Chem 1220

final exam

150 points

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Name_____

Instructions:
This is a closed book, closed notebook test. You may not discuss this exam with anyone, either during or after the exam, until it has been graded and scores have been posted on the internet. You may not use any outside materials - including Periodic Tables - on this exam. You may use a calculator to help you compute the correct answer but may not retrieve or view any reference materials that may be stored in your calculator.

Each question is worth 6 points. All questions are of equal value.

Useful information:

$K_w = 1.0 \times 10^{-14}$	$K_w = K_a K_b$	$p(x) = -\log (x)$
$pH + pOH = 14$	$pH = pKa + \log ([A^-]/[HA])$	
$x = [(-b + (b^2 - 4ac)^{0.5})/2a]$	$R = .0821$ [L·atm/mol·K]	$R = 8.314$ J/mol·K
$K = K_1K_2...$	$K_f = K_d^{-1}$	$\Delta U = q + w$
$\Delta H = \Delta U + P\Delta V$	$\Delta S = \Delta H/T$	$\Delta G = \Delta H - T\Delta S$
$\Delta G = \sum n\Delta G^o_{prod} - \sum n\Delta G^o_{reactants}$	$\Delta G_{rxn} = \Delta G^o + RT \ln Q$	$\Delta G^o = -RT \ln K$
$E = E^o - (RT/nF) \ln Q$	$\Delta G^o = -nFE^o$	$F = 96{,}400$ J/V·mol
$E^o cell = E^o cathode - E^o anode$	$nFE^o = RT \ln K$	

oxidizing agent: a substance that oxidizes another substance in the process of reducing itself

reducing agent: a substance that reduces another substance in the process of oxidizing itself

1. What is the conjugate base of $H_2SeO_3^-$?

A. OH^-
B. H_3SeO_3
C. $HSeO_3^{2-}$
D. H_3Se
E. SeO_3^{3-}

2. What is the K_a for a 0.0200 M solution of 4-aminobenzoic acid if the solution has a pH of 3.31?

A. 2.5×10^{-2}
B. 2.0×10^{-2}
C. 4.9×10^{-4}
D. 1.2×10^{-5}
E. 2.8×10^{-6}

3. Hypobromous acid, HOBr, has an acid dissociation constant of 2.5×10^{-9}. What is the $[H^+]$ of a 0.25 M solution?

A. 5.0×10^{-5} M
B. 2.5×10^{-5} M
C. 5.0×10^{-6} M
D. 2.5×10^{-6} M
E. 5.0×10^{-7} M

4. Carbonic acid (H_2CO_3) is a weak diprotic acid with $K_{a1} = 4.2 \times 10^{-7}$ and $K_{a2} = 4.8 \times 10^{-11}$. What is the hydronium ion concentration of a 0.037 M solution of carbonic acid?

A. 7.4×10^{-2}
B. 3.7×10^{-2}
C. 6.5×10^{-4}
D. 1.2×10^{-4}
E. 4.2×10^{-7}

5. Carbonic acid (H_2CO_3) is a weak diprotic acid with $K_{a1} = 4.2 \times 10^{-7}$ and $K_{a2} = 4.8 \times 10^{-11}$. What is the value of the equilibrium constant for the following carbonic acid reaction?

$$H_2CO_{3\,(aq)} + 2\ H_2O_{(l)} \rightleftharpoons 2\ H_3O^+_{(aq)} + CO_3^{2-}{}_{(aq)}$$

A. 2.1×10^{-4}
B. 4.2×10^{-7}
C. 2.4×10^{-8}
D. 4.8×10^{-11}
E. 2.0×10^{-17}

6. What is the pH of a solution that is 0.10 M in ethanoic acid and 0.50 M in sodium ethanoate? (For ethanoic acid: $Ka = 1.8 \times 10^{-5}$)

A. 0.70
B. 2.87
C. 4.05
D. 4.74
E. 5.44

7. The solubility product expression for $Tb_3(PO_4)_4$ is Ksp =

A. $[Tb^{4+}]^3[PO_4^{3-}]^4$
B. $[3\ Tb^{3+}][4\ PO_4^{3-}]$
C. $[3\ Tb^{3+}]^3[4\ PO_4^{3-}]^4$
D. $[Tb^{3+}]^4[PO_4^{3-}]^3$
E. $[Tb^{2+}]^3[PO_4^{3-}]^2$

8. Which salt in the most soluble in water?

A. $CaCO_3$ ($Ksp = 4.8 \times 10^{-9}$)
B. PbI_2 ($Ksp = 1.1 \times 10^{-9}$)
C. AgBr ($Ksp = 5.0 \times 10^{-13}$)
D. $Fe(OH)_2$ ($Ksp = 8.0 \times 10^{-16}$)
E. $Co(OH)_2$ ($Ksp = 2.5 \times 10^{-16}$)

9. The $[OH^-]$ of a saturated solution of copper (II) hydroxide is 8.0×10^{-7} M. What is the Ksp for copper (II) hydroxide?

A. 6.4×10^{-20}
B. 1.3×10^{-19}
C. 2.6×10^{-19}
D. 5.1×10^{-19}
E. 1.3×10^{-18}

10. The Ksp for AgBr is 5.0×10^{-13}. If you mix 500 mL of 1.4×10^{-6} M silver nitrate and 500 mL of 1.4×10^{-6} M sodium bromide then

A. No precipitation will occur
B. AgBr will precipitate
C. NaBr will precipitate
D. $NaNO_3$ will precipitate
E. None of the above

11. What is the molar solubility of magnesium fluoride in a 0.20 M magnesium nitrate solution? (Ksp for $MgF_2 = 8.0 \times 10^{-8}$)

A. 4.0×10^{-8}
B. 8.0×10^{-8}
C. 3.2×10^{-4}
D. 6.3×10^{-4}
E. 2.7×10^{-3}

12. For the reaction $CH_{4\,(g)} + N_{2\,(g)} + 164$ kJ 6 $HCN_{(g)} + NH_{3\,(g)}$ at 25ºC and 1 atm of pressure ÄGº = 159 kJ. Calculate ÄSº at 25ºC.

A. 2 J/K
B. 17 J/K
C. 73 J/K
D. 120 J/K
E. None of the above

13. In the reaction described in Question 12 above, ΔH_f^o for $CH_{4\,(g)}$ = -74.77 kJ/mol and ΔH_f^o for $NH_{3\,(g)}$ = -46.09 kJ/mol. What is ΔH_f^o for $HCN_{(g)}$?

A. -192 kJ/mol
B. -88.7 kJ/mol
C. 135 kJ/mol
D. 192 kJ/mol
E. 285 kJ/mol

14. For the reaction described in Question 12 above, which of the following statements describes the reaction?

A. It is spontaneous at relatively high temperatures only
B. It is spontaneous at relatively low temperatures only
C. It is spontaneous at all temperatures
D. It is nonspontaneous at all temperatures
E. Insufficient information is given to estimate the temperature range of spontaneity

15. All of the following have values of zero for the free energy of formation except

A. N_2 (g)
B. Br_2 (l)
C. Hg(l)
D. Fe (l)
E. S_8 (s)

16. For the reaction $4\ Ag_{(s)} + O_{2\,(g)} \rightarrow 2\ Ag_2O_{(s)}$ at 25°C and 1 atm of pressure ΔH^o is -61.140 kJ and ΔS^o is -132 J/K. For this problem assume that the enthalpy and entropy are essentially temperature independent. Which of the following statements is true?

A. The reaction will be spontaneous at all temperatures
B. The reaction will not be spontaneous at any temperature
C. The reaction will be spontaneous at high temperatures and the reverse reaction will be spontaneous at low temperatures
D. The reaction will be spontaneous at low temperatures and the reverse reaction will be spontaneous at high temperatures
E. The change in entropy is the driving force at low temperatures

17. For the reaction $3\ C_{(s)} + 4\ H_{2\ (g)} \rightleftharpoons C_3H_{8\ (g)}$ at 25°C ΔH° is -103.8 kJ/mol and ΔS° is -269 J/mol·K. Calculate the equilibrium constant at 25°C for the reaction.

A. 1.0
B. 1.4×10^{4}
C. 1.0×10^{17}
D. 3.7×10^{19}
E. 2.1×10^{32}

18. For a reaction system that is at equilibrium which of the following must always be true?

A. q = 0
B. ΔH = 0
C. ΔU = 0
D. ΔS = 0
E. ΔG = 0

19. Which of the following statements is true for a galvanic cell?

1. the electron flow is from the positive electrode to the negative electrode
2. The electron flow is from the anode to the cathode
3. The electron flow is from the oxidzing agent to the reducing agent through an external circuit

A. 1, 2, and 3
B. 1 and 2 only
C. 1 only
D. 2 only
E. 3 only

20. For a certain reaction ΔH° is -76 kJ and ΔS° is -234 J/K. If n = 3 calculate E° for the reaction at 25°C.

A. 0.022V
B. 0.032 V
C. 0.065 V
D. 0.096 V
E. 0.192 V

21. Given that the standard reduction potentials for $Cr^{3+}_{(aq)} + 3\ e^- \rightarrow Cr_{(s)}$ is -0.74 V and for $Pb^{2+}_{(aq)} + 2\ e^- \rightarrow Pb_{(s)}$ is -0.13 V, what is the standard cell potential for the reaction

$$2\ Cr_{(s)} + 3\ Pb^{2+}_{(aq)} \rightarrow 3\ Pb_{(s)} + 2\ Cr^{3+}_{(aq)}\ ?$$

A. 0.61 V
B. -0.61 V
C. 0.87 V
D. -0.87 V
E. 1.83 V

22. If $E^o = 0.014$ V calculate the equilibrium constant at 25°C for the reaction

$$Sn_{(s)} + Pb^{2+}_{(aq)} \rightarrow Pb_{(s)} + Sn^{2+}_{(aq)}$$

A. 1.7
B. 3.0
C. 4.8
D. 8.8
E. 12

23. Molten magnesium chloride is electrolyzed using inert electrodes and reactions represented by the following half-reactions

$$2\ Cl^-_{(aq)} \rightarrow Cl_{2\ (aq)} + 3\ e^-$$
$$Mg^{2+}_{(aq)} + 2\ e^- \rightarrow Mg_{(s)}$$

Concerning this electrolysis which of the following statements is true?

A. Oxidation occurs at the cathode
B. Magnesium ions are reduced at the anode
C. Electrons pass through the external part of the circuit from the magnesium ions to the chloride ions
D. Chloride ions are oxidizing agents
E. The cations in the electrolyte undergo reduction

24. The sum of the coefficients for the following redox reaction in acidic solution, when balanced, is:

$$U^{4+}_{(aq)} + MnO_4^-{}_{(aq)} \rightarrow Mn^{2+}_{(aq)} + UO_2^+{}_{(aq)}$$

A. 7
B. 9
C. 11
D. 23
E. 30

25. The sum of the coefficients for the following redox reaction in basic solution, when balanced, is:

$$Co^{2+}_{(aq)} + ClO^-_{(aq)} \rightarrow Co(OH)_{3\,(s)} + Cl^-_{(aq)}$$

A. 7
B. 9
C. 11
D. 23
E. 30