NAME (please print): Answer Key
SIGNATURE: 

Watch the time! Show all work on these pages.

(100) Total ___

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

1. How many neutrons are present in $^{237}$U?
   a. 92    b. 237    c. 329    d. 145
   \[ \frac{237}{145} \]
   1. ______ D

2. How many oxygen atoms are present in 3 molecules of Al(NO$_3$)$_3$?
   a. 1    b. 3    c. 9    d. 27
   2. ______ D

3. Halide anions have a charge of:
   a. 1$^-$    b. 2$^-$    c. 2$^+$    d. 1$^+$
   3. ______ A

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

5. High density polyethylene is more dense than low density polyethylene due to
   a. addition of heavy metals    b. oxygen links between the carbons
   c. branching side chains along the polymer    d. only straight chain polymers
   5. ______ D

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

7. A student calculated a theoretical yield of 45.2 g of product for a particular reaction. In running the reaction, the
   student collected 36.8 g of product. What is the percent yield?
   a. 44.9 %    b. 55.1 %    c. 81.4 %    d. 123 %
   7. ______ C
8. How many moles of HCl are required to make 100. mL of 0.50 M HCl?
   a. 0.050 mol  b. 0.25 mol  c. 0.50 mol  d. 5.0 mol
   \[ \text{molarity} = \frac{\text{moles of solute}}{\text{volume of solution (L)}} \]
   \[ \text{moles of solute} = (0.50 \text{ mol/L})(0.1 \text{ L}) = 0.05 \text{ mol} \]  
   8. A

9. If the density of a liquid is 1.60 g/mL, what is the volume of 100. g of the liquid?
   a. 62.5 mL  b. 100 mL  c. 160 mL  d. 1600 mL
   \[ (100 \text{ g}) \left( \frac{1 \text{ mL}}{1.60 \text{ g}} \right) = 62.5 \text{ mL} \]  
   9. A

10. During a test, an automobile engine consumed 2 mol of octane, \( \text{C}_8\text{H}_{18} \), 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)  
    \[ \text{C}_8\text{H}_{18} + \frac{25}{2} \text{O}_2 \rightarrow 8 \text{CO}_2 + 9 \text{H}_2\text{O} \]
    \[ 2 \text{C}_8\text{H}_{18} + 25 \text{O}_2 \rightarrow 16 \text{CO}_2 + 18 \text{H}_2\text{O} \]  
    10. C

(24) II. Write the correct molecular formula for each of the following compounds:

- silicon tetrachloride: \( \text{SiCl}_4 \)
- aluminum oxide: \( \text{Al}_2\text{O}_3 \)
- lead (II) sulfide: \( \text{PbS} \)
- ammonium chloride: \( \text{NH}_4\text{Cl} \)
- calcium carbonate: \( \text{CaCO}_3 \)
- nitrogen dioxide: \( \text{NO}_2 \)
- silver (I) bromide: \( \text{AgBr} \)
- potassium sulfate: \( \text{K}_2\text{SO}_4 \)

(14) III.

a. Circle all of the following species that are present in a 1 M aqueous solution of nitric acid.

   \[ \text{HNO}_3 \quad \text{H}^+ \quad \text{NO}_3^- \quad \text{H}_2\text{O} \]

b. Circle all of the following species that are present in a 1M aqueous solution of sodium hydroxide.

   \[ \text{NaOH} \quad \text{Na}^+ \quad \text{OH}^- \quad \text{H}_2\text{O} \]

c. Write a complete ionic equation for the reaction of a 1:1 mixture of the above two solutions.

   \[ \text{NaOH} + \text{HNO}_3 \rightarrow \text{NaNO}_3 + \text{H}_2\text{O} \]

   \[ \text{Na}^+ + \text{OH}^- + \text{H}^+ + \text{NO}_3^- \rightarrow \text{Na}^+ + \text{NO}_3^- + \text{H}_2\text{O} \]

d. What species are present in the solution after the reaction in part c above?

   \[ \text{HNO}_3 \quad \text{H}^+ \quad \text{NO}_3^- \quad \text{NaOH} \quad \text{Na}^+ \quad \text{OH}^- \quad \text{H}_2\text{O} \]
IV. Air bags in automobiles built in the 1990s were inflated by nitrogen gas produced by the rapid decomposition of solid sodium azide, NaN₃ (see equation below). However, one problem is the production of the very reactive sodium metal.

a. How many grams of sodium are produced in the above reaction from 50 g of NaN₃, the typical amount of NaN₃ in a driver side air bag.

\[
\text{NaN}_3 \xrightarrow{\text{2 NaN}_3 (s) \rightarrow 2 \text{Na}(s) + 3 \text{N}_2 (g)}
\]

\[
\begin{align*}
50 g & \quad 17.7 g \\
2 \text{NaN}_3 & \quad 2 \text{Na} \quad 3 \text{N}_2 \\
0.77 \text{mol} & \quad 0.77 \text{mol}
\end{align*}
\]

\[
\frac{23 \times 1}{23} = 2.3 \\
\frac{14 \times 3}{65} = 0.77 \text{ mol}
\]

\[
\left( \frac{23 g}{1 \text{ mol}} \right) (2.3) = 52.9 g
\]

\[
\left( \frac{1 \text{ mol}}{65 g} \right) = 0.77 \text{ mol}
\]

b. Based on the properties of explosions discussed in your book and in class, would this reaction be categorized as an explosion? Why or why not?

Probably yes —
1) Large increase in volume (solid → gas)
2) Very fast reaction
There is not enough information to evaluate the release of energy.

V. Denton and the UNT campus are located above the Barnett Shale, a geological formation that may contain the largest reserve of natural gas in the United States. There are multiple gas wells in the area.

a. What is the name and what is the chemical formula for the primary component of natural gas?

methane \( \text{CH}_4 \)

b. Give at least two physical properties of this compound.

Colorless, odorless, gas at room temp & pressure

c. Describe a chemical property of this compound and give a balanced chemical reaction to explain your answer.

Bums in air

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

d. Describe at least two differences between natural gas as it comes from the ground and natural gas as it is piped into your home to run your furnace.

From ground mixture of hydrocarbons odorless

Delivered to consumer almost pure \( \text{CH}_4 \)

Has distinctive odor due to addition of S compounds