Instructions

1. Do not open the exam until you are told to start.

2. This exam is closed note and closed book. You are not allowed to use any outside material while taking this exam.

3. Use the spaces provided to write down your answers. To receive full credit, you must show all work. Do not write answers on any other pieces of paper. If you need more room, write on the back of the exam and be sure to include a note describing where the work is located.

4. When solving numerical problems, make sure you include the proper units in your final answer.

5. If a question asks for a response in sentence or paragraph form, make sure you respond in that format.

6. Useful data for the exam and a periodic table are provided on the last page of the exam. Carefully tear out these sheets if you wish.

<table>
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<tr>
<th>Page #</th>
<th>Points possible</th>
<th>Points awarded</th>
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</table>
Multiple Choice

Unless otherwise directed, choose the single best answer for each question.

1. The chemical formula for iodous acid is ____________.
   a. HI
   b. HIO
   c. HIO₂
   d. HIO₃
   e. HIO₄

2. The compound NI₃ is named ____________.
   a. nickel(III) iodide
   b. mononitrogen iodide
   c. nitrogen iodide
   d. nitrogen triiodide
   e. None of the above.

3. When nitrogen reacts with oxygen, a compound containing nitrogen and oxygen is produced. What is the “glue” that holds the nitrogen/oxygen compound together?
   a. The atoms are held together because they share electrons.
   b. The nitrogen atoms secrete a sticky film that the fluorine atoms stick to.
   c. The atoms become charged and are held together via an electrostatic attraction.
   d. The atoms share protons and are held together via the mutual attraction that results.
   e. None of the above.

4. When InCl₂ is placed in deionized water, it is a ________________.
   a. strong electrolyte
   b. weak electrolyte
   c. non-electrolyte
   d. None of the above.

5. When H₂SO₄(aq) is mixed with Al(OH)₃(s) a reaction occurs. What is the sum of all the coefficients for the balanced chemical equation for this reaction? Hint: If the balanced chemical equation was 2A + B \rightarrow 3C, the sum of the coefficients would be 6.
   a. 4
   b. 8
   c. 12
   d. 14
   e. None of the above.
6. What is the oxidation state of chlorine in NaClO₄?

a. +8
b. +7
c. +6
d. -1
e. None of the above.

7. When Pb(NO₃)₂(aq) reacts with KI(aq), which ions are the spectator ions?

a. Pb²⁺(aq) and I⁻(aq)
b. K⁺(aq) and NO₃⁻(aq)
c. NO₃⁻(aq) and I⁻(aq)
d. There are no spectator ions.
e. They are all spectator ions because there is no reaction.

8. When C₆H₁₄(l) is combusted, what is the sum of all the coefficients for the balanced chemical equation for this reaction? Hint: If the balanced chemical equation was 2A + B → 3C, the sum of the coefficients would be 6.

a. 16
b. 24
c. 35
d. 47
e. None of the above.

9. When the following chemical equation is balanced, what is the sum of all of the coefficients? Hint: If the balanced chemical equation was 2A + B → 3C, the sum of the coefficients would be 6.

\[ \text{Fe}_2\text{O}_3 + \text{H}_2 \rightarrow \text{Fe} + \text{H}_2\text{O} \]

a. 9
b. 8
c. 7
d. 4
e. None of the above.
10. Why don’t we change subscripts when balancing a chemical equation?

   a. There is no real reason not to; it is just something that is not done.
   b. We never change subscripts because atoms are neither created nor destroyed during a chemical reaction. This is part of the Law of Conservation of Mass.
   c. It is fine to do once in a while, but do not make a habit of it.
   d. We can change subscripts. We cannot change coefficients.
   e. Compounds composed of the same elements and having different subscripts are different substances.

11. When Mn(ClO$_4$)$_5$(aq) is mixed with Na$_2$S(aq) a reaction occurs. What is the formula of the precipitate?

   a. MnNa$_5$
   b. Na$_2$ClO$_4$
   c. MnS
   d. NaClO$_4$
   e. Mn$_2$S$_5$

12. A 3.992 g sample of matter is found to contain 1.2637x$10^{22}$ atoms of only one type of element. What element is the matter composed of? Hint: Calculate the molar mass and that will help you identify the element.

   a. Pt
   b. Os
   c. Mn
   d. Ar
   e. Ba

13. Which of the following compounds is/are ionic compounds?

   I. H$_2$SO$_4$
   II. NH$_4$Cl
   III. PtCl$_3$
   IV. IF$_5$
   V. MgBr$_2$

   a. I, II, III, IV
   b. I, II, III, V
   c. II, III, IV, V
   d. I, III, V
   e. II, III, V
14. What is the empirical formula for the $\text{H}_2\text{C}_2\text{O}_4$?
   a. $\text{HCO}$
   b. $\text{H}_2\text{CO}$
   c. $\text{H}_2\text{C}_2$
   d. $\text{H}_2\text{C}_2\text{O}_4$
   e. None of the above.

15. What is the mass of one molecule of $\text{O}_2$?
   a. 31.9988 amu
   b. 31.9988 g
   c. 15.9994 amu
   d. 15.9994 g
   e. None of the above.

16. How many moles of $\text{NO}_2$ are there in a 22.06 g sample of $\text{NO}_2$?
   a. 0.4795 moles $\text{NO}_2$
   b. 0.7352 moles $\text{NO}_2$
   c. $1.328 \times 10^{25}$ moles $\text{NO}_2$
   d. $2.888 \times 10^{-23}$ moles $\text{NO}_2$
   e. None of the above.

17. When 100 $\text{HCl}$ particles are dissolved in water, how many ions are produced?
   a. 200 ions are produced.
   b. 100 ions are produced.
   c. Less than 100 ions are produced.
   d. No ions are produced.
   e. None of the above.

18. How many $\text{Ca}$ atoms are in a 1.23 g sample of $\text{Ca}$?
   a. $1.85 \times 10^{22}$ $\text{Ca}$ atoms
   b. $4.55 \times 10^{22}$ $\text{Ca}$ atoms
   c. $3.32 \times 10^{-24}$ $\text{Ca}$ atoms
   d. $7.41 \times 10^{24}$ $\text{Ca}$ atoms
   e. None of the above.

19. One mole of $\text{Na}_2\text{SO}_4$ contains how many moles of oxygen?
   a. 1
   b. 2
   c. 4
   d. 7
   e. None of the above.
20. In the table below, the name or formula for a chemical compound is given. Fill in the table with the corresponding name or formula of the chemical compound. (14 points)

<table>
<thead>
<tr>
<th>NAME</th>
<th>FORMULA</th>
</tr>
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<tbody>
<tr>
<td>hydrobromic acid</td>
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<tr>
<td>strontium acetate</td>
<td>Ca(CN)₂</td>
</tr>
<tr>
<td>zinc nitrite</td>
<td>CoS</td>
</tr>
<tr>
<td></td>
<td>HClO₃</td>
</tr>
<tr>
<td></td>
<td>SF₆</td>
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</table>

21. What are the complete, total ionic and net-ionic equations for the reaction that occurs when a solution containing H₂C₂O₄ is mixed with a solution containing KOH? Assume this reaction takes place in a beaker of deionized water. (6 points)

**Complete**

**Total Ionic**

**Net-Ionic**
22. In the space provided below, show what happens to NH\(_3\) (aq) when it is in deionized water. (i.e. show the ionization or dissociation equation for NH\(_3\) in water) (3 points)

23. What is the molar mass of K\(_2\)S? (3 points)

24. Use the balanced oxidation reduction reaction below to answer the following questions. (6 points)

\[
P_4(s) + 3O_2(g) \rightarrow P_4O_6(s)
\]

a. Which element is oxidized? 

b. Which element is reduced?

c. Which element is the oxidizing agent?

d. Which element is the reducing agent?

e. How many electrons are transferred?

f. Which element are the electrons transferred to?
25. If a sample of hexane (C$_6$H$_{14}$) contains 2.345 g of carbon, how many molecules of hexane are in the sample? (5 points)

26. What are the complete, total ionic and net-ionic equations for the reaction that occurs when a solution containing Fe(NO$_3$)$_3$ is mixed with a solution containing K$_2$CO$_3$? Assume this reaction takes place in a beaker of deionized water. (6 points)

**Complete**

**Total Ionic**

**Net-Ionic**
Conversion Factors, Constants, and Periodic Table

**Solubility Rules**

**SOLUBLE COMPOUNDS**
- group 1 metals + any anion → soluble
- NH₄⁺ + any anion → soluble
- Any cation + NO₃⁻, ClO₄⁻, C₂H₃O₂⁻ → soluble

**Mostly Soluble Compounds**
- Any cation + Cl⁻, Br⁻, I⁻ (except Pb²⁺, Ag⁺, Hg₂²⁺ → insoluble)
- Any cation + SO₄²⁻ (except Sr²⁺, Ba²⁺, Pb²⁺, Hg₂²⁺, Ca²⁺ → insoluble)

**Insoluble Compounds**
- Any cation + OH⁻ (except group I, NH₄⁺, Ca²⁺, Ba²⁺ → soluble)
- Any cation + S²⁻ (except group I, NH₄⁺, group II → soluble)
- Any cation + CO₃²⁻, PO₄³⁻ (except group I, NH₄⁺ → soluble)

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**Conversion Factors, Constants, and Periodic Table**

Avogadro’s Number: $6.022 \times 10^{23}$ particles/mole

Mass of Proton: 1.0073 amu

Mass of Neutron: 1.0087 amu

Mass of Electron: $5.486 \times 10^{-4}$ amu

Mass of 1 amu: $1.66 \times 10^{-24}$ g

Temperature conversion: $T \text{[K]} = 273.15 + T \text{[°C]}$