PART 1

1&2. Which of the following name/symbol pairs is incorrect?
   (a) carbon/C   (b) copper/Cu   (c) fluorine/F
   (d) lead/Pb    (e) sodium/So

3&4. The molecular formula of Vitamin C, ascorbic acid, is C\textsubscript{6}H\textsubscript{8}O\textsubscript{6}. What is the empirical formula of Vitamin C?
   (a) CH\textsubscript{2}O   (b) C\textsubscript{2}H\textsubscript{5}O\textsubscript{3}   (c) CHO   (d) C\textsubscript{3}H\textsubscript{3}O\textsubscript{6}   (e) C\textsubscript{2}H\textsubscript{5}O\textsubscript{2}

5&6. Two moles of Al(NO\textsubscript{3})\textsubscript{3} contain:
   (a) 2 x Avogadro's number of nitrogen atoms
   (b) 2 Al\textsuperscript{3+} cations
   (c) 2 formula units of Al(NO\textsubscript{3})\textsubscript{3}
   (d) 6 moles of NO\textsubscript{3}\textsuperscript{-} anions
   (e) 3 moles of nitrogen atoms
7&8. The correct name for $C_6H_6$ is:

(a) benzene
(b) acetone
(c) methanol
(d) ethanol
(e) acetic acid

9&10. Cholesterol, $C_{27}H_{46}O$, which has been implicated as a contributing factor in certain types of heart disease, is found widely distributed in tissues. How many grams of cholesterol are present in 3.00 mmol of cholesterol?

(a) 0.0116 g  
(b) 116 g  
(c) 11.6 g  
(d) 0.116 g  
(e) 1.16 g

11&12. An amino acid that is one of the basic building blocks of protein is l-asparagine. It contains 36.4% C, 6.10% H, 36.3% O and 21.2% N by mass. If the simplest formula is the same as the molecular formula, what is the molecular formula of this important amino acid?

(a) CH$_2$ON  
(b) C$_2$H$_5$O$_2$N  
(c) C$_6$H$_5$O$_2$N$_2$  
(d) C$_4$H$_8$O$_3$N$_2$  
(e) C$_4$H$_6$O$_2$N
13&14. Which of the following statements is FALSE for the balanced equation given below?

\[ \text{Fe}_3\text{O}_4 + \text{2C} \rightarrow 3\text{Fe} + 2\text{CO}_2 \]

(a) Twelve (12) grams of carbon will produce 84 grams of Fe.
(b) One mole of Fe$_3$O$_4$ will produce two moles of CO$_2$.
(c) Two atoms of carbon require one formula unit of Fe$_3$O$_4$ for reaction.
(d) The reaction of two moles of Fe$_3$O$_4$ will produce 6 moles of Fe.
(e) The reaction of 6.0 g of C produces 44 g of CO$_2$.

15&16. A student weighed out 60.0 g of MgCl$_2$. To what volume should she dissolve and dilute this to make a solution that is 2.00 M MgCl$_2$?

(a) 1350 mL  (b) 285 mL  (c) 544 mL  (d) 315 mL  (e) 780 mL
17&18. Concentrated nitric acid is 70.0% HNO$_3$ by weight and has a density of 1.42 g/mL. One (1.00) liter of concentrated nitric acid contains ______ of HNO$_3$.

(a) 2050 g (b) 1420 g (c) 994 g (d) 715 g (e) 498 g

19&20. One of the most toxic compounds known is a member of the dioxin family, abbreviated TCDD. It is formed as an unwanted by-product in the manufacture of herbicides. Its molecular weight is 321.95 amu/molecule. If each molecule contains 4 chlorine atoms, what is percent by mass of chlorine in TCDD?

(a) 35% (b) 44% (c) 65% (d) 17% (e) 52%
21&22. What volume of 18.4 M $\text{H}_2\text{SO}_4$ acid must you use to prepare 600. mL of 0.10 M $\text{H}_2\text{SO}_4$?

(a) 1.8 mL  
(b) 2.7 mL  
(c) 3.3 mL  
(d) 4.0 mL  
(e) 4.6 mL

23&24. Zinc reacts with nitric acid, $\text{HNO}_3$, in the following reaction:

$$4\text{Zn(s)} + 10 \text{HNO}_3(aq) \rightarrow 4\text{Zn(NO}_3)_2(aq) + \text{NH}_4\text{NO}_3(aq) + 3\text{H}_2\text{O(l)}$$

What mass of Zn metal would be consumed by 35.22 mL of 2.300 M $\text{HNO}_3$, assuming 100% efficiency?

(a) 2.119 g  
(b) 6.233 g  
(c) 4.561 g  
(d) 1.195 g  
(e) 13.25 g
PART 2

(10 pts) 25. Convert the following chemical reaction written in words to formulas, then balance the equation:

When sodium phosphate reacts with iron(II) chloride, the two products are iron(II) phosphate and sodium chloride.

(5 pts) 26. Atacamite, Cu$_2$(OH)$_3$Cl, is a mineral containing copper. What mass of Cu$_2$(OH)$_3$Cl contains 10.0 g of copper?
27. Suppose you have 2 samples of sulfur. Sample #1 has 2 moles of \( S_2 \) molecules and Sample #2 has 1 mole of \( S_4 \) molecules. Answer the following questions and show your work to get full credit.

(3 pts)  
(a) Which sample has more molecules? Explain.

(7 pts)  
(b) Calculate the number of sulfur atoms in each sample. What does your answer show? Draw a picture to illustrate your answer.
28. Butane, \( \text{C}_4\text{H}_{10} \), is the standard fuel for lighters. A spark is used to ignite 1.25 g of butane and 1.25 g of oxygen gas in a sealed container. What mass of water is produced? The unbalanced equation is below:

\[
\text{C}_4\text{H}_{10}(l) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(g) \quad \text{UNBALANCED - you need to balance this}
\]
29. Cyanogen, \((\text{CN})_2\), has been observed in the atmosphere of Titan, Saturn's largest moon. On Earth, it is used as a fumigant. The following unbalanced equation describes its reaction with fluorine:

\[
(\text{CN})_2 + F_2 \rightarrow \text{CF}_4 + \text{NF}_3 \quad \text{UNBALANCED - you need to balance this}
\]

If the reaction has a percent yield of 60.0%, how much \(F_2\) is necessary to produce 100.0 g of \(\text{CF}_4\) in this reaction?