SOLUTIONS TO MOLE CONCEPT, BACK-TITRATIONS, & STOICHIOMETRY.

1. $MgO(s) + H_2SO_4(aq) \longrightarrow MgSO_4(s) + H_2O(l)$

$2\,NaOH(aq) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + 2\,H_2O(l)$

mol H_2SO_4 added $= 0.0400 \times 0.600 = 0.0240$ ——— (1)

mol H_2SO_4 in excess $= (0.0250 \times 0.320)$ mol NaOH $\times \frac{1 \text{ mol } H_2SO_4}{2 \text{ mol NaOH}}$

$= 0.00400$ ——— (2)

mol H_2SO_4 that reacted with MgO = (1) − (2) = 0.020

$\therefore 0.020 \text{ mol } H_2SO_4 \times \frac{1 \text{ mol MgO}}{1 \text{ mol } H_2SO_4} \times \frac{40.3 \text{ g MgO}}{1 \text{ mol MgO}} = 0.806 \text{ g MgO}$

$\% MgO = \frac{0.806}{0.984} \times 100 = 81.9$

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2. $BaCO_3 + 2\,HCl(aq) \longrightarrow BaCl_2 + CO_2 + H_2O$

$NaOH + HCl \longrightarrow NaCl + H_2O$

mol of HCl $= 0.02500 \times 0.2120 = 5.30 \times 10^{-3}$ ——— (1)

mol of HCl in excess $= (0.02248 \times 0.1082) = 2.43 \times 10^{-3}$ ——— (2)

mol of HCl that reacted = (1) − (2) $= 2.87 \times 10^{-3}$

$2.87 \times 10^{-3} \text{ mol HCl} \times \frac{1 \text{ mol } BaCO_3}{2 \text{ mol HCl}} \times \frac{197.3 \text{ g } BaCO_3}{1 \text{ mol } BaCO_3} = 0.283 \text{ g } BaCO_3$

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3. $M_2CO_3 \cdot 3H_2O + 2HCl \longrightarrow 2MCl + CO_2 + 4H_2O$

$KOH + HCl \longrightarrow KCl + H_2O$

mol of HCl $= 0.04000 \times 0.8450 = 0.03380$ ——— (1)

mol HCl excess $= (0.05114 \times 0.1460)\ \text{mol KOH} \times \frac{1\ \text{mol HCl}}{1\ \text{mol KOH}} = 7.46644 \times 10^{-3}$ ——— (2)

mol reacted with $M_2CO_3 \cdot 3H_2O = (1) - (2) = 0.02633$

$0.02633\ \text{mol HCl} \times \frac{1\ \text{mol } M_2CO_3 \cdot 3H_2O}{2\ \text{mol HCl}} = 0.0131667$

$\therefore$ MOLAR MASS $= \frac{5.00}{0.0131667} = 379.74$

$2 \times M + 12 + 48 + (3 \times 18.0) = 379.74$

$M = 132.87$ $\quad Cs_2CO_3 \cdot 3H_2O$

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4. mol of M $= 0.0400 \times 0.500 = 0.02$ — MOL RATIO 2

mol of S $= 0.120 \times 0.250 = 0.03$ — MOL RATIO 3

$\therefore M_2S_3$

$2 \times M + 3 \times S = 150$ $\quad \therefore M = 27.0$

Al_2S_3

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5. $(0.04000 \times 0.100)\ \text{mol NaOH} \times \frac{1\ \text{mol } H^+}{1\ \text{mol NaOH}} \times \frac{1\ \text{mol } SO_3^{2-}}{2\ \text{mol } H^+} = 0.00200$

MOLAR MASS $= \frac{0.4322\ g}{0.00200\ \text{mol}} = 216.1\ g/\text{mol}$

$(2 \times Na) + (1 \times S) + (3 \times O) + (X \times 18.0) = 216.1$

$X = 5$ $\quad Na_2SO_3 \cdot 5H_2O$

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6. $5.623\ g\ \text{NaOH} \times \frac{1\ \text{mol NaOH}}{40.00\ g\ \text{NaOH}} \times \frac{1}{0.2500\ L} = 0.5623\ M$

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7. $M_1V_1 = M_2V_2$ $\quad M_1 = 0.5623$ $\quad M_2 = ?$
$V_1 = 10.00\,mL$ $\quad V_2 = 60.00\,mL$

$$M_2 = \frac{0.5623 \times 10.00}{60.00} = 0.09372\ M$$

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8. $(0.750 \times 0.225)\,mol \times \frac{77.0\,g}{1\,mol} = 13.0\,g\ NH_4C_2H_3O_2$

9. $$\frac{[(0.0250 \times 0.375) + (0.042 \times 0.632)]\,mol\ NaCl}{(25.0 + 42.0)/1000\ L} = 0.5360\ M$$

10. $Ba(OH)_2 + 2\,HCl \longrightarrow BaCl_2 + 2H_2O$

$$(0.03567 \times 0.0748)\,\cancel{mol\ HCl} \times \frac{1\,mol\ Ba(OH)_2}{2\,\cancel{mol\ HCl}} \times \frac{10^3\,mL}{0.0487\,mol\ Ba(OH)_2}$$

$$= 27.40\,mL\ Ba(OH)_2$$

11. $NaOH_{(aq)} + HC_2H_3O_{2(aq)} \longrightarrow NaC_2H_3O_{2(aq)} + H_2O_{(l)}$

$$(0.01655 \times 0.5062)\,\cancel{mol\ NaOH} \times \frac{1\,mol\ HC_2H_3O_2}{1\,\cancel{mol\ NaOH}} \times \frac{60.0\,g}{1\,mol\ HC_2H_3O_2} = 0.5027\,g$$

$$\%\ \text{ACETIC ACID} = \frac{0.5027\,g\ acid}{\left(10.00\,mL \times \frac{1.006\,g}{1\,mL}\right)\ solution} = 5.00\ \%$$

12. $HA_{(aq)} + NaOH_{(aq)} \rightarrow NaA_{(aq)} + H_2O_{(l)}$

$$(0.02468 \times 0.1017)\,\cancel{mol\ NaOH} \times \frac{1\,mol\ ACID}{1\,\cancel{mol\ NaOH}} = 2.510 \times 10^{-3}\,mol\ ACID$$

$$\text{MOLAR MASS} = \frac{0.1506\,g}{2.510 \times 10^{-3}\,mol} = 60.0\ g/mol$$

$HC_2H_3O_2$

13. $M + 2H^+ \rightarrow M^{2+} + H_2(g)$.

mol ACID added $= (0.05000 \times 0.500) = 0.02500$ ——— (1)

$HCl + NaOH \longrightarrow NaCl + H_2O$

mol HCl unused $= (0.02436 \times 0.1054)$ mol NaOH $\times \frac{1 \text{ mol HCl}}{1 \text{ mol NaOH}}$

$= 0.002568$ ——— (2)

mol HCl used $= (1) - (2) = 0.02243$

mol of M $= \frac{0.02243}{2} = 0.01122$

MOLAR MASS OF M $= \frac{0.2726 \text{ g}}{0.01122 \text{ mol}} = 24.3 \text{ g/mol}$

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14. $CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

$HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O(l)$

mol of HCl added $= (2.00 \times 2.52) = 5.04$ ——— (1).

mol of excess HCl $= (0.02487 \times 0.9987)$ mol NaOH $\times \frac{1 \text{ mol HCl}}{1 \text{ mol NaOH}} \times \frac{2000}{10}$

$= 4.9675$ ——— (2)

mol HCl reacted $= (1) - (2) = 0.0725$

mol $CaCO_3 = \frac{0.0725}{2}$

mass of $CaCO_3 = \frac{0.0725}{2} \times 100.1 = 3.63$

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15. (0.02943×0.04212) mol $Cr_2O_7^{2-} \times \frac{6 \text{ mol Fe}}{1 \text{ mol } Cr_2O_7^{2-}} \times \frac{55.85 \text{ g}}{1 \text{ mol Fe}} \times \frac{100}{0.8765}$

$= 47.39\ \%$

16 Let mass of Ag = x g, ∴ mass of Cu = (0.5000 - x) g

$$x\ g\ Ag \times \frac{1\ mol\ Ag}{107.9\ g\ Ag} \times \frac{1\ mol\ Ag_2S}{2\ mol\ Ag} \times \frac{247.9\ g\ Ag_2S}{1\ mol\ Ag_2S} = \left(\frac{247.9}{2\times 107.9}\right)x \quad -(A)$$

$$(0.5000-x)\ g\ Cu \times \frac{1\ mol\ Cu}{63.5\ g\ Cu} \times \frac{1\ mol\ CuS}{1\ mol\ Cu} \times \frac{95.6\ g\ CuS}{1\ mol\ CuS} = (0.5000-x)\left(\frac{95.6}{63.5}\right) \quad -(B)$$

∴ (A) + (B) = TOTAL SULFIDE = 0.730

∴ x = 0.0644

$$\%\ Ag = \frac{0.0644}{0.500} \times 100 = \underline{\underline{12.9}}$$

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17. $$1.69\ L\ H_2 \times \frac{1\ mol\ H_2}{22.4\ L\ H_2} = \frac{1.69}{22.4}$$

$$x\ g\ Al \times \frac{1\ mol\ Al}{27.0\ g\ Al} \times \frac{3\ mol\ H_2}{2\ mol\ Al} = \frac{3x}{54} \quad -(A)$$

$$(1.67-x)\ g\ Zn \times \frac{1\ mol\ Zn}{65.4\ g\ Zn} \times \frac{1\ mol\ H_2}{1\ mol\ Zn} = (1.67-x)\frac{1}{65.4} \quad -(B)$$

(A) + (B) = TOTAL mol H_2 = $\frac{1.69}{22.4}$

x = 1.24 (g of Al)

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18. $$x\ g\ RbCl \times \frac{143.5\ g\ AgCl}{121\ g\ RbCl} = \left(\frac{143.5}{121}\right)x\ g\ AgCl \quad -(A)$$

$$(0.2380-x)\ g\ NaCl \times \frac{143.5\ g\ AgCl}{58.5\ g\ NaCl} = \left(\frac{143.5}{58.5}\right)(0.2380-x)\ g\ AgCl \quad -(B)$$

(A) + (B) = TOTAL AgCl = 0.4302

x = 0.1212

$$\%\ RbCl = \frac{0.1212}{0.2380} \times 100 = 50.92, \quad \therefore NaCl = 49.08$$

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19. $x\ g\ NaI \times \frac{234.8\ g\ AgI}{149.9\ g\ NaI} = \left(\frac{234.8}{149.9}\right) x\ g\ AgI$ ——— (A)

$(3.9762-x)\ g\ KI \times \frac{234.8\ g\ AgI}{166.0\ g\ KI} = (3.9762-x)\left(\frac{234.8}{166.0}\right) g\ AgI$ ——— (B)

(A) + (B) = TOTAL AgI = 5.8622

$x = 1.578$ $\therefore$ % $NaI = \frac{1.578}{3.9762} \times 100 = 39.69$

$\therefore$ % $KI = \underline{60.31}$

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20. $0.990\ g\ H_2O \times \frac{1\ mol\ H_2O}{18.0\ g\ H_2O} \times \frac{2\ mol\ NaHCO_3}{1\ mol\ H_2O} \times \frac{84.0\ g\ NaHCO_3}{1\ mol\ NaHCO_3} = 9.24$

$\therefore$ % $NaHCO_3 = \frac{9.24}{9.90} \times 100 = 93.3$, % $CaCO_3 = \underline{6.67}$

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21. $Na_2O_{(s)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + H_2O_{(l)}$

$BaO_{(s)} + H_2SO_{4(aq)} \longrightarrow BaSO_{4(s)} + H_2O$

$6.00\ g\ BaSO_4 \times \frac{153.3\ g\ BaO}{233.4\ g\ BaSO_4} = 3.94\ g\ BaO$

% $BaO = \frac{3.94}{6.00} \times 100 = \underline{65.7}$