1. You may use a calculator and one 8” by 11-1/2” handwritten “crib” sheet during this exam. Bring extra pencils, batteries, calculators, if necessary.

2. Please place all books, bags, hats, etc. under the table before you begin the Exam.

3. You must work alone. Give or take no assistance from other students. Recall the Georgia Tech Honor Code. Please sign the pledge at the end of this Exam, if you have not violated this honor code during this exam.

4. Show your Buzz Card when you turn in your completed exam.

5. Multiple Choice, no partial credit.

6. You may remove the last page of this test, which contains relevant data. If you do so, please remove it carefully so that remaining pages remain stapled. In order to prevent lost pages, please write your name on the top of each page, in addition to this cover page.

7. Before turning in your test, make sure that you have the correct number of pages, totaling 100 points.

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1. (6 points) The mass of 0.35 moles of silver (Ag) atoms in units of grams is
   a. 38
   b. 150
   c. 2.1 x 10^{23}
   d. 69

2. (6 points) Burning a sample of a hydrocarbon (a compound containing hydrogen and carbon only) in oxygen produced 4.40 grams of CO_2 and 3.60 grams of H_2O. The empirical formula of the hydrocarbon is
   a. CH
   b. CH_2
   c. CH_3
   d. CH_4

3. (6 points) Which of the following compounds has the largest percentage by mass of fluorine (F)?
   a. ClF
   b. BrF
   c. IF
   d. UF_6
4. (6 points) Consider the following balanced chemical equation. If \( w, x, y, z \) are the smallest possible set of whole number coefficients, what is \( z \), the stoichiometric coefficient for HCl?

\[
w \text{HSbCl}_4 + x \text{H}_2\text{S} \rightarrow y \text{Sb}_2\text{S}_3 + z \text{HCl}
\]

- a. 2
- b. 4
- c. 6
- d. 8

5. (6 points) To prepare 1.000 liters of 0.115 M NaBr aqueous solution (M = moles per liter), a technician (or a CHEM 1310 student) must mix

- a. 0.115 moles of NaBr with 1.000 liters of H\(_2\)O
- b. 0.115 moles of NaBr with 1.000 kg of H\(_2\)O
- c. 0.115 moles of NaBr with enough H\(_2\)O to produce 1.000 kg of solution
- d. 0.115 moles of NaBr with enough H\(_2\)O to produce 1.000 liters of solution

6. (6 points) Zinc sulfide (ZnS) reacts with oxygen to form zinc oxide (ZnO) and gaseous sulfur dioxide (SO\(_2\)). What mass of SO\(_2\) is produced by the complete conversion of 10.0 g of ZnS to ZnO?

- a. 3.46 g
- b. 6.57 g
- c. 8.35 g
- d. 10.0 g
7. (6 points) The gaseous elements H₂ and O₂ react explosively to form water (H₂O). 6.00 L of H₂ is mixed with 5.00 L of O₂ and the mixture is ignited in a strong steel vessel. If the gas volumes are all measured at the same temperature and pressure, which gas remains unreacted, and what is its volume?

a. O₂, 1.00 L  
   b. O₂, 2.00 L  
   c. H₂, 1.00 L  
   d. H₂, 2.00 L

8. (6 points) From the Lewis structure, use VSEPR theory to determine the steric number of the central atom of ozone (O₃) and the O–O–O bond angle.

a. Steric number 2, 180 degrees  
   b. Steric number 3, less than 120 degrees  
   c. Steric number 3, greater than 120 degrees  
   d. Steric number 4, less than 109.5 degrees

9. (6 points) What is the formal charge on the nitrogen atom in the NO⁺ cation? Hint: draw the Lewis structure first.

a. −1  
   b. 0  
   c. +1  
   d. +2
10. (6 points) Which element is oxidized in the reaction (unbalanced),

\[ \text{MnO}_4^- + \text{SO}_4^{2-} \rightarrow \text{Mn}^{2+} + \text{S}_2\text{O}_8^{2-} \]

a. Mn  

b. O  

c. S  

d. None; this is not a redox reaction.

11. (6 points) The oxidation number of the bromine atom in Ca(\text{BrO}_3)_2 is

a. $-1$  

b. $+1$  

c. $+3$  

d. $+5$

12. (6 points) The indicator cresol red turns from yellow to red when the medium in which it is dissolved changes from acidic to basic. A 20.0 mL volume of a nitric acid solution is titrated with 0.123 M (M = moles per liter) KOH. It takes 25.2 ml of this base to reach a cresol red end point. The concentration of the HNO₃ solution is

a. 0.101 M  

b. 0.123 M  

c. 0.155 M  

d. 0.310 M
13. (8 points) The synthesis of ammonia from the elements, \( \text{N}_2 \ (g) + 3 \text{H}_2 \ (g) \rightarrow 2 \text{NH}_3 \ (g) \), is carried out at high pressure and temperatures. At one stage of the reaction 149 grams of \( \text{NH}_3 \), 765 grams of \( \text{N}_2 \), and 164 grams of \( \text{H}_2 \) are present in the reaction vessel at a total pressure of 160 atm. What is the partial pressure of \( \text{H}_2 \) at this stage, assuming Dalton’s law of partial pressure behavior for this ideal mixture?

a. 20.5 atm
b. 24.3 atm
c. 111 atm
d. 39.2 atm

14. (7 points) A blimp is filled with helium gas at a temperature of 0.0 °C and a pressure of 1.000 atm. What is the density of helium gas in the blimp in units of grams per cm\(^3\)?

a. \( 3.2 \times 10^{-3} \)
b. \( 1.6 \times 10^{-4} \)
c. \( 1.8 \times 10^{-4} \)
d. \( 4.9 \times 10^{-5} \)
15. (6 points) Refer to the potential energy curve shown. This curve could represent the dependence of 
the potential energy on separation for a pair of ions, atoms, or molecules. In the portion of the 
curve labeled C,

- a. attractive forces dominate over repulsive forces.
- b. repulsive forces dominate over attractive forces.
- c. attractive and repulsive forces roughly balance.
- d. dispersion forces dominate over dipole-dipole.

16. (7 points) A solution is prepared by dissolving 6.54 g of a nonvolatile, nondissociating solute in 
60.0 g of water. If the resulting solution boils at 100.370°C, what is the approximate molar mass of 
the solute? For water, \( K_b \) is 0.512 K kg mol\(^{-1}\).

- a. 78.8 g mol\(^{-1}\)
- b. 91.4 g mol\(^{-1}\)
- c. 151 g mol\(^{-1}\)
- d. 543 g mol\(^{-1}\)
Volume

1 liter = $1 \times 10^{-3}$ m$^3 = 1000$ cm$^3 = 1000$ ml

1 mL = $10^{-3}$ L = $10^{-6}$ m$^3$

Pressure

1 Pa = 1 kg m$^{-1}$ s$^{-2} = 1$ N m$^{-2}$

1 atm = 101,325 Pa = standard pressure

1 bar = 100,000 Pa = 0.986923 atm

1 torr = $(101,325 / 760)$ Pa = $(1/760)$ atm

1 mm Hg at 0°C = $(101,325 / 760)$ Pa = $(1/760)$ atm

1 psi = 1 lbf in$^{-2}$ = 6897.757 Pa = $(1/14.69595)$ atm

Universal Gas Constant

R = 8.31447 J mol$^{-1}$ K$^{-1} = 0.0820574$ L atm mol$^{-1}$ K$^{-1}$

STP

Standard pressure = 1 atm

Standard temperature = 0°C = 273.15°C