Name (Print) ________________________________

UIN # _____________________

Section 502
Exam 1, Version # A

LAST YEAR (2012) WE DIDN’T COVER GASES ON THE FIRST EXAM. THIS YEAR WE WILL. KEEP THIS IN MIND WHEN USING THIS FOR STUDY PURPOSES.

On the last page of this exam, you’ve been given a periodic table and some physical constants, you probably want to tear that page off the to use during the exam – you don’t need to turn it in with the rest of the exam.

The exam contains 11 problems, with 5 numbered pages. You have the full 75 minutes to complete the exam. Please show ALL your work as clearly as possible – this will help us award you partial credit if appropriate. Even correct answers without supporting work may not receive credit. You may use an approved calculator for the exam, one without extensive programmable capabilities or the ability to store alphanumeric information. Print your name above, provide your UIN number, and sign the honor code statement below.

On my honor as an Aggie, I will neither give nor receive unauthorized assistance on this exam.

SIGNATURE: ________________________________

(For grading)

<table>
<thead>
<tr>
<th>Scores</th>
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<tbody>
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<td>1/8</td>
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<td>10/11</td>
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<td>11/11</td>
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</table>

Tot. /100
(1) (8 points) Consider the complete combustion (burning in oxygen, O\textsubscript{2}) of one mole of ethanol (CH\textsubscript{3}CH\textsubscript{2}OH, or C\textsubscript{2}H\textsubscript{5}O). Which of the following statements is true? There may be more than one correct choice; enter ALL the correct letters, in alphabetical order.

(a) In both the reactants and products, two moles of carbon atoms are present.
(b) The combined mass of the products is the same as the combined mass of the reactants.
(c) In all the products, the total number of atoms exceeds the total number of atoms in all the reactants.
(d) The volume occupied by the products is the same as the volume occupied by the reactants.
(e) In all the products, the total number of molecules exceeds the total number of molecules in all the reactants.

Ans. 1 __a, b, e__

(2) (8 points) In the following choices find any that correctly completes this statement: An atom with an atomic number of 8 and a mass number of 16

(a) has 8 neutrons.
(b) has the same number of electrons as a C atom.
(c) exhibits essentially the same chemical behavior as an \textsuperscript{18}O atom.
(d) is a C\textsuperscript{2+} ion.
(e) has 2 fewer electrons than an F\textsuperscript{−} anion.

Write all the correct choices in the space below, in alphabetical order

Ans. 2 __a, c, e__

(3) (8 points) Using the solubility rules you’ve learned, among the following sets of compounds, identify those in which all 3 compounds in the set are soluble. There may be more than one correct choice; enter ALL the correct letters, in alphabetical order.

(a) Ba(ClO\textsubscript{4})\textsubscript{2}, NH\textsubscript{4}NO\textsubscript{3}, NH\textsubscript{4}Br  
(b) Pb(NO\textsubscript{3})\textsubscript{2}, KCl, NaClO\textsubscript{4}  
(c) NaCl, Pb\textsubscript{3}(PO\textsubscript{4})\textsubscript{2}, CaF\textsubscript{2}  
(d) Co(CH\textsubscript{3}COO)\textsubscript{2}, RbCl, RbNO\textsubscript{3}  
(e) Co\textsubscript{3}(PO\textsubscript{4})\textsubscript{2}, BaCO\textsubscript{3}, MgCl\textsubscript{2}

Ans. 3 __a, b, d__
(4) **(8 points)** The following full sets of potential compounds are made up of common cations and anions. Which full sets are most likely to actually exist? (All 3 compounds in a set must be sensible to qualify.) There may be more than one correct choice; enter ALL the correct letters, in alphabetical order.

(a) NH₄(SO₄)₂, ZnCO₃, CaClO₄  (b) KPO₄, NH₄CO₃, KNO₃  (c) Mg₃(PO₄)₂, Ag₂SO₄, NH₄NO₃  
(d) (NH₄)₂SO₄, KClO₄, Ca(OH)₂  (e) (NH₄)₂PO₄, K₂CO₃, Ca₃(PO₄)₂

Ans. 4 __c, d__

(5) **(9 points)** Aluminum hydroxide can be dissolved in hydrochloric acid to form aluminum chloride and water.

(i) (4 pts) Balance the equation below by filling in the blanks with coefficients:

\[
1 \text{Al(OH)}_3 + 3 \text{HCl} \rightarrow 1 \text{AlCl}_3 + 3 \text{H}_2\text{O}
\]

(ii) (5 pts) What volume (in mL) of 3.17 M HCl is needed to react with 12.0 g of Al(OH)₃? (Write the letter of the correct answer below.)

(a) 16.2 mL  (b) 145.6 mL  (c) 0.0485 mL  (d) 48.5 mL  (e) 0.146 mL

Ans. 5 (ii) __b__

(6) **(7 points)** Which of the following is not a strong acid? (Enter ALL the correct letters, in alphabetical order.)

(a) HClO₄  (b) NaOH  (c) H₂SO₄  (d) HBr  (e) CH₃NH₂

Ans. 6 __b,e__
Questions 7-11 – show all work (52 pts)

(7) (11 points) Germanium has five naturally occurring isotopes, $^{70}\text{Ge}$, $^{72}\text{Ge}$, $^{73}\text{Ge}$, $^{74}\text{Ge}$, and $^{76}\text{Ge}$. Use the data in the table given to calculate the molar mass of the $^{74}\text{Ge}$ isotope of germanium. Give an answer with 4-digit precision. The molar mass of germanium is 72.64 g/mol.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Isotopic Molar Mass (g/mol)</th>
<th>Abundance(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{70}\text{Ge}$</td>
<td>69.9242</td>
<td>20.38</td>
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<tr>
<td>$^{72}\text{Ge}$</td>
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<td>$^{74}\text{Ge}$</td>
<td>?</td>
<td>36.72</td>
</tr>
<tr>
<td>$^{76}\text{Ge}$</td>
<td>75.9214</td>
<td>7.83</td>
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</table>

Ans. 73.9212 g/mol

(8) (11 points) Elemental arsenic (As), a poison that kills humans as well as animal pests, may be obtained by reacting $\text{As}_2\text{O}_3$ with carbon, giving As and CO as products.

(a) (4 points) Write a balanced equation for this reaction.

$$\text{As}_2\text{O}_3 + 3 \text{ C} \rightarrow 2 \text{ As} + 3 \text{ CO}$$

(b) (7 points) Compute the masses of As and CO formed if 49.5 g of $\text{As}_2\text{O}_3$ reacts as completely as possible with 7.20 g C.

49.5 g $\text{As}_2\text{O}_3 \Rightarrow 0.2502 \text{ mol } \text{As}_2\text{O}_3$ – Would require 0.75 mol of C for complete reaction

7.2 g C $\Rightarrow 0.600 \text{ mol } \text{C}$ : C is limiting reagent.

Only 0.400 mol As and 0.600 mol CO can be formed

$\Rightarrow 29.97 \text{ g } \text{As} \text{ and } 16.8 \text{ g } \text{CO}$
(9) (8 points) A 0.090 M solution of NaOH was used to titrate a solution of unknown concentration of HCl. A 33.00 mL sample of the HCl solution required 15.15 mL of NaOH solution for complete reaction. What is the molarity of the HCl solution?

The HCl solution is 0.0413 M

(10) (11 points) Silicon carbide (SiC, called carborundum) is an abrasive used in making cutting tools. It is made by heating silicon dioxide (SiO$_2$) with graphitic carbon (C):

\[ 1 \text{SiO}_2 + 2 \text{C} \rightarrow 1 \text{SiC} + 1 \text{CO}_2 \]

(a) (4 points) Using the blanks provided, balance this equation with the smallest possible integer coefficients.

(b) (7 points) How many grams of silicon carbide can be formed from 50.0 g graphite and 50.0 g of silicon dioxide?

50.0 g graphite $\Rightarrow$ 4.17 mol C, which requires 2.085 mol SiO$_2$ for complete reaction

50.0 g of silicon dioxide $\Rightarrow$ 0.832 mol SiO$_2$ $\Rightarrow$ SiO$_2$ is limiting

Can make 0.832 mol SiC or 33.36 g SiC
(11) *(11 points)* The molecule shown below is indigo, the dye used to color blue jeans.

![Indigo molecule](image)

(a) *(7 pts)* Give the **molecular formula** for indigo.

\[ \text{C}_{16}\text{H}_{10}\text{N}_{2}\text{O}_{2} \]

(b) *(4 pts)* Compute the number of nitrogen atoms in 1.0 g of indigo.

Molar mass of indigo = 262.26 g/mol ⇒ 1.0 g of indigo is therefore \(\frac{1}{262.26} \text{ mol} = 3.813 \times 10^{-3} \text{ mol}\)

Therefore there are \(2 \times (3.813 \times 10^{-3} \text{ mol})\) of N atoms = \(7.626 \times 10^{-3} \text{ mol N atoms}\)

⇒ \(4.59 \times 10^{21} \text{ N atoms}\)
### Atomic Data

<table>
<thead>
<tr>
<th>Element</th>
<th>Atomic Number</th>
<th>Electron Configuration</th>
<th>Mass (amu)</th>
<th>Atomic Weight (amu)</th>
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<td>39.948</td>
</tr>
</tbody>
</table>

**Pauling Electronegativity**

- H: 2.1
- Li: 1.0
- Be: 1.5
- B: 2.0
- C: 2.5
- N: 3.0
- O: 3.5
- F: 4.0
- Ne: 2.8
- Na: 0.9
- Mg: 0.7
- Al: 0.9
- Si: 1.8
- P: 2.1
- S: 2.5
- Cl: 3.1
- Ar: 2.8

**Physical Constants/Conversion Factors**

- Speed of light: 3.00 x 10^8 m/s
- Electron charge: 1.602 x 10^-19 C
- Avogadro's number: 6.023 x 10^23 mol^-1
- Rydberg constant: 1.097 x 10^7 m^-1