INSTRUCTIONS/SUGGESTIONS.
READ THIS CAREFULLY!

EACH QUESTION IS WORTH 10 POINTS.
OMIT ANY FOUR (4) OF THE 18 QUESTIONS.

INDICATE ON THE NEXT PAGE WHICH **4** QUESTIONS ARE NOT TO BE GRADED BY WRITING DNG (DO NOT GRADE) NEXT TO THE PROBLEM NUMBER.

NO PARTIAL CREDIT on any question except where indicated by the statement SHOW WORK. When work is requested, set up equations (with numbers substituted in appropriate units) in space provided, but do the calculations on scrap sheet.

IF QUESTION STATES "SHOW WORK" AND YOU GUESS CORRECTLY WITHOUT SHOWING WORK - YOU GET 1/2 CREDIT.

CHECK FRONT BLACKBOARD FOR CORRECTIONS/CHANGES.

IF ANY QUESTION IS NOT CLEAR - ASK DAVID OR ME ABOUT IT!

CONSTANTS AND CONVERSION FACTORS ARE ON THE PAGE FOLLOWING THE LAST PROBLEM. PLEASE LOOK THERE!
LAST THREE PAGES ARE FOR SCRAP WORK.
FEEL FREE TO TEAR THESE PAGES OFF.

REMOVE THIS PAGE PRIOR TO STARTING EXAM.

CHEMISTRY F14O4 FIRST EXAM 2/16/00
PROFESSOR J. MORROW

PRINT NAME, LAST: ____________________________

FIRST: ____________________________

I.D.# : ____________________________

EACH QUESTION IS WORTH 1O POINTS

1. ________	7. ________	13. ________
2. ________	8. ________	14. ________
3. ________	9. ________	15. ________
4. ________	1O. ________	16. ________
5. ________	11. ________	17. ________
6. ________	12. ________	18. ________

COLUMN TOTALS:

________ ________ ________

EXAM TOTAL (14O pts) ___________ ___________
OUT OF 1OO

1) GIVEN THE FOLLOWING STANDARD REDUCTION POTENTIALS ($25^{O}C$)

$$Ag(CN)_2^- + e^- \rightleftharpoons Ag^o + 2\ CN^- \qquad E^o = -\ 0.310\ V$$

$$Ag^+ + e^- \rightleftharpoons Ag^o \qquad E^o = 0.800\ V$$

$$Cu^+ + e^- \rightleftharpoons Cu^o \qquad E^o = 0.520\ V$$

$$Cu(CN)_2^- + e^- \rightleftharpoons Cu^o + 2\ CN^- \qquad E^o = -\ 0.440\ V$$

Calculate ΔG^o_{rxn} (in kJ) for the following reaction; SHOW WORK

$$Cu(CN)_2^- + Ag^+ \rightleftharpoons Ag(CN)_2^- + Cu^+$$

a) -14.5 b) 12.5 c) 14.5 d) -12.5 e) 25.O f) -25.O

ANSWER: ΔG^o_{rxn} = ____

2) For the reaction, $2\ Hg_{(\lambda)} + Cl_{2(g)} \longrightarrow Hg_2Cl_{2(S)}$, $E^o = +1.058$ volts.

For the reaction, $2\ Ag_{(S)} + Cl_{2(g)} \longrightarrow 2\ AgCl_{(S))}$, $E^o = +1.178$ volts.

Calculate the equilibrium constant for the following reaction;

$$2\ AgCl_{(S)} + 2\ Hg_{(\lambda)} \rightleftharpoons Hg_2Cl_{2(S)} + 2\ Ag_{(S)}$$

ANSWER: K = _______

3) For the equilibrium reaction, $Ag^+ + 2\ CN^- \rightleftharpoons Ag(CN)_2^-$, the cell notation when the reactants and products are in standard state is;

$Ag_{(S)}|\ Ag(CN)_2^-(1.00\ M),\ CN^-\ (1.00\ M)\ ||\ Ag^+(1.00\ M)\ |\ Ag_{(S)}$

If the cell with the new indicated concentrations is now set up,

$Ag_{(S)}|\ Ag(CN)_2^-(2.00\ M),\ CN^-\ (2.00\ M)\ ||\ Ag^+(0.50\ M)\ |\ Ag_{(S)}$

then,

a) The reaction will shift to the right

b) The reaction will shift to the left
c) The cell voltage will become more positive
d) The cell voltage will become less positive
e) The cell voltage will be unchanged
f) The equilibrium constant will increase in value
g) The equilibrium constant will decrease in value

YOUR ANSWER(S) IS/ARE: _______

4) Given the reaction, $2\ Hg_{(\lambda)} + Cl_{2(g)} \longrightarrow Hg_2Cl_{2(S)}$

Assume that the standard E^o cell voltage is related to the celcius temperature by the following equation and all substances are at standard state. In doing this, you can assume any temperature(s) you desire.

At 298 K (25^{o}C), E^o_{cell} = + 1.058 volts. SHOW WORK

$$E^o_{cell} = 1.058 - 0.00017\,(t - 25^oC)$$

The ΔH^o (in kJ) for the reaction (as written) at 298 K is;

a) -321 b) +107 c) +214 d) -214 e) -107 f) +321

ANSWER IS: _______

5) What is the highest pH at which 0.050 M Mn^{2+} remains entirely in a solution that is saturated with H_2S, at a concentration of, $[H_2S]$ = O.1O M .

Given: For the reaction, $MnS_{(S)} \rightleftharpoons Mn^{2+} + S^{2-}$, $K_{sp} = 3.6x10^{-15}$ OR

for the reaction, $MnS_{(S)} + H_2O \rightleftharpoons Mn^{2+} + HS^- + OH^-$, $K = 3.0x10^{-14}$

For H_2S: $K_{a1} = 9.2x1O^{-8}$ and $K_{a2} = 1.2x1O^{-15}$ SHOW WORK

a) 2.9 b) 3.9 c) 4.4 d) 4.9 e) 5.4

ANSWER IS: _______

6) Find among the pH values on the right, the value which most closely matches the pH of the solutions described in the first column. SHOW ALL WORK FOR PART B ON THIS PAGE!

HINT: In PART B the following reaction occurs, $H_2CO_3 + CO_3^- \longrightarrow 2\ HCO_3^-$

SOLUTION	pH
A. 0.460 M CH_3COOH (HOAc) that is also 0.0460 M in HNO_3	5.04 4.44 1.34
B. 0.020 M H_2CO_3 that is also 0.250 M in Na_2CO_3	11.12 10.72 5.13 2.70 7.41 2.00

(4 pts) Solution A pH =

(6 pts) Solution B pH =

K_a values: H_2CO_3 ($K_{a1} = 4.3x10^{-7}$) , HCO_3^- ($K_{a2} = 4.4x10^{-11}$) , HOAc ($K_a = 1.8x10^{-5}$)

Solution A:

Solution B:

7) If 0.77 g of $Cu(IO_3)_2$ will dissolve in 1.0 L of 0.10 M $CuSO_4$ solution, what is the solubility product, K_{sp} , of $Cu(IO_3)_2$? Molar mass = 413.3 g/mol

SHOW WORK

a) $1.4x10^{-5}$ b) $1.4x10^{-6}$ c) $2.6x10^{-7}$ d) $3.5x10^{-7}$ e) $2.6x10^{-8}$

ANSWER IS: ____

THE FOLLOWING INFORMATION IS FOR PROBLEMS 8, 9, AND 10.

40.00 mL of O.100 M methylamine, CH_3NH_2 , is titrated with O.15O M HCl.

Calculate the pH; (K_b = $4.0x1O^{-5}$ for $CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$)

8) before any HCl is added.

pH = ________

9) halfway to the equivalence point.

pH = ________

10) at the equivalence point. (This is now an hydrolysis problem)

SHOW WORK

pH = ________

11) How many milliliters (mL) of a 0.0500 M NaOH (a strong base) solution should be added to 1.00 L of 0.100 M H_3PO_4 solution, to produce a buffer of pH = 2.00 ? For H_3PO_4, K_{a1} = $6.67x1O^{-3}$ (SHOW WORK)

GIVEN: H_3PO_4 + OH^- (from NaOH) —> $H_2PO_4^-$ + H_2O

a) 100 b) 200 c) 400 d) 600 e) 800 f) 900

ANSWER IS: ________

12) Given the following cell; $Zn_{(S)}|Zn^{2+}(1\ M)\ ||\ H^+(?\ M)|H_{2(g)}(1\ atm)$.
The measured cell voltage is E_{cell} = O.653 V. Calculate the pH of the solution in the cathode compartment. HINT: First calculate E^o_{cell} . MOLARITIES AND PRESSURE ARE GIVEN IN THE CELL NOTATION ABOVE.

Given: $Zn^{2+} + 2e^- \rightleftharpoons Zn_{(s)}$ E^o = - 0.771 V

a) 1.O b) 1.5 c) 2.O d) 3.O e) 3.5 f) 4.0

ANSWER IS: ________

13) Complete the following table. (For $Ca_3(PO_4)_2$, K_{sp} = 1.3x1O^{-32})

$[Ca^{2+}]$	$[PO_4^{3-}]$
________	1.Ox1O^{-4} M
6.Ox1O^{-3} M	________

14) You have a solution of sodium hydrogen sulfate, $NaHSO_4$. It's initial concentration is C_o . The pH = 2.0 for this solution at equilibrium. Calculate the starting concentration, C_o .

(For the reaction, $HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$, K_{a2} = 0.020)

C_o = ________

15) For Ag_2CO_3 , $K_{sp} = 6.2x10^{-12}$. For AgCl , $K_{sp} = 2.8x10^{-10}$.
Solid Ag_2CO_3 and solid AgCl are added to a beaker containing 1.00 M $Na_2CO_{3(aq)}$. Under these conditions the $[CO_3^{2-}]$ = 1.00 M . Calculate the $[Cl^-]$ in solution when equilibrium is established.

ASSUME THE CO_3^{2-} ION DOES NOT HYDROLYZE. SHOW WORK

a) $1.1x1O^{-4}$ b) $1.26x1O^{-8}$ c) 6.7 d) 0.15 e) $2.8x1O^{-6}$

ANSWER IS: ______

16) Given the following K_{sp} values: for $M(OH)_4$, $K_{sp(M)} = 4.0x1O^{-19}$; for $Z(OH)_2$, $K_{sp(Z)} = 1.0x1O^{-14}$. One mole of each of the above solids is placed in a beaker containing 1 (one) liter of pure water. These solids go into equilibrium with their ions. Calculate the pH required for the metal ion concentrations to be equal, $[M^{2+}] = [Z^{3+}]$. (SHOW WORK)

a) 12.6 b) 9.6 c) 6.7 d) 2.2 e) 11.8

pH = _______

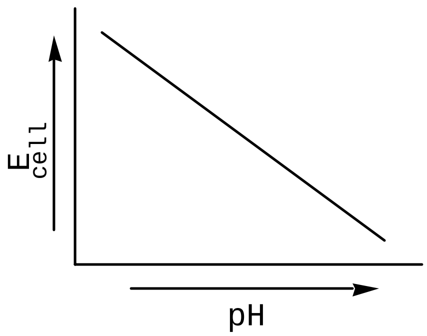
17) Given the following K_a and K_b values: HF ($K_a = 10^{-4}$) , HCN ($K_a = 10^{-9}$), NH_3 ($K_b = 10^{-5}$) , HOAc ($K_a = 10^{-5}$) , and HCl ($K_a = \infty$)

List the following aqueous salts in order of increasing acidity (decreasing basicity); NaF, NH_4Cl, NaCN, NaCl, and NaOAc. THIS IS AN HYDROLYSIS PROBLEM.

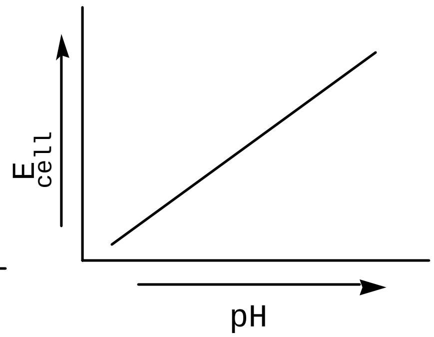
LEAST ACIDIC _____ < _____ < _____ < _____ < _____ MOST ACIDIC

18) Which graph correctly illustrates the dependence of the cell voltage, E_{cell} , on the pH for the reaction, $2\ Ag^+_{(aq)} + H_{2(g)} \longrightarrow 2\ Ag_{(s)} + 2\ H^+_{(aq)}$.
Assume the silver ion remains constant at, $[Ag^+] = 1.0$ M and the H_2 pressure remains constant at 1 atm.

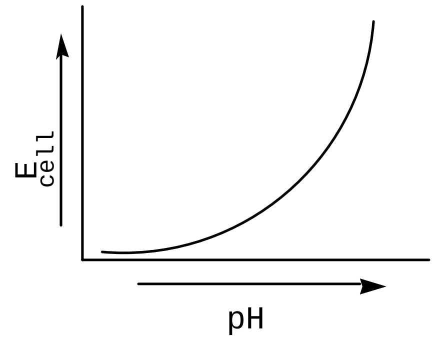
A



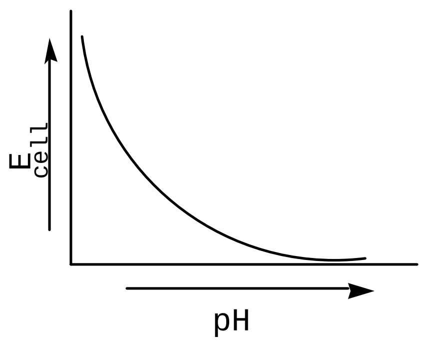
B



C



D



ANSWER IS:_ _

POTENTIALLY USEFUL INFORMATION AND EQUATIONS

1. $\Delta G^{o} = - RT \ln K$

2. $\frac{(\Delta G^{o}_{2} - \Delta G^{o}_{1})}{\Delta T} = - \Delta S^{o}$

3. $\Delta G^{o} = - nFE^{o}$

4. $\Delta G^{o} = \Delta H^{o} - T\Delta S^{o}$

5. $\Delta S^{o} = nF\{ \frac{E^{o}_{2} - E^{o}_{1}}{\Delta T} \}$ where $\Delta T = T_{2} - T_{1}$

6. $\Delta H^{o} = -nF\{E^{o} - T(\frac{E^{o}_{2} - E^{o}_{1}}{\Delta T})\}$ where $\Delta T = T_{2} - T_{1}$

7. 1 Faraday = 965OO Coulombs

8.. $E = E^{o} - \frac{O.O592}{n} \log Q$ (Nernst Equation)

SCRAP WORK SHEET

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