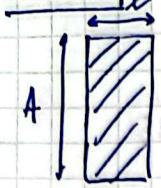
Tutorato scheda 11

Es. 1



$A = 10\ m^2$ $\quad \lambda = 0.465 \frac{W}{mK}$

$\ell = 30\ cm$

$\Delta T = 35\ K$

Da Legge di Fourier per la conduzione termica

$$\dot{Q} = \frac{dQ}{dt} = -\frac{\lambda A \Delta T}{\ell} = -542.5\ W$$

Es. 2

$T_1 = 298\ K$ $\quad d_1 = 0.2\ m$

$T_2 = 273\ K$ $\quad d_2 = 0.1\ m$

$\lambda_1 = 0.25 \frac{W}{mK}$

$\lambda_2 = 0.07 \frac{W}{mK}$

Per regime stazionario il flusso entrante e uscente si eguagliano:

$$\dot{q}_1 = -\lambda_1 \frac{(T_a - T_1)}{d_1} \qquad \dot{q}_2 = -\lambda_2 \frac{(T_b - T_a)}{d_2} \qquad \dot{q}_3 = -\lambda_1 \frac{(T_2 - T_b)}{d_2}$$

$$\begin{cases} +\lambda_1 \frac{(T_a - T_1)}{d_1} = +\lambda_1 \frac{(T_b - T_a)}{d_2} \\ +\lambda_2 \frac{(T_b - T_a)}{d_2} = +\lambda_1 \frac{(T_2 - T_b)}{d_2} \end{cases} \Rightarrow \begin{cases} d_2 (T_a - T_1) = d_1 (T_2 - T_b) \\ \lambda_2 (T_b - T_a) = \lambda_1 (T_2 - T_b) \end{cases}$$

Dalla prima ricaviamo $\quad T_a = \frac{d_1 T_2 + d_2 T_1 - d_1 T_b}{d_2}$

questa inserendola nella seconda porta a

$$T_b = \frac{T_2 (\lambda_1 d_2 + \lambda_2 d_1) + \lambda_2 d_2 T_1}{\lambda_2 (d_2 + d_1) + \lambda_1 d_2} \approx 276.8\ K$$

e usando il valore di T_b appena ricavato troviamo

$$T_a \approx 290.4\ K$$

Es. 3

$V = S_0 \ell = 5 \times 10^{-2}\ m^3$ $\qquad \Delta T = (403 - 363)\,K = 40\,K$

$\rho = 1.25\ \frac{kg}{m^3}$ $\qquad c_V = 1040\ \frac{J}{kg\,K}$

$\rightarrow m = \rho V = 0.0625\ kg$ $\qquad$ efficienza term. $\eta = 0.15$

Assumo trasf. isocora $\rightarrow \Delta U = Q$

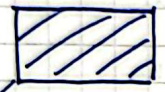
$Q = m\, c_V\, \Delta T = 2.6\ kJ \quad \Rightarrow \quad W = \eta Q = 390\ J$

Es. 4

$V_{dl} = V = 10^{-2}\ m^3$ $\qquad n = 1\ mol$ $\qquad T_0 = 300\ K$

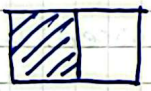
inizio: 

1 mol a T_0

poi:  espansione adiabatica libera $\Rightarrow T_1 = T_0$

$\Rightarrow V_1 = 2V$

infine adiabaticamente e "molto lentamente" $\Leftrightarrow$ reversibilmente

torno a $V_2 = V$ 

Il gas è Argon ($\Rightarrow$ monoatomico) $\rightarrow \gamma = 5/3$

con $c_V = 520\ \frac{J}{kg\,K}$ e $m_\mu = 39.948\ \frac{g}{mol}$

Relazione Adiabatica

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$\rightarrow T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{\gamma-1} = 476\ K \quad \rightarrow \Delta T = T_2 - T_1 = 176\ K$$

$\rightarrow$ Essendo Adiab $\Rightarrow Q = 0 \Rightarrow W = -\Delta U$

$$W = -m\, c_V\, \Delta T = -(n \cdot m_\mu)\, c_V\, \Delta T = -3656\ J$$

Es. 5

Trasformazioni

1) isobara

2) isoterma

$R = 8.314\ \frac{J}{mol\,K}$

$c_V = 717\ \frac{J}{kg\,K}$

$c_p = 1005\ \frac{J}{kg\,K}$

$m_\mu = 28.96\ \frac{g}{mol}$

STATO 0

$p_0 = 58\ atm = 58 \times 10^5\ Pa$

$V_0 = 0.1\ m^3$ $\qquad T_0 = 293\ K$ $\rightarrow n = \frac{p_0 V_0}{R T_0} = 241.3\ mol$

isobara $\Rightarrow p_1 = p_0$

con $Q_1 = 750\ J$

$$\Delta T = \frac{Q_1}{m\, c_p} = \frac{Q_1}{(n \cdot m_\mu)\, c_p} = 0.11\ K$$

$T_1 = T_0 + \Delta T = 293.11\ K$ e $V_1 = \frac{n R T_1}{p_1} = \frac{n R T_1}{p_0} = 0.1\ m^3$

STATO 1

$p_1 = p_0$

$T_1 = 293.11\ K$

$V_1 = 0.1\ m^3$

isoterma $\rightarrow$ $T_2 = T_1$

+ noto $V_2 = 0.3\ m^3$

$\Rightarrow p_2 = \frac{n R T_1}{V_2} = 19.6 \times 10^5\ Pa$

STATO 2

$p_2 = 19.6 \times 10^5\ Pa$

$T_2 = T_1$

$V_2 = 0.3\ m^3$

trasformazione isobara

$Q_1 = 750\ J$

$\Delta U_1 = (n \cdot m_\mu) \cdot c_v \Delta T = 551\ J$

$W = Q_1 - \Delta U_1 = 199\ J$

trasformazione isoterma

$\Delta U_2 = 0$

$Q_2 = W_2$

$W_2 = n R T_2 \ln\left(\frac{V_2}{V_1}\right) = 646\ kJ$

Es. 6

A) Isoterma da $(V_0, 3P_0)$ a $(3V_0, P_0)$

$\rightarrow W_1 = n R T \ln\left(\frac{3V_0}{V_0}\right) = n R T \ln(3)$

B) Isocora + Isobara da $(V_0, 3P_0) \rightarrow (V_0, P_0) \rightarrow (3V_0, P_0)$

isocora $\rightarrow$ non compie lavoro

solo isobara: $W_2 = P_0(3V_0 - V_0) = 2P_0V_0 = 2nRT$

$\Delta W = W_2 - W_1 = nRT(2 - \ln 3)$

Es. 7 Gas monoatomico : $\gamma = 1.66$ $V_0 = 2\,l$

a pressione e temperatura ambiente : $p_0 = 1\,atm$

$T_0 = 293\,K$

Dilatazione adiabatica $V_1 = 2.8\,l$

Usando Relazione adiabatica : $T_0 V_0^{\gamma-1} = T_1 V_1^{\gamma-1}$

$$T_1 = T_0 \left(\frac{V_0}{V_1}\right)^{\gamma-1} = 234.7\ K$$

e $P_0 V_0^{\gamma} = P_1 V_1^{\gamma}$ $\quad P_1 = P_0 \left(\frac{V_0}{V_1}\right)^{\gamma} = 0.57\ atm$