① $R = 6{,}85\,cm$
$q = 1{,}25 \times 10^{-9}\,C$ $\quad K = 9 \times 10^9\,N \cdot m^2/C^2$

$$V = \frac{kq}{r} = 9\times10^9 \frac{N\cdot m^2}{C^2} \cdot \frac{1{,}25\times10^{-9}\,C}{0{,}0685\,m} = \boxed{164\,\frac{N\cdot m}{C}}$$

$$\sigma = \frac{V}{A} \qquad A_{sfera} = 4\pi r^2 = 4\pi(0{,}0685)^2 m^2 = 0{,}059\,m^2$$

$$\sigma = \frac{164\,N\cdot m/C}{0{,}059\,m^2} = 2780\,\frac{N}{Cm}$$

② $m = 680\,g$
$K = 65\,N/m$
$x = 11\,cm \rightarrow 0{,}11\,m$
$t = 0$

a) $F = -kx = -65\,N/m \cdot 0{,}11 = \boxed{-7{,}15\,N}$

b) $\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{65\,N/m}{0{,}68\,kg}} = \boxed{9{,}78\,rad/sec}$

c) $f = \frac{\omega}{2\pi} = \frac{9{,}78\,rad/sec}{2\pi} = \boxed{1{,}55\,s^{-1}}$

d) $T = \frac{1}{f} = \boxed{0{,}65\,s}$

e) $x = A\cos\omega t \qquad t = 0 \qquad x = A = \boxed{0{,}11\,m}$

$v = 2\pi f\sqrt{A^2 - x^2}$ $\quad v_{max}$ quando $x = 0$

f) $v_{max} = 2\pi f A = 9{,}78\,\frac{rad}{s} \cdot 0{,}11\,m = \boxed{1{,}07\,m/s}$

g) $a_{max} = \omega^2 A = \left(9{,}78\,\frac{rad}{s}\right)^2 0{,}11 = \boxed{10{,}5\,m/s^2}$

$x = A\cos(\omega t + \phi) \qquad t = 0$

$x = A \cdot 1 + \cos\phi$

$0{,}11 = 0{,}11 + \cos\phi$

h) $\cos\phi = 1 \qquad \boxed{\phi = 0}$

(3.) $1,2\times10^{-3}\,m^2$ $6\times10^{-4}\,m^2$

$\rho = 791\ kg/m^3$ $\Delta P = 4120\ Pa$

$P_1 + \frac{1}{2}\rho v_1^2 + \cancel{\rho g h_1} = P_2 + \frac{1}{2}\rho v_2^2 + \cancel{\rho g h_2}$ $h_1 = h_2$ tubo orizzontale

$A_1 v_1 = A_2 v_2$

$v_2 = \frac{A_1 v_1}{A_2}$

$P_1 - P_2 = \frac{1}{2}\rho v_2^2 - \frac{1}{2}\rho v_1^2$

$\Delta P = \frac{1}{2}\rho (v_2^2 - v_1^2)$

$\Delta P = \frac{1}{2}\rho \left[\left(\frac{A_1 v_1}{A_2}\right)^2 - v_1^2\right]$

$\Delta P = \frac{1}{2}\rho \left[4 v_1^2 - v_1^2\right]$

$\Delta P = \frac{1}{2}\rho\, 3 v_1^2$

$v_1 = \sqrt{\frac{2\Delta P}{3\rho}} = \sqrt{\frac{2}{3}\frac{4120\,Pa}{791\,kg/m^3}} = 1,86\ \frac{m}{s}$

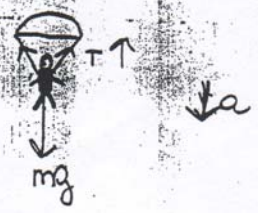
$v_2 = \frac{A_1 v_1}{A_2} = 2 \cdot 1,86 = \boxed{3,72\ m/s}$

$Q = A_2 v_2 = 6\times10^{-4}\ m^2 \cdot 3,72\ \frac{m}{s} = \boxed{2,2\times10^{-3}\ \frac{m^3}{s}}$

(6) $t = 5\,s$ $\quad v_1 = x$

4 $\Delta t = 0{,}8$ $\quad v_2 = 12\ m/s$

$m = 70\ kg$



$v_1 = gt = 9{,}8\ \frac{m}{s^2} \cdot 5\,s = 49\ \frac{m}{s}$

$a = \frac{v_1 - v_2}{\Delta t} = \frac{49\ m/s - 12\ m/s}{0{,}8\,s} = 46{,}25\ \frac{m}{s^2}$

$T = mg + ma$ supponendo che e' uomo pesi 70 kg

$T = 70\,kg + \frac{70}{9{,}8} \cdot 46{,}25\ \frac{m}{s^2}$

$T = 70\,kg + 330\,kg = \boxed{400\,kg}$

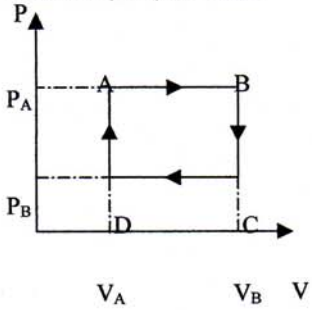
$T = 3920\ N$

Esercizio 5

Un gas perfetto monoatomico ($\gamma = 1{,}7$; $C_P = \frac{5}{2}R$; $C_V = \frac{3}{2}R$) esegue il ciclo reversibile mostrato in figura. I tratti BC e DA sono isocori, mentre i tratti AB e CD sono isobari. Calcolare:

d) Il lavoro compiuto dal sistema nell'intero ciclo;
e) Il calore scambiato con l'esterno nei tratti AB, BC, CD e DA
f) Il rendimento del ciclo.

[P_A=4 atm, P_B=2 atm, V_A= 1 lt, V_B=4 lt]



$1\,dm^3 = 10^{-3}\,m^3$

Soluzione Esercizio 5

$6\cdot10^{-3}\,m^3 \cdot 1.013\cdot10^5\,Pa$

a) Il lavoro è espresso da

$$L = L_{AB} + L_{BC} + L_{CD} + L_{DA} = P_A(V_B - V_A) + P_B(V_A - V_B) = (V_B - V_A)(P_A - P_B) = 3l \cdot 2atm = 6l \cdot atm \simeq 607.8\,J$$

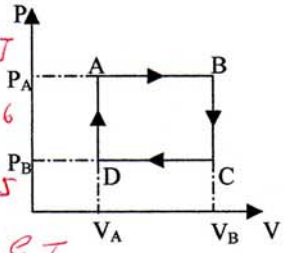
b) Ricordando che $PV = nRT$ il calore scambiato risulta essere

$$Q_{AB} = nC_P(T_B - T_A) = \frac{C_P}{R}(P_BV_B - P_AV_A) = \frac{5}{2}(16-4) = 30l \cdot atm = 3039\,J$$

$$Q_{BC} = nC_V(T_C - T_B) = \frac{C_V}{R}(P_CV_C - P_BV_B) = \frac{3}{2}(8-16) = -12l \cdot atm = -1215.6\,J$$

$$Q_{CD} = nC_P(T_D - T_C) = \frac{C_P}{R}(P_DV_D - P_CV_C) = \frac{5}{2}(2-8) = -15l \cdot atm = -1519.5\,J$$

$$Q_{DA} = nC_V(T_A - T_D) = \frac{C_P}{R}(P_AV_A - P_DV_D) = \frac{3}{2}(4-2) = 3l \cdot atm = 303.9\,J$$



Si osservi che $Q_{ass} = Q_{AB} + Q_{DA} = 33l \cdot atm$

$Q_{ced} = Q_{BC} + Q_{CD} = -27l \cdot atm$

c) il rendimento si calcola come $\eta = 1 + \frac{Q_{ced}}{Q_{ass}} = 1 - \frac{27}{33} = 0{,}18$

$$PV = nRT \Rightarrow nT = \frac{PV}{R}$$