Chem 115
Sample Examination #1

This exam consists of seven (7) pages, including this cover page. Be sure your copy is complete before beginning your work. If this test packet is defective, ask for another one.

A copy of the Periodic Table is attached to the end of this exam. You may remove it and use the back side as scratch paper. No work on scratch paper will be graded or collected.

The following information may be useful:

<table>
<thead>
<tr>
<th>Constants of nature</th>
<th>Conversions/Metric Prefixes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avogadro's number</td>
<td></td>
</tr>
<tr>
<td>( N_A = 6.022 \times 10^{23} ) units = 1 mole of units</td>
<td>1 mL = 1 cm(^3)</td>
</tr>
</tbody>
</table>

DO NOT WRITE BELOW THIS LINE

<table>
<thead>
<tr>
<th>Part I: Multiple-choice</th>
<th>Part II: Problems</th>
<th>Part III: Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1-18</td>
<td>Problem 1</td>
<td>omitted from this sample exam since laboratory is now a separate course</td>
</tr>
<tr>
<td>________ (max 54)</td>
<td>________ (max 20)</td>
<td></td>
</tr>
<tr>
<td>Problem 2</td>
<td>________ (max 16)</td>
<td></td>
</tr>
<tr>
<td>Extra credit</td>
<td>________ (max 4)</td>
<td></td>
</tr>
</tbody>
</table>

Total (out of 100 points) = 

Disclaimer:
This is a copy of a typical Exam 1 given in Chem 115 during the academic year. Your test will be different. This test is being posted to give you a sense of the format, style, scope and level of a typical test on this material. This test may have questions on topics that may not be covered on your exam. Moreover, your test may have questions on topics not covered in this practice exam. Posting this test in no way limits the format, style, scope and level of the test that you will take. Do not limit your preparation to the material in this practice exam.
Part I. Multiple-Choice or Short Response
Each multiple-choice question is worth 3 points. This part of the exam is worth 54% of the total points.

1. Oxygen and ozone (pictured above) are
A) the same substance and the same element.
B) the same element, but two different substances.
C) the same substance, but two different elements.
D) two different substances and two different elements.

2. What is the molar mass (in g·mol⁻¹) of anhydrous iron (III) sulfate, to the nearest whole number?

<table>
<thead>
<tr>
<th>Atomic molar masses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
</tr>
<tr>
<td>O</td>
</tr>
<tr>
<td>S</td>
</tr>
</tbody>
</table>

A) 104  B) 152  C) 248  D) 336  E) 400

3. The species designated as \(^{\text{56}}_{\text{24}}X\) is
A) Fe  B) Ge  C) Ba  D) Cr

4. Which pair of particles has the same number of electrons?
A) F⁻, Mg²⁺  C) Br⁻, Se
B) Ne, Ar  D) Al³⁺, P³⁻
5. The ions present in solid silver chromate, $\text{Ag}_2\text{CrO}_4$, are
   
   A) $\text{Ag}^+ \text{ and CrO}_4^{2-}$  
   B) $\text{Ag}^{2+} \text{ and CrO}_4^{4-}$
   C) $\text{Ag}^+ \text{ and Cr}^{6+}$ and $\text{O}^{2-}$  
   D) $\text{Ag}^{+} \text{ and Cr}^{3+}$ and $\text{O}^{2-}$

6. Which represents an isotope of element “E”?

   $\frac{27}{13} \text{E}$

   A) $^{26}\text{Al}$  
   B) $^{27}\text{Si}$  
   C) $^{27}\text{Co}$  
   D) $^{25}\text{Mg}$

7. What is the correctly reported mass of water based on these data?

   Mass of beaker and water | 29.62 g  
   Mass of beaker only     | 28.3220 g

   A) 1.3 g  
   B) 1.30 g  
   C) 1.298 g  
   D) 1.2980 g

8. Based on their positions in the periodic table, which is most likely to replace selenium, Se, in a biological system?

   A) Te  
   B) Br  
   C) As  
   D) I

9. Balance the equation

   $\text{? N}_2\text{H}_4 + \text{? N}_2\text{O}_4 \rightarrow \text{? N}_2 + \text{? H}_2\text{O}$

   How many moles of $\text{N}_2$ will be produced for every mole of $\text{N}_2\text{O}_4$ that reacts?

   A) one  
   B) two  
   C) three  
   D) four

10. Which procedure can be used to demonstrate experimentally that the reaction

    $2 \text{ Mg} + \text{ O}_2 \rightarrow 2 \text{ MgO}$

    A) Take a mass of 1.000 g of Mg ribbon, burn it in pure $\text{O}_2$, and compare the mass of the product with the original mass of the Mg.
    B) Show that the sum of 2 atomic molar masses of Mg plus 1 molar mass of $\text{O}_2$ is equal to 2 molar masses of MgO.
    C) Determine the mass of a sealed flash-bulb containing magnesium and oxygen, ignite (light on fire) the mixture, cool, and compare the final mass of bulb plus contents with the original mass of the bulb plus contents.
    D) Burn 1.000 g of Mg ribbon in a tall beaker filled with air, scrape out all of the MgO formed, and compare with the original mass of the Mg.
Use the periodic table below for questions 11-12.

<table>
<thead>
<tr>
<th>Main Groups</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>First period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>₂He</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second period</td>
<td></td>
<td></td>
<td></td>
<td>₉F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third period</td>
<td>₁₉K</td>
<td>E</td>
<td>M</td>
<td>Q</td>
<td>T</td>
<td>₃₆Kr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth period</td>
<td>X</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. Judging from its position in the periodic table, what type of element is element X?
   
   A) a metal       D) an inert gas
   B) a nonmetal    E) unpredictable in character
   C) an amphoteric element

12. How many electrons will an atom of element Q need to gain to form a stable ion?
   
   A) 1       B) 2       C) 3       D) 4       E) 7

13. If 1.0 g samples of each compound were dehydrated, which sample would lose the greatest mass of water?

<table>
<thead>
<tr>
<th>Molar masses</th>
</tr>
</thead>
<tbody>
<tr>
<td>LiCl•H₂O</td>
</tr>
<tr>
<td>MgSO₄•H₂O</td>
</tr>
<tr>
<td>FeSO₄•H₂O</td>
</tr>
<tr>
<td>SrC₂O₄•H₂O</td>
</tr>
</tbody>
</table>

   A) LiCl•H₂O       C) FeSO₄•H₂O
   B) MgSO₄•H₂O       D) SrC₂O₄•H₂O

14. A compound containing only carbon and hydrogen has this composition: C = 80% and H = 20% by mass. What is the simplest formula of the compound?

<table>
<thead>
<tr>
<th>Atomic molar masses</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
</tr>
<tr>
<td>H</td>
</tr>
</tbody>
</table>

   A) CH₄       B) CH₃       C) C₂H₆       D) C₃H₈       E) C₄H
15. What is the percentage of nitrogen by mass in \((\text{NH}_4)_3\text{PO}_4\) ?

<table>
<thead>
<tr>
<th>Atomic molar masses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>1.0 g·mol(^{-1})</td>
</tr>
<tr>
<td>N</td>
<td>14.0 g·mol(^{-1})</td>
</tr>
<tr>
<td>O</td>
<td>16.0 g·mol(^{-1})</td>
</tr>
<tr>
<td>P</td>
<td>31.0 g·mol(^{-1})</td>
</tr>
</tbody>
</table>

\[
\text{A) } (\frac{14}{62}) \times 100\% \quad \text{C) } (\frac{14}{113}) \times 100\%
\]

\[
\text{B) } (\frac{21}{80.}) \times 100\% \quad \text{D) } (\frac{42}{149}) \times 100\%
\]

16. The element \(X\) occurs naturally to the extent of 20.0\% \(^{12}\)X and 80.0\% \(^{13}\)X. The atomic mass of \(X\) is nearest to

A) 12.2  B) 12.5  C) 12.6  D) 12.8  E) 13.0

17. Why is the following equation incorrect?

\[
\text{Mg}_3 + \text{N}_2 \rightarrow \text{Mg}_3\text{N}_2
\]

A) Some of the subscripts are incorrectly used.
B) The equation is not balanced.
C) The valence (charge) of the nitride ion is incorrect.
D) The valence (charge) of the magnesium ion is incorrect.
E) The coefficient of \(\text{N}_2\) is incorrect.

18. Which of these atoms has the greatest number of neutrons in its nucleus?

A) \(^{52}_{26}\text{Fe}\)  B) \(^{56}_{25}\text{Mn}\)  C) \(^{55}_{26}\text{Fe}\)  D) \(^{57}_{27}\text{Co}\)  E) \(^{56}_{28}\text{Ni}\)
Part II. Problems
Points possible per question and per part are indicated in curly braces {...}.

1. {20 pts} Nomenclature: correct spelling and correct symbols matter.

   a) Name the following compounds. {10 pts}

   NaCl
   HCl
   HClO₂
   CH₄
   Ni(NO₂)₂

   b) Provide chemical formulas for the following compounds. {10 pts}

   calcium fluoride
   dinitrogen tetroxide
   ammonium permanganate
   hypobromous acid
   iron (II) sulfate
2. {16 pts} Consider the following reaction:

\[ 2 \text{ NO}_2 (g) + \text{ Cl}_2 (g) \rightarrow 2 \text{ NO}_2\text{Cl} (g) \]

<table>
<thead>
<tr>
<th>Molar masses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NO(_2)</td>
<td>46.01 g·mol(^{-1})</td>
</tr>
<tr>
<td>Cl(_2)</td>
<td>70.90 g·mol(^{-1})</td>
</tr>
<tr>
<td>NO(_2)Cl</td>
<td>81.46 g·mol(^{-1})</td>
</tr>
</tbody>
</table>

Notes:
- The parts of this problem are independent.
- You must show your work to receive credit. Partially correct work will receive partial credit. A correct answer with no work shown will receive no credit.

a) How many molecules of Cl\(_2\) are in 1.39 g of Cl\(_2\)? {6 pts}

b) If 1.39 g of Cl\(_2\) reacts with sufficient NO\(_2\) for the reaction to go to completion, how many grams of NO\(_2\)Cl will be produced? {10 pts}

Extra credit on this problem: If 2.10 g of NO\(_2\) and 2.00 g of Cl\(_2\) were placed in a reaction vessel and this reaction occurred, which one would be the limiting reagent? {up to 4 pts extra credit, work must be shown to receive extra credit, use back side of this page if the space below is insufficient}