

Universidad Nacional de Cuyo - Facultad de Ingeniería

Química Aplicada

Estequiometría en solución

- RESOLUCIÓN -

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I. EJERCICIOS

1.

H_2SO_4 ¿% m/v?

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

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

otra forma:

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

$CaSO_4$

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

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

otra forma:

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

KBr

$$\% \text{ m/v} = \frac{m_{\text{soluto}}}{V_{\text{solución}}} \times 100$$

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

$H_2(SO_4)_3$

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

Na_2CO_3

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

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

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

$$M = \frac{n}{\text{Vol. solución (L)}}$$

$$n = \frac{\text{masa soluto}}{\text{masa molar}} = \frac{15\text{g}}{110,98\text{g/mol}}$$

$$n = 0,135\text{ mol}$$

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

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

2.

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

b) $2,2\text{ L sol.} \times \frac{3\text{ g H}_2\text{SO}_4}{0,1\text{ L sol}} = \boxed{66\text{ g H}_2\text{SO}_4}$

c) $250\text{ mL} \times \frac{0,35\text{ mol}}{1000\text{ mL}} \times \frac{170\text{ g AgNO}_3}{1\text{ mol AgNO}_3} = \boxed{14,87\text{ g AgNO}_3}$

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

3.

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

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

b) 48g H₃PO₄ en 500ml de sol.

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

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

c) 2,5g H₂CO₃ en 100 ml sol.

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

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

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

$$M = \frac{\frac{1,45\text{g}}{74\text{g Ca(OH)}_2/\text{mol}}}{1,5\text{L}}$$

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

4.

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

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

$$\boxed{V_1 = 0,28\text{L}}$$

5.

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

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

$$V_{\text{sol. F}} = V_{\text{H}_2\text{O}} + V_{\text{sol. Me.}}$$

$$V_{\text{H}_2\text{O}} = V_{\text{sol. F}} - V_{\text{sol. Me.}} = 1350\text{ml} - 900\text{ml}$$

$$\boxed{V_{\text{H}_2\text{O}} = 450\text{ml}}$$

6.

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

$$n_{\text{soluto}} = \frac{m}{MM} = \frac{20 \text{ g}}{40 \text{ g/mol}} = 0,5 \text{ mol soluto}$$

$$n_{\text{solvente}} = \frac{m}{MM} = \frac{80 \text{ g}}{18 \text{ g/mol}} = 4,4 \text{ mol solvente}$$

$$X_{\text{soluto}} = \frac{n_{\text{soluto}}}{n_{\text{tot}}} = \frac{0,5}{0,5+4,4} = \boxed{0,10} \text{ moles concentrada.}$$

B) 5 molal = 5 moles soluto / kg solvente

$$\frac{1000 \text{ g solvente}}{18 \text{ g/mol}} = 55,5 \text{ mol solvente}$$

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

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

7.

$m_{\text{Ca(OH)}_2}$? 500ml sol. 0,05 M. \Rightarrow 0,12 M.

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

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

$$m_i = 0,05 \frac{\text{mol}}{\text{l}} \times 0,5 \text{ l} \times \frac{74 \text{ g}}{\text{mol}}$$

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

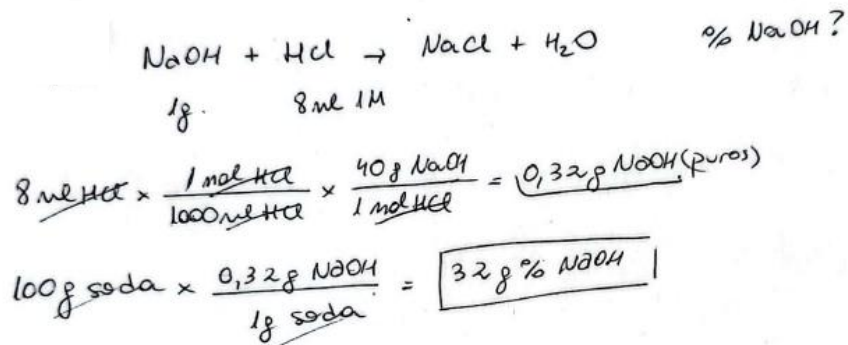
$$m_{\text{aportar}} = m_f - m_i = \boxed{2,59 \text{ g Ca(OH)}_2}$$

8.

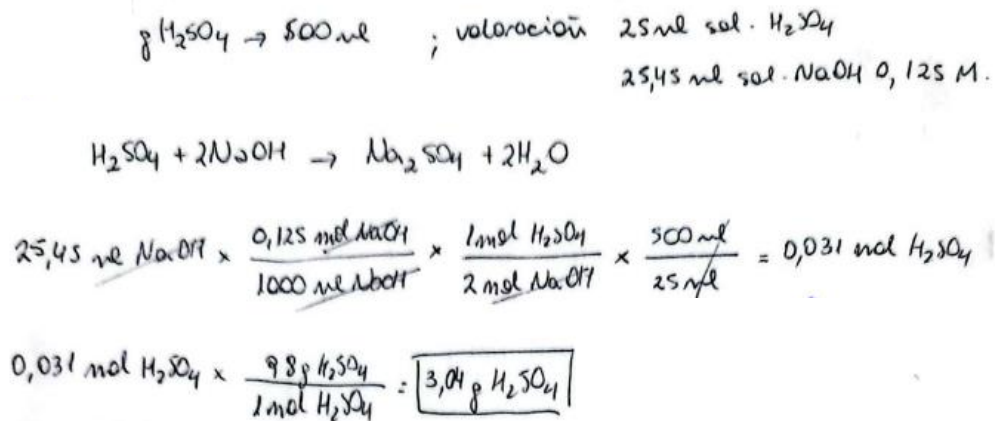
$$M = \frac{\frac{m}{MM}}{V(l)} = \frac{\frac{5 \text{ g}}{106 \text{ g/mol}}}{0,25 \text{ l}}$$

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

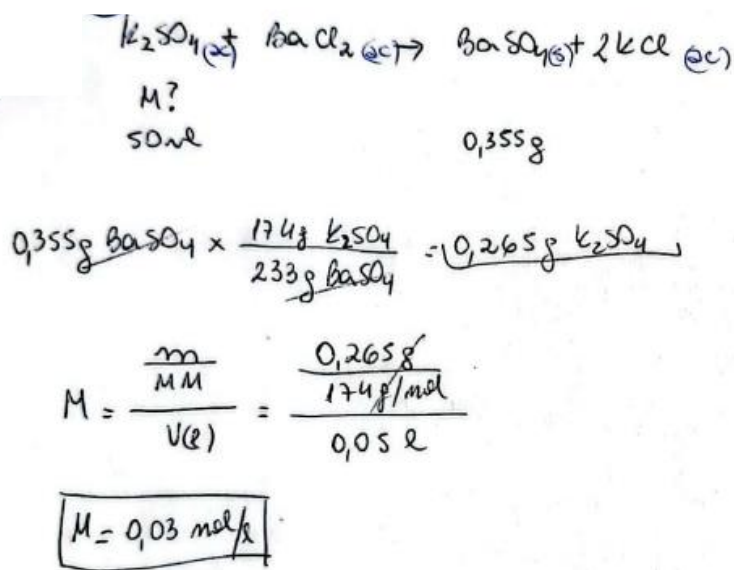
9.



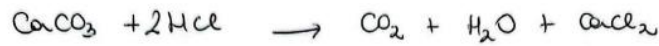
10.



11.



12.



pureza? 15 ml
% 0,35 M
CaCO₃
masa

$$15 \text{ ml} \times \frac{0,35 \text{ mol HCl}}{1000 \text{ ml HCl}} \times \frac{1 \text{ mol CaCO}_3}{2 \text{ mol HCl}} = 2,625 \cdot 10^{-3} \text{ mol CaCO}_3$$

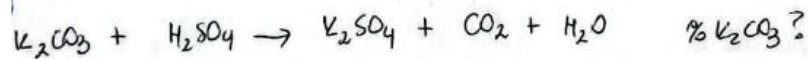
$$2,625 \cdot 10^{-3} \text{ mol CaCO}_3 \times \frac{100 \text{ g CaCO}_3}{1 \text{ mol CaCO}_3} = 0,2625 \text{ g CaCO}_3 \text{ masa pura}$$

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

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

$$\boxed{\text{Pureza} = 87,5\% \text{ CaCO}_3}$$

13.



0,5 g 10 ml
0,15 M

$$10 \text{ ml H}_2\text{SO}_4 \times \frac{0,15 \text{ mol H}_2\text{SO}_4}{1000 \text{ ml H}_2\text{SO}_4} \times \frac{1 \text{ mol K}_2\text{CO}_3}{1 \text{ mol H}_2\text{SO}_4} \times \frac{138 \text{ g K}_2\text{CO}_3}{1 \text{ mol K}_2\text{CO}_3} \times \frac{100 \text{ g}}{0,5 \text{ g}} = \boxed{82,8\% \text{ K}_2\text{CO}_3}$$

14.



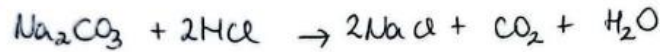
35 ml 0,2 g

$$0,2 \text{ g Al}(\text{OH})_3 \times \frac{3 \cdot (98 \text{ g H}_2\text{SO}_4)}{2 \cdot (78 \text{ g Al}(\text{OH})_3)} = 0,37 \text{ g H}_2\text{SO}_4$$

$$M = \frac{0,37 \text{ g}}{98 \text{ g/mol}} = 0,00377 \text{ mol}$$

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

15.



pureza?
 \swarrow
 Na_2CO_3

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

$$28,5 \text{ ml sol HCl} \times \frac{0,5 \text{ mol HCl}}{1000 \text{ ml HCl}} \times \frac{1 \text{ mol Na}_2\text{CO}_3}{2 \text{ mol HCl}} \times \frac{106 \text{ g Na}_2\text{CO}_3}{1 \text{ mol Na}_2\text{CO}_3} \times \frac{100 \text{ g}}{0,8 \text{ g}} = \boxed{94,4\% \text{ Na}_2\text{CO}_3}$$

16.



250 ml
0,7M

...v? a 25°C, 1,2 atm

$$250 \text{ ml HNO}_3 \times \frac{0,7 \text{ mol HNO}_3}{1000 \text{ ml HNO}_3} \times \frac{1 \text{ mol H}_2}{2 \text{ mol HNO}_3} = \underline{0,0875 \text{ mol H}_2}$$

$$V = \frac{n \cdot R \cdot T}{P} = \frac{0,0875 \text{ mol} \times 0,082 \frac{\text{atm} \cdot \text{l}}{\text{K} \cdot \text{mol}} \times 298 \text{ K}}{1,2 \text{ atm}} = \boxed{1,78 \text{ l}}$$

17.



vol?

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

$$a) \frac{20 \text{ g HCl}}{100 \text{ g sol}} \times \frac{1,095 \text{ g sol}}{1 \text{ ml sol}} \times \frac{1000 \text{ ml sol}}{1 \text{ L sol}} \times \frac{1 \text{ mol HCl}}{36,5 \text{ g HCl}} = 5,96 \frac{\text{mol}}{\text{L}} \text{ HCl}$$

$$30,4 \text{ g MgCO}_3 \times \frac{1 \text{ mol MgCO}_3}{84 \text{ g MgCO}_3} \times \frac{2 \text{ mol HCl}}{1 \text{ mol MgCO}_3} = 0,72 \text{ mol HCl}$$

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

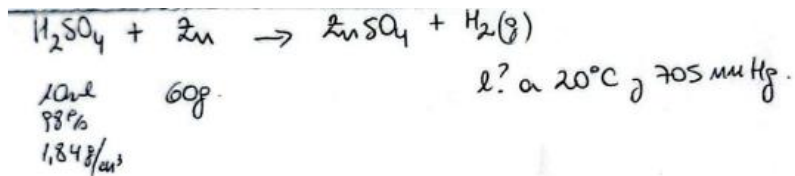
$$V = \frac{n \cdot R \cdot T}{P} = \frac{0,36 \text{ mol} \times 0,082 \frac{\text{atm} \cdot \text{l}}{\text{K} \cdot \text{mol}} \times 300 \text{ K}}{1 \text{ atm}}$$

$$V = 8,9 \text{ l, cónico}$$

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

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

18.



$$10 \text{ ml H}_2\text{SO}_4 \times \frac{1,84 \text{ g sol}}{1 \text{ ml H}_2\text{SO}_4} \times \frac{98 \text{ g H}_2\text{SO}_4}{100 \text{ g sol}} \times \frac{1 \text{ mol}}{98 \text{ g H}_2\text{SO}_4} = 0,184 \text{ mol H}_2\text{SO}_4$$

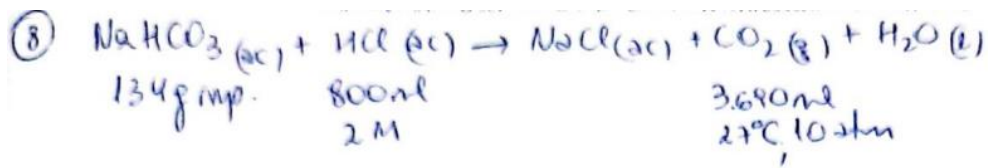
$$60 \text{ g Zn} \times \frac{1 \text{ mol Zn}}{65 \text{ g Zn}} = 0,923 \text{ mol Zn}$$

$$\frac{1 \text{ mol H}_2\text{SO}_4}{1 \text{ mol Zn}} ; \frac{0,184 \text{ mol H}_2\text{SO}_4}{0,923 \text{ mol Zn}} \text{ Rvs limitante}$$

$$0,184 \text{ mol H}_2\text{SO}_4 \times \frac{1 \text{ mol H}_2}{1 \text{ mol H}_2\text{SO}_4} = 0,184 \text{ mol H}_2 \times \frac{45}{100} = 8,28 \cdot 10^{-2} \text{ mol H}_2$$

$$V = \frac{n \cdot R \cdot T}{P} = \frac{8,28 \cdot 10^{-2} \text{ mol H}_2 \cdot 0,082 \frac{\text{atm} \cdot \text{l}}{\text{K} \cdot \text{mol}} \cdot 293 \text{ K}}{705 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}}}$$

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

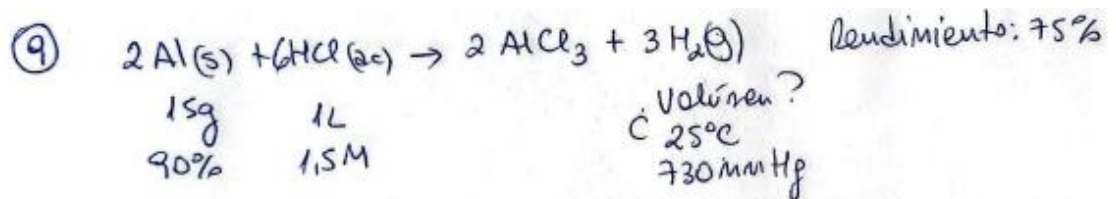


$$PV = n R.T$$

$$n = \frac{PV}{RT} = \frac{10 \text{ atm} \cdot 3680 \cdot 10^{-3} \text{ L}}{0,082 \frac{\text{atm} \cdot \text{L}}{\text{K} \cdot \text{mol}} \cdot 300 \text{ K}} = 1,5 \text{ mol CO}_2$$

$$1,5 \text{ mol CO}_2 \times \frac{1 \text{ mol NaHCO}_3}{1 \text{ mol CO}_2} \times \frac{84 \text{ g NaHCO}_3}{1 \text{ mol NaHCO}_3} = 126 \text{ g NaHCO}_3$$

$$\text{Pureza} = \frac{m_{\text{pura}}}{m_{\text{impura}}} \times 100 = \frac{126 \text{ g}}{134 \text{ g}} \times 100 = \boxed{94\%}$$



$$n_{\text{Al}} = 15 \text{ g Al imp.} \times \frac{90 \text{ g Al}}{100 \text{ g Al imp.}} \times \frac{1 \text{ mol Al}}{27 \text{ g Al}} = 0,5 \text{ mol Al}$$

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

$$R_E = \frac{6 \text{ mol HCl}}{2 \text{ mol Al}}$$

$$R_R = \frac{1,5 \text{ mol AlCl}_3}{0,5 \text{ mol Al}}$$

No hay R^{vo} limit.

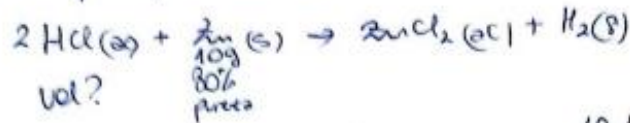
$$n_{\text{H}_2} = 1,5 \text{ mol HCl} \times \frac{3 \text{ mol H}_2}{6 \text{ mol HCl}} = 0,75 \text{ mol H}_2$$

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

$$\underline{V = 19 \text{ L}}$$

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

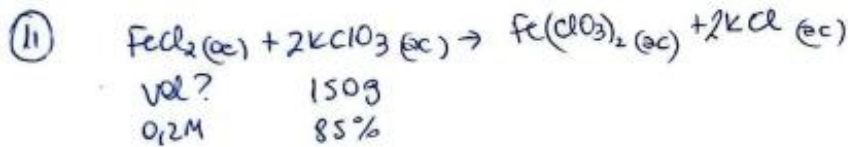
10) HCl 1,16g/ml ; 32% w/v vol ?



$$\frac{32 \text{ g HCl}}{100 \text{ g sol}} \times \frac{1,16 \text{ g sol}}{1 \text{ ml sol}} \times \frac{1000 \text{ ml sol}}{1 \text{ L sol}} \times \frac{1 \text{ mol HCl}}{36,5 \text{ g HCl}} = 10,16 \text{ M HCl}$$

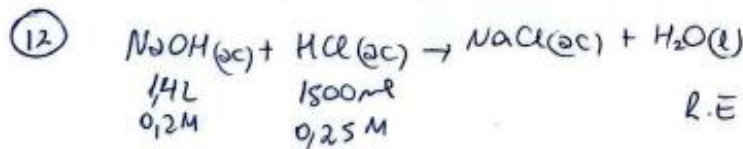
$$10 \text{ g aleación} \times \frac{80 \text{ g Zn}}{100 \text{ g aleación}} \times \frac{1 \text{ mol Zn}}{65 \text{ g Zn}} \times \frac{2 \text{ mol HCl}}{1 \text{ mol Zn}} = 0,24 \text{ mol HCl}$$

$$0,24 \text{ mol HCl} \times \frac{1000 \text{ ml HCl}}{10,16 \text{ mol HCl}} = \boxed{236 \text{ ml}}$$



$$150 \text{ g KClO}_3 \times \frac{85 \text{ g KClO}_3 \text{ puros}}{100 \text{ g KClO}_3 \text{ imp}} \times \frac{1 \text{ mol KClO}_3}{122,5 \text{ g KClO}_3} \times \frac{1 \text{ mol FeCl}_2}{2 \text{ mol KClO}_3} = 0,52 \text{ mol FeCl}_2$$

$$0,52 \text{ mol FeCl}_2 \times \frac{1000 \text{ ml FeCl}_2}{0,2 \text{ mol FeCl}_2} = 2600 \text{ ml} = \boxed{2,6 \text{ L}}$$



R.E 1 mol HCl / 1 mol NaOH

R.L 0,375 mol HCl / 0,28 mol NaOH
 RVO Limitante

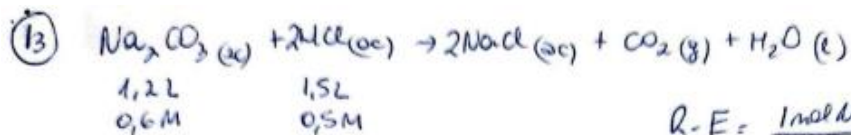
$$1,4 \text{ L} \times \frac{0,2 \text{ mol NaOH}}{1 \text{ L}} = 0,28 \text{ mol NaOH}$$

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

a) RVO en exceso: HCl.

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

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



$$\begin{array}{cc} 1,2 \text{ L} & 1,5 \text{ L} \\ 0,6 \text{ M} & 0,5 \text{ M} \end{array}$$

$$R.E = \frac{1 \text{ mol Na}_2\text{CO}_3}{2 \text{ mol HCl}}$$

$$1,2 \text{ L} \times \frac{0,6 \text{ mol Na}_2\text{CO}_3}{1 \text{ L}} = 0,72 \text{ mol Na}_2\text{CO}_3$$

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

$$R.R = \frac{0,72 \text{ mol Na}_2\text{CO}_3}{0,75 \text{ mol HCl}}$$

R. v. limitante

$$0,75 \text{ mol HCl} \times \frac{2 \text{ mol NaCl}}{2 \text{ mol HCl}} \times \frac{58,5 \text{ g NaCl}}{1 \text{ mol NaCl}} = \boxed{43,88 \text{ g NaCl}} \quad \text{a)}$$

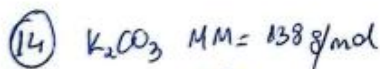
$$\text{b)} \quad 0,75 \text{ mol HCl} \times \frac{1 \text{ mol Na}_2\text{CO}_3}{2 \text{ mol HCl}} \times \frac{106 \text{ g Na}_2\text{CO}_3}{1 \text{ mol Na}_2\text{CO}_3} = 39,75 \text{ g Na}_2\text{CO}_3 \text{ se consumen}$$

$$0,72 \text{ mol Na}_2\text{CO}_3 \times \frac{106 \text{ g Na}_2\text{CO}_3}{1 \text{ mol Na}_2\text{CO}_3} = 76,32 \text{ g Na}_2\text{CO}_3 \text{ inicial}$$

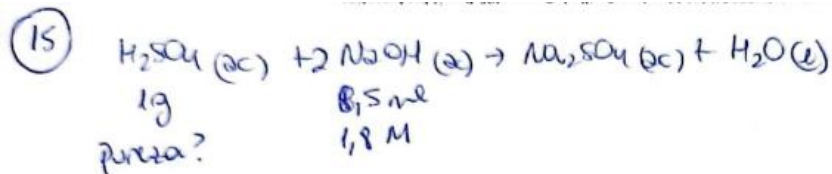
$$76,32 \text{ g} - 39,75 \text{ g} = \boxed{36,57 \text{ g Na}_2\text{CO}_3} \text{ sin reaccionar}$$

$$\text{c)} \quad 0,75 \text{ mol HCl} \times \frac{1 \text{ mol CO}_2}{2 \text{ mol HCl}} = 0,375 \text{ mol CO}_2$$

$$V = \frac{nRT}{P} = \frac{0,375 \text{ mol} \cdot 0,082 \frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}} \cdot 298 \text{ K}}{720 \frac{\text{mmHg}}{760 \text{ mmHg}}} = \boxed{9,68 \text{ L CO}_2}$$



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



$$\begin{array}{cc} 1 \text{ g} & 8,5 \text{ ml} \\ \text{pureza?} & 1,8 \text{ M} \end{array}$$

$$8,5 \text{ ml NaOH} \times \frac{1,8 \text{ mol NaOH}}{1000 \text{ ml NaOH}} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaOH}} \times \frac{98 \text{ g H}_2\text{SO}_4}{1 \text{ mol H}_2\text{SO}_4} = 0,75 \text{ g H}_2\text{SO}_4$$

$$\text{Pureza} = \frac{m \text{ pura}}{m \text{ impuro}} \times 100 = \frac{0,75}{1} \times 100 = \boxed{75\%}$$