Chem 3C Midterm 2
Version B

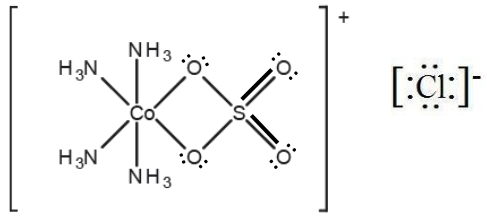
Credit will only be given for answers on this sheet. Units must be included in your answers and points will be taken off for incorrect or missing units. No partial credit will be awarded. Calculators are allowed. Cell phones may not be used as calculators.

Name:	**Perm Number**

Make sure your writing is dark and large enough to be picked up by a scanner. Failure to do this results in the loss of 5 points on the exam.

If you are sitting next to someone with the same version of the test, you both will lose 5 points on the exam.

If you are still writing after time is called, you will lose 5 points on the exam.

<table>
<tr><th colspan="4">Fundamentals</th></tr>
<tr><td>Question
(Points)</td><td colspan="3">Answer</td></tr>
<tr><td>1
(6 pts)
2 each</td><td>M = 1.8 M</td><td>χ = 0.033</td><td>m = 1.9 m</td></tr>
<tr><td>2
(7 pts)</td><td colspan="3">  </td></tr>
<tr><td rowspan="3">3
(6 pts)
2 each</td><td colspan="3">potassium diaquabis(oxalato)chromate(II)
$K_2[Cr(C_2O_4)_2(H_2O)_2]$ or $K_2[Cr(ox)_2(H_2O)_2]$</td></tr>
<tr><td colspan="3">$[CoCl_2(NH_3)_2(en)]NO_3$
diamminedichloroethylenediaminecobalt(III) nitrate</td></tr>
<tr><td colspan="3">chlorobis(ethylenediamine)thiocyanatocobalt(III) tetrachlorocadmiumate(II)
$[CoCl(SCN)(en)_2]_2[CdCl_4]$</td></tr>
<tr><td>4
(6 pts)</td><td colspan="3">5690 $\frac{g}{mol}$</td></tr>
<tr><td>5
(6 pts)
2 each</td><td>Oxidation Number
3+ or Co^{3+}</td><td>Electron Configuration
$[Ar]3d^6$</td><td>Coordination Number
6</td></tr>
<tr><td>6
(7 pts)</td><td colspan="3">$1.63\ g$</td></tr>
</table>

Multiple Choice	
Question (Points)	**Answer**
7 (6 pts)	○ A ○ B ● C ○ D ○ E
8 (6 pts) 2 each	○ A ○ B ○ C ○ D ● E ○ F
	● A ○ B
	● A ○ B ○ C ○ D
9 (6 pts)	● A ○ B ● C ○ D ● E ○ F
10 (6 pts)	○ A ○ B ○ C ○ D ● E
11 (6 pts) 3 each	● A ○ B ○ C ○ D
	● A ○ B ○ C ○ D ○ E
12 (8 pts) 2 each	○ A ● B ○ C
	● A ○ B ○ C
	● A ○ B ○ C
	○ A ○ B ● C

Challenge Problems	
Question (Points)	**Answer**
13 (14 pts) (8,6)	0.657
	0.345 atm
14 (10 pts)	$[CrI(NH_3)_5]I_2$

Fundamental Questions

1) *6 pts* If you have an aqueous solution that is 10.% NaCl by mass, calculate the following:
   a) Molarity of NaCl
   b) Mole fraction of NaCl
   c) Molality of NaCl

   The density of the NaCl solution is 1.07 $\frac{g}{cm^3}$ and the density of water is 1.00 $\frac{g}{cm^3}$.

2) *7pts* A coordination compound of cobalt (III) contains four ammonia molecules, one sulfate ion, and one chloride ion. Addition of aqueous $BaCl_2$ solution to an aqueous solution of the compound gives no precipitate. Addition of aqueous $AgNO_3$ to an aqueous solution of the compound procures a white precipitate. Propose a structure (draw Lewis structure) for this coordination compound.

3) *6 pts* What is the name or formula of the following?

   potassium diaquabis(oxalato)chromate(II)

   $[CoCl_2(NH_3)_2(en)]NO_3$

   chlorobis(ethylenediamine)thiocyanatocobalt(III) tetrachlorocadmiumate(II)

4) *6 pts* 135. mg of an unknown protein is dissolved in enough solvent to make 5.00 mL of solution. The osmotic pressure of this solution is measured to be 0.116 atm at 25.0˚C. Calculate the molar mass of the protein. Round your answer to 3 significant digits.

5a) *2 pts* What is the oxidation number (on the metal) of $[Co(ox)_3]^{3-}$?

5b) *2 pts* What is the electron configuration for Co^x (x is the oxidation number found in 6a)?

5c) *2 pts* What is the coordination number for $[Co(ox)_3]^{3-}$

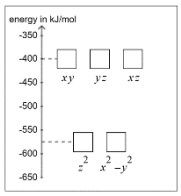
6) *7 pts* If the partial pressure of CO_2 over water is 1.09 atm, what is the mass of CO_2 (in g) dissolved in 1.00 L of water at 298K if k_H is 1.64×10^3 atm? Assume the density of the solution is 1.00 $\frac{g}{ml}$.

Multiple Choice

7) *6 pts* Which of the following complexes is chiral?

A. trans-$[CoCl_2(en)_2]$
B. trans-$[CoCl(NH_3)(en)_2]$
C. $[Co(en)_3]^{3+}$
D. $[Fe(CN)_6]^{3-}$
E. All of the above are achiral

8) *6 pts* When a certain weak-field ligand forms a tetrahedral complex with Fe^{2+} cation, the energies of the valence d orbitals on the iron atom are split according to this electron box diagram:



Using this diagram, answer the following questions.
How many unpaired d electron spins does the iron atom have?

A. 0
B. 1
C. 2
D. 3
E. 4
F. None of the above

Is the complex paramagnetic or diamagnetic?

A. paramagnetic
B. diamagnetic

Predict the color of the complex.

A. blue or green
B. red or violet
C. orange or yellow
D. white or transparent

9) *6 pts* Which of the following are capable of linkage isomers

A. SCN^-
B. N_3^-
C. NO_2^-
D. $NH_2CH_2CH_2NH_2$
E. OCN^-
F. I^-

10) *6 pts* A solution with 0.640 g of azulene in 100.0 g of benzene boils at 80.230˚C. The boiling point of benzene is 80.100˚C; the K_b is 2.53 $\frac{^\circ C \cdot kg}{mol}$. What is the molecular weight of azulene? Helpful Information: The van't Hoff factor is 1 for azulene.

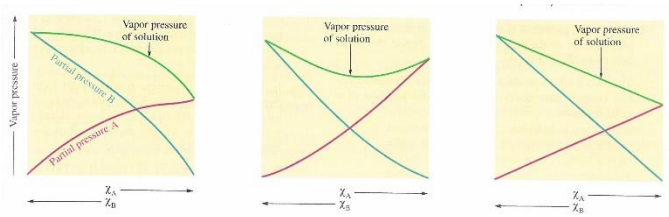
A. 108 $\frac{g}{mol}$
B. 117 $\frac{g}{mol}$
C. 134 $\frac{g}{mol}$
D. 99 $\frac{g}{mol}$
E. None of the Above

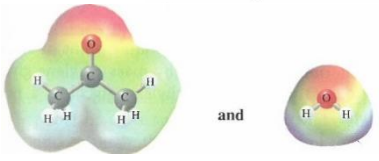
11) *6 pts* Predict what will be observed in each experiment below.

Experiment	predicted observation (choose 1)
A student sees tiny bubbles clinging to the inside of an unopened plastic bottle full of carbonated soft drink. The student squeezes the bottle.	A. The bubbles will shrink, and some may vanish. B. The bubbles will grow, and more may appear. C. The bubbles won't change. D. I need more information to predict what will happen to the bubbles.
A pair of 100 ml samples of water are taken from a well bored into a large underground salt (NaCl) deposit. Sample #1 is from the top of the well, and is initially at 32°C. Sample #2 is from a depth of 50.m, and is initially at 42°C. Both samples are allowed to come to room temperature (20°C) and 1 atm pressure. An NaCl precipitate is seen to form in Sample #1.	A. A bigger mass of NaCl precipitate will form in Sample #2. B. A smaller mass of NaCl precipitate will form in Sample #2. C. The same mass of NaCl precipitate will form in Sample #2. D. No precipitate will form in Sample #2. E. I need more information to predict whether and how much precipitate will form in Sample #2.

12) *8 pts* Match the vapor pressure diagrams with the solute-solvent combination.

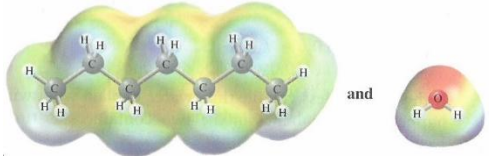
A B C





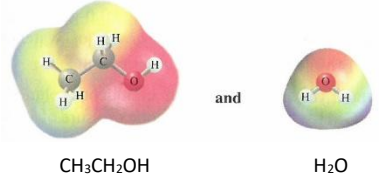
CH_3COCH_3 H_2O

A. B. C. (see drawing above)



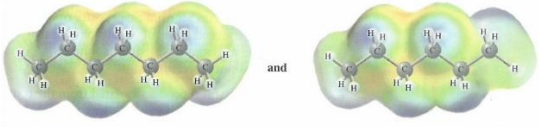
$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$ H_2O

A. B. C. (see drawing above)



CH_3CH_2OH H_2O

A. B. C. (see drawing above)



$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$ $CH_3CH_2CH_2CH_2CH_2CH_3$

A. B. C. (see drawing above)

Challenge Problems

13a) *8 pts* The vapor pressure of carbon tetrachloride CCl_4, is 0.354 atm and the vapor pressure of chloroform, $CHCl_3$, is 0.526 atm at 316 K. A solution is prepared from equal masses of these two compounds at this temperature. Calculate the mole fraction of the chloroform in the vapor above the solution

13b) *6 pts* If the vapor above the original solution is condensed and isolated into a separate flask, what would the vapor pressure of chloroform be above this new solution?

14) *10 pts* Ammonia and potassium iodide solutions were added to an aqueous solution of $Cr(NO_3)_3$. A solid was isolated (compound A) and the following data was collected:

1. When 0.105 g of compound A was strongly heated in excess O_2. 0.0203 g of CrO_3 was formed.
2. In a second experiment it took 32.93 mL of 0.100M HCl to titrate completely the NH_3 present in 0.341 g of compound A.
3. Compound A was found to contain 73.53% iodine by mass.
4. The freezing point of water was lowered by 0.64˚C when 0.601 g of compound A was dissolved in 10.00 g of H_2O (K_f = 1.86$\frac{^\circ C \cdot kg}{mol}$)

What is the formula of the compound? What is the structure of the complex ion present? [*Hints:* Cr^{3+} is expected to be six-coordinate with NH_3 and (possibly) I^- acting as ligands. The I^- ions will be the counter ions if needed.
A will have the formula $[CrI_x(NH_3)_y]I_z$