CHEMISTRY 101 EXAM 3
SECTIONS 572-580 Dr. Joy Heising

FORM 3M
November 20, 2001

Directions:

1. This examination consists of two parts: 17 multiple choice questions (6 points each) in Part 1 and 4 free response questions (48 points total) in Part 2. The total point value for the exam is 150 points.

2. Fill out your scantron sheet to be used for Part 1.
   a. Do not forget to include your SIGNATURE and ID number.
   b. Dept = CHEM, Course No. = 101
   c. If you want your scores posted, mark A under the option column

3. Fill in your NAME, SIGNATURE and ID number at the beginning of Part 2 (stapled separately).

4. Use a #1 or #2 pencil for marking the scantron. Fill in the appropriate circles completely. You may write on the multiple choice questions.

5. Read each question carefully, then choose the best answer for each question. There is no penalty for guessing.

6. Write your answers in Part 2 clearly and neatly. Show your work for partial credit.

7. DO NOT write on the envelope.

8. The last page of each Part is a sheet of scrap paper. You may tear it off.

9. When finished, put the SCANTRON SHEET AND PART 2 back in the envelope and turn it in. You may keep Part 1 (this stapled portion).

Some Helpful Equations/Constants:

\[ PV = nRT \quad R = \frac{0.0821 \text{ atm} \cdot \text{L}}{\text{mol} \cdot \text{K}} \quad R = \frac{62.4 \text{ torr} \cdot \text{L}}{\text{mol} \cdot \text{K}} \]

\[ \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \]

\[ P_{\text{tot}} = P_a + P_b + \ldots \]
\[ n_{\text{tot}} = n_a + n_b + \ldots \]
PART 1

Multiple Choice (6 points each). Choose the BEST answer.

1. Which of the following is the **strongest** acid?
   a) H$_2$SeO$_3$
   b) HSO$_4^-$
   c) H$_2$SO$_3$
   d) H$_2$SO$_4$
   e) H$_2$S

2. According to the **Lewis** theory, a base is best described as _____.
   a) a proton acceptor
   b) an electron pair acceptor
   c) a proton donor
   d) an electron pair donor
   e) any compound that contains OH

3. One mole of Al(OH)$_3$ has ___________ equivalents of the base.
   a) 1/3
   b) 1/2
   c) 1
   d) 2
   e) 3

4. Which one of the following pairs of acids and conjugate bases is **incorrect**?

<table>
<thead>
<tr>
<th>Acid</th>
<th>Conjugate Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) HF</td>
<td>F$^-$</td>
</tr>
<tr>
<td>b) HClO</td>
<td>ClO$^-$</td>
</tr>
<tr>
<td>c) H$_2$O</td>
<td>OH$^-$</td>
</tr>
<tr>
<td>d) NH$_4^+$</td>
<td>NH$_2^-$</td>
</tr>
<tr>
<td>e) H$_3$O$^+$</td>
<td>H$_2$O</td>
</tr>
</tbody>
</table>

5. Which of the following is the best example of a Brönsted-Lowry acid?
   a) AlCl$_3$
   b) CH$_4$
   c) NaOH
   d) H$_2$O
   e) H$_2$
6. Which of the following is not an amphoteric acid salt?
   a) NaHSO$_4$
   b) NaHCO$_3$
   c) KH$_2$PO$_4$
   d) K$_2$HPO$_4$
   e) K$_3$PO$_4$

7. Acid rain is formed when assorted gaseous nonmetal oxides (the combustion products of nonmetal impurities in gasoline) react with atmospheric water. Which nonmetal oxide, when reacted with H$_2$O, forms H$_2$SO$_4$?
   a) SO
   b) SO$_2$
   c) SO$_3$
   d) HSO$_3^-$
   e) H$_2$S

8. What is the oxidation number of tin in H$_2$SnO$_3$?
   a) +1
   b) +2
   c) +3
   d) +4
   e) +5

9. In an oxidation/reduction reaction, the oxidizing agent
   a) loses electrons
   b) gains electrons
   c) adds H$_2$O, OH$^-$ or H$^+$ to balance the charge and/or atoms
   d) is a government spy
   e) all of the above

10. When balanced, what is the total number of electrons transferred?
    \[
    \text{Hg}_2^{2+}(aq) + \text{Cr}^{2+}(aq) \rightarrow \text{Hg}(l) + \text{Cr}^{3+}(aq) \quad \text{(UNBALANCED)}
    \]
    a) 0
    b) 2
    c) 3
    d) 5
    e) 6
11. By international agreement the standard temperature and pressure (STP) for gases is
   a) 298.15 K and 760 torr.
   b) 0°C and 700 torr.
   c) 25°C and one atmosphere.
   d) 273.15 K and 760 torr.
   e) 293 K and one atmosphere.

12. The average kinetic energy of ideal gas molecules is directly proportional to the ________.
   a) volume of the sample
   b) pressure of the sample
   c) mass of the molecule
   d) density of the sample
   e) absolute temperature of the sample

13. The van der Waals constant, \( a \), in the relationship
   \[ P + \frac{n^2a}{V^2} + \frac{n}{V} \quad (V - nb) = nRT \]
   is a factor that corrects for
   a) deviations in the gas constant, \( R \).
   b) the attractive forces between gas molecules.
   c) the tendency of the gas molecules to ionize.
   d) the average velocities of the gas molecules.
   e) the volume occupied by the gas molecules.

14. A sample of a gas occupies a volume of 0.350 L at 3000 torr and 25°C. Calculate the
    number of moles of gas present.
   a) 5.65 x 10\(^{-2}\) mol
   b) 8.39 x 10\(^{-3}\) mol
   c) 1.25 x 10\(^{-2}\) mol
   d) 1.38 x 10\(^{-2}\) mol
   e) 2.19 x 10\(^{-3}\) mol

15. What volume of \( \text{O}_2 \) would be required to react with excess \( \text{SO}_2 \) at 273 K and 1.00 atm to
    produce 2.00 moles of \( \text{SO}_3 \)?
    \[ 2\text{SO}_2(g) + \text{O}_2(g) \rightarrow 2\text{SO}_3(g) \]
   a) 44.8 L
   b) 22.4 L
   c) 33.6 L
   d) 5.60 L
   e) 11.2 L
16. What is the pressure exerted by 0.41 mol $\text{SO}_2$, 2.00 mol $\text{H}_2$, and 1.00 mol $\text{Ne}$ in a 10.0-liter container at 50.0°C?

a) 9.04 atm  
b) 10.1 atm  
c) 14.4 atm  
d) 18.6 atm  
e) 26.3 atm

17. When aluminum carbide is reacted with water, a gaseous product is formed. A small sample of this gas weighing 0.0771g is collected in a 250 ml flask at a pressure of 350 torr. The temperature is 18.0°C. What is the molar mass of the gas?

a) 16.0 g/mol  
b) 36.6 g/mol  
c) 26.0 g/mol  
d) 11.0 g/mol  
e) 4.82 g/mol
PART 2  FORM 3M

Dr. Heising    CHEM 101    Sections 572-580    EXAM 3    November 20, 2001

NAME:  

SID #:  

SIGNATURE:  

Free Response (48 pts total, see margin for point values). Show all work for partial credit!

(6 pts)  18. At 30 °C a sample of CH$_4$ occupies a volume of 250 ml under a pressure of 4.0 atm. What volume would it occupy at a pressure of 2.0 atm?

19. Succinic acid, H$_2$C$_4$H$_4$O$_4$, is a diprotic acid, molar mass = 118.1 g/mol.

(6 pts)  a) If you dissolve 2.00 g of succinic acid in enough water to make 100 ml of solution, what is the normality of the solution?

(6 pts)  b) You have 10.0 ml of a 2.5N solution of succinic acid. How many milliliters of 1.0 N NaOH are required to fully react with the succinic acid?
20. One of the products formed upon the reaction of succinic acid, \( \text{H}_2\text{C}_4\text{H}_4\text{O}_4 \), a weak acid, with \( \text{NaOH} \) in aqueous solution is the soluble salt \( \text{Na}_2\text{C}_4\text{H}_4\text{O}_4 \).

(6 pts) a) write a balanced formula equation to describe the reaction complete with phase labels (s, l, aq, etc.). write a balanced formula equation to describe the reaction complete with phase labels (s, l, aq, etc.).

(2 pts) b) Label the acid/conjugate base and the base/conjugate acid pairs on the equation.

(4 pts) c) write the total ionic equation for the reaction.

(2 pts) d) write the net ionic equation.

(2 pts) e) which of the three acid/base theories best describes this reaction?_________________________
21. Consider the following *unbalanced* redox reaction in *basic solution*:

\[ \text{Zn}(s) + \text{NO}_3^-(aq) \rightarrow \text{Zn(OH)}_4^{2-}(aq) + \text{NH}_3(g) \]

(6 pts) a) The _________________ atom is oxidized from __________ to ___________.

(oxidation numbers)

The _________________ atom is reduced from __________ to ___________.

(oxidation numbers)

(8 pts) b) balance the reaction using the method of your choice. **SHOW YOUR WORK.**
SCRAP PAPER (PART 2)