ANSWER KEY

CHEMISTRY F14O3 FIRST EXAM 10/11/99
PROFESSOR J. MORROW

PRINT NAME, LAST: _____

FIRST: _____

I.D.# : _____

MAXIMUM POINT VALUE IS IN PARENTHESES

1. _____ (6)	9. _____ (6)	17. _____ (6)
2. _____ (15)	10. _____ (6)	18. _____ (6)
3. _____ (15)	11. _____ (6)	19. _____ (6)
4. _____ (15)	12. _____ (6)	20. _____ (6)
5. _____ (15)	13. _____ (6)	21. _____ (6)
6. _____ (15)	14. _____ (6)	22. _____ (6)
7. _____ (15)	15. _____ (6)	23. _____ (6)
8. _____ (15)	16. _____ (6)	24. _____ (6)

COLUMN TOTALS (MAXIMUM):

_____(81)	_____(48)	_____(48)

EXAM TOTAL (165 pts) _____ _____
OUT OF 1OO

USE THE FOLLOWING INFORMATION FOR PROBLEMS 1 AND 2

Given the following 3 reactions:

1. $FeSO_3 \longrightarrow FeO + SO_2$

2. $Fe(HSO_3)_2 \longrightarrow FeO + 2\,SO_2 + H_2O$

and

3. $2\,NaHSO_3 \longrightarrow Na_2O + 2\,SO_2 + H_2O$

You are given a mixture of iron(II)sulfite ($FeSO_3$), iron(II)hydrogensulfite ($Fe(HSO_3)_2$) and sodium hydrogensulfite ($NaHSO_3$). When heated this mixture completely reacts as shown above, forming 57.6O g of $SO_{2(g)}$, 5.4O g of H_2O , and O.1OO mol Na_2O .

Molar masses: $FeSO_3$ (135.9) , $Fe(HSO_3)_2$ (217.9) , $NaHSO_3$ (104.O) , SO_2 (64.O) , FeO (71.9) , H_2O (18.O) , Na_2O (62.O)

1) Calculate the number of moles of H_2O and of SO_2 formed. (6 pts)

$n_{H2O} = \frac{5.40}{18.0} = 0.3OO$ $\qquad$ $n_{SO2} = \frac{57.60}{64.0} = 0.900$

ANSWER IS (H_2O): <u>0.3OO</u>

ANSWER IS (SO_2): <u>0.900</u>

2) Calculate the number of moles of $FeSO_3$, $Fe(HSO_3)_2$, and $NaHSO_3$ present initially. SHOW WORK (OR REASONING) (15 pts - 5 pts each part)

To produce 0.100 mol of Na_2O requires <u>0.200</u> mol of $NaHSO_3$ which also produces 0.200 mol of SO_2 and 0.100 mol H_2O from rxn 3 $\therefore$ 0.200 mol H_2O came from rxn 2 along with 0.400 mol of SO_2 requiring 0.200 mol of $Fe(HSO_3)_2$.

The remaining 0.300 mol of SO_2 came from 0.300 mol of $FeSO_3$.

$\underline{n}_{NaHSO3}$ IS: <u>0.200</u>

$\underline{n}_{Fe(HSO3)2}$ IS: <u>0.200</u>

$\underline{n}_{FeSO3}$ IS: <u>0.300</u>

3) Given the following 3 reactions:

1. $FeSO_3 \longrightarrow FeO + SO_2$

2. $Fe_2(SO_3)_3 \longrightarrow Fe_2O_3 + 3\,SO_2$

and 3. $FeCO_3 \longrightarrow FeO + CO_2$

Starting with 3 moles <u>total</u> of $FeSO_3$, $FeCO_3$, and $Fe_2(SO_3)_3$, 1.5 moles of CO_2 and 2.5 moles of FeO are obtained. Calculate the starting number of moles of $Fe_2(SO_3)_3$ and the total number of moles of SO_2 produced. SHOW WORK (OR REASONING) (15 pts)

CO_2 only comes from rxn 3 ∴ 1.5 mol FeO were also produced in rxn 3 from 1.5 mol $FeCO_3$. Of the 2.5 mol FeO, the remaining 1.0 mol came from rxn 1 requiring 1 mol $FeSO_3$. ∴ there must be 0.5 mol of $Fe_2(SO_3)_3$ (which would produce 1.5 mol SO_2). Rxn 1 also produces 1 mol SO_2 (from 1 mol $FeSO_3$).

moles of $Fe_2(SO_3)_3$: <u>0.5</u>

moles of SO_2: <u>2.5</u>

USE THE FOLLOWING INFORMATION FOR PROBLEMS 4 AND 5

A mixture of $ZnCl_2$ and $ZnSO_4$ weighing 8.513 g was dissolved in water. The mixture was allowed to react with solid aluminum and the following two reactions occurred. The total weight of solid zinc produced was 3.707 g.
(molar masses: Zn (65.38 g), Al (26.98 g), $ZnCl_2$ (136.28), $ZnSO_4$ (161.38)

1. $3\,ZnCl_{2(aq)} + 2\,Al_{(s)} \longrightarrow 3\,Zn_{(s)} + 2\,AlCl_{3(aq)}$

and

2. $3\,ZnSO_{4(aq)} + 2\,Al_{(s)} \longrightarrow 3\,Zn_{(s)} + Al_2(SO_4)_3$

4) Calculate the weight of $ZnCl_2$ present in the original mixture. SHOW WORK

$8.513\text{ g} = W_{ZnCl2} + W_{ZnSO4} \quad \| \quad n_{Zn(TOTAL)} = \frac{3.707}{65.38} = 0.05670$

$n_{Zn(TOTAL)} = 0.05670 = n_{Zn(1)} + n_{Zn(2)} = n_{ZnCl2} + n_{ZnSO4}$

$0.05670 = \frac{W_{ZnCl2}}{136.28} + \frac{8.513 - W_{ZnCl2}}{161.38} \qquad \therefore W_{ZnCl2} = 3.46\text{ g}$

ANSWER IS: <u>3.46 g</u>

5) Calculate the <u>total</u> weight of aluminum used. THE ANSWER FOR THIS PART IS <u>NOT</u> DEPENDENT UPON YOUR ANSWER FOR QUESTION 4. SHOW WORK

$n_{Al(total)} = (\frac{2}{3})n_{Zn(total)} = (\frac{2}{3})(0.05670) = 0.0378$ mol

$\therefore\ W_{Al} = n_{Al(total)} F_{Al} = (0.0378(26.98) = 1.02$ g

ANSWER IS: 1.02 g

6) A 0.20 mol sample of a hydrocarbon, C_xH_y reacts with 1.3 mol of O_2 gas, to yield 1.6 mol TOTAL of CO_2 and H_2O. The molecular formula of C_xH_y is;

a) C_4H_2 b) C_4H_4 c) C_4H_6 d) C_4H_{10} e) C_5H_4
f) C_5H_6 g) C_5H_8 h) C_5H_{10} i) C_5H_{12}

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

moles: 0.20 1.3 1.6 mol TOTAL
OR moles: 2.0 13 16 mol TOTAL

$\therefore\ 2\ C_xH_y + 13\ O_2 \longrightarrow 2x\ CO_2 + y\ H_2O$

$2x + y = 16$ AND $4x + y = 26$ $\therefore\ x = 5$ AND $y = 6$

ANSWER IS: f

7) A compound has the formula $C_xH_yO_zCl_w$. 7.80 g of this compound is burned producing 0.200 mol of CO_2 , 2.27 g of H_2O , and ultimately 0.100 mol of AgCl. What is the empirical formula of this compound? HINT: First obtain the weights of hydrogen and oxygen in the original compound. ATOMIC WEIGHTS: H (1.00), C (12.00), O (16.00), Cl (35.50)

a) $C_2H_3O_2Cl_2$ b) $C_4H_5OCl_2$ c) $C_4H_6O_2Cl$ d) $C_6H_8O_2Cl_4$ e) $C_4H_5O_2Cl_2$

$n_C = n_{CO2} = 0.200 = \frac{W_C}{12.00}$ $\therefore\ W_C = 2.40$ g $n_c = 0.200$

$n_{Cl} = n_{AgCl} = 0.100 = \frac{W_{Cl}}{35.50}$ $\therefore\ W_{Cl} = 3.55$ g $n_{Cl} = 0.100$

$W_H = (\frac{2}{18})(2.27) = 0.25$ g $n_H = 0.250$

$W_{O2} = 7.80 - 2.40 - 3.55 - 0.25 = 1.60$ g OR 0.100 mol of atoms

ANSWER IS: e

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

$$H_2S + 3\ F_2 \longrightarrow 2\ HF + SF_4$$

Initially, three moles of H_2S and six moles of F_2 are mixed in this vessel. The reaction then occurs until the reactant in limiting quantity is totally consumed. (15 pts - 5 pts each part)

Molar masses: H_2S (34.O) , F_2 (38.O) , HF (2O.O) , SF_4 (1O8.O)

a) Which reactant is limiting? ANSWER IS: $\underline{F_2}$

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

ANSWER IS: one (1)

c) What is the mole ratio of HF to SF_4 produced, $\frac{n_{HF}}{n_{SF4}}$?

ANSWER IS: $\frac{n_{HF}}{n_{SF4}} = \frac{2}{1} = 2$

9) The spatial appearance of the SF_4^{2-} ion is,
(GROUP NUMBERS: S (6) ; F (7))

a) tetrahedral
b) seesaw
c) square planar
d) pyramidal

ANSWER IS: c

10) The mass in grams of a single molecule of C_3H_6 is....
(at. wt: C = 12.0 , H = 1.0)

a) $7 \times 1O^{23}$
b) $7 \times 1O^{-21}$
c) $7 \times 1O^{-22}$
d) $7 \times 1O^{-23}$
e) 42

ANSWER IS: d

11) Element X reacts with oxygen to form a pure sample of X_2O_3 In an experiment it is found that 1.0000g of X produces 1.1596 g of X_2O_3 . Using the known atomic weight of oxygen, 16.000 g/mol , calculate the atomic weight of X.

a) 20.70 b) 66.85 c) 100.2 d) 150.4 e)168.9

$W_x = 1.0000g$ $\therefore W_o = 0.1596$ g

$$\frac{1.0000}{(2)(F)} = \frac{0.1596}{(3)(16)} \quad \therefore\ 2F = 300.8\ (= 2 \text{ atomic weights of X})$$

$$\therefore\ F = 150.4$$

GIVE 3 PTS IF THEY GIVE C AS THE ANSWER! ANSWER IS: d

12) Complete the following table (isotopic symbols are hypothetical)

Symbol	Atomic Number	# of neutrons	mass number	# of electrons
$^{x}_{12}M^{2+}$	*12*	13	*25*	*10*
$^{31}_{y}A^{3-}$	15	*16*	*31*	*18*

13) Give the conjugate acid of $NHOH^-$. ANSWER IS: NH_2OH

14) Give the hydrated form of the anhydrous acid Br_2O_3 .

ANSWER IS: $HBrO_2$

15) give the formula for the anhydrous form of H_2SeO_3 .

ANSWER IS: SeO_2

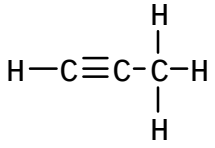
16) Beaker A contains O.1OO L of an O.2O M KOH solution; beaker B contains O.1OO L of an O.1O M H_2SO_4 solution. The contents of both beakers are thoroughly mixed together in a sufficiently large third beaker. The resulting solution is; (HINT: BALANCE EQUATION(S) CAREFULLY)

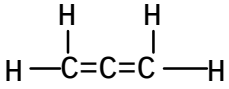
a) O.O5 M in K_2SO_4 b) O.O5 M in both $KHSO_4$ and KOH
c) O.1O M in K_2SO_4 d) O.1O M in both $KHSO_4$ and KOH
e) O.1O M in $KHSO_4$ f) O.1O M in KOH

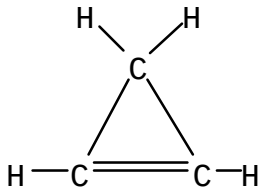
GIVE 3 PTS IF THEY GIVE b AS THE ANSWER!

ANSWER IS: a

17) Draw a Lewis structure for C_3H_4 . If possible satisfy the octet rule and covalency.





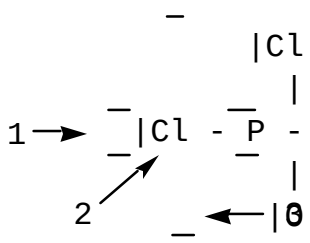


ANY ONE OF THE ABOVE IS ACCEPTABLE

18) Write the oxidation number above the symbol of each atom that changes oxidation state in the course of reaction.

$$\overset{+7}{2\ MnO_4^-} + \overset{+3}{C_2O_4^{2-}} \longrightarrow 2\ CO_2 + \overset{+6}{2\ MnO_4^{2-}}$$

19) Give the formal charge of each indicated atom in the following molecule.



atom 1 = O atom 2 = +1 atom 3 = -1

20) Indicate which reactant species is the Lewis acid and which is the Lewis base in the following reaction.

ACID **BASE**

$$HgCl_2 + BCl_4^- \longrightarrow HgCl_3^- + BCl_3$$

21) Given the reaction:

$$2\ C_5H_{10(g)} + 15\ O_{2(g)} \longrightarrow 10\ CO_{2(g)} + 10\ H_2O_{(g)}$$

How many liters of CO_2 were recovered by burning 16 L of C_5H_{10}? (P and T constant) if the percent yield was 75 % .

a) 55 L b) 60 L c) 70 L d) 75 L e) 80 L

ANSWER IS: b

22) 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. (1 point 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.

23) $C_3H_8O + KClO_4 \longrightarrow CO_2 + H_2O + KCl$

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

24) $Ca(N_3)_2 + I_2 \longrightarrow CaI_2 + NI_3$

$\underline{1}\ Ca(N_3)_2 + \underline{10}\ I_2 \longrightarrow \underline{1}\ CaI_2 + \underline{6}\ NI_3$

THE COEFFICIENT, 1, CAN BE OMITTED