# Lösungsblatt

## Theorie

1.1 Expansion ins Vakuum:

$T_2 = T_1 = 300$ K  $U_2 = U_1 = \frac{3}{2}nRT_1 = 3741.5$ J  $P_2 = \frac{nRT_2}{V_2} = \frac{nRT_1}{2V_1} = \frac{P_1}{2} = 4989$ Pa

1.2 Adiabatische Expansion:

a) $P_2$ [Formel] = $P_1\left(\frac{V_1}{V_2}\right)^{5/3}$  $P_2$ [Wert] = $9976.8\text{ Pa}\left(\frac{1}{2}\right)^{5/3} = 3142.5$ Pa

b) $W = U \times f(V_2/V_1)$ [Formel] = $U_1\left(1-\left(\frac{V_1}{V_2}\right)^{2/3}\right)$  $W$ [Wert] = $U_1 \times 0.37 = 1385$ J

1.3 Isotherme Expansion:

a) $P_2$ [Formel] = $\frac{P_1V_1}{V_2}$  $P_2$ [Wert] = 9976.8 Pa / 2 = 4988.4 Pa

b) W = U × f(V2/V1) [Formel] = $U\frac{2}{3}\ln\frac{V_2}{V_1}$  W [Wert] = $U \times 0.46 = 1729$ J

1.4 Wärmekapazität:

a) $C_V$ [Formel] = $\frac{3}{2}R$  $C_V$ [Wert] = 12.47 J mol$^{-1}$ K$^{-1}$

$C_P$ [Formel] = $\frac{5}{2}R$  $C_P$ [Wert] = 20.79 J mol$^{-1}$ K$^{-1}$

b) $C$ [Formel] = $\frac{\Delta Q}{\Delta T}$

2.1 Aufbau des Carnot-Kreisprozesses:

a) $P_B$ [Formel] = $\frac{P_AV_A}{V_B}$  $P_B$ [Wert] = $\frac{P_A}{2} = \frac{19954.7\text{ Pa}}{2} = 9977.35$ Pa

b) $P_C$ [Formel] = $P_B\left(\frac{T_1}{T_2}\right)^{5/2}$  $P_C$ [Wert] = $9977.35\text{ Pa}\left(\frac{400\text{ K}}{600\text{ K}}\right)^{5/2} = 3620.65$ Pa

c) $P_D$ [Formel] = $P_A\left(\frac{T_1}{T_2}\right)^{5/2} = 2P_C$  $P_D$ [Wert] = 7241.3 Pa

2.2 Analyse und Optimierung des Carnot-Kreisprozesses:

a) $\eta_{Carnot}$ [Formel] = $1-\frac{T_1}{T_2}$  $\eta_{Carnot}$ [Wert] = $1-\frac{400\text{ K}}{600\text{ K}} = 33\%$

b) Formeln und Werte:

$W_{AB} = U_A\frac{2}{3}\ln\frac{V_B}{V_A} = 3458$ J  $Q_{AB} = W_{AB}$

$W_{BC} = U_B\left(1-\left(\frac{V_B}{V_C}\right)^{2/3}\right) = U_B\left(1-\frac{T_C}{T_B}\right) = U_A\left(1-\frac{T_1}{T_2}\right) = 2494$ J  $Q_{BC} = 0$

$W_{CD} = U_C\frac{2}{3}\ln\frac{V_D}{V_C} = -W_{AB}\frac{T_1}{T_2} = -2305$ J  $Q_{CD} = W_{CD}$

$W_{DA} = -W_{AD} = -U_A\left(1-\frac{T_1}{T_2}\right) = -W_{BC}$  $Q_{DA} = 0$

$\eta = W / Q$ [Formel als Funktion von $T_1$, $T_2$] = $1-\frac{T_1}{T_2} = \eta_{Carnot}$