Name _____ Sec: AM or PM

Exam 1 / Dr. Rusay Chem 121 / Fall 2006

100 Exam pts. (114 raw pts.total): Answer questions 1-25 on the Scantron (1-20 = 4pts. each, 21-25 = 2pts. each), Answer the remaining questions on the exam, pt values are indicated.

1) Which equation represents the balanced Net Ionic equation for the reaction of aqueous solutions of potassium hydroxide and iron(II)chloride?

A. $Fe^{+2}(aq) + (OH)^{-}(aq) \rightarrow Fe(OH)2(s)$

B. $KOH(aq) + FeCl2(aq) \rightarrow Fe(OH)2(s) + K^{+}(aq) + Cl^{-}(aq)$

C. $2\ KOH(aq) + FeCl2(aq) \rightarrow Fe(OH)2(s) + 2K^{+}(aq) + 2Cl^{-}(aq)$

D. $2\ (OH)^{-}(aq) + Fe^{+2}(aq) \rightarrow Fe(OH)2(s)$

E. $K^{+}(aq) + Cl^{-}(aq) \rightarrow KCl(aq)$

2) Select the pair of substances in which an acid is listed followed by its conjugate base.

A. NH_3, NH_4^+
B. HPO_4^{2-}, $H_2PO_4^-$
C. HCO_3^-, CO_3^{2-}
D. CH_3COOH, $CH_3COOH_2^+$

3) A 0.10M aqueous solution of sodium chlorite was basic when tested with pH paper. What will be the effect on the pH after adding 0.10 moles of sodium fluoride without changing the volume of solution? ($HClO_2$ $Ka = 1.1 \times 10^{-2}$; HF $Ka = 6.8 \times 10^{-4}$)

A. The pH will decrease since fluoride is the conjugate base of a weak acid.
B. The pH will increase since fluoride is a conjugate base of a strong acid.
C. The pH will increase slightly since fluoride is a stronger base than chlorite.
D. The pH will decrease slightly since fluoride is a weaker base than chlorite.
E. There will be no change in the pH.

4) Which is the ion product expression for calcium phosphate, $Ca_3(PO_4)_2$.

A. $[Ca^{2+}]\ [PO_4^{3-}]$

B. $[Ca^{2+}]^2\ [PO_4^{3-}]^3$

C. $[Ca^{2+}]^3\ [PO_4^{3-}]^2$

D. $\dfrac{[Ca^{2+}]^2\ [PO_4^{3-}]^3}{[Ca_3(PO_4)_2]}$

5) The solubility of lead(II)chloride (MM = 278 g/mol) is 0.45 g/100 mL of solution. What is the K_{sp} of $PbCl_2$?

A. 4.9×10^{-2}
B. 1.7×10^{-5}
C. 4.2×10^{-6}
D. 8.5×10^{-6}

6) Which of the following substances has the greatest solubility in water?

A. $MgCO_3$, $K_{sp} = 3.5 \times 10^{-8}$
B. $NiCO_3$, $K_{sp} = 1.3 \times 10^{-7}$
C. $AgIO_3$, $K_{sp} = 3.1 \times 10^{-8}$
D. CuBr, $K_{sp} = 5.0 \times 10^{-9}$

7) The concentration of the complex ion in each of following solutions is 1.00 *M*. In which of the solutions will the concentration of the uncomplexed metal ion be the greatest?

CdI_4^{2-}	$K_f = 1.0 \times 10^{6}$
$Cu(NH_3)_4^{2+}$	$K_f = 5.6 \times 10^{11}$
$Zn(OH)_4^{2-}$	$K_f = 3.0 \times 10^{15}$
$Be(OH)_4^{2-}$	$K_f = 4.0 \times 10^{18}$

A. Cd^{2+} B. Cu^{2+}

C. Zn^{2+} D. Be^{2+}

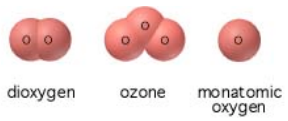
8) What is the approximate value of the equilibrium constant for the silver halide complexation reaction below?

$AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$	$K_{sp} \approx 1 \times 10^{-10}$
$AgBr(s) \rightleftharpoons Ag^+(aq) + Br^-(aq)$	$K_{sp} \approx 1 \times 10^{-13}$
$AgI(s) \rightleftharpoons Ag^+(aq) + I^-(aq)$	$K_{sp} \approx 1 \times 10^{-17}$
$Ag^+(aq) + 2\ S_2O_3^{2-}(aq) \rightleftharpoons Ag(S_2O_3)_2^{2-}(aq)$	$K_f \approx 1 \times 10^{13}$

$AgCl(s) + + 2\ S_2O_3^{2-}(aq) \rightleftharpoons Ag(S_2O_3)_2^{2-}(aq) + Cl^-(aq)$

A. $\approx 1 \times 10^{4}$ B. $\approx 1 \times 10^{-10}$ C. $\approx 1 \times 10^{-13}$ D. $\approx 1 \times 10^{3}$ E. $\approx 1 \times 10^{0}$

9) Predict the relative trend of entropy per mole for molecular oxygen, ozone, and monatomic oxygen gases under identical conditions.



A. $O_2 < O < O_3$
B. $O < O_2 < O_3$
C. $O_2 < O_3 < O$
D. $O_3 < O_2 < O$
E. $O_2 < O_3 < O$

10) Calculate $\Delta G°$ for the reaction below at 25°C.

$2SO_2\,(g) + O_2\,(g) \rightarrow 2SO_3(g)$

Substance	**$\Delta Hf°$(kJ/mol)**	**$\Delta S°$(J/mol·K)**
$SO_2\,(g)$	-297	249
$O_2\,(g)$	0	205
$SO_3\,(g)$	-395	256

A. -253 kJ B. -149 kJ C. -39.0 kJ D. -200 kJ E. -196 kJ

11) Which of the following results in a decrease in entropy?

A. $O_2(g)$, 300 K $\rightarrow$ $O_2(g)$, 400 K
B. $H_2O(s)$, 0°C $\rightarrow$ $H_2O(l)$, 0°C
C. $N_2(g)$, 25°C $\rightarrow$ $N_2(aq)$, 25°C
D. $NH_3(l)$, -34.5°C $\rightarrow$ $NH_3(g)$, -34.5°C

12) Oxidation of ethanol is spontaneous. The reaction is shown below. Predict the respective signs of $\Delta S°$ and $\Delta G°$.

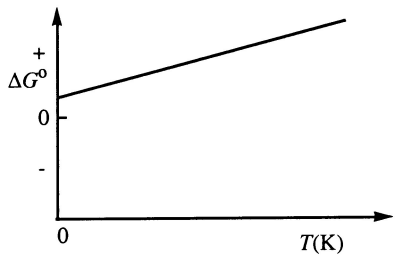
$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

A. $\Delta S° \approx 0$, $\Delta G° = 0$
B. $\Delta S° < 0$, $\Delta G° < 0$
C. $\Delta S° > 0$, $\Delta G° > 0$
D. $\Delta S° > 0$, $\Delta G° < 0$
E. $\Delta S° < 0$, $\Delta G° > 0$

13) When sodium nitrate dissolves in water, the container holding the solution becomes very cold. This can be explained by:

A. $\Delta S° > 0$, $\Delta H° > 0$
B. $\Delta S° > 0$, $\Delta H° < 0$
C. $\Delta S° < 0$, $\Delta H° < 0$
D. $\Delta S° < 0$, $\Delta H° > 0$
E. $\Delta S° = 0$, $\Delta H° < 0$

14) Consider the figure alongside which shows $\Delta G°$ for a chemical process plotted against absolute temperature. From this plot, it is reasonable to conclude that:



A. $\Delta H° > 0$, $\Delta S° > 0$
B. $\Delta H° > 0$, $\Delta S° < 0$
C. $\Delta H° < 0$, $\Delta S° > 0$
D. $\Delta H° < 0$, $\Delta S° < 0$
E. None of the above

A Chem 121 student sets out to study antacids and their effects on indigestion. She decides to research the solubility of $Mg(OH)_2$ under various conditions and conducts 3 experiments. All of the experiments were conducted at 25°C. You are to assist her in predicting/interpreting her experimental results.

Experiment 1

The student dissolved some solid $Mg(OH)_2$ in de-ionized water and found the $[Mg^{2+}]$ in the saturated solution to be 1.65×10^{-4} M.

15) From Experiment 1, the student should have concluded that the solubility of the salt is:

A. $(1.65 \times 10^{-4})^3$
B. 1.65×10^{-4}
C. $(3.3 \times 10^{-4})^2 (1.65 \times 10^{-4})$
D. $(1.65 \times 10^{-4})^2$
E. 3.3×10^{-4}

Experiment 2

She dissolved enough $Mg(OH)_2$ in 0.1 *M* NaOH to make a saturated solution.

16) She considered the Common Ion effect and LeChatelier's Principle and how the solubility of the compound in 0.1 *M* NaOH in Experiment 2 will compare to the solubility of the compound in water. She should conclude that:

A. It will be the same.
B. It will be greater.
C. It will be less.
D. It will be independent of the Common Ion effect and LeChatelier's Principle.

17) Which of the following expressions would allow the student to solve for the approximate concentration of Mg^{2+} in Experiment 2?

A. $[Mg^{2+}](0.1)^2 = Ksp$
B. $[Mg^{2+}](0.2)^2 = Ksp$
C. $[Mg^{2+}](0.1) = Ksp$
D. $[Mg^{2+}]2(0.1) = Ksp$

Experiment 3

She prepared a saturated solution of $Mg(OH)_2$ in 1.0 *M* HCl.

18) The student measured the solubility of the salt in the strong acid solution. How would the solubility in acid compare to the solubility in the basic solution?

A. It will be less.
B. It would be greater.
C. It cannot be determined.
D. It would be about the same.

19) Using all of the experiments, which of the following are expected conclusions?

I. The *K*sp of of $Mg(OH)_2$ varies among the experiments.

II. The solubility of $Mg(OH)_2$ is pH-dependent.

III. The solubility of $Mg(OH)_2$ in acid and base will serve as a model for any and all other magnesium salts.

A. II only
B. I only
C. I and II only
D. III only
E. I, II and III

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20) Rank the following in order of increasing acidity.

1) 0.1 *M* $Al(NO_3)_3$, $pK_a = 5$
2) 0.1 *M* $Be(NO_3)_2$, $pK_a = 5.4$
3) 0.1 *M* $Pb(NO_3)_2$, $pK_a = 7.5$
4) 0.1 *M* $Ni(NO_3)_2$, $pK_a = 10$

A. 4 < 3 < 2 < 1
B. 1 < 2 < 3 < 4
C. 4 < 1 < 3 < 2
D. 1 < 4 < 2 < 3
E. 4 < 2 < 3< 1

END of Multiple Choice

True /False (Answer on Scantron, A = True; B = False). Read each carefully.

21) A 0.010 M solution of acetic acid ($Ka = 1.8 \times 10^{-5}$) has a pH > 2.0.

22) If 0.074 g of $Ca(OH)_2$ (MM = 74 g/mol) is dissolved in water to form 100 mL of solution, the molality of the solution is equal to 0.01.

23) The enthalpy of formation of $O_2(g)$ equals zero.

24) 1 mole of HCOOH(*l*) has a lower entropy than 1 mole of HCOOH(*aq*)

25) A reaction will be spontaneous at low temperature if $\Delta H° < 0$ and $\Delta S° > 0$.

Answer the remaining questions on the Exam. Show your work.

26) [8pts] A solution of slaked lime, $Ca(OH)_2$, was used by the second century Roman physician, Claudius Galen, in a process to dye hair black. Provide the correct values for the following acid-base features of a solution prepared from 0.074 g of $Ca(OH)_2$ (MM = 74 g/mol) dissolved in water to form 100 mL of solution?

$[H^+]$ = $[OH^-]$ =

pH = pOH =

27) [4pts] The formation constant for a silver-ammonia complex is $K_f = 1.7 \times 10^7$ at 25°C.

$Ag^+(aq) + 2NH_3(aq) \rightarrow Ag(NH_3)_2^+(aq)$

Show your calculation for $\Delta G°$ at 298K.

28) [12pts] An enterprising Chem 121 student wants to develop a better hair dye than *Grecian Formula* and explores using lead(II)iodide instead of lead(II)acetate. The solubility product constant of lead(II)iodide is $K_{sp} = 7.9 \times 10^{-9}$. He wants to form the iodide salt by mixing solutions of potassium iodide with lead(II)nitrate. Will a precipitate form when 100mL of 0.0000050 mol L^{-1} solution of potassium iodide is mixed with 100mL of 0.0000050 mol L^{-1} solution of lead(II)nitrate?

a.) Yes / No (Circle one.) Show your calculation supporting your choice in (f.) below.

b.) Is the lead(II)iodide saturated or unsaturated? (Circle one.)

c.) Show a balanced molecular equation for the overall reaction which forms lead(II)iodide.

d.) Write the corresponding Net Ionic Equation for the overall reaction which forms lead(II)iodide.

e.) Write the ion product expression for the lead(II)iodide salt.

f.) Show your calculation determining if a precipitate will form:

g.) Briefly explain why or why not a precipitate will form using the answer from Part f.)