NAME (Block Print)____

CHEMISTRY 102 FALL 2010

FINAL EXAM FORM C Section 502 DR. KEENEY-KENNICUTT

Directions: (1) Put your name on PART 1 and your name and signature on PART 2 of the exam where indicated.
(2) Sign the Aggie Code on PART 2 of this exam.
(3) Each multiple choice question is actually 2 questions on your scanning sheet. If you are sure of an answer, **put the same answer down for both questions** for 5 pts. If you cannot decide between two answers, put your best answer down for the first (odd) question and the other answer down for the second (even) question. If you get the first one correct you'll get 3 pts; if you get the second one correct you'll get 2 pts. If there is an ambiguous multiple choice question, use the last page to explain your answer.
(4) Do NOT write on the envelope.
(5) When finished, put everything in the envelope and wait to be excused. At the table, take everything out of the envelope. You can pick up the multiple choice part with the answers outside my office after the exam.
(6) There are a total of 60 multiple choice questions (30 actual questions) plus 20 pts free response.

PART 1

1&2. Which is the correct K_c expression for the equilibrium: $Ni(s) + 4CO(g) \rightleftarrows Ni(CO)_4(g)$?

(a) $K_c = \frac{[Ni(CO)_4]}{[Ni][CO]}$ (b) $K_c = \frac{[Ni][CO]^4}{[Ni(CO)_4]}$ (c) $K_c = \frac{[Ni(CO)_4]}{[CO]^4}$

(d) $K_c = \frac{[Ni(CO)_4]}{4[CO]}$ (e) $K_c = \frac{[Ni(CO)_4]}{[Ni][CO]^4}$

3&4. Which one of the following combinations <u>**cannot**</u> produce a buffer solution?

(a) NH_3 and NH_4Br (b) NH_3 and $(NH_4)_2SO_4$ (c) HCN and NaCN

(d) HNO_2 and $NaNO_2$ (e) $HClO_4$ and $NaClO_4$

5&6. Which of the following statements is **FALSE** about solubility and miscibility?

(a) Iodine, I_2(s), should be more soluble in carbon tetrachloride, CCl_4, than water.
(b) CsCl is more soluble in water than CaS.
(c) In the phrase "Like dissolves like," the term "like" refers to molecules with similar molecular weights.
(d) Benzene, C_6H_6, is miscible in chloroform, $CHCl_3$.
(e) Water and methanol, CH_3OH are miscible.

7&8. The best representation for the reaction whose heat of reaction is equal to the standard molar enthalpy of formation for $CHCl_3(g)$ is:

(a) $C(s,graphite) + \frac{1}{2} H_2(g) + 3/2\ Cl_2(g) \rightarrow CHCl_3(g)$

(b) $2C(s,graphite) + H_2(g) + 3\ Cl_2(g) \rightarrow 2CHCl_3(g)$

(c) $CHCl_3(g) \rightarrow C(s,graphite) + \frac{1}{2} H_2(g) + 3/2\ Cl_2(g)$

(d) $2CHCl_3(g) \rightarrow 2C(s,graphite) + H_2(g) + 3\ Cl_2(g)$

(e) $C(s,graphite) + H(g) + 3Cl(g) \rightarrow CHCl_3(g)$

9&10. The rate law for the chemical reaction, $2ClO_2(aq) + 2OH^-(aq) \rightarrow ClO_3^-(aq) + ClO_2^-(aq) + H_2O(\ell)$ has been determined experimentally to be:

$$\text{Rate} = k[ClO_2]^2[OH^-]$$

The reaction order with respect to the hydroxide ion is:

(a) $k[OH^-]^2$ (b) $k[ClO_2]^2[OH^-]$ (c) 3 (d) 2 (e) 1

11&12. Consider the gas phase reaction: $2C + D \rightarrow C_2D$, which occurs by the following mechanism:

Step 1	$C + C \rightarrow C_2$	slow
Step 2	$C_2 + D \rightarrow C_2D$	fast
Overall	$2C + D \rightarrow C_2D$	

The rate law expression must be Rate = ________.

(a) $k[C][D]$ (b) $k[C]^2$ (c) $k[D]$ (d) $k[C]^2[D]$ (e) $k[C]$

13&14. Which one of the following statements is TRUE about the following reaction?

$$HNO_2 + H_2O \rightleftarrows H_3O^+ + NO_2^-$$

(a) There are no conjugate acid-base pairs.

(b) OH^- is the conjugate acid of H_2O.

(c) H_2O is the conjugate base of OH^-.

(d) HNO_2 is the conjugate acid of H_2O.

(e) NO_2^- is the conjugate base of HNO_2.

15&16. For Ag_3PO_4, the relationship between K_{sp} and s, the molar solubility in mol/L, is

(a) $K_{sp} = s^{1/2}$ (b) $K_{sp} = s^2$ (c) $K_{sp} = 4s^3$

(d) $K_{sp} = 8s^4$ (e) $K_{sp} = 27s^4$

17&18. Consider the following gaseous phase system at equilibrium:

$$N_2O_4(g) \rightleftarrows 2NO_2(g) \qquad \Delta H = +58 \text{ kJ}$$

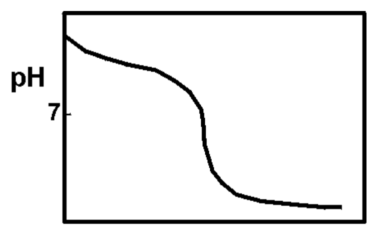
Which of the following changes will INCREASE the amount of NO_2 at equilibrium?

(a) adding $N_2(g)$
(b) increasing the temperature
(c) decreasing the volume of the container
(d) adding a catalyst
(e) removing $N_2O_4(g)$

19&20. Which of the following statements is **FALSE**?

(a) At absolute 0 K, the entropy of a pure perfect crystalline substance is zero.
(b) Endothermic processes are those that absorb heat.
(c) ΔS is a state function.
(d) The system's enthalpy alone does not determine the spontaneity of a reaction.
(e) A reaction is spontaneous if $\Delta S_{universe}$ decreases.

21&22. In this titration, what is being titrated with what?



(a) a weak acid is being titrated with a strong base
(b) a weak base is being titrated with a strong acid
(c) a strong acid is being titrated with a strong base
(d) a strong base is being titrated with a strong acid
(e) none of the above.

23&24. Which statement or statements are TRUE about catalysts?

(1) Catalysts change the mechanism of a reaction.
(2) A catalyst cannot appear as a reactant in a rate law expression.
(3) A catalyst lowers the activation energy of both the forward and reverse reaction.

(a) 1 & 2 (b) 2 & 3 (c) 1 & 3 (d) only 1 (e) only 3

25&26. Which statement is **TRUE** about aqueous solutions?

(a) As the value of the van't Hoff factor of the solute increases, the freezing point of the solution will increase.

(b) When the molality of the solute doubles, the boiling point of the solution will double.

(c) When a solute dissolves into the solvent, the vapor pressure of the solution will be lower than the vapor pressure of the pure solvent at a particular temperature.

(d) A solution is a heterogeneous mixture in which no settling occurs.

(e) A solution can only be made by dissolving a solid into a liquid.

27&28. Of the following species, which is the STRONGEST reducing agent?

(a) Cr (b) Zn^{2+} (c) Cr^{2+} (d) Cu (e) Co^{2+}

29&30. Consider the following reaction and choose the correct statement:

$$2\ H_2O(\ell) + O_2(g) \rightarrow 2\ H_2O_2(\ell) \qquad \Delta H^\circ = +196\ \text{kJ}$$
$$\Delta S^\circ = -126\ \text{J/K}$$

(a) The reaction becomes spontaneous as the temperature increases.

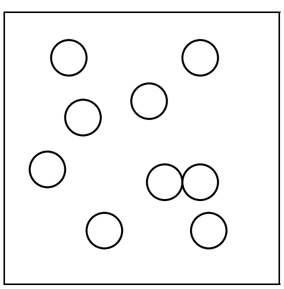
(b) The reaction becomes spontaneous as the temperature decreases.

(c) The reaction is spontaneous at all temperatures.

(d) The reaction is nonspontaneous at all temperatures.

(e) The temperature does not influence the spontaneity of any reaction.

31&32. Consider the equilibrium, $B_2 \rightleftarrows 2B$ with $K_c >> 1$. Which picture represents this system?

(a)


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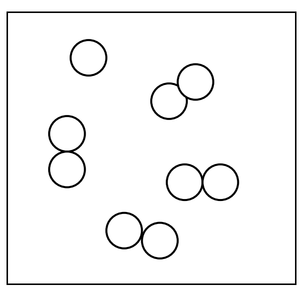

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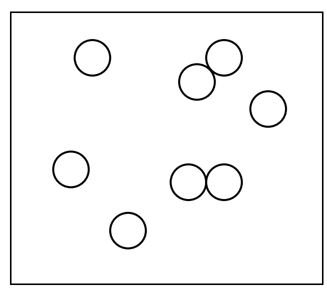

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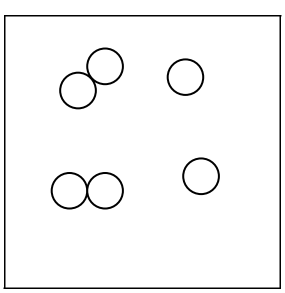

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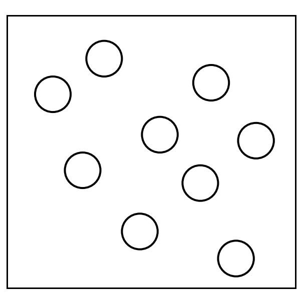

33&34. For the standard voltaic cell using Au^{3+}/Au and Fe^{2+}/Fe electrode compartments, which of the following statements is FALSE?

(a) The initial concentration of Fe^{2+} ions in the half cell must be 1.0 M.
(b) The gold electrode is labeled "–".
(c) The standard cell potential is 1.94 V.
(d) The electron flow through the external wire is from the iron electrode to the gold electrode.
(e) The iron electrode is the anode.

35&36. What is the pH of a 1.4 x 10^{-4} M HBr?

(a) 3.85 (b) 4.51 (c) 4.72 (d) 3.09 (e) 3.17

37&38. What concentration of Pb^{2+} will initiate precipitation in a solution that is 0.10 M KCl?

(a) 1.7 x 10^{-3} M (b) 1.7 x 10^{-5} M (c) 1.7 x 10^{-7} M
(d) 1.7 x 10^{-4} M (e) 1.7 x 10^{-2} M

39&40. What is the enthalpy change of the reaction below at 298 K and 1 atm pressure?

	$CO_2(g)$	+	$2H_2S(g)$	$\rightarrow$	$CS_2(\ell)$	+	$2H_2O(\ell)$
$\Delta H^{o}_{f\,298}$ (kJ/mol)	–394.0		–20.2		+89.5		–286.0

(a) +144 kJ (b) +227 kJ (c) –461.7 kJ (d) –48.1 kJ (e) –311.6 kJ

41&42. What will be the freezing point of an aqueous solution prepared by dissolving 60.0 g of ethylene glycol ($C_2H_6O_2$ – a nonelectrolyte) in 150. g of water?

(a) –14.4°C (b) –9.80°C (c) –12.0°C (d) –6.93°C (e) –4.77°C

43&44. Rate data were collected for the following reaction at a particular temperature. What is the correct rate law expression?

$$2X + Y \rightarrow Z$$

Experiment	$[X]_{initial}$	$[Y]_{initial}$	Initial Rate of Reaction
1	0.60 M	0.20 M	0.050 M/s
2	0.30 M	0.20 M	0.025 M/s
3	0.60 M	0.40 M	0.20 M/s

(a) Rate = $k[X][Y]^2$ (b) Rate = $k[X]^2[Y]$ (c) Rate = $k[X][Y]$
(d) Rate = $k[X]^2[Y]^2$ (e) Rate = $k[X]^2$

45&46. Calculate the standard cell potential for the cell: $Cd/CdSO_4$ (1 M) || $CuSO_4$ (1 M) /Cu

(a) +0.74 V (b) +0.32 V (c) +0.06 V (d) +0.45 V (e) +0.82 V

47&48. What is the pH of a 0.30 M HCN solution?

(a) 1.85 (b) 4.96 (c) 3.81 (d) 3.44 (e) 6.13

49&50. How many grams of cobalt metal can be made from a solution of $Co(NO_3)_2$ when a current of 5.00 amperes flows for 20.0 minutes?

(a) 5.68 g (b) 1.83 g (c) 2.11 g (d) 0.921 g (e) 1.43 g

51&52. Consider the following equilibrium in which the $K_c = 36$: $2\ HBr(g) \rightleftarrows H_2(g) + Br_2(g)$
Initially in the container there is 0.30 M of HBr. At equilibrium, what is the concentration of HBr?

(a) 0.15 M (b) 0.089 M (c) 0.018 M (d) 0.023 M (e) 0.14 M

53&54. What ratio of $[NH_3]/[NH_4^+]$ is required to give a solution with a pH of 9.60?

(a) 1.5:1 (b) 0.43:1 (c) 2.2:1 (d) 4.1:1 (e) 0.87:1

55&56. If a solution is 1.0×10^{-2} M in Pb^{2+} and 1.0×10^{-5} M in I^-, will precipitation occur?

(a) Yes, because Qsp > Ksp
(b) Yes, because Ksp > Qsp
(c) No, because Qsp > Ksp
(d) No, because Ksp > Qsp
(e) cannot be determined

OVER ⇒

57&58. Calculate ΔG^o for the reaction at 25°C:

$2\ HgO(s)\ +\ \underline{181.7\ kJ} \rightarrow Hg\ (\ell) + O_2(g)$ At 25°C, the ΔS^o for the reaction is +216.5 J/K.

(a) 178 kJ (b) –197 kJ (c) 67.8 kJ (d) 117 kJ (e) –5310 kJ

59&60. What is the pH of a solution that is 0.10 M KClO?

(a) 8.36 (b) 9.11 (c) 9.67 (d) 10.23 (e) 9.91

CHEMISTRY 102 **FALL 2010** NAME ____________________________

FINAL EXAM Section 502 (Please blockprint)

Form C

PART 2

Please read and sign: "On my honor, as an Aggie, I have neither given nor received unauthorized aid on this exam." ______________________________

61. Draw the electrolytic cell that results when two inert electrodes are put into an aqueous solution of KCl and connected to a battery. The observations are:

(1) chlorine gas is evolved at one electrode.

(2) H_2 gas is evolved at the other electrode and the solution becomes more basic around the electrode.

(1 pt) Label the anode and give the anodic reaction.

(1 pt) Label the cathode and give the cathodic reaction?

(1 pt) Give the sign on each electrode?

(1 pt) Show the direction of the electron flow.

(1 pt) What is the overall reaction?

5 pts) **62.** Assign oxidation numbers to every element in the reaction (2 pts). Balance the following redox reaction in acidic solution (3 pts):

$$NO(g) + Pb^{2+}(aq) \rightarrow PbO_2(s) + N_2(g)$$

OVER ⇒

(5 pts) **63.** Calculate the potential (in volts) for the non-standard voltaic cell when the following two half-cells are connected: Anode: Cu electrode in 1.0 x 10^{-3} Cu^{2+} solution
Cathode: Ag electrode in M 0.10 M Ag^{+} solution

Given: $E_{cell} = E^{o}_{cell} - (0.0257/n) \bullet \ln Q_{thermo}$ $E_{cell} = E^{o}_{cell} - (0.0592/n) \bullet \log Q_{thermo}$

(5 pts) **64.** A buffer is prepared by mixing 100. mL of 0.200 M nitrous acid and 300 mL of 0.100 M sodium nitrite. What is the pH of the final solution after 50.0 mL of 0.150 M HCl is added?

SCRAP PAPER OR COMMENTS ON THIS EXAM