CHEMISTRY 121 MIDTERM 1

Sept. 28, 2007

Show all your reasoning/work/sig. figs. for full marks

(2) 1) Calculate the number of H atoms in 12.45 g of propanol ($CH_3CH_2CH_2OH$, MW = 60.1 g/mol).

$$\frac{12.45\text{ g } C_3H_8O}{60.1\text{ g/mol}} \times \frac{8\text{ H atoms}}{C_3H_8O} \times \frac{6.022\times10^{23}\text{ atoms}}{\text{mol}} = 9.98\times10^{23}\text{ H atoms}$$

(1) Setup (1)

(3) 2) An old bottle has the label shown at the lower right. This could mean a couple of things...lousy label. Using the label info., calculate the actual formula of the nickel hydroxide.

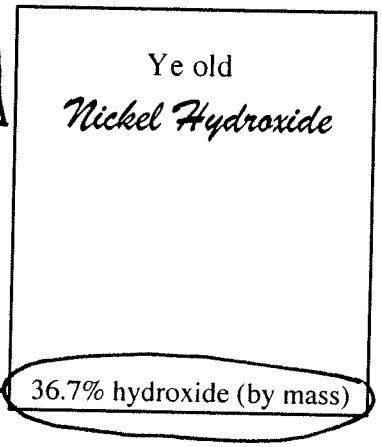
$$\frac{36.7\text{ g OH}}{17\text{ g/mol}} = 2.159\text{ mol} = 2$$

(1)

$$\frac{63.3\text{ g Ni}}{58.69\text{ g/mol}} = 1.079\text{ mol} = 1$$

(1) $Ni(OH)_2$

∴ in 100 g (1)



(2) 3) Write **ONE** correct name and **ONE** correct formula only. Your choice.

$P(NH_4)_3$ Ammonium phosphide

Mn_3As_2 Manganese (II) arsenide (-1/2 error)

Nickel (II) hydroxide $Ni(OH)_2$ ☺

Aluminum chromate $Al_2(CrO_4)_3$

(3) 4) Silicon has three isotopes: ^{28}Si, ^{29}Si and ^{30}Si in the ratio of 1000:50:23. Calculate silicon's atomic mass (g/mol).

$$\frac{1000}{1073}(28) + \frac{50}{1073}(29) + \frac{23}{1073}(30) = 28.09\text{ g/mol}$$

(1) (1) Setup (1)

(4) 5) An unknown metal (1.2 g) has chlorine gas (Cl_2) bubbled into it and they completely react to produce a MCl_3 solid which weighs 5.93 g. Identify the unknown metal. Fully explain.

$$2M + 3Cl_2 \longrightarrow 2MCl_3$$ (1) Eq$^{\Delta}$

1.2 g .... 5.93 g

$\frac{4.73\,g\ Cl_2}{70.9\,g/mol}$ (1)

↓

0.0667 mol Cl_2

↓ $\frac{2M}{3Cl_2}$ (1)

0.0445 mol M and we have 1.2 g M

$\therefore \frac{1.2\,g}{.0445\,mol} = \frac{26.97\,g}{mol} = AW_M = Al$ (1)

6) The reaction of butan-2,3-dione with hydride forms the butan-2,3-diol and methoxide anion in a 57% yield.

(4) a) Calculate the limiting reagent.

$$2\,H^{\ominus} + H_3C\text{-}C(=O)\text{-}C(=O)\text{-}CH_3 + 2\,CH_3OH \longrightarrow H_3C\text{-}CH(OH)\text{-}CH(OH)\text{-}CH_3 + 2\,CH_3O^{\ominus}$$ (1) Balanced

	$H^{\ominus}$	butan-2,3-dione	CH_3OH	butan-2,3-diol	$CH_3O^{\ominus}$
Amount	0.112 g	5.0 g	3.2 mL, 30M		
FW (g/mol)	1.0	86.1	32.0	90.1	31

- $H^{\ominus}$: .112 mol ↓ ÷2 → .0560
- butan-2,3-dione: .0581 mol ↓ ÷1 → .0581 (1)
- CH_3OH: $\frac{30\,mol}{1000\,mL} \times 3.2\,mL$ (1) → .0960 mol ↓ ÷2 → .0480

$\therefore CH_3OH = L.R.$ (1)

(3) b) Calculate the volume of the diol made using info. from the other page and that the density of the diol = 0.995 g/mL.

$$.0960 \text{ mol } CH_3OH \times \frac{CH_3\text{-}CH(OH)\text{-}CH(OH)\text{-}CH_3}{2\,CH_3OH} \times \frac{90.1\text{ g}}{\text{mol}} \times .57 \times \frac{\text{mL}}{.995\text{ g}} = \boxed{2.5\text{ mL}}$$

(1) (1) (1)

(3) 7) Glassware, water and 0.46 M KCl (aq) are made available to you. Make 250.0 mL of a 0.152 M KCl solution. Fully explain how to do this from start to finish.

$$\frac{0.152\text{ mol}}{1000\text{ mL}} \times 250\text{ mL} = .0380\text{ mol}$$ (1)

Have 0.46 mol in 1000 mL
as 0.038 " " x mL

$x = 82.61$ mL (1)
$= 83.$ mL

Take 83. mL of stock 0.46 M sol'n & put in 250 mL volumetric flask & make up to the mark. (1) - description

(3) 8) Methylammonium chloride, NH_3CH_3Cl, can be made in a series of three steps. Write the **overall** balanced equation for the reaction sequence.

$3\,H_2(g) + N_2(g) \longrightarrow 2NH_3(g)$ – balanced (1)

$2\,NH_3(g) + 2CH_3Cl \longrightarrow 2NH_2CH_3(g) + 2HCl(g)$

$2\,NH_2CH_3(g) + 2\,HCl(g) \longrightarrow 2NH_3CH_3Cl(s)$

(1) attempts to cancel like quantities

$$\boxed{3H_2 + N_2 + 2CH_3Cl \longrightarrow 2NH_3CH_3Cl}$$ (1)

(5) 9) Hydrogen gas (MW = 2.0 g/mol) is reacted with oxygen gas (1.76 g, MW = 32.0 g/mol) to yield the products of water (MW = 18.0 g/mol) and hydrogen peroxide H_2O_2 (MW = 34.0 g/mol). This, dare I say, mixture of products has a mass of 1.9 g. Calculate the % (by mass) of the water in the original mixture. Follow the general procedure we talked about in class. It works.

$H_2 + O_2 \longrightarrow H_2O + H_2O_2$ — 1.9 g

1.76 g

Balanced Eq NS

(1) $H_2 + O_2 \longrightarrow H_2O_2$

$2H_2 + O_2 \longrightarrow 2H_2O$

(1) -let statement

Let x = g H_2O ∴ $1.9 - x$ = g H_2O_2

(1) Setup

$$\frac{x\ g\ H_2O}{18.0\ g/mol}\left(\frac{1\ O_2}{2\ H_2O}\right)\left(\frac{32.0\ g}{mol}\right) + \frac{(1.9-x)\ g\ H_2O_2}{34.0\ g/mol}\left(\frac{1\ O_2}{1\ H_2O_2}\right)\left(\frac{32.0\ g}{mol}\right) = 1.76$$

$$16x(34) + (1.9-x)(32)(18) = 1.76(34)(18)$$

$$544x + (-576x) + 1094 = 1077.12$$

$$-32x = -17.28$$

$$x = 0.54\ g\ H_2O\ (1)$$

$$\therefore\ \% = \frac{0.54}{1.9} \times 100$$

$$= 28.42$$

$$\boxed{= 28.\%}\ (1)$$

(1) Bonus. What is the either the first or last name of the president of UBC?

(1) Stephen Toope