of about 579 nm and red about 690 nm. Fill in the blanks: of these, \_\_\_\_\_ light has the highest energy and \_\_\_\_\_ light has the lowest frequency.  
a) Yellow                      Green  
b) Red                      Green  
c) Green                      Red  
d) Red                      Yellow  
e) Green                      Yellow
- In which of the following compounds is cobalt in the highest oxidation state?  
a)  $[\text{Co}(\text{NH}_3)_6]\text{Cl}_2$                       b)  $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$                       c)  $\text{Na}_2[\text{CoCl}_4]$   
d)  $\text{K}_4[\text{CoF}_6]$                       e)  $\text{Na}_2[\text{Co}(\text{NH}_3)_2\text{Cl}_4]$

"Long" Questions (15 points each):

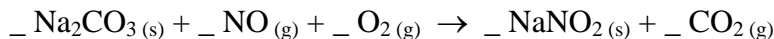
- 7) A total of 17.34 mL of 0.122 M  $\text{H}_2\text{O}_2$  titrant is required to completely neutralize 25.00 mL of an unknown concentration of  $\text{Fe}^{2+}$  in *basic* aqueous solution according to the generalized redox reaction formula:



Based on the balanced form of this redox reaction formula, what is the initial concentration of the  $\text{Fe}^{2+}(\text{aq})$  solution? (Molar masses -  $\text{H}_2\text{O}_2$ : 34.02 g/mol,  $\text{Fe}^{2+}$ : 55.85 g/mol)

- a) 0.169 M      b) 0.0425 M      c) 0.176 M      d) 0.00212 M      e) 0.0846 M
- 8) Using an old spectrophotometer, you once determined that the molar absorptivity of a  $5.00 \times 10^{-5}$  M standard solution of a Ni complex was  $1.22 \times 10^4 \text{ M}^{-1}\text{cm}^{-1}$  at 750 nm. However, your lab just received a new spectrophotometer and you do not know what the pathlength of the cell is. You use your new spectrophotometer to measure the transmittance of the  $5.00 \times 10^{-5}$  M standard solution of the Ni complex and obtain a transmittance value of 9.7%. What is the pathlength of the cell in this new spectrophotometer?
- a) 1.7 cm      b) 0.16 cm      c) 17 cm      d) 0.62 cm      e) 0.059 cm
- 9) What is the solubility of mercury,  $\text{Hg}_2^{2+}$ , in a solution of 0.045 M  $\text{HBr}(\text{aq})$  knowing that  $K_{\text{sp}}(\text{Hg}_2\text{Br}_2) = 1.3 \times 10^{-21}$ ?
- a)  $6.4 \times 10^{-19}$  M      b)  $1.9 \times 10^{-22}$  M      c)  $1.3 \times 10^{-21}$  M  
d)  $2.7 \times 10^{-24}$  M      e)  $2.9 \times 10^{-20}$  M
- 10) You calculate that the  $n = 6$  to  $n = 3$  transition in hydrogen will generate a photon with a wavelength of 1090 nm. Will this photon be visible to the eye and what will the energy of this photon be? ( $R_{\text{H}} = 3.29 \times 10^{15}$  Hz)
- a) no, 109 kJ      b) yes,  $2.42 \times 10^{-32}$  J      c) no,  $1.82 \times 10^{-19}$  J  
d) yes,  $6.06 \times 10^{-28}$  J      e) no,  $1.82 \times 10^{-28}$  J

- 11) A reaction between 470 g of  $\text{Na}_2\text{CO}_3$ , 235 g of NO and 105 g of  $\text{O}_2$  takes place, resulting in the formation of 130 g of carbon dioxide ( $\text{CO}_2$ ) gas via the following chemical reaction:



What is the % yield of this reaction? (Hint: Balance the reaction equation first!  $\text{Na}_2\text{CO}_3$ : 105.99 g/mol, NO: 30.01 g/mol,  $\text{O}_2$ : 32.00 g/mol,  $\text{NaNO}_2$ : 69.00 g/mol, and  $\text{CO}_2$ : 44.01 g/mol)

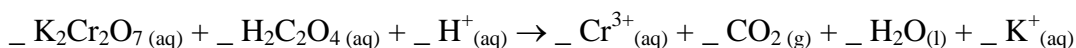
- a) 45.0%      b) 66.6%      c) 37.7%      d) 90.0%      e) 75.4%

Two-Part Question (33 points total):

An analytical chemist is given 1.546 g of a solid coordination complex that definitely contains a  $\text{Co}_x(\text{C}_2\text{O}_4)_y$  complex (with the Co in the  $\text{Co}^{2+}$  oxidation state) and Li counterions, and possibly also water. His mission is to determine its correct empirical formula.

12) Part I (18 points). He takes the  $\text{Co}_x(\text{C}_2\text{O}_4)_y$  solid and chips off a 0.5103 g solid sample. He manages to dissolve this sample into a solution of about 150 mL of 2 M sulfuric acid. He then titrates a 0.101 M solution of  $\text{K}_2\text{Cr}_2\text{O}_7$  into this  $\text{Co}_x(\text{C}_2\text{O}_4)_y$  analyte solution. The analyte solution remains colorless until the endpoint, at which point it turns yellow. The volume of 0.101 M  $\text{K}_2\text{Cr}_2\text{O}_7$  solution titrated in this experiment is 11.00 mL. What is the weight % of oxalate in the original sample and what is the mmol of oxalate/100.0 g of complex?

(Molar masses -  $\text{K}^+$ : 39.10 g/mol,  $\text{Cr}_2\text{O}_7^{2-}$ : 216.00 g/mol,  $\text{H}^+$ : 1.008 g/mol,  $\text{C}_2\text{O}_4^{2-}$ : 88.02 g/mol,  $\text{H}_2\text{O}$ : 18.02 g/mol) Remember to first balance the following equation:



- a) 7.67 wt% & 87.1 mmol                      b) 47.9 wt% & 544 mmol  
c) 19.2 wt% & 218 mmol                      d) 57.5 wt% & 654 mmol  
e) 6.39 wt% & 72.6 mmol

13) Part II (15 points) - After thinking it over, the analytical chemist decides that a precipitation would be more accurate (and easier) than spectrophotometry. Hence, he dissolves a 0.5168 g sample of  $\text{Co}_x(\text{C}_2\text{O}_4)_y$  in 100.0 mL of aqueous solution and makes sure the  $\text{Co}^{2+}$  is freed from the  $\text{Co}_x(\text{C}_2\text{O}_4)_y$  with the addition of acid. He then adds an excess of ammonium phosphate,  $(\text{NH}_4)_3\text{PO}_4$ , resulting in the precipitation of a red solid powder. Once completely dried, the mass of the red solid powder of  $\text{Co}_3(\text{PO}_4)_2$  is measured to be 0.1356 g. Determine the amount of  $\text{Co}^{2+}$  in the original sample.

From the determination of the amount of  $\text{Co}^{2+}$  in the original  $\text{Co}_x(\text{C}_2\text{O}_4)_y$  complex and your answer for  $\text{C}_2\text{O}_4^{2-}$  in Question 12) above, which one of the following answers appears to be the full empirical formula?

(Molar Masses -  $\text{Li}^+$ : 6.94 g/mol;  $\text{Co}^{2+}$ : 58.93 g/mol,  $\text{PO}_4^{3-}$ : 94.97 g/mol,  $\text{H}_2\text{O}$ : 18.02 g/mol;  $K_{\text{sp}}(\text{Co}_3(\text{PO}_4)_2) = 2.05 \times 10^{-35}$ ) Remember to first balance the precipitation equation!

- a)  $\text{Li}_6[\text{Co}_2(\text{C}_2\text{O}_4)_6] \cdot 13\text{H}_2\text{O}$                       b)  $\text{Li}_6[\text{Co}_2(\text{C}_2\text{O}_4)_5] \cdot 18\text{H}_2\text{O}$   
c)  $\text{Li}_3[\text{Co}(\text{C}_2\text{O}_4)_3] \cdot 6\text{H}_2\text{O}$                       d)  $\text{Li}_{16}[\text{Co}(\text{C}_2\text{O}_4)_9] \cdot 24\text{H}_2\text{O}$   
e)  $\text{Li}_4[\text{Co}(\text{C}_2\text{O}_4)_3] \cdot 6\text{H}_2\text{O}$

***The answer key to this practice exam is provided on Page 9***

***Note: Pages 6-8 are provided with any regular 6BL exam***

# Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
hydrogen 1 1.00794(7)	helium 2 4.002602(2)	lithium 3 6.941(2)	beryllium 4 9.012182(3)	boron 5 10.811(7)	carbon 6 12.0107(8)	nitrogen 7 14.00643(4)	oxygen 8 15.9994(3)	fluorine 9 18.9984032(5)	neon 10 20.1797(6)	sodium 11 22.98976928(2)	magnesium 12 24.3046(7)	aluminum 13 26.9815385(3)	silicon 14 28.0855(3)	phosphorus 15 30.973761(2)	sulfur 16 32.06(6)	chlorine 17 35.4527(8)	argon 18 39.948(1)
potassium 19 39.0983(1)	calcium 20 40.078(4)	scandium 21 44.955910(8)	titanium 22 47.867(1)	vanadium 23 50.9415(1)	chromium 24 51.9961(6)	manganese 25 54.938049(9)	iron 26 55.845(2)	cobalt 27 58.933200(9)	nickel 28 58.6934(2)	copper 29 63.546(3)	zinc 30 65.39(2)	gallium 31 69.723(1)	germanium 32 72.631(2)	arsenic 33 74.92160(2)	selenium 34 78.96(3)	bromine 35 79.904(1)	krypton 36 83.80(1)
rubidium 37 85.4678(3)	strontium 38 87.62(1)	yttrium 39 88.90585(2)	zirconium 40 91.224(2)	niobium 41 92.90638(2)	molybdenum 42 95.94(1)	technetium 43 97.9072(1)	ruthenium 44 101.07(2)	rhodium 45 102.90550(2)	palladium 46 106.42(1)	silver 47 107.8682(2)	cadmium 48 112.411(8)	indium 49 114.818(3)	tin 50 118.710(7)	antimony 51 121.750(1)	tellurium 52 127.60(3)	iodine 53 126.90447(3)	xenon 54 131.29(2)
cesium 55 132.90545(2)	barium 56 137.327(7)	lanthanum 57 138.9055(2)	hafnium 72 178.49(2)	tantalum 73 180.9479(1)	tungsten 74 183.84(1)	rhenium 75 186.207(1)	osmium 76 190.23(3)	iridium 77 192.227(3)	platinum 78 195.078(2)	gold 79 196.96655(2)	mercury 80 200.59(2)	thallium 81 204.3833(2)	lead 82 207.2(1)	bismuth 83 208.98038(2)	polonium 84 [209]	astatine 85 [209]	radon 86 [222.01761]
francium 87 [223.0197]	radium 88 [226.0254]	actinium 89 [227.0277]	rutherfordium 104 [261.1087]	dubnium 105 [262.1144]	seaborgium 106 [266.1219]	bohrium 107 [264.1247]	hassium 108 [269.1043]	meitnerium 109 [268.1038]	unnilium 110 [272.1463]	ununium 111 [277.1535]	unbinium 112 [277]	ununseptium 114 [289]	ununhexium 116 [289]	ununpentium 117 [289]	ununquadium 118 [293]	ununtrium 119 [293]	ununnonium 120 [293]

Key: element name  
atomic number  
symbol  
1987 atomic weight (mean relative mass)

lanthanum 57 138.9055(2)	cerium 58 140.118(1)	praseodymium 59 140.90765(2)	neodymium 60 144.24(3)	promethium 61 [144.9127]	samarium 62 150.36(3)	europium 63 151.964(1)	gadolinium 64 157.25(3)	terbium 65 158.92534(2)	dysprosium 66 162.50(3)	holmium 67 164.93032(2)	erbium 68 167.26(3)	thulium 69 168.93421(2)	ytterbium 70 173.04(3)	lutetium 71 174.967(1)
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
actinium 89	thorium 90	protactinium 91	uranium 92	neptunium 93	plutonium 94	americium 95	curium 96	berkelium 97	californium 98	einsteinium 99	fermium 100	mendelevium 101	nobelium 102	lawrencium 103
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

\*lanthanoids  
\*\*actinoids

- R = 8.31451 J/K-mol
- 1 L atm = 101.325 J
- 1 CV = 1 J
- c = 2.998 x 10<sup>8</sup> m/sec
- $^1_0n = 1.00866490 \text{ u}$ ;
- $^1_1p = 1.00727647 \text{ u}$ ;
- $^0_{-1}e$  or  $^0_{+1}e = 5.485799 \times 10^{-4} \text{ u}$
- $^4_2\text{He} = 4.0026 \text{ u}$
- R = 0.082057 L-atm/mol-K
- 1 atm = 760 torr = 101.325 kPa
- F = 9.64853 x 10<sup>4</sup> C/mol e<sup>-</sup>
- h = 6.626 x 10<sup>-34</sup> J-sec
- $^1_0n = 1.00866490 \text{ u}$ ;
- $^1_1p = 1.00727647 \text{ u}$ ;
- $^0_{-1}e$  or  $^0_{+1}e = 5.485799 \times 10^{-4} \text{ u}$
- $^4_2\text{He} = 4.0026 \text{ u}$
- R = 0.082057 L-atm/mol-K
- 1 Ci = 3.70 x 10<sup>10</sup> Bq
- 1 J = 1 kg-m<sup>2</sup>/sec<sup>2</sup>
- $\mathcal{H} = 3.2898 \times 10^{15} \text{ Hz (Rydberg)}$
- 1 MeV = 1.6022 x 10<sup>-13</sup> J
- $^0_{-1}e$  or  $^0_{+1}e = 5.485799 \times 10^{-4} \text{ u}$
- $^4_2\text{He} = 4.0026 \text{ u}$
- R = 8.31451 J/K-mol
- 1 L atm = 101.325 J
- 1 cal = 4.184 J
- 1 Bq = 1 event/sec
- 1 Pa = 1 kg/m-sec<sup>2</sup>
- 1 amu = 1.6605 x 10<sup>-27</sup> kg = 931.494 MeV
- Elementary charge (e) = 1.60218 x 10<sup>-19</sup> C
- $^1_1\text{H} = 1.00782505 \text{ u}$
- $^4_2\text{He} = 4.0026 \text{ u}$

When in doubt, remember that the answer is always 42, or π. Never forget that!

**SCRATCH PAPER: RETURN ALL SCRATCH PAPER WITH YOUR EXAM!!!!!!**

## CHEM 6BL COMMON FORMULAS & VALUES

$$\sigma = \sqrt{\frac{\sum_1^i (\bar{x} - x_i)^2}{N-1}}$$

$$Q = \frac{|\text{outlier} - \text{value closest to outlier}|}{|\text{highest value} - \text{lowest value}|}$$

$$N = 3: QC = 0.94; \quad N = 4: QC = 0.76; \quad N = 5: QC = 0.64; \quad N = 6: QC = 0.56$$

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$K_b = \frac{[HB^+][OH^-]}{[B]}$$

$$K_w = K_a \times K_b = 1.0 \times 10^{-14}$$

$$pH = -\log[H^+] = 14 - pOH$$

$$pK_a = -\log[K_a]$$

$$\text{If } A_z B_y \rightleftharpoons z A + y B, \text{ then } K_{sp} = [A]^z [B]^y$$

$$q = m c \Delta T = n C_p \Delta T$$

$$q_{\text{cold}} = -q_{\text{hot}}$$

$$C_{\text{metal}} \approx 26 \text{ J/K}\cdot\text{mol}$$

$$C_{\text{water}} = 4.18 \text{ J/K}\cdot\text{g} \quad C_{\text{water}} = 75.3 \text{ J/K}\cdot\text{mol}$$

$$A = \log\left(\frac{100\%}{\%T}\right) = \log\left(\frac{1}{T}\right) = \log\left(\frac{I_o}{I}\right)$$

$$\% T = 100 T$$

$$T = \frac{1}{10^A}$$

Beer's Law:  $A = \epsilon bc$  (where  $\epsilon$  = molar absorptivity (in  $M^{-1}cm^{-1}$ ),  $b$  = cell length (usually 1.0 cm) and  $c$  = concentration)

$$c = v \times \lambda \quad (c = 2.998 \times 10^8 \text{ m/s})$$

$$E = h \times v \quad (h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s})$$

$$\text{For Hydrogen: } E = \Delta E = +1312.75 \frac{\text{kJ}}{\text{mol}} \times \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$R_H \times h \times N_A = +1312.75 \text{ kJ/mol} \quad (N_A = 6.022 \times 10^{23} \text{ molec./mol})$$

**ANSWER KEY:**

1) C

2) E

3) B

4) D

5) C

6) B

7) A

8) A

9) A

10) C

11) E

12) D

13) E