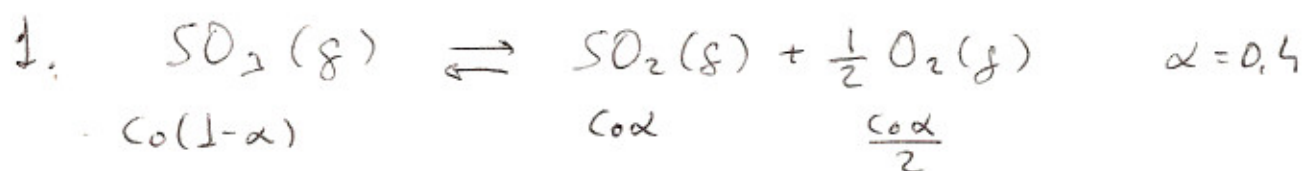


PROBLEMAS DE EQUILIBRIO PAU (1)



a) $C_{\text{tot}} = C_0(1-\alpha) + C_0\alpha + C_0\frac{\alpha}{2} = C_0\left(1 + \frac{\alpha}{2}\right) = 1,2 C_0$

$$X_{\text{SO}_2} = \frac{C_0(1-\alpha)}{C_0(1+\frac{\alpha}{2})} = \frac{0,6}{1,2} = \frac{1}{2}$$

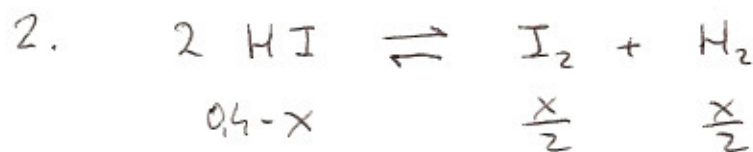
$$X_{\text{SO}_2} = \frac{C_0\alpha}{C_0(1+\frac{\alpha}{2})} = \frac{0,4}{1,2} = \frac{1}{3}$$

$$X_{\text{O}_2} = \frac{C_0\frac{\alpha}{2}}{C_0(1+\frac{\alpha}{2})} = \frac{0,2}{1,2} = \frac{1}{6}$$

b) $P_{\text{SO}_2} = P_{\text{tot}} \cdot X_{\text{SO}_2} = 100 \times 0,5 = 50 \text{ atm.}$

$$P_{\text{SO}_2} = 33,3 \text{ atm}, \quad P_{\text{O}_2} = 16,6 \text{ atm.}$$

$$K_p = \frac{P_{\text{SO}_2} \cdot P_{\text{O}_2}^{\frac{1}{2}}}{P_{\text{SO}_2}} = 2,72$$



a) $n_{\text{total}} = 0,4 - x + \frac{x}{2} + \frac{x}{2} = 0,4$

$$X_{\text{HI}} = 0,8 \Rightarrow n_{\text{HI}} = 0,8 \times 0,4 = 0,32 \text{ mol}$$

$$X_{\text{I}_2} = X_{\text{H}_2} = 0,1 \Rightarrow n_{\text{I}_2} = n_{\text{H}_2} = 0,04 \text{ mol}$$

$$[\text{HI}] = \frac{0,32}{1,6} = 0,2 \text{ M}$$

$$[\text{I}_2] = [\text{H}_2] = 0,025 \text{ M}$$

$$K_c = \frac{[\text{I}_2][\text{H}_2]}{[\text{HI}]^2} = \frac{(0,025)^2}{(0,2)^2} = 1,56 \times 10^{-2}$$

$$b) P_T = \frac{nRT}{V} = \frac{0.4 \times 0.082 \times 673}{1.6} = 13.80 \text{ atm.}$$

$$P_{H_2} = 0.8 \times 13.80 = 11.04 \text{ atm.}$$

$$P_{I_2} = P_{H_2} = 0.1 \times 13.80 = 1.38 \text{ atm.}$$



$$2.3 \text{ g } N_2O_4 \xrightarrow{\div 92 \text{ g/mol}} 0.025 \text{ mol } N_2O_4$$

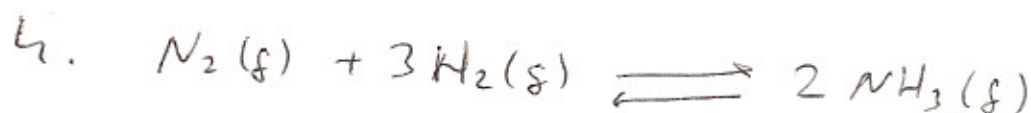
$$[N_2O_4]_0 = \frac{0.025}{0.5} = 0.05 \text{ M}$$

$$K_c = 4.6 \times 10^{-3} = \frac{x^2}{0.05 - x} \Rightarrow x^2 + 4.6 \times 10^{-3}x - 2.3 \times 10^{-4} = 0$$

$$x = \frac{-4.6 \times 10^{-3} \pm \sqrt{(4.6 \times 10^{-3})^2 + 4 \times 2.3 \times 10^{-4}}}{2} = \begin{matrix} 0.013 \text{ M} \\ < 0 \end{matrix}$$

$$n_{N_2O_4} = 0.025 - \frac{0.013}{2} = 0.0185 \text{ mol} \xrightarrow{\times 92 \text{ g/mol}} 1.70 \text{ g } N_2O_4$$

$$m_{N_2O_4} = 1.70 \text{ g} \quad ; \quad m_{NO_2} = m_T - m_{N_2O_4} = 2.3 - 1.7 = 0.6 \text{ g } NO_2$$



a) Reaccionan 5% molar $N_2 = 0.05 \times 2.5 = 0.125 \text{ mols} \Rightarrow$ quedan sin reaccionar $2.5 - 0.125 = 2.375 \text{ mol } N_2$

Reaccionan $3 \times 0.125 = 0.375 \text{ mols } H_2 \Rightarrow$ quedan $2.5 - 0.375 = 2.125 \text{ mol } H_2$

Se producen $0.125 \times 2 = 0.250 \text{ mols } NH_3$

$$K_c = \frac{\left(\frac{0.250}{2.5}\right)^2}{\left(\frac{2.375}{2.5}\right)\left(\frac{2.125}{2.5}\right)^3} = 1.71$$

$$K_p = K_c \cdot (RT)^{-2} = 1.71 \times (0.082 \times 673)^{-2} = 5.61 \times 10^{-4}$$

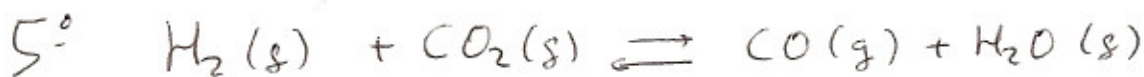
4^o b) $n_T = 2,375 + 2,125 + 0,250 = 4,75 \text{ mol}$

$$P_t = \frac{nRT}{V} = 10,485 \text{ atm.}$$

$$P_{N_2} = X_{N_2} \cdot P_T = \frac{2,375}{4,75} \times 10,485 = 5,24 \text{ atm.}$$

$$P_{H_2} = X_{H_2} \cdot P_T = 4,69 \text{ atm}$$

$$P_{NH_3} = X_{NH_3} \cdot P_T = 0,55 \text{ atm.}$$



inicial: 0,85 mol 0,85 mol

equil: 0,85 - 0,55 = 0,3 mol 0,3 mol 0,55 mol 0,55 mol

a) $n_{\text{total}} = 0,3 + 0,3 + 0,55 + 0,55 = 1,7 \text{ mol.}$

$$P_t = \frac{n_T \cdot R \cdot T}{V} = \frac{1,7 \times 0,082 \times 1873}{5} = 52,22 \text{ atm.}$$

$$P_{H_2} = P_{CO_2} = X_{H_2} \cdot P_T = \frac{0,3}{1,7} \times P_T = 9,215 \text{ atm}$$

$$P_{CO} = P_{H_2O} = X_{CO} \cdot P_T = \frac{0,55}{1,7} \times P_T = 16,895 \text{ atm.}$$

b) $K_c = \frac{(0,55)^2}{(0,3)^2} = 3,36$



$$3,36 = \frac{(0,95 - x)(0,55 - x)}{(0,33 + x)^2}$$

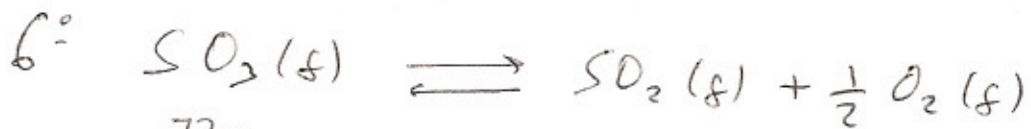
$$2,26 x^2 + 3,7126 x - 0,1566 = 0 \quad \nearrow 3,8986$$

$$x = \frac{-3,7126 \pm \sqrt{(3,7126)^2 + 4 \cdot 2,26 \cdot 0,1566}}{2 \cdot 2,26} = \begin{matrix} \rightarrow CO \times \\ \rightarrow 0,04115 \text{ mol.} \end{matrix}$$

$$|H_2| = |CO_2| = \frac{0.33 + 0.04115}{5} = 0.07423 M$$

$$|CO| = \frac{0,95 - 0,04115}{5} = 0,1818 M$$

$$[H_2O] = \frac{0,55 - 0,04115}{5} = 0,1018 M$$



72 &

$$\int \div M = 80 \text{ g/mol}$$

0.9 mol

$$1 \div 2.5 = 0.4$$

0.36 M

$$0,36 - x$$

x

$$\frac{x}{2}$$

$$n_T = 0,36 - x + x + \frac{x}{2} = 0,36 + \frac{x}{2}$$

$$n_T = \frac{pV}{RT} = \frac{18 \times 2,5}{0,082 \times 573} = 0,96 \text{ mol}$$

$$1.46 = 2.5 \cdot \left(0.36 + \frac{x}{2}\right) = 0.9 + 1.25x \Rightarrow x = 0.208 \text{ m}$$

$$K_c = \frac{0.208 \times \left(\frac{0.208}{2}\right)^{\frac{1}{2}}}{0.36 - 0.208} = 0.4413$$

$$K_p = K_c (RT)^{\frac{1}{2}} = 2.75$$



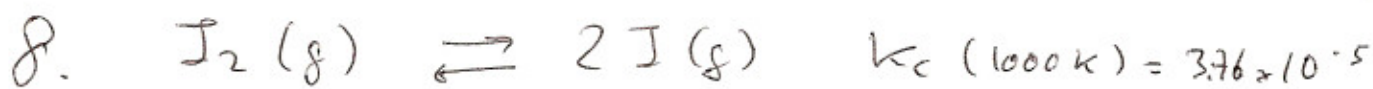
$$P_{PCL_5} = \frac{0.042 \times 0.082 \times 523}{2} = 0.9006$$

$$P_{Pa_2} = \frac{0.023 \times 0.082 \times 523}{2} = 0.4932$$

$$K_p = 1.05 = \frac{0.5932 \times P_{\text{Cl}_2}}{0.9006} \Rightarrow \boxed{P_{\text{Cl}_2} = 1.92 \text{ atm}}$$

Problemas equilibrio PAU

3



$$[I_2] = 0.5 M \quad [I] = 2.5 \times 10^{-3} M$$

$$Q = \frac{[I]^2}{[I_2]} = 1.25 \times 10^{-5} < K_c \Rightarrow \text{la reacción se desplaza hacia la derecha}$$

$$[I_2]_e = 0.5 - x \quad [I]_e = 2.5 \times 10^{-3} + 2x$$

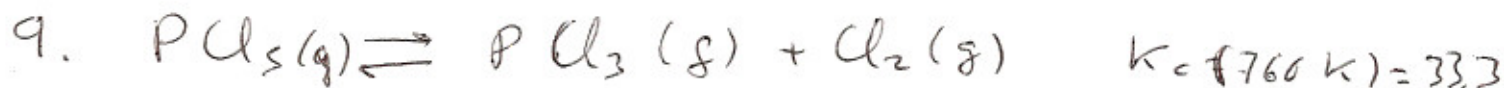
$$3.76 \times 10^{-5} = \frac{(2.5 \times 10^{-3} + 2x)^2}{0.5 - x}$$

$$4x^2 + 1.00376 \times 10^{-2}x - 2.255 \times 10^{-5} = 0 \quad \Delta = 3.7365 \times 10^{-2}$$

$$x = \frac{-1.00376 \times 10^{-2} \pm \sqrt{(1.00376 \times 10^{-2})^2 + 4 \times 4 \times 2.255 \times 10^{-5}}}{8} = -0.001254 M < 0 \quad x$$

$$[I_2] = 0.5 - x = 0.499 M$$

$$[I] = 4.33 \times 10^{-3} M$$



$$1.5 g$$

$$15 g$$

$$\downarrow M = 208.5 g/mol$$

$$\downarrow M = 137.5 g/mol$$

$$7.19 \times 10^{-3} mol$$

$$0.109 mol$$

$$\downarrow \pm 0.0363 l$$

$$\downarrow \pm 0.0363 l$$

$$0.198 M$$

$$3.01 M$$

$$0.198 - x$$

$$3.01 + x$$

$$x$$

$$33.3 = \frac{(3.01 + x) \cdot x}{0.198 - x} \Rightarrow 6.593 - 33.3x = 3.01x + x^2$$

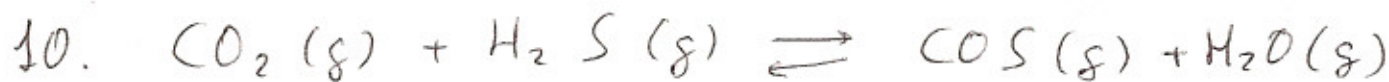
$$x^2 + 36.31x - 6.593 = 0 \quad \Delta = 36.67$$

$$x = \frac{-36.31 \pm \sqrt{(36.31)^2 + 4 \times 6.593}}{2} = -0.1807 M \approx 0.181 M < 0 \quad x$$

$$[PCl_5] = 0.017 M$$

$$[PCl_3] = 3.181 M$$

$$[Cl_2] = 0.181 M$$



4.4 g

"

0.1 mol

n_0

—

—

equilibrio: $0.1 - 0.01 = 0.09$

$n - 0.01$

0.01

0.01

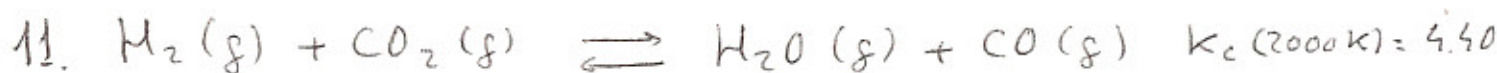
a) $n_T = 0.09 + n_0 - 0.01 + 0.01 + 0.01 = n + 0.1$

$n_T = \frac{PV}{RT} = 0.499 \text{ mol}$

$0.499 = n_0 + 0.1 \Rightarrow n_0 = 0.399 \text{ mol}$

En el equilibrio hay: 0.09 mols CO_2 , 0.399 mol H_2S , 0.01 mol de COS y 0.01 g/mol de H_2O .

b) $K_p = K_c \cdot (RT)^{\Delta n} = K_c = \frac{0.01 \cdot 0.01}{0.09 \cdot 0.389} = 2.86 \times 10^{-3}$



1 mol

1 mol

1 mol

—

$1 - x$

$1 - x$

$1 + x$

x

$4.40 = \frac{(1+x) \cdot x}{(1-x)^2}$

$3.40x^2 + 9.8x + 4.40 = 0 \quad \leftarrow 6.0166$

$x = \frac{9.8 \pm \sqrt{9.8^2 - 4 \cdot 3.40 \cdot 4.40}}{6.8} = \begin{matrix} 0.556 \\ 2.326 > 1 \end{matrix} \quad \times$

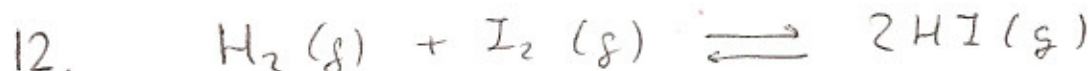
$n_{\text{H}_2} = n_{\text{CO}_2} = 1 - x = 0.444 \Rightarrow [\text{H}_2] = [\text{CO}_2] = 9.49 \times 10^{-2} \text{ M}$

$n_{\text{H}_2\text{O}} = 1 + x = 1.556$

$\Rightarrow [\text{H}_2\text{O}] = 0.332 \text{ M}$

$n_{\text{CO}} = x = 0.556$

$\Rightarrow [\text{CO}] = 0.119 \text{ M}$



1 M

1 M

—

$1 - x$

$1 - x$

$2x$

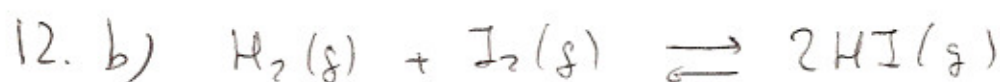
a) $45.9 = \frac{(2x)^2}{(1-x)^2} \Rightarrow 6.775 = \frac{2x}{1-x} \Rightarrow x = 0.772 \text{ M}$

$[\text{H}_2] = [\text{I}_2] = 1 - x = 0.228 \text{ M}$

$[\text{HI}] = 2x = 1.544 \text{ M}$

Problemas de equilibrio PAU

4



$$\begin{array}{ccc} 2,228 - x & 0,228 - x & 1,544 + 2x \end{array}$$

$$45,9 = \frac{(1,544 + 2x)^2}{(2,228 - x)(0,228 - x)}$$

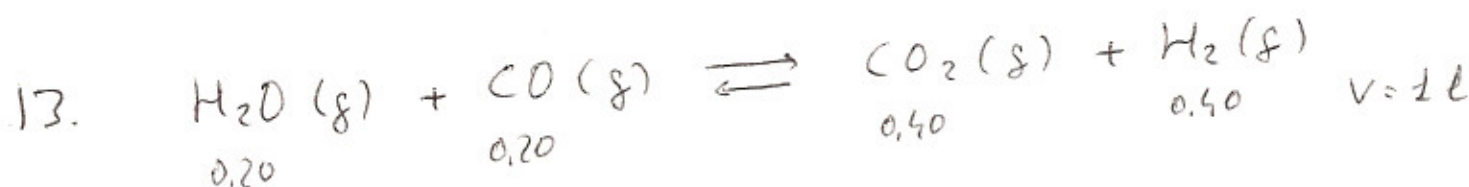
$$41,9 x^2 - 118,88 x + 20,932 = 0 \quad \checkmark \quad 107,07$$

$$x = \frac{118,88 \pm \sqrt{(118,88)^2 - 4 \times 41,9 \times 20,932}}{2 \times 41,9} = \begin{cases} 0,189 \text{ M} \\ 2,649 \text{ M} > 0,228 \text{ M} \times \end{cases}$$

$$\boxed{[\text{H}_2] = 2,228 - x = 2,039 \text{ M}}$$

$$\boxed{[\text{I}_2] = 0,228 - x = 0,039 \text{ M}}$$

$$\boxed{[\text{HI}] = 1,544 + 2x = 1,922 \text{ M}}$$



$$K_c = \frac{(0,40)^2}{(0,20)^2} = 4$$

Se añaden 0,4 mols CO_2 y $\text{CO} \Rightarrow |\text{CO}| > |\text{CO}_2| =$

$$Q = \frac{0,4 \times 0,8}{0,2 \times 0,6} = 2,67 < 4 \Rightarrow \text{la reacción se desplaza a la dcha.}$$

$$4 = \frac{(0,8+x)(0,4+x)}{(0,2-x)(0,6-x)}$$

$$3x^2 - 4,4x + 0,16 = 0 \quad \checkmark \quad 4,1761$$

$$x = \frac{4,4 \pm \sqrt{4,4^2 - 4 \times 3 \times 0,16}}{6} = \begin{cases} 0,0373 \text{ M} \\ 3,429 \text{ M} > 0,2 \text{ M} \times \end{cases}$$

$$\boxed{[\text{CO}] = 0,6 - x = 0,563 \text{ M}}$$