Chemistry 105 Exam 2

Name Key

Useful information: $N_A = 6.022 \times 10^{23}$, percent yield = actual/theoretical x 100%

(1)(4 pts) Are the following compounds electrolytes or nonelectrolytes?

(a) $V(NO_3)_3$ electrolyte (ionic)

(b) ClF_3 nonelectrolyte (molecular)

(c) N_2O_5 nonelectrolyte (molecular)

(d) S_2Cl_2 nonelectrolyte (molecular)

(2) (4pts) Write the formulas for the following compounds

(a) diiodine pentoxide I_2O_5

(b) barium phosphate $Ba_3(PO_4)_2$

(c) copper(II)chlorate $Cu(ClO_3)_2$

(d) silicon dioxide SiO_2

(3) (4pts) Write the names of the following compounds

(a) $PbSO_4$ lead (II) sulfate

(b) LiF lithium fluoride

(c) HNO_2 nitrous acid

(d) $AsCl_5$ arsenic pentachloride

(3) (4pts) Balance the following equations

(a) $SO_2 + O_2$ --------> SO_3

$2SO_2 + O_2 \longrightarrow 2SO_3$

(b) $P_4O_{10} + 6H_2O$ --------> $4H_3PO_4$

$P_4O_{10} + 6H_2O \longrightarrow 4H_3PO_4$

(4) (4pts) Calculate the masses of the following compounds state the units.

(a) $FeCl_3 \cdot 4H_2O$

$234.3\ g/mole$

Fe $55.85\ g/mole$
3Cl $3(35.45\ g/mole)$
8H $8(1.01\ g/mole)$
4O $4(16.00\ g/mole)$
$234.3\ g/mole$

(b) $C_{10}H_{10}O$

$146.20\ g/mole$

10C $10(12.01\ g/mole)$
10H $10(1.01\ g/mole)$
O $16.00\ g/mole$
$146.20\ g/mole$

(5) (4pts) $N_2H_4 + 7H_2O_2 \text{ -------> } 2HNO_3 + 8H_2O$

Using the balanced equation above, answer the following questions.

(a) How many moles of hydrogen peroxide (H_2O_2) are needed to react with 0.35 moles of hydrazine (N_2H_4)?

$0.35 \text{ moles } N_2H_4 \times \frac{7 \text{ moles } H_2O_2}{1 \text{ mole } N_2H_4} = 2.45 \text{ moles } H_2O_2$

(b) If 0.35 moles of N_2H_4 is reacted with excess H_2O_2, how many grams of water would be formed ideally?

$0.35 \text{ moles } N_2H_4 \times \frac{8 \text{ moles } H_2O}{1 \text{ mole } N_2H_4} = 2.80 \text{ moles } H_2O$

$H_2O \text{ MW} = 18.02 \text{ g/mole}$

$2.80 \text{ moles} \times \frac{18.02 \text{ g}}{\text{mole}} = 50.45 \text{ g } H_2O = 51 \text{ g}$

(6) (4pts) If you know that there are $4.39 \times 10^{25} ClO_2^-$ ions in a sample of $Al(ClO_2)_3$, how many moles of $Al(ClO_2)_3$ are there in the sample?

$4.39 \times 10^{25} \text{ ions} \div \frac{6.022 \times 10^{23} \text{ ions}}{\text{mole}} = 72.9 \text{ moles } ClO_2^- \text{ ions}$

$72.9 \text{ moles } ClO_2^- \text{ ions} \times \frac{1 \text{ mole } Al(ClO_2)_3}{3 \text{ moles } ClO_2^-} = 24.3 \text{ moles } Al(ClO_2)_3$

(7) (4 pts) Do you think that an element will ever be discovered between Magnesium and Aluminum on the periodic table? Why or why not?

No. Mg is element #12 which means it has 12 protons in its nucleus. Al is element #13 and has 13 protons in its nucleus. An element would have to have between 12 & 13 protons in its nucleus to fall between Mg & Al on the periodic table and the number of protons has to be an integer.

(8) (4pts) Who is credited with inventing the periodic table and what nationality was he?

Dimitri Mendeleev, Russian

(9) (8 pts) $2\ MnI_2 + 13F_2 \text{ -----> } 2MnF_3 + 4IF_5$

Using the balanced equation above, if 0.451 moles of MnI_2 is reacted with 2.98 moles of F_2...

(a) what is the limiting reagent (show work)

$0.451 \text{ mole } MnI_2 \times \frac{13 \text{ mole } F_2}{2 \text{ mole } MnI_2} = 2.93 \text{ mole } F_2$ ∴ 0.451 mole MnI_2 could react with 2.93 mole of F_2. There are 2.98 moles of F_2 ∴ MnI_2 is the limiting reagent.

(b) What is the theoretical yield of MnF_3?

MnI_2 is the limiting reagent; ∴

$0.451 \text{ moles } MnI_2 \times \frac{2 \text{ mole } MnF_3}{2 \text{ mole } MnF_2} = 0.451 \text{ mole } MnF_3$

MnF_3 MW = 111.94 g/mole

$0.451 \text{ mole } MnF_3 \times 111.94 \text{ g/mole} = 50.48 \text{ g } MnF_3$

= 50.5 g

(c) If the actual yield of MnF_3 is 42.0 g, what is the percent yield for the reaction?

$\%\ yield = \frac{actual}{theoretical} \times 100\%$ actual = 42.0 g

theoretical (part b) = 50.5 g

$\frac{42.0\ g}{50.5\ g} \times 100\% = 83.2\%$

(10) A compound is found to have a composition that is 40.05% S and 59.95% O by mass. What is the empirical formula for the compound?

Assume a 100 g sample. ∴ 40.05 g S and 59.95 g O

S AW = 32.052 g/mol O AW = 16.00 g/mol

S $40.05\ g \div 32.052\ g/mole = 1.250$ moles

O $59.95\ g \div 16.00\ g/mole = 3.747$ moles

divide by the smallest # moles to get whole # ratio's

S $1.250\ moles \div 1.250\ moles = 1$

O $3.747\ moles \div 1.250\ moles = 2.998 \approx 3$

∴ SO_3 is the empirical formula

(11) Write the balanced molecular, ionic, and net ionic equations for the reaction of the following reagents

$FeSO_{4(aq)} + Na_3PO_{4(aq)}$ -------->

$Fe_3^{2+}(PO_4^{3-})_{2(s)}$ $Na_3PO_{4(aq)}$

$Fe^{2+}SO_4^{2-}{}_{(aq)}$ $Na_2SO_{4(aq)}$

$3FeSO_{4(aq)} + 2Na_3PO_{4(aq)} \longrightarrow Fe_3(PO_4)_{2(s)} + 3Na_2SO_{4(aq)}$ molecular

$3Fe^{2+}_{(aq)} + 3SO_4^{2-}{}_{(aq)} + 6Na^+_{(aq)} + 2PO_4^{3-}{}_{(aq)} \longrightarrow Fe_3(PO_4)_{2(s)} + 6Na^+_{(aq)} + 3SO_4^{2-}{}_{(aq)}$ ionic

$3Fe^{2+}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \longrightarrow Fe_3(PO_4)_{2(s)}$ net ionic

(Extra Credit) (4 pts) Predict the products of the following reactions (you only have to give the balanced molecular equation)

(a) $Na_2S_{(aq)} + Pb(NO_3)_{2(aq)}$ --------> $PbS_{(s)} + 2NaNO_{3(aq)}$

$NaNO_{3(aq)}$ $Pb(NO_3)_{2(aq)}$

$Na_2S_{(aq)}$ $PbS_{(s)}$

(b) $Ca(OH)_{2(aq)} + FeSO_{4(aq)}$ ----------> $Fe(OH)_{2(s)} + CaSO_{4(s)}$

$Ca(OH)_{2(aq)}$ $FeSO_{4(aq)}$

$CaSO_{4(s)}$ $Fe(OH)_{2(s)}$