NAME (please print): Answer Key

SIGNATURE: 

Watch the time! Show all work on these pages.

(30) I. Put the letter of the correct answer in the blank to the right.

1. How many nitrogen atoms are present in 3 molecules of Al(NO₃)₃?
   a. 1   b. 3   c. 9   d. 27

2. How many electrons are present in neutral \(^{237}\text{U}\)?
   a. 92   b. 237   c. 329   d. 145

3. Alkali metal cations have a charge of:
   a. 1⁺   b. 2⁻   c. 2⁺   d. 1⁺

4. Which of the following are examples of transition metals?
   a. Cl and Br   b. Ag and Au   c. Mg and Ca   d. Li and Na

5. A chemical reaction identified as an explosion
   a. gives off large amounts of energy   b. involves production or expansion of gases
   c. is very rapid   d. all of the above

6. The biggest difference in the molecular structure of polyvinylchloride and polyethylene is
   a. different monomer   b. different amount of branching
   c. different polymer backbone   d. all of the above

7. A student calculated a theoretical yield of 81.4 g of product for a particular reaction. In running the reaction, the student collected 45.2 g of product. What is the percent yield?
   a. 45.2 %   b. 55.5 %   c. 81.4 %   d. 180 %
8. How many moles of HCl are required to make 500. mL of 0.10 M HCl?
   a. 0.005 mol  b. 0.050 mol  c. 0.50 mol  d. 5.0 mol
   \[
   \text{molarity} = \frac{\text{moles of solute}}{\text{volume of solution}}
   \]
   \[
   \text{molarity} = \frac{0.10 \text{ mol HCl}}{0.50 \text{ L}}
   \]
   \[
   \text{molarity} = 0.020 \text{ mol/L}
   \]
   8. \( B \)

9. If the density of mercury is 13.6 g/mL, what is the mass 1 quart of mercury?
   (1 L = 1.06 qt, 1 kg = 2.2 lbs)
   \[
   \left(1 \text{qt}\right) \left(\frac{1 \text{L}}{1 \text{qt}}\right) \left(\frac{1000 \text{g}}{1 \text{L}}\right) \left(\frac{13.6 \text{g}}{1 \text{L}}\right) \left(\frac{1 \text{kg}}{1000 \text{g}}\right) \left(\frac{2.2 \text{lbs}}{1 \text{kg}}\right)
   \]
   a. 0.429 lbs  b. 5.83 lbs  c. 6.18 lbs  d. 28.2 lbs
   9. \( D \)

10. During a test, an engine running on propane gas consumed 2 mol of propane, C\text{}_3\text{H}_8, and 20 mol of oxygen. What condition best describes the fuel mix?
   a. too lean (too much oxygen)  b. reasonably correct  c. too rich (too little oxygen)
   \[
   \frac{1}{2} \frac{2}{10} \rightarrow C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O
   \]
   10. \( A \)

24. II. Write the correct molecular formula for each of the following compounds:
   - sulfur dioxide \( SO_2 \)
   - potassium sulfate \( K_2SO_4 \)
   - ammonium nitrate \( NH_4NO_3 \)
   - lead (II) sulfide \( PbS \)
   - magnesium carbonate \( MgCO_3 \)
   - phosphorus pentafluoride \( PF_5 \)
   - mercury (II) chloride \( HgCl_2 \)
   - aluminum oxide \( Al_2O_3 \)

14. III. a. Circle all of the following species that are present in an aqueous solution of perchloric acid.
   Write a balanced chemical reaction to support your answer.
   \[
   \text{HClO}_4 \rightleftharpoons \text{H}^+ + \text{ClO}_4^- \\
   \text{OR} \ \text{HClO}_4 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{ClO}_4^- \\
   \]
   b. Circle all of the following species that are present in an aqueous solution of sodium hydroxide.
   Write a balanced chemical reaction to support your answer.
   \[
   \text{NaOH} \rightarrow \text{Na}^+ + \text{OH}^- \\
   \]
   c. Write a balanced chemical equation and a complete ionic equation for the reaction in aqueous solution of equal molar amounts of HClO\text{₄} and NaOH.
   \[
   \text{NaOH} + \text{HClO}_4 \rightarrow \text{NaClO}_4 + H_2O \\
   \text{Na}^+ + \text{OH}^- + \text{H}^+ + \text{ClO}_4^- \rightarrow \text{Na}^+ + \text{ClO}_4^- + H_2O
   \]
IV. Air bags in automobiles built in the 1990s were inflated by nitrogen gas produced by the rapid decomposition of solid sodium azide, NaN\(_3\) (see equation below).

\[
\text{NaN}_3 \rightarrow 2 \text{Na} + 3 \text{N}_2
\]

\[
\begin{align*}
\text{Na} & \quad 23 \\
\text{N} & \quad 3 \times 14 = 42 \\
\text{g/mol} & \quad \frac{65 \text{g}}{\text{mol}} \\
(50 \text{g})(\frac{1 \text{ mole}}{65 \text{ g}}) & = 0.77 \text{ mole}
\end{align*}
\]

\[
\frac{0.77 \text{ mole}}{2 \times 14 = 28 \text{ g/mol}} \times 3 \times 28 \text{ g/mol} = 132.2 \text{ g}
\]

a. How many grams of nitrogen are produced in the above reaction from 50 g of NaN\(_3\), the typical amount of NaN\(_3\) in a driver side air bag. (Show all work.)

b. Why does this reaction represent a very large increase in volume? 

\textit{reactant is a solid, N}_2 \textit{ is a gas}

V. The oil well explosion and oil spill in the Gulf of Mexico earlier this year was one of the largest environmental disasters in U.S. history. Both oil and methane came from this well.

a. What is the chemical formula for methane? What is a common name for methane?

\[\text{CH}_4 \quad \text{natural gas}\]

b. Give two \textit{physical} properties of methane.

\text{colorless, odorless, gas at room temperature and pressure}

c. How would you expect the chemical formulas of the components of oil to be \textit{similar} to methane?

\text{both are hydrocarbons, i.e. only C and H in formulas}

d. How would you expect the chemical formulas of the components of oil to be \textit{different} from methane?

\[\text{CH}_4 \text{ is only one carbon component of oil have more carbons}\]

e. Write a chemical equation for the complete combustion of methane.

\[\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}\]

f. What causes incomplete combustion? Name at least one product of incomplete combustion of methane that is not formed in the complete combustion of methane.

- Products of incomplete combustion could be \text{CO or soot (carbon)}

- caused by insufficient oxygen