Chem 102  Sample Exam 4-2n  Dr. V. Williamson

FORM A is EXAM VI, VERSION 2 (v2)

Name______________________________

1. DO NOT TURN THIS PAGE UNTIL DIRECTED TO DO SO.
2. These tests are machine graded; therefore, be sure to use a No. 1 or 2 pencil for marking the answer sheets.
3. Completely blacken the answer circle. If you change an answer, erase completely the previous mark.
4. You may remove you answer sheet from this booklet. If you have a pink test, test form A should be darkened (B for Blue), if it is not, notify your instructor immediately.
5. Fill in your last name, first name, and initial. Blacken the corresponding letters.
6. Fill in your ID number. CAREFULLY, blacken the corresponding numbers below this section.
7. Fill in the Dept. Course No. and Section. The Dept. = CHEM, the Course No. = 102, and your section.
8. If you what your scores posted by a portion of your ID #, mark A under the option column.
9. READ THE TEST CAREFULLY. The time limit on this test is 50 minutes.
10. Use the test for scratch paper.
11. Mark your answers in this booklet as well as on the answer sheet so you can check your score with the key after the test.
12. There are 17 questions. Each counts 6 points for a total of 102 points. NO GRADES OVER 100 WILL BE RECORDED.
13. Your score will be calculated from the number of correct answers. There is no penalty for guessing.
14. Turn in your scan sheet, show your ID, and have your calculator checked. You will also turn in your test.

15. A key will be on the electronic class bulletin board at 2:15PM. This is accessed through the class homepage.

IMPORTANT INFORMATION:

- $F = 1.8 \, \text{C} + 32$  
- $4.184 \, \text{J} = 1 \, \text{calorie}$
- $R = 0.0821 \, \text{L} \cdot \text{atmos}/\text{K} \cdot \text{mol}$  
- $R = 8.314 \, \text{J}/\text{K} \cdot \text{mol}$
- $c = 3.00 \times 10^{-3} \, \text{m/s}$
- $q = ms\Delta t$
- $\Delta G = \Delta H - T\Delta S$
- $\Delta G^\circ = -RT \ln K$
- $S_{\text{liquid water}} = 4.184 \, \text{J}/\text{g} \cdot \degree \text{C}$
- $\ln[A] = -akt + \ln [A]_0$
- $K_p = K_c(RT)^{\Delta n}$
- $[A] = -akt + [A]_0$
- $\Delta G^\circ = -nFE^\circ$
- $[A]_0 = \frac{t_{1/2}}{2ak}$
- $\frac{0.693}{ak} = t_{1/2}$
- $\frac{1}{ak[A]_0} = t_{1/2}$
- $\frac{1}{[A]} = akt + [A]_0$
- $\ln [k_f] = E_a \left[ \frac{1 - 1}{T_f, T_i} \right]$
- $\ln [K_f] = \Delta H \left[ \frac{1 - 1}{T_f, T_i} \right]$
- $\ln [K_i] = \Delta H \left[ \frac{1 - 1}{T_i, T_f} \right]$
- $\ln [K_i] = \Delta H \left[ \frac{1 - 1}{T_i, T_f} \right]$
- $\ln [A] = \frac{E_a}{ak} - \frac{0.0592}{R} \log Q$
- $F = 96,500 \, \text{coul/mol}$
- $1 \, \text{coul} = 1 \, \text{amp} \cdot \text{sec} = J/V$
- $E = E^\circ - 0.0592 \log Q$

Standard Reduction Potentials in V:

- $\text{Zn}^{2+} + 2e \rightarrow \text{Zn}, \ -0.76$
- $\text{Ca}^{2+} + 2e \rightarrow \text{Ca}, \ -2.87$
- $\text{I}_2 + 2e \rightarrow 2\text{I}^-, \ +0.535$
- $\text{Ni}^{2+} + 2e \rightarrow \text{Ni}, \ -0.28$
- $\text{F}^-, +2e \rightarrow 2\text{F}^-, +2.87$
- $2\text{H}_2\text{O} + 2e \rightarrow \text{H}_2 + 2\text{OH}^-, \ -0.83$
- $\text{Cu}^{2+} + 2e \rightarrow \text{Cu}, \ 0.34 \, \text{V}$
- $4\text{H}^+ + \text{O}_2 + 4e \rightarrow 2\text{H}_2\text{O}, \ +1.23$
- $\text{Ga}^{3+} + 3e \rightarrow \text{Ga}, \ -0.53$
- $\text{Pb}^{2+} + 2e \rightarrow \text{Pb}, \ -0.126 \, \text{V}$
- $\text{Al}^{3+} + 3e \rightarrow \text{Al}, \ -1.66 \, \text{V}$

102 Sample Exam 4-2  page 1
1. The solubility of Mg(OH)$_2$ is $1.4 \times 10^{-4}$ mol/L. Determine the Ksp for Mg(OH)$_2$.
   A. $2.7 \times 10^{-12}$  B. $1.1 \times 10^{-11}$  C. $3.9 \times 10^{-8}$  D. $2.0 \times 10^{-8}$  E. $2.8 \times 10^{-8}$

2. What is the oxidation number of Co in CoCl$_6^{3-}$?
   A. +6  B. -6  C. +8  D. -3  E. +3

3. In which aqueous system is AuI least soluble?
   A. 0.3 M KI  B. 0.2 M CaI$_2$  C. 0.2 M Ca(NO$_3$)$_2$
   D. 0.2 M HI  E. H$_2$O

4. What are the products of the electrolysis of aqueous GaF$_3$? (electrolytic cell)
   A. Ga + F$_2$  B. H$_2$ + F$_2$  C. Ga + O$_2$  D. Ga + H$_2$  E. H$_2$ + O$_2$

5. What is the coefficient on O$_2$ when the following equation is correctly balanced?
   \[ \text{H}_2\text{O}_2(aq) + \text{Cl}_2\text{O}_7(aq) \rightarrow \text{ClO}_2^-(aq) + \text{O}_2(g) \] (Basic solution)
   A. 5  B. 4  C. 3  D. 2  E. 1

6. The respective standard reduction potentials in V for Ag$^+$ and Zn$^{2+}$ are +0.80 and -0.76. Which substance will be oxidized in this voltaic cell?
   A. Ag  B. Zn$^{2+}$  C. Ag$^+$  D. Zn  E. none, since the salt bridge allows charge to equalize

7. Consider a solution prepared by adding 0.45 moles of KC$_2$H$_3$O$_2$ to 1.00 L of 2.00 M HC$_2$H$_3$O$_2$.
   (Ka = $1.8 \times 10^{-5}$)
   If 0.05 mol of HCl is added to this buffer solution, the pH of the solution will drop slightly.
   The pH does not drastically decrease because the HCl reacts with the ________ present in the buffer solution.
   A. H$^+$  B. HCl doesn’t react  C. C$_2$H$_3$O$_2^-$  D. H$_3$O  E. HC$_2$H$_3$O$_2$
8. Which of the following are TRUE?

(1) In a voltaic cell, the anode is negative.
(2) Al\(^{3+}\) is a stronger oxidizing agent than I\(_2\).
(3) Zn is a stronger reducing agent than Pb.
(4) In an electrolytic cell, the anode is negative.

A. #3 & #4  
B. #1 & #2  
C. #2 & #4  
D. #1 & #3  
E. #4 only

9. Which transformation could take place at the anode of an electrochemical cell?

A. Cr\(^{3+}\) to Cr\(_2\)O\(_7\)\(^{2-}\)  
B. HAsO\(_2\) to As  
C. F\(_2\) to F\(^-\)  
D. O\(_2\) to H\(_2\)O  
E. None of these

10. The mass of chromium (in g) deposited by passing a 27.2 A current through an aqueous solution of Cr(NO\(_3\))\(_3\) for 989 s is ________________.

Use the facts that 1 A* s = 1 C and the total charge on 1 mole of electrons is 9.65 x 10\(^4\) C.

A. 14.5  
B. 95.5  
C. 4.83  
D. 27.9  
E. 43.5

11. The two electrodes Cr(s)/Cr\(^{3+}\) (aq) and Sn(s)/Sn\(^{2+}\)(aq) are combined to afford a spontaneous electrochemical reaction. The standard reduction potentials in V for Cr\(^{3+}\) (aq) and Sn\(^{2+}\) (aq) are -0.74 and -0.14, respectively. E\text{°} cell in V is:

A. +0.88  
B. -0.60  
C. +2.50  
D. +0.60  
E. -0.88

12. Calculate the equilibrium constant for the reaction:

\[ \text{IO}_3^- + 6\text{H}^+ + 3\text{Hg} \rightleftharpoons 3\text{Hg}^{2+} + \text{I}^- + 3\text{H}_2\text{O} \]

\( E^\circ = 0.247 \text{ V} \)

Calculate the equilibrium constant. The exponent on this equilibrium constant is:

A. \(10^{-12}\)  
B. \(10^{25}\)  
C. \(10^{12}\)  
D. \(10^{-25}\)  
E. \(10^4\)

13. The Ksp for Zn(OH)\(_2\) is 5.0 x 10\(^{-17}\). Determine the solubility of Zn(OH)\(_2\) in a solution with a pH of 11.50.

A. 5.0 x 10\(^6\)  
B. 5.0 x 10\(^{-12}\)  
C. 5.0 x 10\(^{-17}\)  
D. 1.6 x 10\(^{-14}\)  
E. 1.2 x 10\(^{-12}\)

14. Which of the following are TRUE?

(1) Batteries are voltaic cells where electrical energy is produced.
(2) In a voltaic cell, electrons flow through the salt bridge to balance charges.
(3) In an electrolytic cell, a salt bridge is not needed.
(4) In an electrolytic cell, the anode is negative.

A. #2 & #3  
B. #2 & #4  
C. #1 & #3  
D. #3 & #4  
E. #1 & #2

15. The standard reduction potentials of Cu\(^{2+}\) and Ag\(^+\) in V are +0.34 and +0.80, respectively. Determine the value of E (in volts) for the following cell at 25°C.

\[ \text{Cu} | \text{Cu}^{2+} (1.00 \text{ M}) || \text{Ag}^+ (0.0010 \text{ M}) | \text{Ag} \]

A. 0.11  
B. 0.28  
C. 0.55  
D. 0.37  
E. 0.46
16. Which statement about the following reaction is INCORRECT?

\[ \text{Cr(s)} + \text{H}_2\text{SO}_4 \text{(aq)} \rightarrow \text{CrSO}_4 \text{(aq)} + \text{H}_2 \text{(g)} \]

A. The oxidation number of Cr(s) is 0.
B. The chromium is reduced.
C. The oxidation number of the Cr ion in CrSO\(_4\) is +2.
D. H\(^+\) in H\(_2\)SO\(_4\) is the oxidizing agent.
E. The reducing agent releases a total of 2 electrons.

17. Which is TRUE concerning the effect of adding the following to a solution of Zn(OH)\(_2\)
Ksp for Zn(OH)\(_2\) is 5.0 x 10\(^{-17}\)

A. Adding a 0.10 M solution of KCl will decrease the solubility of Zn(OH)\(_2\)
B. Adding a 0.10 M solution of ZnCl\(_2\) will increase the solubility of Zn(OH)\(_2\)
C. Adding a 0.10 M solution of KOH will increase the solubility of Zn(OH)\(_2\)
D. Adding a 0.10 M solution of HCl will increase the solubility of Zn(OH)\(_2\)
E. NONE of these will affect the solubility of Zn(OH)\(_2\)

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NUCLEAR

1. The nuclide $^{77}\text{Se}$ can be formed in a cyclotron by bombarding _____ with alpha particles (assuming no fragmentation).

   A. $^{77}\text{As}$  
   B. $^{35}\text{Br}$  
   C. $^{81}\text{Kr}$  
   D. $^{32}\text{Ge}$  
   E. $^{73}\text{Br}$

2. This reaction is an example of ___________.

   \[
   ^{41}\text{Ca} + \quad \rightarrow ^{41}\text{K} 
   \]

   A. beta decay  
   B. electron capture  
   C. alpha decay  
   D. X-ray emission  
   E. positron decay

3. Predict the mode of decay of Plutonium-239 (Pu)

   A. gamma only  
   B. positron  
   C. alpha  
   D. beta  
   E. no decay predicted

4. The basic assumption of the carbon-14 dating method is that:

   A. carbon-14 is very unstable and is readily lost from the atmosphere.  
   B. living tissue will not absorb carbon-14 but will absorb carbon-12.  
   C. the ratio of carbon-14 to carbon-12 in the atmosphere is a constant.  
   D. the number of grams of carbon-14 in all living objects is the same.  
   E. carbon can be easily turned to diamond.

5. I-131 has a half-life of 8.04 days. Assuming you start with a 1.35 mg sample of I-131, how much will remain after 13.0 days?

   A. 0.440 mg  
   B. 0.104 mg  
   C. 0.035 mg  
   D. 0.268 mg  
   E. 0.417 mg

6. The mass of a proton is 1.00783 g/mol. The mass of a neutron is 1.00867 g/mol. The mass of the nucleus of an $^{65}\text{Cu}$ atom is 64.92780 g/mol. What is the nuclear binding energy in kJ/mol $^{65}\text{Cu}$?

   A. 5.50 e10  
   B. 1.83 e2  
   C. 5.08 e13  
   D. 8.47 e5  
   E. 9.289 e23

7. Answer each of the following as True or False. Then choose the response that contains the largest number of TRUE statements?

   (1) Fusion is a process that involves two or more nuclei becoming one.
   (2) Radon gas is dangerous because of its abundance and because the particles emitted from its decay ionize the tissue in the lungs.
   (3) Hydrogen bombs are fusion bomb and only work at high temperatures.
   (4) Fission bombs require a traditional explosive to compress the fuel to critical mass.
   (5) Radiation from nuclear decay has been present from the beginning and did not begin with the testing of nuclear warheads.

   A. #2, #3, and #5 are true.  
   B. #1 and #3 are true.  
   C. #2 and #5 are true.  
   D. #1 and #4 are true.  
   E. all are true.
8. The purpose of the control rods is:
   A. to absorb neutrons given off in the fission
   B. to slow down the neutrons
   C. to add more fuel to the reactor
   D. to speed up the reaction
   E. to cool the reactor core

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