ANSWER KEY

CHEMISTRY S14O3 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. _____ (1O)	1O. _____ (5)	17. _____ (4)
4. _____ (12)	11. _____ (5)	18. _____ (8)
5. _____ (8)	12. _____ (1O)	19. _____ (1O)
6. _____ (8)	13. _____ (8)	
7. _____ (8)	14. _____ (4)	

COLUMN TOTALS (MAXIMUM):

_____(67) _____(5O) _____(3O)

EXAM TOTAL (147 pts) _____ _____
OUT OF 1OO

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. $FeCO_3 \longrightarrow FeO + CO_2$

2. $Fe(HCO_3)_2 \longrightarrow FeO + 2\,CO_2 + H_2O$

and

3. $2\,NaOH \longrightarrow Na_2O + H_2O$

You are given a mixture of iron(II)carbonate ($FeCO_3$), iron(II)bicarbonate ($Fe(HCO_3)_2$) and sodium hydroxide (NaOH). When heated this mixture completely reacts as shown above, forming 17.6O g of $CO_{2(g)}$, 3.6O g of H_2O , and O.1OO mol Na_2O .

Molar masses: $FeCO_3$ (115.9) , $Fe(HCO_3)_2$ (177.9) , NaOH (4O.O) , CO_2 (44.O) , FeO (71.9) , H_2O (18.O) , Na_2O (62.O)

1) Calculate the number of moles of H_2O and of CO_2 formed. (6 pts)

$n_{H2O} = \frac{3.60}{18.0} = O.2OO$ ANSWER IS (H_2O): O.2OO

$n_{CO2} = \frac{17.6}{44.0} = O.4OO$ ANSWER IS (CO_2): O.4OO

2) Calculate the number of moles of $FeCO_3$, $Fe(HCO_3)_2$, and NaOH present initially. SHOW WORK (15 pts - 5 pts each part)

FROM RXN 3: $n_{Na2O} = O.1O$ \ $n_{H2O} = O.1O$ AND $\underline{n}_{NaOH} = O.2O$

FROM RXN 2: $n_{H2O(rxn\ 2)} = O.2OO$ (total) - O.1OO(rxn 3) = O.1O

\ $n_{CO2} = O.2O$ AND $\underline{n}_{Fe(HCO3)2} = O.1O$

FROM RXN 1: $n_{CO2} = O.4O$ (TOTAL) - O.2O (rxn 2) = $O.2O = \underline{n}_{FeCO3}$

$\underline{n}_{NaOH} = O.2O$, $\underline{n}_{Fe(HCO3)2} = O.1O$, $\underline{n}_{FeCO3} = O.2O$

$\underline{n}_{NaOH}$ IS: O.2O

$\underline{n}_{Fe(HCO3)2}$ IS: O.1O

$\underline{n}_{FeCO3}$ IS: O.2O

3) Given the following 2 reactions:

1, $FeCO_3 \longrightarrow FeO + CO_2$

and

2. $Fe_2(CO_3)_3 \longrightarrow Fe_2O_3 + 3\,CO_2$

Starting with 1 mole total of $FeCO_3$ and $Fe_2(CO_3)_3$, 1.5 mol of CO_2 are obtained. Calculate the starting number of moles of $FeCO_3$. (1O pts)

$n_{CO2(TOTAL)} = 1.5 = n_{CO2(rxn\,1)} + n_{CO2(rxn\,2)}$

$n_{CO2(TOTAL)} = 1.5 = n_{FeCO3} + 3\,n_{Fe2(CO3)3}$

$n_{CO2(TOTAL)} = 1.5 = n_{FeCO3} + 3\,(1 - n_{FeCO3})$

$\therefore\ n_{FeCO3} = O.75$

ANSWER IS: O.75

4) The following gaseous reaction occurs in a vessel of 5O.O L volume at 3OO K.

$N_2H_4 + 5\,F_2 \longrightarrow 2\,NF_3 + 4\,HF$

Initially, three moles of N_2H_4 and two moles of 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: N_2H_4 (32.O), F_2 (38.O), HF (2O.O), NF_3 (71.O)

a) Which reactant is limiting? ANSWER IS: F_2

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

ANSWER IS: 2.6

c) How many grams of NF_3 are produced?

ANSWER IS: 56.8

5) What volume of CO_2 can be produced from the reaction of 13.1 g of N_2O (as shown below)? Assume an excess of C_3H_8, and take the density of CO_2 to be 1.96 $\frac{g}{L}$. Molar masses: $N_2O = CO_2 = 44.O$ (8 pts)

$1O\ N_2O_{(g)} + C_3H_{8(g)} \longrightarrow 1O\ N_{2(g)} + 3\ CO_{2(g)} + 4\ H_2O_{(g)}$

i) 2.OO L ii) 2.24 L iii) 3.5O L iv) 6.OO L

ANSWER IS: i

6) Given the reaction:

$2\ C_4H_{1O(g)} + 13\ O_{2(g)} \longrightarrow 8\ CO_{2(g)} + 1O\ H_2O_{(g)}$

How many liters of CO_2 were recovered by burning 2O L of C_4H_{1O}?

(P and T constant) if the percent yield was 75 % . (8 pts)

i) 55 L ii) 6O L iii) 7O L iv) 8O L

Give 4 pts if their answer is iv

ANSWER IS: ii

7) An unknown gas has a density of 6.36 $\frac{g}{L}$ at a pressure of O.912 atm and a temperature of 57°C. What is the molar mass of this gas?

R = O.O821 $\frac{L \cdot atm}{mol \cdot deg}$ (8 pts)

i) 28.O g/mol ii) 114 g/mol iii) 146 g/mol iv) 189 g/mol

ANSWER IS: iv

8) What would be the density of the gas from question 8 if its temperature and pressure returned to STP? (6 pts)
CREDIT FOR THIS IS BASED UPON YOUR ANSWER FROM QUESTION 8.

i) 1.25 g/L ii) 5.O9 g/L iii) 6.52 g/L iv) 8.43 g/L

ANSWER IS: _____

9) GIVEN: $ZrCl_2$ is zirconium(II)chloride; $ZrCl_4$ is; $NaVO_3$ 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) $Zr(SO_4)_2$: zirconium(IV)sulfate

ii) SF_6 sulfur hexafluoride

iii) zirconium(II)vanadate : $Zr(VO_3)_2$

iv) $CrBr_3$: chromium(III)bromide OR chromic bromide

v) ferric phosphate : $FePO_4$

vi) aluminum chromate $Al_2(CrO_4)_3$

BALANCE THE FOLLOWING EQUATIONS BY INSERTING INTEGERS IN THE SPACES PRECEDING THE FORMULAS. (5 pts each)

1O) $C_3H_8O + KClO_4 \longrightarrow CO_2 + H_2O + KCl$

$$\underline{4}\ C_3H_8O + \underline{9}\ KClO_4 \longrightarrow \underline{12}\ CO_2 + \underline{16}\ H_2O + \underline{9}\ KCl$$

11) $Ca(N_3)_2 + I_2 \dashrightarrow CaI_2 + NI_3$

$$\underline{1}\ Ca(N_3)_2 + \underline{1O}\ I_2 \longrightarrow \underline{1}\ CaI_2 + \underline{6}\ NI_3$$

THE 1 (ONE) MAY BE OMITTED.

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 O.24O x $1O^{23}$ atoms of D, and O.O7OO moles of L, exactly 1.2O g of M react . First write the formula of the compound. HINT: This is a limiting quantity problem. (1O pts)

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

i) 3O $\frac{g}{mol}$ ii) 45 $\frac{g}{mol}$ iii) 6O $\frac{g}{mol}$ iv) 9O $\frac{g}{mol}$

(3 pts) FORMULA IS: $D_2L_3M_2$

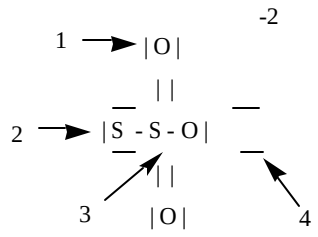
(3 pts) MOLES GIVEN: $n_D = O.O4O$ $n_L = O.O7O$ $n_M = \frac{1.2O}{F}$

(4 pts FOR FINISHING) MOLES USED:

$$n_D = O.O4O \quad n_L = O.O6O \quad n_M = O.O4O = \frac{1.2O}{F}$$

ANSWER IS: i

13) Give the formal charge of each indicated atom in the thiosulfate ($S_2O_3^{2-}$) anion. (8 pts)



atom 1 = ___O__

atom 2 = __-1__

atom 3 = ___O__

atom 4 = __-1__

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)

ACID BASE

$$AlCl_3 + O(CH_3)_2 \dashrightarrow Cl_3Al\text{-}O(CH_3)_2$$

15) Give the conjugate acid of $(CH_3)_2NH$. (4 pts)

ANSWER IS: $(CH_3)_2NH_2^+$

16) Give the hydrated form of the anhydrous acid I_2O_5 . (4 pts)

ANSWER IS: $\underline{HIO_3}$

17) Give the formula for the anhydrous form of H_2SeO_4 . (4 pts)

ANSWER IS: $\underline{SeO_3}$

18) Beaker A contains O.1OO L of an O.2O M KOH solution; beaker B contains O.1OO L of an O.4O 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) O.O5 M. ii) O.1O M. iii) O.2O M. iv) O.4O M. v) no salt is formed.

$$M = \frac{\text{O.O2O mol KCl}}{\text{O.2OO L}} = \text{O.1O M}$$

ANSWER IS: ii

19) Complete combustion (burning) of two (2) liters of a gaseous hydrocarbon, C_xH_y, to $CO_{2(g)}$ and $H_2O_{(g)}$ 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_2O, is 18 liters. The unbalanced reaction is,

$$C_xH_y + O_2 \longrightarrow CO_2 + H_2O$$

The most likely molecular formula of the hydrocarbon is; (1O pts)

i) C_6H_{12} ii) C_5H_{12} iii) C_4H_{1O} iv) C_5H_8

$$2C_xH_y + 14\ O_2 \longrightarrow 2x\ CO_2 + y\ H_2O$$

BALANCING VOLUME, $2x + y = 18$; BALANCING O ATOMS, $4x + y = 28$

$x = 5$ AND $y = 8$

YOU CAN ALSO DO THIS BY TRIAL AND ERROR

ANSWER IS: iv