INSTRUCTIONS:

1. This exam consists of 6 different pages including a periodic table. PRINT your name NOW in the designated space on each page. DO NOT SEPARATE THE PAGES. PRINT YOUR NAME ON THE BACK OF THE LAST PAGE.

2. For the short-answer questions, write your answer neatly in the space provided.

3. ANSWERS TO MULTIPLE CHOICE QUESTIONS SHOULD BE ENTERED IN THE BOX TO THE RIGHT OF THIS PAGE; OTHERWISE, THEY WILL NOT BE GRADED. All other questions should be answered in this packet.

4. For all other questions, you must show your work clearly, explaining how you obtained your answer. Credit will be assigned on the clarity of your work as well as on the correctness of your final answer. Your answers to numerical problems should be given to the accuracy of the supplied data. Show units for any numerical answer and, please, box your answer.

5. Point values are shown next to the number of the question.

6. Budget your time for each question so that you spend no more minutes than half of the point value shown; e.g., a question worth 10 points should be completed in 5 minutes. This procedure will enable you to finish the whole exam in 50 minutes and will give you 10 minutes to review and check your work and go over questions that have given you problems.

7. NOW, look over the whole exam; plan your work; then begin.

It took me ______ minutes to finish this exam

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For Multiple Choice Questions

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<td>II. These questions are 2 points each.</td>
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<td>1. D</td>
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<td>2. E</td>
<td>6. B</td>
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<td>3. B</td>
<td>7. D</td>
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<td>4. D</td>
<td>8. D</td>
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<td>I.</td>
<td>/10</td>
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<td>II.</td>
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<td>V.</td>
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<td>VI.</td>
<td>/36</td>
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<td>VII.</td>
<td>/10</td>
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<td>TOTAL</td>
<td>/100</td>
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\[ \bar{x} = 23.6 \]

"The true measure of a person is what they would do if no one ever found out."

Anonymous

HONOR CODE

I do solemnly swear that I have not received assistance from another student or any other source no have I given assistance to another student while taking this examination and I am not aware of anyone taking this examination who has committed a misconduct.

Signature ____________________
I. (10 pts) Answer the following by placing the appropriate word(s), formula(s) or number(s) in each blank.

1. What is the molar mass of calcium nitrate? $\text{Ca(NO}_3\text{)}_2$ \[ 164.086 \text{ g/mol} \]

2. What is the oxidation state of Mn in KMnO$_4$? +7

3. How many atoms are present in 3.14 g of copper? \[ \frac{3.14 \text{ g Cu}}{63.546 \text{ g/mol}} \times \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = \frac{2.97 \times 10^{22} \text{ atoms}}{1} \]

4. What is the molecular geometry of H$_2$O? Bent

5. A reaction that gives off heat is said to be Exothermic

6. What is the oxidizing agent in the following reaction $\text{Cl}_2 + \text{NaBr} \rightarrow 2 \text{ NaCl} + \text{Br}_2$ Cl$_2$

7. At constant pressure, as temperature decreases, volume decreases

8. List three ways to increase the production of NH$_3$.
   - Increase N$_2$ or H$_2$
   - Remove NH$_3$
   - Decrease temperature
   - Increase pressure

II. (16 pts) Multiple Choice Questions. EACH QUESTION IS WORTH 2 POINTS. ONLY THE ANSWERS ON THE FRONT SHEET WILL BE GRADED.

1. Balance the equation: $\text{AlCl}_3 + 3\text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{HCl}$. In the balanced equation, the coefficient of HCl is
   A. 2     B. 3     C. 4     D. 6     E. 12

2. The addition of a catalyst to a reaction system
   A. Increases the amount of heat evolved F
   B. Increases the yield of product F
   C. Decreases the yield of product F
   D. Decreases the amount of heat produced F
   E. Lowers the activation energy T
3. Hydrogen peroxide is used to disinfect wounds because
   A. it is a reducing agent
   B. It is an oxidizing agent
   C. it is a bleach
   D. None of the above

4. A substance is reduced if it
   A. Loses oxygen T
   B. Gains hydrogen T
   C. Gains electrons T
   D. All of the above
   E. None of these

5. If the pressure on 10.0 L of gas is changed from 0.75 atm to 2.5 atm with the temperature constant, its new volume will be
   \[ P_1 V_1 = P_2 V_2 \]
   \[ V_2 = \frac{P_1 V_1}{P_2} = \frac{(0.75 \text{ atm})(10.0 \text{ L})}{2.5 \text{ atm}} = 3.0 \text{ L} \]
   A. 2.5 L
   B. 3.0 L
   C. 3.3 L
   D. 30 L
   E. 33 L

6. If you raise the temperature of a gas in a container of fixed volume, the molecules will strike the walls
   A. Harder, but less often F
   B. Harder and more often
   C. Less hard, less often F
   D. Less hard, but more often F
   E. There will be no change F

7. If 8.50 L of a gas cools from 100°C to 20°C at constant pressure, its volume is
   \[ V_1 \quad \frac{T_1}{V_2} = \frac{T_2}{V_1} \]
   \[ V_2 = \frac{V_1 T_2}{T_1} = \frac{(8.50 \text{ L})(300 \text{ K})}{300 \text{ K}} = 6.68 \text{ L} \]
   A. 42.5 L
   B. 21.6 L
   C. 10.8 L
   D. 6.68 L
   E. 1.70 L

8. At which location would the pressure of carbon dioxide be lower in a healthy individual?
   A. In the cell
   B. In the fluid surrounding the cell
   C. In venous blood
   D. In arterial blood
   E. In cerebro-spinal fluid
III. (8 pts) Discuss from a molecular point of view the factors that affect the rate of a chemical reaction (temperature, concentration, surface area, catalyst).

2 Temp: An increase in temp will increase the K.E. of the molecules. This will cause the molecules to move faster causing more collisions and a faster rate of reaction. Because of the increased K.E. more molecules will also have the required activation energy.

2 Conc: An increase in conc. will increase the # of molecules present. This will allow for more collisions and thus a faster rate.

2 Surface Area: The greater the potential surface for collisions, the more collision that will occur. Thus, an increased rate of reaction.

2 Catalyst: Addition of a catalyst will provide an alternate pathway to products that has a lower activation energy. Thus, a faster rate of reaction.

IV. (16 pts) The reaction that takes place in the reusable solid rocket booster for the space shuttle is shown by the following balanced equation:

\[ 3Al(s) + 3NH_4ClO_4(s) \rightarrow Al_2O_3(s) + AlCl_3(s) + 3NO(g) + 6 H_2O(g) \]

A. How many grams of \(Al_2O_3\) (mm \(Al_2O_3 = 101.96 \text{ g/mol}\)) are formed by the reaction of 100 kg of Al (s)

\[
\frac{(100 \text{ kg Al}) \left( \frac{1000 \text{ g}}{1 \text{ kg}} \right) \left( \frac{1 \text{ mol Al}}{26.982 \text{ g Al}} \right) \left( \frac{1 \text{ mol } Al_2O_3}{3 \text{ mol Al}} \right) \left( \frac{101.96 \text{ g } Al_2O_3}{1 \text{ mol } Al_2O_3} \right)}{1 \text{ mol }} = \sqrt{1.26 \times 10^5 \text{ g } Al_2O_3}
\]

B. What volume of NO gas is formed from the reaction of 100 kg of Al (s) if the reaction is run at 1.03 atm and 300°C

\[
\frac{(100 \text{ kg Al}) \left( \frac{1000 \text{ g}}{1 \text{ kg}} \right) \left( \frac{1 \text{ mol Al}}{26.982 \text{ g Al}} \right) \left( \frac{3 \text{ mol NO}}{3 \text{ mol Al}} \right)}{2 \text{ mol NO}} = 3706.2 \text{ mL NO}
\]

\[
PV = nRT \\
V = \frac{nRT}{P} = \left( \frac{3706.2 \text{ mL NO}}{0.0821 \text{ L atm/mol K}} \right) \left( \frac{300 + 273 \text{ K}}{1.03 \text{ atm}} \right) = 1.69 \times 10^5 \text{ mL NO}
\]

V. (4 pts) A miner drinks a carbonated drink while he is a mile below the surface of the earth. Shortly after he leaves the mine and begins to burp uncontrollably. Explain what is happening to the miner.

A mile below the surface there is an very large increase in the pressure. This increased pressure caused the CO₂ in the drink to be very soluble in the liquid. As the miner came to the surface the pressure decreased, causing the CO₂ to be less soluble. Thus the miner experienced the burping caused by the CO₂ leaving the liquid.
VI. (36 pts) Two's company, but three is a crowd. With four, however, the numerous possibilities become very interesting. Describe the molecular structure of the following molecules or ions.

<table>
<thead>
<tr>
<th>Lewis structure</th>
<th>Electronic shape</th>
<th>Molecular shape</th>
<th>Polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{SF}_4$</td>
<td>$\text{tetrahedral}$</td>
<td>$\text{tetrahedral}$</td>
<td>Polar</td>
</tr>
<tr>
<td>$\text{CF}_4$</td>
<td>$\text{tetrahedral}$</td>
<td>$\text{tetrahedral}$</td>
<td>Non-polar</td>
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<tr>
<td>$\text{PCl}_3$</td>
<td>$\text{trigonal}$</td>
<td>$\text{Pyramidal}$</td>
<td>Polar</td>
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</table>

VII. (10 pts) Kerosene is a mixture of hydrocarbons used in domestic heating and as a jet fuel. Assume that kerosene can be represented as $C_{16}H_{30}$, ($\text{mm} = 198.38 \text{ g/mol}$) and that it has a density of 0.763 g/mL.

$$2 C_{16}H_{30} (l) + 43 \text{O}_2 (g) \rightarrow 28 \text{CO}_2 (g) + 30 \text{H}_2\text{O} (l)$$

How many grams of $\text{CO}_2$ (mm = 44.01 g/mol) are produced by the combustion of 1.00 gal of kerosene?

$$\left(1.00 \text{ gal} \frac{4.94 \text{ L}}{1 \text{ gal}} \right) \left( \frac{1000 \text{ mL}}{1 \text{ L}} \right) \left(0.763 \text{ g} \frac{C_{16}H_{30}}{1 \text{ mL}} \right) \left( \frac{1 \text{ mol} \text{C}_{16}H_{30}}{198.38 \text{ g}} \right) \left( \frac{2 \text{ mol} \text{CO}_2}{2 \text{ mol} \text{C}_{16}H_{30}} \right) \left(44.01 \text{ g} \frac{1 \text{ mol} \text{CO}_2}{1 \text{ mol} \text{CO}_2} \right) =$$

$$= 8.97 \times 10^3 \text{ g \ CO}_2$$

_If you want peace, work for justice. Pope Paul VI_