EQUILIBRIO | OLIMPIADAS VALENCIA

a) $CH_4 + H_2O \rightarrow 3H_2 + CO$

eq: $n_0 - n_x \qquad n_0 - n_x \qquad 3n_x \qquad n_x$

$$n_{Teq} = n_0 - n_x + n_0 - n_x + 3n_x + n_x = \boxed{2(n_0 + n_x) = n_{Teq}}$$

b) $K_p = 28{,}6$

$n_0(CH_4) = n_0(H_2O) = 1{,}0 \cdot 10^3$ mol

$P_0 = 1{,}6$ atm

$$\alpha = \frac{n_x}{n_0} \; ; \quad K_p = \frac{P_{H_2}^3 \, P_{CO}}{P_{CH_4} \, P_{H_2O}} \; ; \quad P_i = P_T \, X_i$$

$$\frac{P_{Teq} V}{P_0 V} = \frac{n_{Teq} RT}{n_0 RT} \rightarrow P_{Teq} = \frac{2(n_0 + n_x)}{2n_0} P_0 = \boxed{(1+\alpha)P_0 = P_T}$$

$$P_{H_2} = P_T \, X_{H_2} = (1+\alpha) P_0 \cdot \frac{3n_x}{2(n_0 + n_x)} = (1+\alpha) P_0 \frac{3}{2\left(\frac{1}{\alpha} + 1\right)}$$

$$P_{H_2} = (1+\alpha) P_0 \frac{3}{2\left(\frac{1+\alpha}{\alpha}\right)} = \cancel{(1+\alpha)} P_0 \frac{3\alpha}{2\cancel{(1+\alpha)}}$$

$$\boxed{P_{H_2} = \frac{3}{2} P_0 \alpha} \quad \boxed{P_{CO} = \frac{1}{2} P_0 \alpha}$$

$$P_{CH_4} = P_{H_2O} = (1+\alpha) P_0 \frac{n_0 - n_x}{2(n_0 + n_x)} = \cancel{(1+\alpha)} P_0 \frac{1-\alpha}{2\cancel{(1+\alpha)}}$$

$$P_{CH_4} = P_{H_2O} = \frac{1}{2} P_0 (1-\alpha)$$

$$K_p = \frac{P_{H_2}^3 \, P_{CO}}{P_{CH_4} \, P_{H_2O}} = \frac{\left(\frac{3}{2} P_0 \alpha\right)^3 \left(\frac{1}{2} P_0 \alpha\right)}{\left(\frac{1}{2} P_0 (1-\alpha)\right)\left(\frac{1}{2} P_0 (1-\alpha)\right)}$$

$$\sqrt{K_p} = \sqrt{\frac{27}{4} P_0^2 \frac{\alpha^4}{(1-\alpha)^2}} \rightarrow \sqrt{K_p} - \sqrt{K_p}\,\alpha = \frac{\sqrt{27}}{2} P_0 \alpha^2$$

$$\frac{\sqrt{27}}{2} P_0 \alpha^2 + \sqrt{K_p}\,\alpha - \sqrt{K_p} = 0$$

$$4{,}16\,\alpha^2 + 5{,}35\,\alpha - 5{,}35 = 0$$

$$\alpha = \frac{-5{,}35 \pm \sqrt{5{,}35^2 + 4 \cdot 4{,}16 \cdot 5{,}35}}{8{,}32} = \frac{-5{,}35 \pm 10{,}85}{8{,}32} = 0{,}661$$

$$\boxed{\alpha\,(\%) = 66{,}1\,\%}$$

c) $P_T = (1+\alpha) P_0 = (1 + 0{,}661)\, 1{,}6 = \boxed{2{,}7 \text{ atm} = P_T}$