INTRODUCTION TO NATURAL SCIENCE

CHEMISTRY HW - WEEK 8 - FALL 2006

Chapter 5

(42) Molar mass of $K_2Cr_2O_7$ = 294.119 g/mol

moles of $K_2Cr_2O_7$ $= 2.335\,g \times \frac{mol}{294.119\,g}$

$= 7.9389 \times 10^{-3}$ mol

Molarity $= \frac{\#\text{ moles solute}}{\text{volume of solution}}$

$= \frac{7.9389 \times 10^{-3}\text{ mol}}{500 \times 10^{-3}\text{ L}}$

$= 1.5878 \times 10^{-2}$ M

$= 1.588 \times 10^{-2}$ M

$K_2Cr_2O_7(aq) \longrightarrow 2K^+(aq) + Cr_2O_7^{2-}(aq)$

1.588×10^{-2} M | $2(1.588 \times 10^{-2}$ M$)$ = 3.176×10^{-2} M | 1.588×10^{-2} M

(44) molarity $= \frac{\#\text{ moles solute}}{\text{volume of solution}}$ $\left(M = \frac{n}{V}\right)$

$\Rightarrow n = M.V.$

$\#$ moles of solute $= \left(1.023 \times 10^{-3} \frac{\text{mol}}{\text{L}}\right)(125\text{ mL}) \times \left(\frac{\text{L}}{10^3\text{ mL}}\right)$

$= 1.27875 \times 10^{-4}$ mol

molar mass of Na_3PO_4 = 163.87 g/mol

mass of Na_3PO_4 = 1.27875×10^{-4} mol × $\frac{163.87g}{1 mol}$

= ~~0~~ 2.0955×10^{-2} g

= $\underline{2.10 \times 10^{-2} g}$

$Na_3PO_4(aq) \longrightarrow 3 Na^+(aq) + PO_4^{3-}(aq)$

1.023×10^{-3} M | $3(1.023 \times 10^{-3} M)$ | $\underline{1.023 \times 10^{-3} M}$

= $\underline{3.069 \times 10^{-3} M}$

(46) Molar mass of $KMnO_4$ = 157.996 g/mol

moles of $KMnO_4$ = $322 g \times \frac{mol}{157.996 g}$ = 2.0380 mol

Volume of solution = $\frac{\text{\# moles of solute}}{\text{molarity}}$

= $\frac{2.0380 mol}{2.06 (mol/L)}$ = ~~0.98933 L~~

= $\underline{0.989 L}$

(47) (a) $(NH_4)_2SO_4(aq) \longrightarrow 2 NH_4^+(aq) + SO_4^{2-}(aq)$

0.25 M | 2(0.25M) | $\underline{0.25 M}$

= $\underline{0.50M}$

(b) $Na_2CO_3(aq) \longrightarrow 2 Na^+(aq) + CO_3^{2-}(aq)$

0.123 M | 2(0.123M) | $\underline{0.123M}$

= $\underline{0.246 M}$

(C) $HNO_3(aq) \longrightarrow H^+(aq) + NO_3^-(aq)$

0.056M 0.056M 0.056M

(49) Molar mass of Na_2CO_3 = 105.959 g/mol

$$\# \text{ moles } Na_2CO_3 = (\text{molarity}) \times (\text{volume of solution})$$
$$= \left(0.0200 \frac{\text{mol}}{\text{L}}\right)\left(500. \times 10^{-3}\ \text{L}\right)$$
$$= 0.0100 \text{ mol}$$

$$\text{mass of } Na_2CO_3 = 0.0100 \text{mol} \times \boxed{\frac{105.959 \text{ g}}{1 \text{mol}}}$$
$$= 1.059599 \text{ g}$$
$$= 1.059 \text{ g}$$

Weigh out 1.059g of Na_2CO_3. Transfer quantitatively into the 500. mL volumetric flask. Add some DI water and swirl to dissolve the solid. Then add enough DI water to make up to the mark. Cap and invert the flask a few times to mix the contents.

(51)

1.50M 25.0mL	M_D = ? 500. mL
Conc. HCl	dilute HCl

$$\left(\begin{array}{c}\# \text{ of moles HCl taken} \\ \text{from conc. solution}\end{array}\right) = \left(\begin{array}{c}\# \text{ of mol HCl in} \\ \text{dilute solution}\end{array}\right)$$

$$M_C \cdot V_C = M_D \cdot V_D$$

$$\therefore M_D = \frac{M_C V_C}{V_D} = \frac{\left(1.50 \frac{mol}{L}\right)(25.0\,mL)}{(500.\,mL)}$$

$$= \underline{\underline{0.0750\ M}}$$

(52)

$V_C = 4.00\,mL$
$M_C = 0.0250\,M$

conc. solution

$M_D = ?$
$V_D = 10.00\,mL$

dilute soln.

\# moles of $CuSO_4$ in conc. solution = # moles of $CuSO_4$ in dilute solution

$$M_C \cdot V_C = M_D \cdot V_D$$

$$M_D = \frac{M_C V_C}{V_D} = \frac{\left(0.0250 \frac{mol}{L}\right)(4.00\,mL)}{(10.00\,mL)}$$

$$= \underline{\underline{0.0100 \frac{mol}{L}}}$$

(54) moles of $K_2Cr_2O_7$ in the desired solution = (molarity)(volume of solution)

$$= \left(0.500 \frac{mol}{L}\right)(300. \times 10^{-3}\,L)$$

$$= \underline{0.150\ mol}$$

(54) **method (a)**

30.0 mL of 1.50 M $K_2Cr_2O_7$

$$\#\text{ moles } K_2Cr_2O_7 \text{ in this solution} = \left(1.50\,\frac{mol}{L}\right)\left(30.0\,mL\right) \times \left(\frac{L}{10^3\,mL}\right)$$

$$= 0.0450\text{ mol}$$

When you add 270. mL of water, total volume $\neq$ 300. mL

This method cannot work.

method (b)

Conc. solution	Dilute solution
$250.\,mL = V_C$	$300.\,mL = V_D$
$0.600\,M = M_C$	$M_D = ?$

$\#$ moles $K_2Cr_2O_7$ in conc. solution = $\#$ moles $K_2Cr_2O_7$ in dilute solution

$$M_C \cdot V_C = M_D V_D$$

$$M_D = \frac{M_C V_C}{V_D} = \frac{(0.600\,M)(250.\,mL)}{(300.\,mL)} = \underline{0.500\,M}$$

This will provide us with a $K_2Cr_2O_7$ solution of 0.500M concentration that has a volume of 300. mL. Method (b) works.

$2\,HNO_3\,(aq) + Ba(OH)_2\,(s) \longrightarrow 2\,H_2O(l) + Ba(NO_3)_2\,(aq)$

0.109 M 2.50 g

~~Molar~~

V = ?

molar mass of $Ba(OH)_2$ = 171.323 g/mol

moles of $Ba(OH)_2$ = $2.50\,g \times \frac{mol}{171.323\,g} = 1.459 \times 10^{-2}$ mol

1.459×10^{-2} mol $Ba(OH)_2 \times \frac{2\,mol\,HNO_3}{1\,mol\,Ba(OH)_2}$

$= 2.9185 \times 10^{-2}$ mol HNO_3

volume of HNO_3 = $\frac{\text{moles of } HNO_3}{\text{molarity of } HNO_3} = \frac{2.9185 \times 10^{-2}\,mol}{0.109\,mol/L}$

$= 0.267749\,L \times \frac{1000\,mL}{L}$

$= 267.75\,mL = \underline{\underline{268\,mL}}$

$Na_2CO_3\,(aq) + 2\,HNO_3(aq) \longrightarrow 2\,NaNO_3(aq) + CO_2(g) + H_2O(l)$

mass = ? 0.125 M 50.0 mL

moles of HNO_3 = (molarity) × (volume)

$= \left(0.125\,\frac{mol}{L}\right)\left(50.0 \times 10^{-3}\,L\right)$

$= 6.25 \times 10^{-3}$ mol

6.25×10 mol HNO_3 × $\frac{1\,mol\,Na_2CO_3}{2\,mol\,HNO_3}$ = 3.125×10 mol Na_2CO_3

molar mass of Na_2CO_3 = 105.961 g/mol

mass of Na_2CO_3 = 3.125×10^{-3} mol × $\frac{105.961\,g}{1\,mol}$

= 0.331123 g

= **0.331 g**

(3) $2\,NaCl(aq) + 2\,H_2O(l) \longrightarrow H_2(g) + Cl_2(g) + 2\,NaOH(aq)$

15.0 L
0.35 M

mass = ?　　mass = ?

moles of NaCl = molarity × volume

$= \left(0.35\,\frac{mol}{L}\right)(15.0\,L) = 5.25\,mol$

5.25 mol NaCl × $\frac{2\,mol\,NaOH}{2\,mol\,NaCl}$ = 5.25 mol NaOH

5.25 mol NaCl × $\frac{1\,mol\,Cl_2}{2\,mol\,NaCl}$ = 2.625 mol Cl_2

molar mass of NaOH = 39.988 g/mol

mass of NaOH = 5.25 mol × $\frac{39.988\,g}{1\,mol}$ = 209.937 g

= **210 g**

molar mass of Cl_2 = 70.90 g/mol

mass of Cl_2 $= 2.625 \text{ mol} \times \boxed{\frac{70.90 g}{1 mol}}$

$= 186.113 \text{ g} = \underline{\underline{186 \text{ g}}}$