

תרמודינאמיקה – פתרון תרגיל מספר 4

.1

$$P_1 = 10 \text{ bar}$$

$$P_2 = 1 \text{ bar}$$

$$T_1 = 298.15$$

$$T_2 = ?$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$P_1 V_1^\gamma = P_2 V_2^\gamma$$

$$\left(\frac{V_1}{V_2}\right)^\gamma = \frac{P_2}{P_1}$$

$$\frac{V_1}{V_2} = \left(\frac{P_2}{P_1}\right)^{\frac{1}{\gamma}}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$$

$$\gamma = \frac{C_p}{C_v} = \frac{5/2 R}{3/2 R} = \frac{5}{3}$$

$$\gamma - 1 = \frac{2}{3}$$

$$\frac{\gamma - 1}{\gamma} = \frac{2}{5}$$

$$T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} = 298.15 \text{ K} \left(\frac{1}{10}\right)^{\frac{2}{5}} = 118.7 \text{ K}$$

.2

$$Q_1 = q_{1 \rightarrow 2} = nRT_1 \log \frac{V_2}{V_1}$$

$$Q_2 = q_{3 \rightarrow 4} = nRT_2 \log \frac{V_4}{V_3}$$

$$T_1 V_2^{(\gamma-1)} = T_2 V_3^{(\gamma-1)}; T_2 V_4^{(\gamma-1)} = T_1 V_1^{(\gamma-1)}$$

$$\frac{V_2}{V_1} = \frac{V_3}{V_4}$$

$$q_{3 \rightarrow 4} = -nRT_2 \log \frac{V_2}{V_1}$$

$$\frac{Q_1}{T_1} = nR \log \frac{V_2}{V_1}$$

$$\frac{Q_2}{T_2} = -nR \log \frac{V_2}{V_1}$$

$$\frac{Q_1}{T_1} = -\frac{Q_2}{T_2}$$

.3

שלב	P(atm)	V(L)	T(K)
1	1	24.4	298
2	1	48.8	596
3	2	24.4	596

ובטבלה הבאה:

מסלול	סוג תהליך	q(cal)	w(cal)	$\Delta U(cal)$	$\Delta H(cal)$
1->2	איזוברי	1480	-591	889	1480
2->3	איזותרמי	-822	822	0	0
3->1	איזוכורי	-889	0	-889	-1480
סה"כ		-231	231	0	0

מסלול 1-2:

$$w = -\int_{V_1}^{V_2} PdV = -1atm(48.8 - 24.4)L = -24.4Latm \cdot 24.22 \frac{cal}{Latm} = -591cal$$

$$\Delta U = C_v \Delta T = \frac{3}{2} R(596 - 298)K = 889cal$$

$$\Delta H = C_p \Delta T = \frac{5}{2} R(596 - 298)K = 1480cal$$

$$q = \Delta U - w = 889cal - (-591)cal = 1480cal$$

מסלול 2-3:

$$w = -RT \ln \frac{V_3}{V_2} = -R596K \ln \frac{24.4L}{48.8L} = 822cal$$

$$\Delta U = 0$$

$$\Delta H = 0$$

$$q = \Delta U - w = -822cal$$

מסלול 3-1:

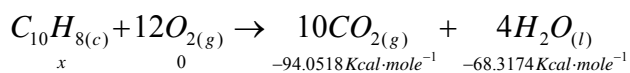
$$w = 0$$

$$\Delta U = C_v \Delta T = \frac{3}{2} R(298 - 596)K = -889cal$$

$$\Delta H = C_p \Delta T = \frac{5}{2} R(298 - 596)K = -1480cal$$

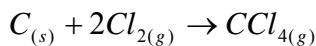
$$q = \Delta U - w = -889cal = -889cal$$

.4



$$\Delta H^\circ = 10 \times -94.0518Kcal \cdot mole^{-1} + 4 \times -68.3174Kcal \cdot mole^{-1} - x = -1231Kcal \cdot mole^{-1}$$

$$x = 17.8Kcal \cdot mole^{-1}$$

.5 התגובה ליצירת CCl_4 היא:

נשתמש באוסף הנתונים:



$$\Delta H_f^\circ(CCl_4) = \Delta H_1^\circ + \Delta H_2^\circ - 4\Delta H_3^\circ = -397.3kJ - 74.81kJ + 369.24kJ = -102.87kJ$$