SLC 0664 – PROVA I

Questão 1

$R = 8,314\ J\ K^{-1}\ mol^{-1}$

(1) $T_i = 27\ ^\circ C = 300\ K$ $\quad n = 0,1\ mol$

$T_f = 67\ ^\circ C = 340\ K$ $\quad P_{ex} = 10^5\ Pa \cong 1\ atm$

GÁS IDEAL $\quad V_i = \dfrac{n R T_i}{P_i}$ $\quad C_p = 29,12\ J\ K^{-1}\ mol^{-1}$

$C_v = C_p - R = 20,81$

$$V_i = \frac{0,1 \times 0,082 \cdot 300}{1\ atm} = 2,46\ L$$

$$V_f = \frac{0,1 \times 0,082 \times 340}{1} = 2,79\ L$$

(a) $W = -P_{ex}\,\Delta V = 10^5 \cdot (2,79 - 2,46) \times 10^{-3}$

$W = -33\ J$

(b) $\Delta U = n C_v \Delta T = 0,1 \times 20,81 \times 40$

$\Delta U = 83,24\ J$

(c) $\Delta H = n C_p \Delta T = 0,1 \times 29,12 \times 40$

$\Delta H = 116,48\ J$

(d) VARIAÇÃO DE ENTROPIA: GÁS IDEAL

$$\Delta S = n \bar{C}_v \ln\left(\frac{T_2}{T_1}\right) + n R \ln\left(\frac{V_2}{V_1}\right)$$

$$\Delta S = 0,1 \times 20,81 \cdot \ln\left(\frac{342}{300}\right) + 0,1 \times 8,314 \ln\left(\frac{2,79}{2,46}\right)$$

$$\Delta S = 0,26 + 0,10$$

$$\Delta S_{SIST} = 0,36\ J\ K^{-1}$$

ou $$\Delta S = n \bar{C}_p \ln\left(\frac{T_2}{T_1}\right) = 0,1 \cdot 29,12 \ln\left(\frac{342}{300}\right)$$

$$\Delta S_{SIST} = 0,36\ J\ K^{-1}$$

(e) $\Delta S_T = \underbrace{\Delta S_{SIST}}_{>0} + \underbrace{\Delta S^{*}_{VIZ}}_{q_{VIZ}=0}$ $\qquad \Delta S_T > 0$ (PROCESSO IRREVERSÍVEL)

* Não considerando a entropia do conjunto de fótons

(f) Sim $\qquad E_{hv} = \Delta u - (q + w) \qquad q = 0$

$$E_{hv} \simeq \Delta u - w = 83,24 - (-33)$$

$$E_{hv} \simeq 116,24\ J$$

Questão 2

(a) BALANCEAMENTO

(1) $CaC_{2(s)} + 2H_2O_{(\ell)} = Ca(OH)_{2(s)} + C_2H_2$

(2) $C_2H_2 + \frac{5}{2}O_2 = 2CO_2 + H_2O_{(\ell)}$

(b) ENTALPIA PADRÃO DE REAÇÃO:

Reação 1

$$\Delta H_r^\circ = (\Delta H_{f\,Ca(OH)_{2(s)}}^\circ + \Delta H_{f\,C_2H_5}^\circ) - (\Delta H_{f\,CaC_2}^\circ + 2 \times \Delta H_{f\,H_2O(\ell)}^\circ)$$

$$\Delta H_r^\circ = (-986,1 + 226,7) - (-60 + 2 \times (-285,83))$$

$$\boxed{\Delta H_r^\circ = -127,74\ kJ/mol \quad (\text{EXOTÉRMICO})}$$

Reação 2

$$\Delta H_r^\circ = (2 \times \Delta H_{f\,CO_2}^\circ + \Delta H_{f\,H_2O(\ell)}^\circ) - (\Delta H_{f\,C_2H_2}^\circ + 5/2\ \Delta H_{f\,O_2}^\circ)$$

$$\Delta H_r^\circ = (2 \times (-393,51 - 285,83) - (226,7 + 0)$$

$$\boxed{\Delta H_r^\circ = -1.299,55\ kJ/mol \quad \text{ALTAMENTE EXOTÉRMICO}}$$

(2) (c) calor liberado 6,4 g carbeto

$$n = \frac{6,4\ g}{64\ g/mol} = 0,1\ mol$$

Assim $q = n\,\Delta H_r^{\circ}(1) + n\,\Delta H_r^{\circ}(2)$

$$q = 0,1 \times (-127,74) + 0,1 \times (-1299,55)$$

$$q = -(12,77 + 129,95)$$

$$\boxed{q = -142,72\ kJ}$$

(d) $\Delta S_r^{\circ}(1) = (S^{\circ}_{Ca(OH)_2} + S^{\circ}_{C_2H_2}) - (S^{\circ}_{CaC_2} + 2 \times S^{\circ}_{H_2O(l)})$

$$\Delta S_r^{\circ}(1) = (83,4 + 200,8) - (70 + 2 \times 69,95)$$

$$\Delta S_r^{\circ}(1) = 284,2 - 209,9$$

$$\boxed{\Delta S_r^{\circ}(1) = 74,3\ J\,K^{-1}}$$

$$\Delta S_r^{\circ}(2) = (2 \times S^{\circ}_{CO_2} + S^{\circ}_{H_2O(l)}) - (S^{\circ}_{C_2H_2} + (\tfrac{5}{2}) S^{\circ}_{O_2})$$

$$\Delta S_r(2) = (2 \times 213,68 + 69,95) - (200,8 + \tfrac{5}{2}\ 205,04)$$

$$\boxed{\Delta S_r^{\circ}(2) = 447,3 - 713,4 = -216,09\ J\,K^{-1}}$$

(e) Variação da Energia Livre padrão de reação ΔG°_r

$$\Delta G^\circ_r(1) = \Delta H^\circ_r(1) - T\Delta S^\circ_r(1)$$

$$\Delta G^\circ_r(1) = -127.740\ J - 298 \times 74,3\ J\,K^{-1}$$

$$\boxed{\Delta G^\circ_r(1) = -149.881\ J = -149,88\ kJ}$$

$$\Delta G^\circ_r(2) = \Delta H^\circ_r(2) - T\Delta S^\circ_r(2)$$

$$\Delta G^\circ_r(2) = -1.299.550 - 298(-216,09)$$

$$\Delta G^\circ_r(2) = -1299,55 + 64,39$$

$$\boxed{\Delta G^\circ_r(2) = -1235,2\ kJ}$$

(f) Reação global é a soma (1) + (2)

$$CaC_2(s) + H_2O + \frac{5}{2}O_2 = Ca(OH)_2(s) + 2CO_2 \qquad (3)$$

$$\Delta G^\circ_r(3) = \Delta G^\circ_r(1) + \Delta G^\circ_r(2)$$

Como $K = \exp(-\Delta G^\circ_r(3)/RT) = e^{-\Delta G^\circ_r(1)/RT} \cdot e^{-\Delta G^\circ_r(2)/RT}$

ou $K = K_1 \cdot K_2$