CHEMISTRY S1403        FIRST EXAM        6/4/99
PROFESSOR J. MORROW

PRINT NAME, LAST: _________________________
FIRST: _________________________
I.D. #: _________________________

MAXIMUM POINT VALUE IS IN PARENTHESES

1. _____ (6)          8. _____ (6)          15. _____ (4)
2. _____ (15)         9. _____ (12)         16. _____ (4)
3. _____ (10)         10. _____ (5)          17. _____ (4)
4. _____ (12)         11. _____ (5)          18. _____ (8)
5. _____ (8)          12. _____ (10)         19. _____ (10)
6. _____ (8)          13. _____ (8)
7. _____ (8)          14. _____ (4)

COLUMN TOTALS (MAXIMUM):

_____ (67)          _____ (50)          _____ (30)

EXAM TOTAL (147 pts)                OUT OF 100

NO PARTIAL CREDIT on any question except where indicated by the statement SHOW WORK. 
CHECK FRONT BLACKBOARD FOR CORRECTIONS/CHANGES.
SUGGESTION: DO THE SIMPLER PROBLEMS FIRST.
IF ANY PART OF EXAM IS NOT CLEAR - ASK PROCTORS ABOUT IT!

SCRAP WORK SHEETS ARE AT THE END OF EXAM. FEEL FREE TO TEAR THESE PAGES OFF.
USE THE FOLLOWING INFORMATION FOR PROBLEMS 1 AND 2

Given the following 3 reactions:

1. \( \text{FeCO}_3 \rightarrow \text{FeO} + \text{CO}_2 \)

2. \( \text{Fe(HCO}_3)_2 \rightarrow \text{FeO} + 2 \text{CO}_2 + \text{H}_2\text{O} \)

and

3. \( 2 \text{NaOH} \rightarrow \text{Na}_2\text{O} + \text{H}_2\text{O} \)

You are given a mixture of iron(II)carbonate (\( \text{FeCO}_3 \)), iron(II)bicarbonate (\( \text{Fe(HCO}_3)_2 \)) and sodium hydroxide (\( \text{NaOH} \)). When heated this mixture completely reacts as shown above, forming 17.60 g of \( \text{CO}_2 \), 3.60 g of \( \text{H}_2\text{O} \), and 0.100 mol \( \text{Na}_2\text{O} \).

Molar masses: \( \text{FeCO}_3 \) (115.9), \( \text{Fe(HCO}_3)_2 \) (177.9), \( \text{NaOH} \) (40.0), \( \text{CO}_2 \) (44.0), \( \text{FeO} \) (71.9), \( \text{H}_2\text{O} \) (18.0), \( \text{Na}_2\text{O} \) (62.0)

1) Calculate the number of moles of \( \text{H}_2\text{O} \) and of \( \text{CO}_2 \) formed. (6 pts)

    ANSWER IS (\( \text{H}_2\text{O} \)): ______

    ANSWER IS (\( \text{CO}_2 \)): ______

2) Calculate the number of moles of \( \text{FeCO}_3 \), \( \text{Fe(HCO}_3)_2 \), and \( \text{NaOH} \) present initially. SHOW WORK (15 pts - 5 pts each part)

    \( n_{\text{NaOH}} \) IS: ______

    \( n_{\text{Fe(HCO}_3)_2} \) IS: ______

    \( n_{\text{FeCO}_3} \) IS: ______

3) Given the following 2 reactions:
1. \( \text{FeCO}_3 \longrightarrow \text{FeO} + \text{CO}_2 \) 

and 

2. \( \text{Fe}_2(\text{CO}_3)_3 \longrightarrow \text{Fe}_2\text{O}_3 + 3 \text{CO}_2 \)

Starting with 1 mole total of \( \text{FeCO}_3 \) and \( \text{Fe}_2(\text{CO}_3)_3 \), 1.5 mol of \( \text{CO}_2 \) are obtained. Calculate the starting number of moles of \( \text{FeCO}_3 \).

SHOW WORK (10 pts)

ANSWER IS: ______

4) The following gaseous reaction occurs in a vessel of 50.0 L volume at 300 K.

\( \text{N}_2\text{H}_4 + 5 \text{F}_2 \longrightarrow 2 \text{NF}_3 + 4 \text{HF} \)

Initially, three moles of \( \text{N}_2\text{H}_4 \) and two moles of \( \text{F}_2 \) are mixed in this vessel. The reaction then occurs until the reactant in limiting quantity is totally consumed. (12 pts - 4 pts each part)

Molar masses: \( \text{N}_2\text{H}_4 \) (32.0), \( \text{F}_2 \) (38.0), \( \text{HF} \) (20.0), \( \text{NF}_3 \) (71.0)

a) Which reactant is limiting? ANSWER IS: ______

b) How many moles of the reactant in excess remain, when the reaction is complete? ANSWER IS: ______

c) How many grams of \( \text{NF}_3 \) are produced? ANSWER IS: ______

5) What volume of \( \text{CO}_2 \) can be produced from the reaction of 13.1 g of \( \text{N}_2\text{O} \) (as shown below)? Assume an excess of \( \text{C}_3\text{H}_8 \), and take the density of \( \text{CO}_2 \) to be 1.96 g L\(^{-1}\). Molar masses: \( \text{N}_2\text{O} = \text{CO}_2 = 44.0 \) (8 pts)

\( 10 \text{N}_2\text{O}(g) + \text{C}_3\text{H}_8(g) \longrightarrow 10 \text{N}_2(g) + 3 \text{CO}_2(g) + 4 \text{H}_2\text{O}(g) \)

i) 2.00 L  ii) 2.24 L  iii) 3.50 L  iv) 6.00 L

ANSWER IS: ______

6) Given the reaction:
\[ 2 \text{C}_4\text{H}_1\text{O(g)} + 13 \text{O}_2\text{(g)} \rightarrow 8 \text{CO}_2\text{(g)} + 10 \text{H}_2\text{O}_\text{(g)} \]

How many liters of \(\text{CO}_2\) were recovered by burning 20 L of \(\text{C}_4\text{H}_1\text{O}\)? (P and T constant) if the percent yield was 75%. (8 pts)

i) 55 L  ii) 60 L  iii) 70 L  iv) 80 L

ANSWER IS: 

7) An unknown gas has a density of 6.36 \(\frac{\text{g}}{\text{L}}\) at a pressure of 0.912 atm and a temperature of 57°C. What is the molar mass of this gas?

\[ R = 0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{deg}} \]  

(8 pts)

i) 28.0 g/mol  ii) 114 g/mol  iii) 146 g/mol  iv) 189 g/mol

ANSWER IS: 

8) What would be the density of the gas from question 7 if its temperature and pressure returned to STP? (6 pts)

CREDIT FOR THIS IS BASED UPON YOUR ANSWER FROM QUESTION 7.

ANSWER IS: 

9) GIVEN: \(\text{ZrCl}_2\) is zirconium(II)chloride; \(\text{ZrCl}_4\) is; \(\text{NaVO}_3\) is sodium vanadate. For the following: where there is a formula, give it's name; where there is a name, give it's formula. (12 pts - 2 points each.)

i) \(\text{Zr} (\text{SO}_4)_2\):

ii) \(\text{SF}_6\)

iii) zirconium(II)vanadate:

iv) \(\text{CrBr}_3\):

v) ferric phosphate:

vi) aluminum chromate

BALANCE THE FOLLOWING EQUATIONS BY INSERTING INTEGERS IN THE SPACES PRECEDING THE FORMULAS. (5 pts each)
10) \[ \text{C}_3\text{H}_8\text{O} + \text{KClO}_4 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{KCl} \]

\[ \underline{\text{C}_3\text{H}_8\text{O}} + \underline{\text{KClO}_4} \rightarrow \underline{\text{CO}_2} + \underline{\text{H}_2\text{O}} + \underline{\text{KCl}} \]

11) \[ \text{Ca(N}_3\text{)}_2 + \text{I}_2 \rightarrow \text{CaI}_2 + \text{N}_3\text{I} \]

\[ \underline{\text{Ca(N}_3\text{)}_2} + \underline{\text{I}_2} \rightarrow \underline{\text{CaI}_2} + \underline{\text{N}_3\text{I}} \]

12) A compound Q is composed of the elements D, L, and M. For every 2 atoms of D, there are 3 atoms of L and 2 atoms of M. Starting with 0.240 \times 10^{23} \text{ atoms of D, and 0.0700 \text{ moles of L, exactly 1.20 g of M react.} First write the formula of the compound. HINT: This is a limiting quantity problem. (10 pts)

The molar mass (atomic weight) of element M is,

i) \(30 \text{ g mol}^{-1}\)

ii) \(45 \text{ g mol}^{-1}\)

iii) \(60 \text{ g mol}^{-1}\)

iv) \(90 \text{ g mol}^{-1}\)

ANSWER IS: ______

13) Give the formal charge of each indicated atom in the thiosulfate \((\text{S}_2\text{O}_3^{2-})\) anion. (8 pts)

\[ \begin{array}{c}
\text{atom 1} = \\
\text{atom 2} = \\
\text{atom 3} = \\
\text{atom 4} = 
\end{array} \]

14) Indicate which reactant species is the Lewis acid and which is the Lewis base in the following reaction. HINT: Think Lewis structure. (4 pts)
\[
\text{AlCl}_3 + \text{O(CH}_3\text{)}_2 \rightarrow \text{Cl}_3\text{Al-O(CH}_3\text{)}_2
\]

15) Give the conjugate acid of (CH\(_3\))\(_2\)NH. (4 pts)

ANSWER IS: ______

16) Give the hydrated form of the anhydrous acid I\(_2\)O\(_5\). (4 pts)

ANSWER IS: ______

17) Give the formula for the anhydrous form of H\(_2\)SeO\(_4\). (4 pts)

ANSWER IS: ______

18) Beaker A contains 0.100 L of an 0.20 M KOH solution; beaker B contains 0.100 L of an 0.40 M HCl solution. The contents of both beakers are thoroughly mixed together in a sufficiently large third beaker. The molarity, M, of the resulting salt solution is; (8 pts)

i) 0.05 M.  ii) 0.10 M.  iii) 0.20 M.  iv) 0.40 M.  v) no salt is formed.

ANSWER IS: ______

19) Complete combustion (burning) of two (2) liters of a gaseous hydrocarbon, C\(_x\)H\(_y\), to CO\(_2\)(g) and H\(_2\)O(g) required 14 liters of pure O\(_2\)(g). All volumes were measured at the same temperature and pressure. The TOTAL volume of the products, CO\(_2\) and H\(_2\)O, is 18 liters. The unbalanced reaction is,

\[
\text{C}_x\text{H}_y + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}
\]

The most likely molecular formula of the hydrocarbon is; (10 pts)

i) C\(_6\)H\(_{12}\)  ii) C\(_5\)H\(_{12}\)  iii) C\(_4\)H\(_{10}\)  iv) C\(_5\)H\(_8\)

ANSWER IS: ________

SCRAP WORK PAGE
SCRAP WORK PAGE