Universidad Nacional de Cuyo - Facultad de Ingeniería

Química Aplicada

Estequiometría en solución

- RESOLUCIÓN -

Profesora Titular: Dra. Graciela Valente

Profesora Adjunta: Dra. Rebeca Purpora

Jefe de Trabajos Prácticos: Ing. Alejandra Somonte
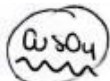
I. EJERCICIOS

1.

H_2SO_4 ¿% m/v?

$$\% \, m/v = \frac{\text{masa de soluto (g)}}{\text{Volumen de solución (ml)}} \times 100 = \frac{50g}{250ml} \times 100$$

$$\boxed{\% \, m/v = 20 \, g\%ml}$$

otra forma:

$$100 \, ml \, \underline{solución} \times \frac{50g \, H_2SO_4}{250 \, ml \, \underline{solución}} = \boxed{20 \, g\%ml}$$

$(CuSO_4)$

$$\% \, m/m = \frac{m \, soluto}{m \, solución} \times 100$$

$$m \, solución = \frac{m \, soluto}{\% \, m/m} \times 100 = \frac{7,5 \, g}{25} \times 100 = \boxed{30g \, solución}$$
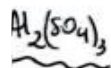
otra forma:

$$7,5 \, g \, soluto \times \frac{100 \, g \, solución}{25 \, g \, soluto} = \boxed{30g \, solución}$$

$\underline{KBr}$

$$\% \, m/v = \frac{m \, soluto}{V \, solución} \times 100$$

$$m \, soluto = \% \, m/v \cdot \frac{V \, solución}{100} = \frac{6 \, g}{100ml} \times 20ml = \boxed{1,20g}$$

$Al_2(SO_4)_3$

$$M = \frac{\frac{m \, soluto}{MM}}{V(l)} = \frac{\frac{60g}{342g/mol}}{2l} = \boxed{0,088M}$$

$\underline{Na_2CO_3}$
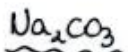
$$M = \frac{\frac{m}{MM}}{V(l)} = \frac{m}{MM \cdot V(l)}$$

$$m = M \cdot V \cdot MM = 2,5 \, \frac{mol}{l} \times 1,5 \, l \times 106 \, \frac{g}{mol} = \boxed{397,5g}$$

$CaCl_2$ ¿vol. de solución? 15g soluto; sol. 0,1 M

$$M = \frac{n}{Vol.\ solución\ (L)}$$

$$n = \frac{masa\ soluto}{masa\ molar} = \frac{15g}{110,9\ g/mol}$$

$$vol.\ sol = \frac{n}{M} = \frac{0,135\ mol}{0,1\ mol/L}$$

$$n = 0,135\ mol$$

$$\boxed{vol.\ sol = 1,35\ L}$$

2.

a) $1,2\ l\ solución \times \frac{2\ mol}{1\ l\ sol} \times \frac{40g\ NaOH}{1\ mol\ NaOH} = \boxed{96g\ NaOH}$

b) $2,2\ l\ sol. \times \frac{3g\ H_2SO_4}{0,1\ l\ sol} = \boxed{66g\ H_2SO_4}$

c) $250\ ml \times \frac{0,35\ mol}{1000\ ml} \times \frac{170g\ AgNO_3}{1\ mol\ AgNO_3} = \boxed{14,87g\ AgNO_3}$

d) $650g\ sol \times \frac{25g\ KCl}{100g\ sol} = \boxed{162,5g\ KCl}$

3.

a) 6g KOH en 100ml de sol.   M?

$$M = \frac{\frac{m}{mm}}{V(l)} = \frac{\frac{6g}{56g/mol}}{0,1\ l} = \boxed{1,07\ M}$$

b) 48 g H_3PO_4 en 500ml de sol.

$$M = \frac{\frac{48g}{98\ g/mol}}{0,5\ l} = \boxed{0,98\ mol/l}$$

$$N = M \cdot z = 0,98 \times 3$$

c) 2,5g H_2CO_3 en 100 ml sol.

$$M = \frac{\frac{2,5g}{62g/mol}}{0,1\ l}$$

$$\boxed{M = 0,40\ mol/l}$$

d) $1,45 g$ $Ca(OH)_2$ en $1500 ml$ sol.

$$M = \dfrac{\dfrac{1,45 g}{74 g\, Ca(OH)_2/mol}}{1,5 l}$$

$$\boxed{M = 0,013\ mol/l}$$

4.

$$C_1 \times V_1 = C_2 \times V_2$$

$$V_1 = \frac{C_2 \times V_2}{C_1} = \frac{0,5 M \times 500 ml}{0,9 M} \times \frac{l\ l}{1000 ml}$$

$$\boxed{V_1 = 0,28\ l}$$

5.

$$C_1 \times V_1 = C_2 \times V_2$$

$$V_2 = \frac{C_1 \times V_1}{C_2} = \frac{900 ml \times 0,3 M}{0,2 M} = 1.350 ml\ solución$$

$$V_{sol.f} = V_{H_2O} + V_{sol.inc.}$$

$$V_{H_2O} = V_{sol.f} - V_{sol.inc} = 1350 ml - 900 ml$$

$$\boxed{V_{H_2O} = 450\ ml}$$

6.

(A) 20% g/g   20 g soluto en 100 g solución

moles de soluto $= \dfrac{m}{MM} = \dfrac{20\,g}{40\,g/mol} = \underline{0,5\ mol\ soluto}$

moles de solvente $= \dfrac{m}{MM} = \dfrac{80\,g}{18\,g/mol} = \underline{4,4\ mol\ solvente}$

$X_{soluto} = \dfrac{n_{soluto}}{n_{tot}} = \dfrac{0,5}{0,5+4,4} = \boxed{0,10}$ más concentrada.

B) S molal = S moles soluto/kg solvente

$\dfrac{1000\,g\ solvente}{18\,g/mol} = \underline{55,5\ mol\ solvente}$

$X_{soluto} = \dfrac{S\,mol}{(55,5+S)} = \boxed{0,08}$

c) $X_{soluto} = \boxed{0,02}$

7.

m Ca(OH)$_2$?   500 ml sol. 0,05 M. $\Rightarrow$ 0,12 M.

$M = \dfrac{\frac{m}{MM}}{V(\ell)} \Rightarrow m = M \cdot V \cdot MM = 0,12\,\dfrac{mol}{\ell} \times 0,5\,\ell \times 74\,\dfrac{g}{mol}$

$\underline{m_f = 4,44\,g\ Ca(OH)_2}$

$m_i = 0,05\,\dfrac{mol}{\ell} \times 0,5\,\ell \times 74\,\dfrac{g}{mol}$

$\underline{m_i = 1,85\,g\ Ca(OH)_2}$

$m\ agregar = m_f - m_i = \boxed{2,59\ g\ Ca(OH)_2}$

8.

$M = \dfrac{\frac{m}{MM}}{V(\ell)} = \dfrac{\frac{5\,g}{106\,g/mol}}{0,25\,\ell}$

$\boxed{M = 0,18\ mol/\ell}$

9.

$$NaOH + HCl \rightarrow NaCl + H_2O \qquad \% \ NaOH?$$

$$1g. \qquad 8 ml \ 1M$$

$$8 \ ml \ HCl \times \frac{1 \ mol \ HCl}{1000 \ ml \ HCl} \times \frac{40 \ g \ NaOH}{1 \ mol \ HCl} = 0,32 \ g \ NaOH \ (puros)$$

$$100 \ g \ soda \times \frac{0,32 \ g \ NaOH}{1 \ g \ soda} = \boxed{32 \ g \ \% \ NaOH}$$

10.

$$g \ H_2SO_4 \rightarrow 500 \ ml \qquad ; \ valoración \quad 25 \ ml \ sol. \ H_2SO_4$$
$$25,45 \ ml \ sol. \ NaOH \ 0,125 \ M.$$

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

$$25,45 \ ml \ NaOH \times \frac{0,125 \ mol \ NaOH}{1000 \ ml \ NaOH} \times \frac{1 \ mol \ H_2SO_4}{2 \ mol \ NaOH} \times \frac{500 \ ml}{25 \ ml} = 0,031 \ mol \ H_2SO_4$$

$$0,031 \ mol \ H_2SO_4 \times \frac{98 \ g \ H_2SO_4}{1 \ mol \ H_2SO_4} = \boxed{3,04 \ g \ H_2SO_4}$$

11.

$$K_2SO_{4 \ (ac)} + BaCl_{2 \ (ac)} \rightarrow BaSO_{4 \ (s)} + 2KCl_{(ac)}$$
$$M?$$
$$50 ml \qquad\qquad 0,355 g$$

$$0,355 \ g \ BaSO_4 \times \frac{174 \ g \ K_2SO_4}{233 \ g \ BaSO_4} = 0,265 \ g \ K_2SO_4$$

$$M = \frac{\frac{m}{MM}}{V(l)} = \frac{\frac{0,265 \ g}{174 \ g/mol}}{0,05 \ l}$$

$$\boxed{M = 0,03 \ mol/l}$$

12.

$$CaCO_3 + 2HCl \longrightarrow CO_2 + H_2O + CaCl_2$$

pureza?   15 ml
%   0,35 M
$CaCO_3$

$$15\,ml \times \frac{0,35\ mol\ HCl}{1000\ ml\ HCl} \times \frac{1\ mol\ CaCO_3}{2\ mol\ HCl} = 2,625 \cdot 10^{-3}\ mol\ CaCO_3$$

$$2,625 \cdot 10^3\ mol\ CaCO_3 \times \frac{100\ g\ CaCO_3}{1\ mol\ CaCO_3} = 0,2625\ g\ CaCO_3\ \text{masa pura}$$

$$Pureza = \frac{masa\ pura}{masa\ impura} \times 100$$

$$Pureza = \frac{0,2625\ g}{0,300\ g} \times 100$$

$$\boxed{Pureza = 87,5\%\ CaCO_3}$$

13.

$$K_2CO_3 + H_2SO_4 \rightarrow K_2SO_4 + CO_2 + H_2O \qquad \%\ K_2CO_3?$$

0,5 g   20 ml
            0,15 M

$$20\,ml\ H_2SO_4 \times \frac{0,15\ mol\ H_2SO_4}{1000\ ml\ H_2SO_4} \times \frac{1\ mol\ K_2CO_3}{1\ mol\ H_2SO_4} \times \frac{138\ g\ K_2CO_3}{1\ mol\ K_2CO_3} \times \frac{100\ g}{0,5\ g} = \boxed{82,8\%\ K_2CO_3}$$

14.

$$3H_2SO_4 + 2Al(OH)_3 \rightarrow Al_2(SO_4)_3 + 6H_2O$$

35 ml   0,2 g

$$0,2\ g\ Al(OH)_3 \times \frac{3 \cdot (98\ g\ H_2SO_4)}{2(78\ g\ Al(OH)_3)} = 0,37\ g\ H_2SO_4$$

$$M = \frac{\dfrac{0,37\ g}{98\ g/mol}}{0,035\ l}$$

$$\boxed{M = 0,11\ mol/l}$$

15.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$$

pureza %?

Na_2CO_3

0,8 g   28,5 ml , 0,5M

$$28,5 \,ml \,sol \,HCl \times \frac{0,5 \,mol \,HCl}{1000 \,ml \,HCl} \times \frac{1 \,mol \,Na_2CO_3}{2 \,mol \,HCl} \times \frac{106 g \,Na_2CO_3}{1 \,mol \,Na_2CO_3} \times \frac{100 \,\%}{0,8 g} = \boxed{94,4\% \,Na_2CO_3}$$

16.

$$2HNO_3 + Mg \rightarrow Mg(NO_3)_2 + H_2 (g)$$

250 ml   ...v? a 25°C , 1,20 atm
0,7 M

$$250 \,ml \,HNO_3 \times \frac{0,7 \,mol \,HNO_3}{1000 \,ml \,HNO_3} \times \frac{1 \,mol \,H_2}{2 \,mol \,HNO_3} = \boxed{0,0875 \,mol \,H_2}$$

$$V = \frac{n \cdot R \cdot T}{P} = \frac{0,0875 \,mol \times 0,082 \frac{atm \cdot l}{K \cdot mol} \times 298 \,K}{1,20 \,atm} = \boxed{1,78 \,l}$$

17.

$$2HCl \,(ac) + MgCO_3 \,(ac) \rightarrow MgCl_2 (ac) + CO_2 (g) + H_2O (l)$$

vol?

1,095 g/ml   30,4 g
20% m/m

a) $$\frac{20 g HCl}{100 g sol} \times \frac{1,095 \,g \,sol}{1 \,ml \,sol} \times \frac{1000 \,ml \,sol}{1 L \,sol} \times \frac{1 \,mol \,HCl}{36,5 g \,HCl} = 6 \,\frac{mol}{L} \,HCl$$

$$30,4 g \,MgCO_3 \times \frac{1 \,mol \,MgCO_3}{84 g \,MgCO_3} \times \frac{2 \,mol \,HCl}{1 \,mol \,MgCO_3} = 0,72 \,mol \,HCl$$

$$0,72 \,mol \,HCl \times \frac{1000 \,ml \,HCl}{6 \,mol \,HCl} = \boxed{120 \,ml \,HCl}$$

$$V = \frac{n \cdot R \cdot T}{P} = \frac{0,36 \, mol \times 0,082 \frac{atm \cdot l}{K \cdot mol} \times 300 \, K}{1 \, atm}$$

$$\underline{V = 8,9 \, l}, \; teórico$$

$$Rendimiento = \frac{real}{teórico} \times 100 = \frac{7,4 \, l}{8,9 \, l} \times 100$$

$$\boxed{Rendimiento = 83,1 \, \%}$$

18.

$$H_2SO_4 + Zn \rightarrow ZnSO_4 + H_2(g)$$

10ml   60g   l? a 20°C y 705 mmHg.
98%
1,84 g/cm³
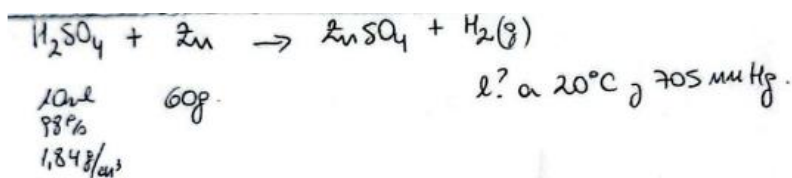
$$10 \, ml \; H_2SO_4 \times \frac{1,84 \, g \, sol}{1 \, ml \, H_2SO_4} \times \frac{98 \, g \, H_2SO_4}{100 \, g \, sol} \times \frac{1 \, mol}{98 \, g \, H_2SO_4} = 0,184 \; mol \; H_2SO_4$$

$$60 \, g \; Zn \times \frac{1 \, mol \, Zn}{65 \, g \, Zn} = 0,923 \; mol \; Zn$$

$$\frac{1 \, mol \, H_2SO_4}{1 \, mol \, Zn} \quad ; \quad \boxed{\frac{0,184 \, mol \, H_2SO_4}{0,929 \, mol \, Zn}} \quad R_{vo} \; limitante$$

$$0,184 \; mol \; H_2SO_4 \times \frac{1 \, mol \, H_2}{1 \, mol \, H_2SO_4} = 0,184 \, mol \; H_2 \times \frac{45}{100} = 8,28 \cdot 10^{-2} \, mol \; H_2$$

$$V = \frac{n \cdot R \cdot T}{P} = \frac{8,28 \cdot 10^{-2} mol \; H_2 \cdot 0,082 \frac{atm \cdot l}{K \cdot mol} \cdot 293 \, K}{705 \, mmHg \times \frac{1 \, atm}{760 \, mmHg}}$$

$$\boxed{V = 2,1 \, l}$$

II. AUTOEVALUACIÓN

① $C_1 \times V_1 = C_2 \times V_2$

$C_2 = \dfrac{C_1 \times V_1}{V_2} = \dfrac{12M \times 1\cancel{L}}{20\cancel{L}} = \boxed{0,6\,M}$

② $C_1 \times V_1 = C_2 \times V_2$

$V_2 = \dfrac{C_1 \times V_1}{C_2} = \dfrac{0,6N \times 100ml}{0,1N} = 600\,ml\ solución - 100ml\ soluto = \boxed{500\,ml\,H_2O}$

③ $\dfrac{15g\,NaCl}{100g\,sot} \times \dfrac{1,05g\,sot}{1ml\,sol} \times \dfrac{1mol\,NaCl}{58,5\,g\,NaCl} \times \dfrac{1000\,ml\,sot}{1\,L\,sol} = 2,69\ M$

$C_1 \times V_1 = C_2 \times V_2$

$V_2 = \dfrac{C_1 \times V_1}{C_2} = \dfrac{2,69\,M \times 100ml}{0,9\,M} = \boxed{299\,ml\ solución}$

④ $M = \dfrac{\dfrac{20g\,CaCl_2}{111\,g/mol}}{0,5\,L} = 0,36\ M$

$C_1 \times V_1 = C_2 \times V_2$

$C_2 = \dfrac{C_1 \times V_1}{V_2} = \dfrac{0,36\,M \times 50\,ml}{200\,ml} = \boxed{0,09\,M}$

⑤ $2HCl_{(ac)} + Ca(OH)_{2\,(ac)} \rightarrow CaCl_{2(ac)} + 2H_2O_{(l)}$

$\begin{array}{ccc} \text{---}\,ml & 100\,ml \\ 5\,M & 0,5\,M \end{array}$
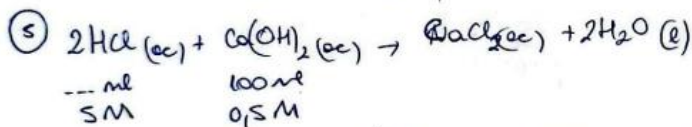
$100\,ml\,Ca(OH)_2 \times \dfrac{0,5\,mol\,Ca(OH)_2}{1000ml\,Ca(OH)_2} \times \dfrac{2\,mol\,HCl}{1mol\,Ca(OH)_2} \times \dfrac{1000\,ml\,HCl}{5\,mol\,HCl} = \boxed{20\,ml\,HCl}$

⑥ $H_2SO_{4\,(ac)} + Na_2CO_{3(S)} \rightarrow Na_2SO_{4\,(ac)} + H_2O_{(l)} + CO_{2\,(g)}$

$\begin{array}{cc} 1500\,ml & \\ 1M & \quad l?\ CNPT \end{array}$
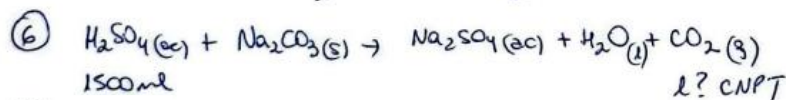
$1500\,ml\,H_2SO_4 \times \dfrac{1\,mol\,H_2SO_4}{1000\,ml\,H_2SO_4} \times \dfrac{1mol\,CO_2}{1mol\,H_2SO_4} \times \dfrac{22,4\,L}{1mol\,CO_2} = \boxed{33,6\,L}$

⑦ $HCl_{(ac)} + NaOH_{(ac)} \rightarrow NaCl_{(ac)} + H_2O_{(l)}$

$\begin{array}{cc} 150\,ml & 20\,ml \\ 0,9\,M & 30\%\,m/V \end{array}$

¿Pureza?
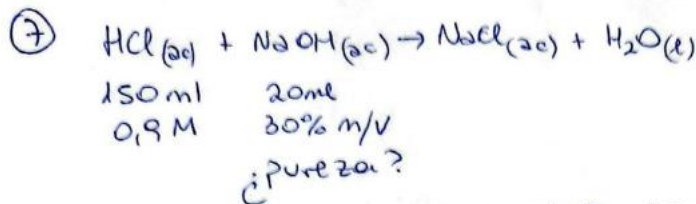
$\begin{array}{l} m\,NaOH \\ (puros) \end{array} = 150\,ml\,HCl \times \dfrac{0,9\,mol\,HCl}{1000\,ml\,HCl} \times \dfrac{1mol\,NaOH}{1mol\,HCl} \times \dfrac{40g\,NaOH}{1mol\,NaOH} = \boxed{5,4\,g\ puros}$

$\begin{array}{l} m\,NaOH \\ (imp) \end{array} = 20\,ml\,NaOH \times \dfrac{30g\,NaOH}{100ml\,NaOH} = \boxed{6g\ NaOH\ impuros}$

$Pureza = \dfrac{masa\ pura}{masa\ impura} \times 100 = \dfrac{5,4\,g}{6\,g} \times 100 = \boxed{90\%}$

(8) $NaHCO_3$ (ac) + HCl (ac) → $NaCl$ (ac) + CO_2 (g) + H_2O (l)

134 g imp.   800 ml   3.690 ml
              2 M   27°C, 10 atm
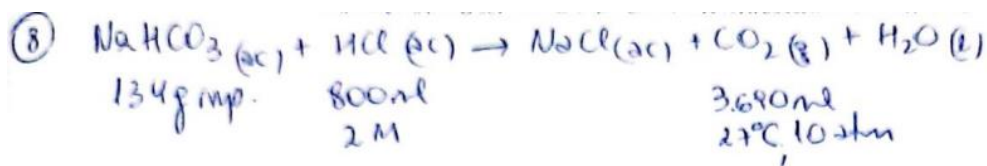
$PV = nRT$

$n = \dfrac{PV}{RT} = \dfrac{10\ atm \cdot 3690 \cdot 10^{-3}\ L}{0,082\ \frac{atm\ L}{K\ mol} \cdot 300 K} = 1,5\ mol\ CO_2$

$1,5\ mol\ CO_2 \times \dfrac{1\ mol\ NaHCO_3}{1\ mol\ CO_2} \times \dfrac{84\ g\ NaHCO_3}{1\ mol\ NaHCO_3} = 126\ g\ NaHCO_3$

$Pureza = \dfrac{m\ pura}{m\ impura} \times 100 = \dfrac{126\ g}{134\ g} \times 100 = \boxed{94\%}$

(9) $2\ Al$ (s) $+ 6HCl$ (ac) → $2\ AlCl_3 + 3\ H_2$ (g)   Rendimiento: 75%

15 g   1 L   ¿Volúmen?
90%   1,5 M   25°C
                                 730 mmHg
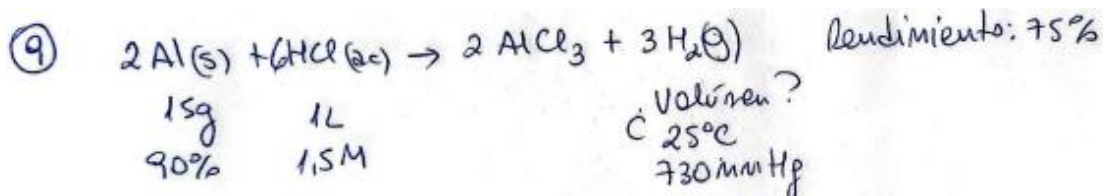
$n_{Al} = 15\ g\ Al\ imp \times \dfrac{90\ g\ Al}{100\ g\ Al\ imp} \times \dfrac{1\ mol\ Al}{27\ g\ Al} = \underline{0,5\ mol\ Al}$

$n_{HCl} = \underline{1,5\ mol\ HCl}$

$RE = \dfrac{6\ mol\ HCl}{2\ mol\ Al}$ $QR = \dfrac{1,5\ mol\ HCl}{0,5\ mol\ Al}$ No hay R^{vo} limit.

$n_{H_2} = 1,5\ mol\ HCl \times \dfrac{3\ mol\ H_2}{6\ mol\ HCl} = \underline{0,75\ mol\ H_2}$

$V = \dfrac{n \cdot R \cdot T}{V} = \dfrac{0,75\ mol \cdot 0,082\ \frac{atm\ L}{K\ mol} \cdot 298\ K}{730\ mmHg \times \frac{1\ atm}{760\ mmHg}}$

$\underline{V = 19\ L}$

Considerando el Rendimiento $19\ L \times \dfrac{75}{100} = \boxed{14,25\ L}$

10') HCl $1,16 g/ml$; 32% m/m vol?

$$2 HCl_{(ac)} + \underset{10g}{Zn}_{(s)} \rightarrow ZnCl_2{}_{(ac)} + H_2{}_{(g)}$$

vol? 80% pureza
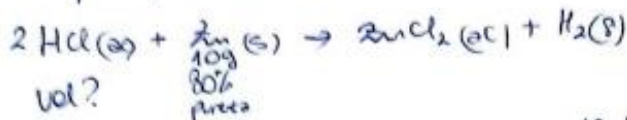
$$\frac{32 g HCl}{100 g sol} \times \frac{1,16 g sol}{1 ml sol} \times \frac{1000 ml sol}{1 L sol} \times \frac{1 mol HCl}{36,5 g HCl} = \underset{10,16 M}{\cancel{0,1218 M}} HCl$$

$$10g\ aleación \times \frac{80 g Zn}{100 g aleación} \times \frac{1 mol Zn}{65 g Zn} \times \frac{2 mol HCl}{1 mol Zn} = 0,24\ mol\ HCl$$

$$0,24\ mol\ HCl \times \frac{1000\ ml\ HCl}{10,16\ mol\ HCl} = \boxed{23,6\ ml}$$

11) $$FeCl_2{}_{(ac)} + 2KClO_3{}_{(ac)} \rightarrow Fe(ClO_3)_2{}_{(ac)} + 2KCl_{(ac)}$$
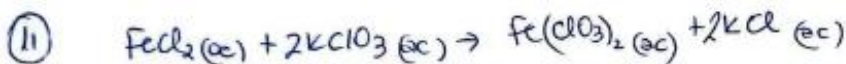
vol?   150g
$0,2M$ 85%

$$150 g\ KClO_3\ imp \times \frac{85 g\ KClO_3\ pus}{100 g\ KClO_3\ imp} \times \frac{1 mol\ KClO_3}{122,5 g\ KClO_3} \times \frac{1 mol\ FeCl_2}{2 mol\ KClO_3} = 0,52\ mol\ FeCl_2$$

$$0,52\ mol\ FeCl_2 \times \frac{1000\ ml\ FeCl_3}{0,2\ mol\ FeCl_2} = 2600\ ml = \boxed{2,6\ L}$$

12) $$NaOH_{(ac)} + HCl_{(ac)} \rightarrow NaCl_{(ac)} + H_2O_{(l)}$$
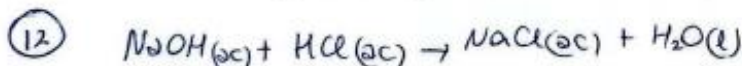
1,4L   1500ml
$0,2M$ $0,25 M$

R.E   1 mol HCl / 1 mol NaOH

R.L $0,375$ mol HCl / $\underset{R^{vo}\ Limitante}{0,28\ mol\ NaOH}$

$$1,4 L \times \frac{0,2\ mol\ NaOH}{1 L} = 0,28\ mol\ NaOH$$

$$1500 ml \times \frac{0,25\ mol\ HCl}{1000\ ml} = 0,375\ mol\ HCl$$

a) R^{vo} en exceso: HCl.

b) $0,28\ mol\ NaOH \times \frac{1 mol\ HCl}{1 mol\ NaOH} = 0,28\ mol\ HCl\ neutralizados$ -

$$(0,375\ mol - 0,28\ mol) = \boxed{9,5 \cdot 10^{-2}\ mol\ HCl\ en\ exc.}$$

⑬ $Na_2CO_{3\,(ac)} + 2HCl_{(ac)} \rightarrow 2NaCl_{(ac)} + CO_{2\,(g)} + H_2O_{(l)}$

1,2 L   1,5 L

0,6 M   0,5 M

$R-E = \dfrac{1\,mol\,Na_2CO_3}{2\,mol\,HCl}$

$1,2\,L \times \dfrac{0,6\,mol\,Na_2CO_3}{1\,L} = 0,72\,mol\,Na_2CO_3$

$1,5\,L \times \dfrac{0,5\,mol\,HCl}{1\,L} = 0,75\,mol\,HCl$

$R.R = \dfrac{0,72\,mol\,Na_2CO_3}{0,75\,mol\,HCl}$ R vo limitante
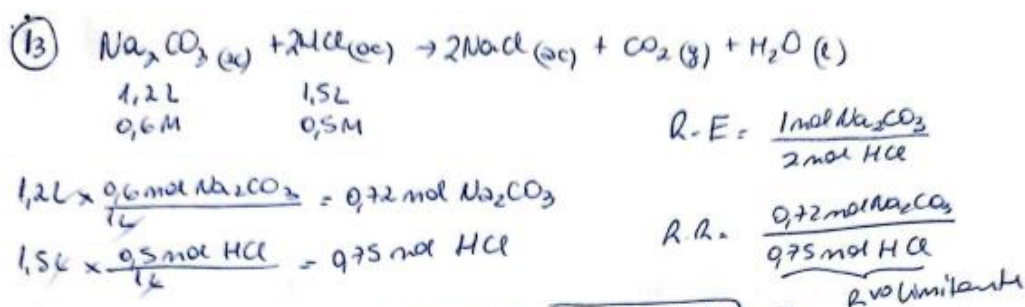
$0,75\,mol\,HCl \times \dfrac{2\,mol\,NaCl}{2\,mol\,HCl} \times \dfrac{58,5\,g\,NaCl}{1\,mol\,NaCl} = \boxed{43,88\,g\,NaCl}$ a)

b) $0,75\,mol\,HCl \times \dfrac{1\,mol\,Na_2CO_3}{2\,mol\,HCl} \times \dfrac{106\,g\,Na_2CO_3}{1\,mol\,Na_2CO_3} = 39,75\,g\,Na_2CO_3$ se consumen.

$0,72\,mol\,Na_2CO_3 \times \dfrac{106\,g\,Na_2CO_3}{1\,mol\,Na_2CO_3} = 76,32\,g\,Na_2CO_3$ inicial.

$76,32\,g - 39,75\,g = \boxed{36,57\,g\,Na_2CO_3}$ sin reaccionar

c) $0,75\,mol\,HCl \times \dfrac{1\,mol\,CO_2}{2\,mol\,HCl} = 0,375\,mol\,CO_2$

$V = \dfrac{nRT}{p} = \dfrac{0,375\,mol \cdot 0,082\,\frac{atm\,L}{K\,mol} \cdot 288\,K}{720\,mmHg \times \frac{1\,atm}{760\,mmHg}} = \boxed{9,68\,L\,CO_2}$

⑭ K_2CO_3 MM = 138 g/mol

$M = \dfrac{\frac{0,3\,g}{138\,g/mol}}{0,5\,L} = \boxed{4,34 \cdot 10^3\,M}$

⑮ $H_2SO_{4\,(ac)} + 2NaOH_{(ac)} \rightarrow Na_2SO_{4\,(ac)} + H_2O_{(l)}$

1 g   8,5 ml

pureza?   1,8 M
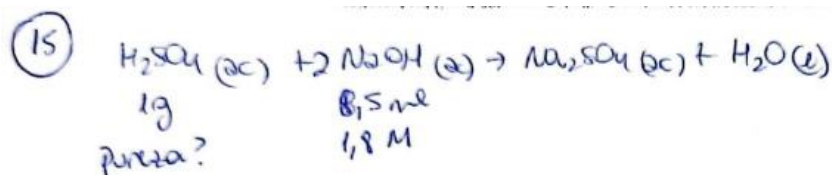
$8,5\,ml\,NaOH \times \dfrac{1,8\,mol\,NaOH}{1000\,ml\,NaOH} \times \dfrac{1\,mol\,H_2SO_4}{2\,mol\,NaOH} \times \dfrac{98\,g\,H_2SO_4}{1\,mol\,H_2SO_4} = 0,75\,g\,H_2SO_4$

$Pureza = \dfrac{M\,pura}{M\,impura} \times 100 = \dfrac{0,75}{1} \times 100 = \boxed{75\%}$