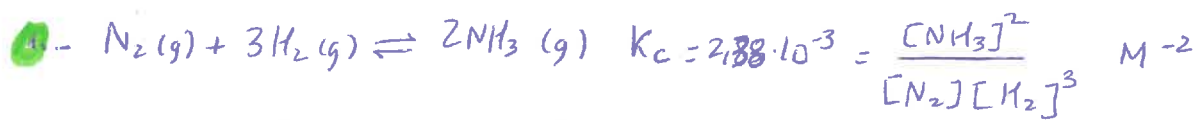


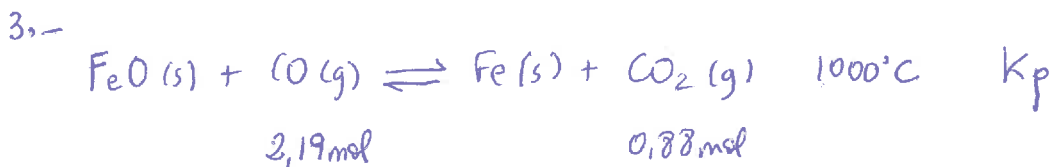
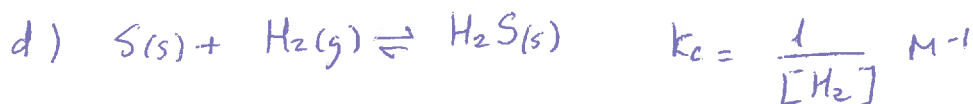
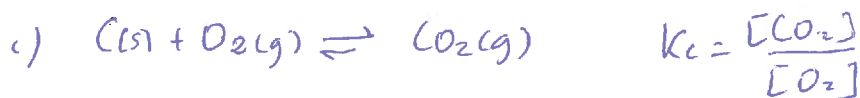
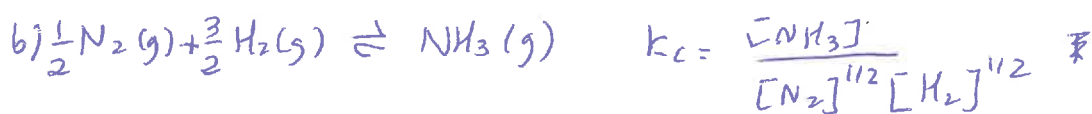
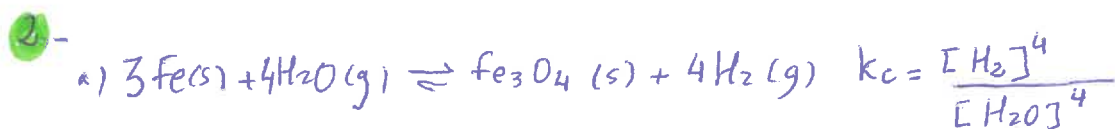
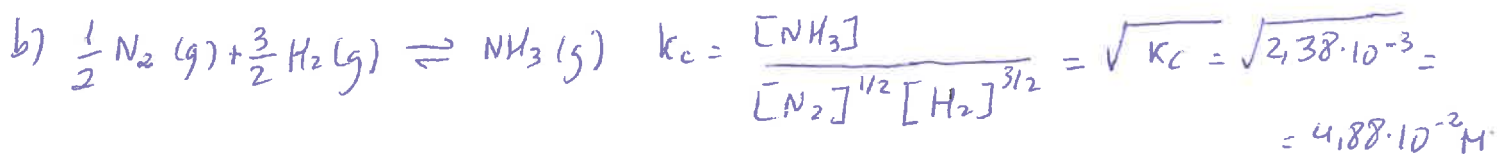
# Equilibrio químico FASE GAS (tema 5 baía) PARTE I

- 1.- Concepto equilibrio químico
- 2.- Ley acción masas y constante de equilibrio
  - Ej. 1-2-3 p 225 ( $K_c$ )
  - Ej. 4 p 225. ( $K_p$ )
  - Ej. 5 p 225
- 3.- Relación entre  $K_c$  y  $K_p$ 
  - Ej. resuelto p 201
- 4.- Coeficiente de reacción
  - Ej. 5 p 225
- 5.- Composición en el equilibrio
  - Ej. 6-7-8 p 225
- 6.- Grado de disociación
  - Ej. 9- p 225
  - 10-11-12-13-14-15-16-17 p 226
- 7.- Principio de Le chatelier p 206-207-208-209
  - Enunciado
  - factores  $\begin{cases} [\ ] \\ P_{\text{Total}} \text{ por } \Delta V \\ T \end{cases}$
  - Ej. 18-19-20-21-22-23-24+25-26 p 226-227



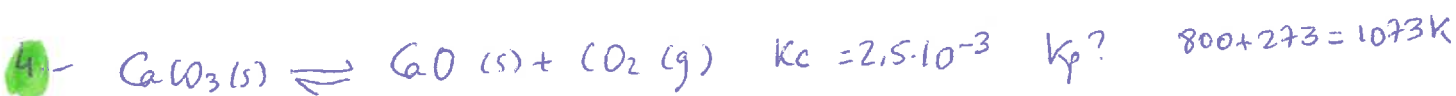


$$K_c = \frac{[N_2][H_2]^3}{[NH_3]^2} = \frac{1}{K_c} = \frac{1}{2,38 \cdot 10^{-3}} = 420 \text{ M}^2$$



$$K_p = \frac{P_{CO_2}}{P_{CO}} = \frac{[CO_2]RT}{[CO]RT} = \frac{\frac{0,88}{V}}{\frac{2,19}{V}} = \boxed{0,402}$$

$$= K_c [RT]^0 =$$



$$K_p = P(CO_2) = [CO_2]RT = K_c RT = 2,5 \cdot 10^{-3} (0,082 \cdot 1073) = \boxed{0,22 \text{ atm}}$$



mol a 25°C	0,0100	0,0200	0,0300	2,00 dm <sup>3</sup>	400 + 273 = 673 K
a 400°C	?	?	?		

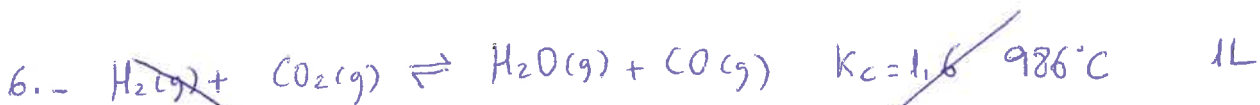
$$K_p = \frac{P_{NH_3}^2}{P_{N_2} \cdot P_{H_2}^3} = \frac{[NH_3]^2 (RT)^2}{[N_2] \cdot RT [H_2]^3 (RT)^3} = \prod C_i (RT)^{\Delta n} = K_c RT^{\Delta n}$$

$$K_c = \frac{K_p}{(RT)^{\Delta n}} = K_p (RT)^{-\Delta n} = 1,67 \cdot 10^{-4} (0,022 \cdot 673 \text{ K})^{+2} = 0,5086 \text{ M}^{-2}$$

(  $\Delta n = 2 - 3 - 1 = -2$  )

$$Q = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{(0,03)^2}{\frac{[2]^2}{(0,01)} \cdot \frac{(0,02)^3}{(2)^{3 \cdot 2}}} = \frac{(0,03)^2}{\frac{(0,01)(0,02)^3}{2^2}} = 45.000 \text{ M}^{-2}$$

Como  $Q > K$  el eq. está desplazado hacia la dcha hay + P y - R de los que corresponden a una situac. de eq.  
El eq. tiende a desplazarse a la izda.



i moles	0,2	0,3	0,4	0,4	a) eq?
e	0,2-x	0,3-x	0,4+x	0,4+x	b) [J]eq
					c) P inicio P final metche

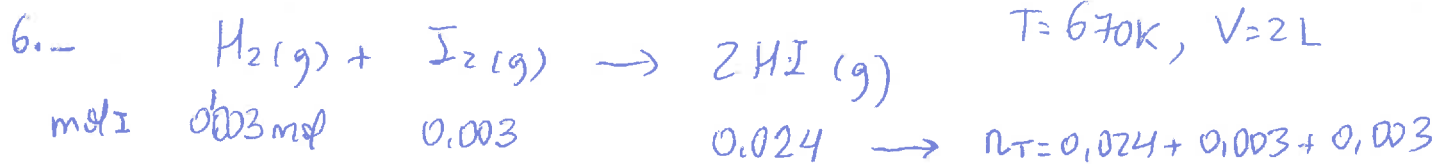
$$Q = \frac{[CO][H_2O]}{[H_2][CO_2]} = \frac{0,4 \cdot 0,4}{0,2 \cdot 0,3} = 2,67 \quad \text{como } Q > K \text{ hay más P y menos R de lo q corresponde. Se desplaza "←"$$

$$K = \frac{[CO][H_2O]}{[H_2][CO_2]} = \frac{\frac{0,4+x}{1} \cdot \frac{0,4+x}{1}}{\frac{(0,2-x)}{1} \cdot \frac{(0,3-x)}{1}} = \frac{(0,4+x)^2}{0,06 - 0,5x + x^2} = \frac{0,16 + 0,8x + x^2}{0,06 - 0,5x + x^2} = 1,6$$

$$0,16 + 0,8x + x^2 = 1,6(0,06 - 0,5x + x^2); \quad 0,16 + 0,8x + x^2 = 0,096 - 0,8x + 1,6x^2$$

$$0,6x^2 - 1,6x - 0,064 = 0$$

$$x = \frac{1,6 \pm 1,647}{1,2} \quad \begin{cases} x_1 < 0 \\ x_2 = \end{cases}$$



$n_T = 0,03\text{ mol}$

$$K_c = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} = \frac{\left(\frac{0,024}{2}\right)^2}{\left(\frac{0,003}{2}\right)\left(\frac{0,003}{2}\right)} = 64$$

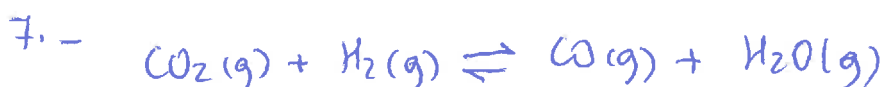
$$K_p = K_c(RT)^{\Delta n} = K_c = 64$$

$\uparrow$   
 $\Delta n = 0$

$$P = \frac{nRT}{V} = \frac{(0,024 + 0,003 + 0,003) \cdot 0,082 \cdot 670}{2} = 0,82\text{ atm}$$

$$P_{\text{H}_2} = \frac{0,003}{0,3} \cdot P = 0,1 \cdot 0,82 = 0,082 = P_{\text{I}_2}$$

$$P_{\text{HI}} = \frac{0,024}{0,3} \cdot 0,82 = 0,656\text{ atm}$$



$n_0$   $0,61\text{ mol}$   $0,39$   $-$   $-$

$n_e$   $0,61 - x$   $0,39 - x$   $x$   $x$

$V = 10,0\text{L}$

$T = 1250^\circ\text{C} = 1523\text{K}$

a)  $n_{\text{CO}_2} = 0,61 - x = 0,35 \rightarrow x = 0,61 - 0,35 = 0,26\text{ mol}$

$n_{\text{CO}_2} = 0,61 - 0,26 = 0,35\text{ mol CO}_2$

$n_{\text{H}_2} = 0,39 - 0,26 = 0,13\text{ mol H}_2$

$n_{\text{CO}} = n_{\text{H}_2\text{O}} = x = 0,26\text{ mol}$

b)  $K_c = \frac{[\text{CO}][\text{H}_2\text{O}]}{[\text{CO}_2][\text{H}_2]} = \frac{\frac{0,26}{10} \cdot \frac{0,26}{10}}{\frac{0,35}{10} \cdot \frac{0,13}{10}} = 1,49$

8. ... mol	$2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{SO}_3(\text{g})$		
ini	1,0 mol	1,0 mol	-
.	$1,0 - 2x$	$1,0 - x$	$2x$
eq.	0,15 mol		

$$V = 5 \text{ L}$$

$$T = 727^\circ\text{C} + 273 = 1000 \text{ K}$$

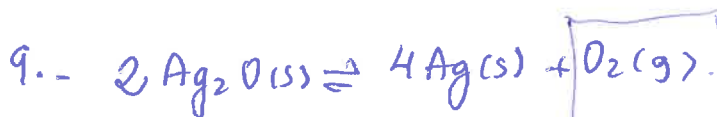
$$0,15 = 1 - 2x \rightarrow 0,15 - 1 = -2x \rightarrow x = 0,425 \text{ mol}$$

cant.  $\text{SO}_3$  en equil. :

$$2x = 2 \cdot 0,425 \text{ mol } \text{SO}_3 = 0,85 \text{ mol } \text{SO}_3 \quad ; \quad 0,85 \text{ mol } \text{SO}_3 \cdot \frac{80 \text{ g } \text{SO}_3}{1 \text{ mol}} = 68 \text{ g } \text{SO}_3$$

$$n_{\text{SO}_2} = 0,15 \text{ mol} \quad ; \quad n_{\text{O}_2} = 1 - 0,425 = 0,575 \text{ mol} \quad ; \quad n_{\text{SO}_3} = 0,85 \text{ mol}$$

$$K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 [\text{O}_2]} = \frac{\left(\frac{0,85}{5}\right)^2}{\left(\frac{0,15}{5}\right)^2 \left(\frac{0,575}{5}\right)} = 279,2 \text{ M}^{-1}$$



6,0g  
 $n = 2,59 \cdot 10^{-2} \text{ mol}$

ne:  
 $2,59 \cdot 10^{-2} - 2x$        $4x$        $x$

$$6,0 \text{ g } \text{Ag}_2\text{O} \cdot \frac{1 \text{ mol } \text{Ag}_2\text{O}}{231,7 \text{ g } \text{Ag}_2\text{O}} = 2,59 \cdot 10^{-2} \text{ mol}$$

$$V = 0,40 \text{ L}$$

$$T = 460 \text{ K}$$

$$P = 0,93 \text{ atm}$$

$$K_p = p_{\text{O}_2} = P = 0,93 \text{ atm}$$

única sust. gaseosa

$$P = \frac{nRT}{V} \rightarrow n = \frac{PV}{RT} = \frac{0,93 \cdot 0,4}{0,082 \cdot 460} = 9,86 \cdot 10^{-3} \text{ mol} = x$$

$$\alpha = \frac{2x}{2,59 \cdot 10^{-2}} = \frac{2 \cdot 9,86 \cdot 10^{-3}}{2,59 \cdot 10^{-2}} = 0,76 \xrightarrow{\%} 76\%$$



no 1,0                  1,0                  -

ne 1-x                  1-x                  2x

$T = 448^\circ C = 721 K$

$K_c = 50$  ;  $V = 1 L$

$$K_c = 50 = \frac{[HI]^2}{[I_2][H_2]} = \frac{\left(\frac{2x}{1}\right)^2}{\left(\frac{1-x}{1}\right)\left(\frac{1-x}{1}\right)} = \frac{4x^2}{1^2 - 2x + x^2} = 50$$

$$4x^2 = 50 - 100x + 50x^2$$

$$46x^2 - 100x + 50 = 0$$

$$\rightarrow 23x^2 - 50x + 25 = 0 ; \quad x = \frac{50 \pm 14,14}{46}$$

$x = 1,39 \text{ mol}$  No se puede disociar más de lo que tengo

$x = 0,78 \text{ mol}$

$n_{HI} = 2x = 2 \cdot 0,78 = 1,56 \text{ mol HI}$

$P_{I_2} = P_{H_2} = \frac{(1 - 0,78) \cdot 0,082 \frac{\text{atm} \cdot L}{\text{mol} \cdot K} \cdot 721 K}{1 L} = 13 \text{ atm}$

$P_{HI} = \frac{2 \cdot 0,78 \cdot 0,082 \cdot 721}{1} = 92 \text{ atm}$



masa 1,660g                  0,385g

ne  $1,8 \cdot 10^{-2}$                    $8,37 \cdot 10^{-3}$

a)  $K_c = \frac{[NO_2]^2}{[N_2O_4]} = \frac{\left(\frac{8,37 \cdot 10^{-3}}{0,310}\right)^2}{\left(\frac{1,8 \cdot 10^{-2}}{0,310}\right)} = 1,26 \cdot 10^{-2} M$

b)

$T = 35^\circ C + 273 = 308 K$

$V = 0,310 L$

$1,660 g \frac{1 \text{ mol } N_2O_4}{92 g N_2O_4} = 1,8 \cdot 10^{-2} \text{ mol } N_2O_4$

$0,385 g \frac{1 \text{ mol } NO_2}{46 g NO_2} = 8,37 \cdot 10^{-3} \text{ mol } NO_2$



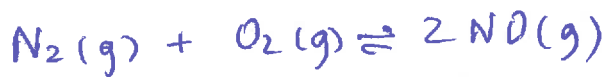


$$K_c = \frac{[I]^2}{[I_2]} = \frac{\left(\frac{2x}{V}\right)^2}{\left(\frac{n_0-x}{V}\right)} = \frac{2^2 x^2}{V(n_0-x)} = \frac{4 \cdot (3,14 \cdot 10^{-3})^2}{1 \cdot (7,87 \cdot 10^{-3} - 3,14 \cdot 10^{-3})}$$

$$\boxed{K_c = 8,3 \cdot 10^{-3} \text{ M}}$$

$$K_p = K_c (RT)^{\Delta n} = 8,3 \cdot 10^{-3} (0,082 \cdot 1473)^1 = \boxed{1 \text{ atm}}$$

15 L ;  $n_0 = 0,92 \text{ mol N}_2$   $n_0 = 0,51 \text{ mol O}_2$  ,  $T = 2200 \text{ K}$  ;  $\alpha = \frac{1,09}{100}$



$$n_0 \quad 0,92 \quad \quad 0,51 \quad \quad -$$

$$n_e \quad 0,92-x \quad \quad 0,51-x \quad \quad 2x$$

$$\alpha = \frac{x}{n_0} \rightarrow \frac{1,09}{100} = \frac{x}{0,92} \rightarrow \boxed{x = 1 \cdot 10^{-2} \text{ mol}}$$

$$\left\{ \begin{array}{l} [\text{N}_2] = \frac{0,92 - 1 \cdot 10^{-2}}{5} = 0,182 \text{ M} \\ [\text{O}_2] = \frac{0,51 - 1 \cdot 10^{-2}}{5} = 0,100 \text{ M} \\ [\text{NO}] = \frac{2 \cdot 1 \cdot 10^{-2}}{5} = 0,004 \text{ M} \end{array} \right.$$

$$K_c = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]} = \frac{(0,004)^2}{(0,182)(0,100)} = 8,79 \cdot 10^{-4}$$

$$\boxed{K_p = K_c (RT)^{\Delta n} = K_c = 8,79 \cdot 10^{-4}}$$

↑  
 $\Delta n = 0$



$$K_p = \frac{P_{CO} \cdot P_{Cl_2}}{P_{COCl_2}} = \frac{\left(\frac{p_0 \alpha}{p_0(1+\alpha)}\right) \left(\frac{p_0 \alpha}{p_0(1+\alpha)}\right)}{\left(\frac{p_0(1-\alpha)}{p_0(1+\alpha)}\right)} \cdot P$$

$$K_p = \frac{\alpha^2}{\frac{(1+\alpha)(1+\alpha)}{(1-\alpha)(1+\alpha)}} = \frac{\alpha^2}{(1^2 - \alpha^2)} = \frac{0,492^2}{1 - 0,492^2} = \boxed{0,32 \text{ atm}}$$

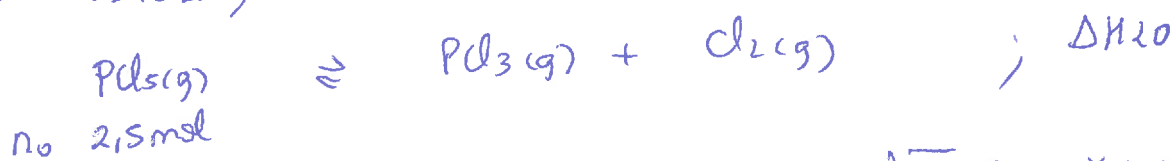
$$b) \quad 0,32 = \frac{\alpha^2}{1^2 - \alpha^2} \cdot 5$$

$$0,32 - 0,32 \alpha^2 = 5 \alpha^2$$

$$\cancel{5} \alpha^2 \quad 5,32 \alpha^2 = 0,32$$

$$\alpha = \pm \sqrt{\frac{0,32}{5,32}} = 0,25$$

$$18. - V = 10L, \quad T = 270^\circ C + 273 = 543K; \quad P = 15,68 \text{ atm.}$$



$n_0$  2,5 mol

$n_e$  2,5 - x

x

x

$$n = 2,5 - x + x + x = \boxed{2,5 + x}$$

$$a) \quad K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{\left(\frac{x}{10}\right)^2}{\left(\frac{2,5-x}{10}\right)} = \frac{x^2}{10(2,5-x)} \quad \uparrow \quad \frac{1,02^2}{10(2,5-1,02)} \approx 0,07 M$$

$$PV = nRT; \quad 15,68 \cdot 10 = (2,5 + x) \cdot 0,082 \cdot 543; \quad x = 1,02 \text{ mol}$$

$$b) \quad n_{PCl_5} = 2,5 - 1,02 = 1,48 \text{ mol}; \quad n_{PCl_3} = n_{Cl_2} = 1,02 \text{ mol}$$

c) "Le Chatelier"...

↳ ↑P → menos n gas → "←"

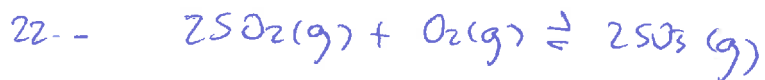
↳ ↑T → intenta consumir calor → "←"

19. -



- $$K = \frac{[\text{P}]}{[\text{R}]^{\uparrow}} \quad \downarrow$$
- $\uparrow T \rightarrow$  absorbe calor  $\rightarrow$  " $\leftarrow$ "
  - $\uparrow P_{\text{HBr}} \rightarrow$  " $\leftarrow$ "
  - $\uparrow V \rightarrow \downarrow P \rightarrow$  mayor mol gas  $\rightarrow$  como  $n_{\text{P}} = n_{\text{R}} \rightarrow$  no sufre nada

21. -

a)  $\uparrow P \rightarrow$ 

b) F

$$c) K_p = K_c (RT)^{\Delta n} = K_c \left( \frac{RT}{K} \right)^{-1} = \frac{K_c}{RT}$$

$$K_p \cdot (RT) = K_c \quad \text{luego} \quad K_p < K_c$$



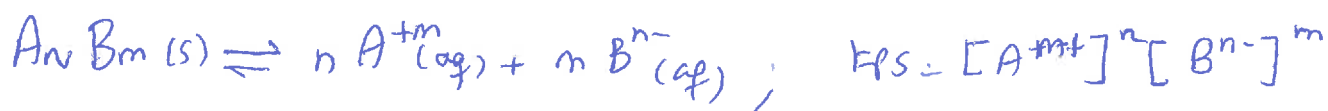
- Equilibrio de solubilidad . Gua de trabajo

p108 p208-238

x simulación U.V ("simulación solubilidad distintas sales")

Explicar  $\left\{ \begin{array}{l} \text{dis sat} \\ \text{equilibrio solubilidad} \\ \text{solubilidad} \end{array} \right\}$  p209-210

x p210 producto solubilidad



• ir mirando tabla S-2

• Ejercicio resuelto p212

x p212 relación entre S y KPS

- ejercicio tipo 1. Nos dan KPS y calculo S

- ejercicio tipo 2. Nos dan S y calculo KPS

- JAREA  $\rightarrow$  coger tabla S-2  $\begin{array}{l} \rightarrow \text{nombrar todas las sales} \\ \rightarrow \text{escribir los equilibrios} \\ \rightarrow \text{poner KPS en función de S} \end{array}$

- Ej: 27-28

- Kaca ej resuelto p213

x p214 Decidir si precipita

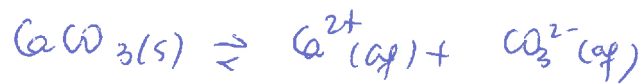
Ej: 32-33-34-35

x **p215**  $K_{sp}$  común  $\rightarrow$   $S \downarrow$   $\begin{cases} \text{Le Chatelier} \\ \text{cálculos} \end{cases}$   
L Ejercicios tipo 1 y tipo 2 pero con  $K_{sp}$  común  
29-30-31-37

• Hacer ejercicios p216

x **p218** Disolución de precipitados (práctica)

$\left\{ \begin{array}{l} \downarrow S \text{ si } \dots \\ \uparrow S \text{ si } \dots \end{array} \right\}$

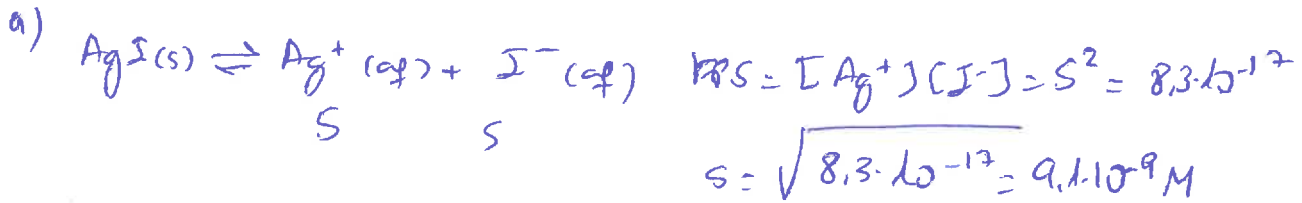


x (práctica - preparar precipitado y separarlo por filtración)

40-41-42-43-44-45

33-

$$K_{PS}(AgI) = 8,3 \cdot 10^{-17}$$



$$9,1 \cdot 10^{-9} \frac{\text{mol AgI}}{L} \cdot \frac{234,8 \text{ g}}{1 \text{ mol AgI}} = \boxed{2,1 \cdot 10^{-6} \text{ g/L}}$$



100 mL

0,005 mol/L

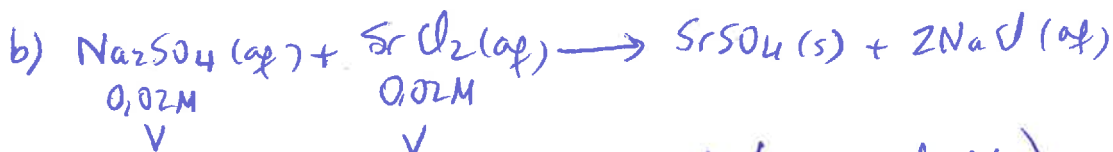
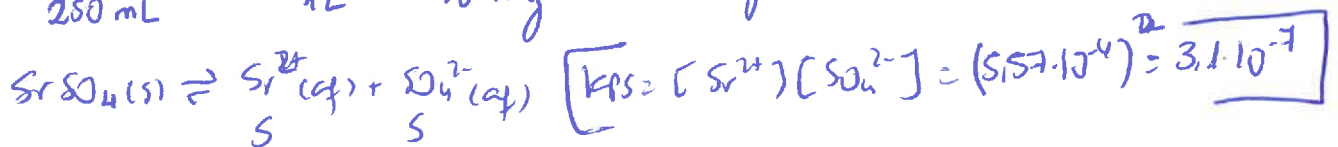
$$8,3 \cdot 10^{-17} = [Ag^+][I^-] = 0,005 \cdot [I^-]$$

$$[I^-] = \frac{8,3 \cdot 10^{-17}}{0,005} = 1,66 \cdot 10^{-14} \frac{\text{mol KI}}{L}$$

$$1,66 \cdot 10^{-14} \frac{\text{mol KI}}{L} \cdot 0,1 L \cdot \frac{166 \text{ g KI}}{1 \text{ mol KI}} = 2,8 \cdot 10^{-13} \text{ g KI}$$

35.-

$$a) \frac{26,0 \text{ mg SrSO}_4}{250 \text{ mL}} \cdot \frac{10^3 \text{ mL}}{1 L} \cdot \frac{1 \text{ g SrSO}_4}{10^3 \text{ mg}} \cdot \frac{1 \text{ mol}}{186,62 \text{ g}} = 5,57 \cdot 10^{-4} \frac{\text{mol SrSO}_4}{L} = [Sr^{2+}] = [SO_4^{2-}]$$



$$Q = [Sr^{2+}][SO_4^{2-}] = \left( \frac{0,02 \frac{\text{mol}}{L} \cdot V}{2V} \right) \left( \frac{0,02 \frac{\text{mol}}{L} \cdot V}{2V} \right) = 10^{-4}$$

$Q > K_{PS}$  precipitate

