Lezione 21 25/05/2023

giovedì 25 maggio 2023 11:30

Lezione # 21

25/05/2023

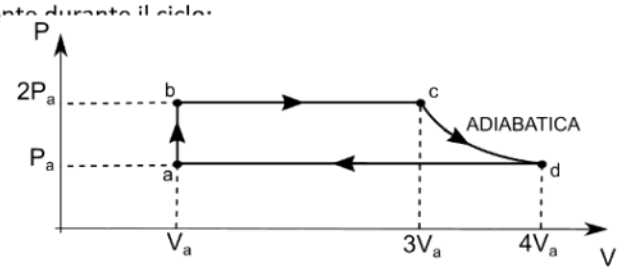
Esercitazione aggiuntiva:

Testo esercizi:

Esercizio 1 (13 pti)

Un certo numero *n* di moli (sconosciute) di un gas perfetto monoatomico (Cv=3/2 R; Cp= 5/2 R), compie il ciclo termodinamico mostrato in figura con p_aV_a = 2486 J. Calcolare:

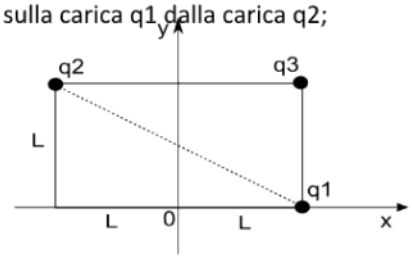
1. Il calore assorbito e ceduto complessivamente durante il ciclo;
2. Il lavoro svolto durante il ciclo;
3. Il rendimento termico di questa macchina;
4. Il rendimento di una macchina di Carnot che opera tra due sorgenti a T_1 = 365 K e T_2 = 922 K, rispettivamente.



Esercizio 2 (13 pti)

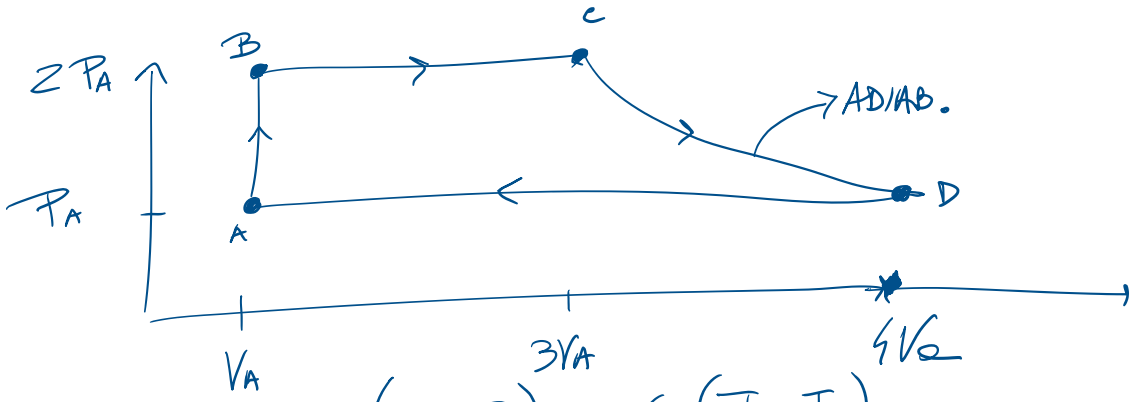
Tre cariche puntiformi q1, q2 e q3, sono tenute ferme nella configurazione riportata in figura. Le cariche valgono: q1 = q2 = 3.20 10^{-19} C e q3 = -2q1 e la distanza L = 2.66 cm. Calcolare:

1. Il modulo, direzione e verso della forza di Coulomb esercitata sulla carica q1 dalla carica q2;
2. Il valore del campo elettrico complessivo all'origine degli assi;
3. Supponendo ora che la carica q2 si metta in movimento con una velocità pari a v_2 = 2 10^6 m/s diretta lungo l'asse delle x crescenti e che sia immersa in un campo B = 5 T perpendicolare al piano xy e uscente, calcolare e disegnare la Forza di Lorentz risultante.



Esercizio #1

1)



$$Q_{ASS} = Q_{AB} + Q_{BC} = n C_V (T_B - T_A) + n C_P (T_C - T_B)$$

$$PV = nRT \qquad T = \frac{PV}{nR} \qquad T_A = \frac{P_A V_A}{nR}; \quad T_B = \frac{P_B V_B}{nR}; \quad T_C = \frac{P_C V_C}{nR}$$

$$Q_{ASS} = n \frac{3}{2} R \left(\frac{P_B V_B}{nR} - \frac{P_A V_A}{nR} \right) + n \frac{5}{2} R \left(\frac{P_C V_C}{nR} - \frac{P_B V_B}{nR} \right)$$

$$= \frac{3}{2} \left(2 P_A V_A - P_A V_A \right) + \frac{5}{2} \left(6 P_A V_A - 2 P_A V_A \right)$$

$P_A V_A$ ↑ $\quad \frac{5}{2} \cdot 4 P_A V_A$

$$= \frac{3}{2} P_A V_A + \frac{20}{2} P_A V_A = \frac{23}{2} P_A V_A$$

$$Q_{ASS} = \frac{23}{2} P_A V_A = \frac{23}{2} \cdot 2486 = 28589\ J$$

P_A ↓ ↑ $4V_A$

$$Q_{CED} = n C_P (T_A - T_D) = n \frac{5}{2} R \left(\frac{P_A V_A}{nR} - \frac{P_D V_D}{nR} \right)$$

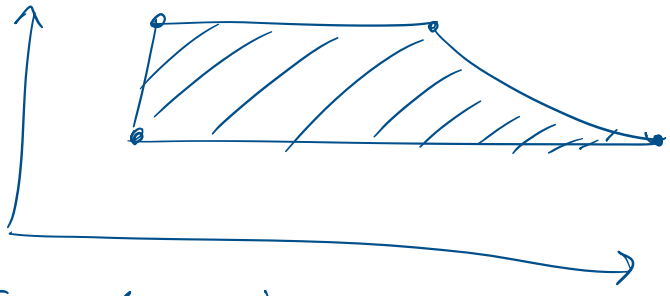
$$= \frac{5}{2}\left(P_A V_A - 4 P_A V_A\right) = -\frac{15}{2} P_A V_A$$

$(-4+1) = -3$

$-3 P_A V_A$

$$Q_{CED} = -\frac{15}{2} P_A V_A = -1864{,}5\ J$$

3) Lavoro svolto?



Ciclo $\Rightarrow \Delta E = 0 \Rightarrow$ 1° legge Termodinamica

$\Rightarrow 0 = Q - L \Rightarrow Q = L \Rightarrow |Q_{ASS}| - |Q_{CED}| = L$

↑ ↑ ↓ ?

$L = \frac{23}{2} P_A V_A - \frac{15}{2} P_A V_A = \frac{8}{2} P_A V_A = 4 P_A V_A$

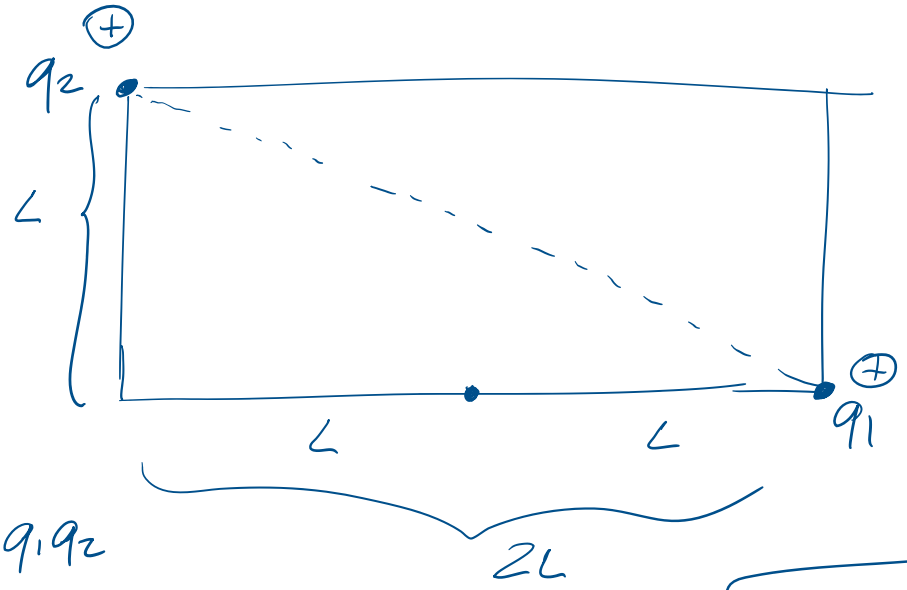
$L = 28589 - 18645 = 9944\ J$

4) $\eta = \frac{L}{Q_{ASS}} = \frac{4 P_A V_A}{\frac{23}{2} P_A V_A} = \frac{8}{23} = 0{,}34 = 34\%$ ✓

5) $\eta_{CARNOT} = 1 - \frac{T_1}{T_2} = 0{,}6041 \simeq 60\%$ ✓

Esercizio #2

1)



$$F_{12} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r_{12}^2}$$

$|q_1| = |q_2| = q$

$$= \frac{1}{4\pi\varepsilon_0} \frac{q^2}{5L^2}$$

$$r_{12} = \sqrt{(2L)^2 + L^2}$$

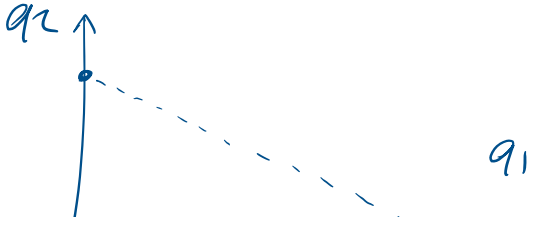
$$= \sqrt{4L^2 + L^2}$$

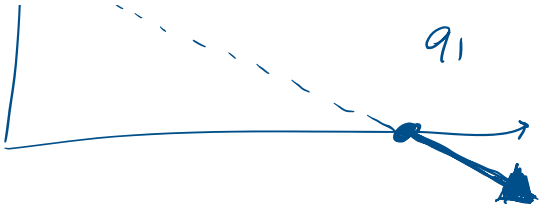
$$= \sqrt{5L^2}$$

$$r_{12} = L\sqrt{5}$$

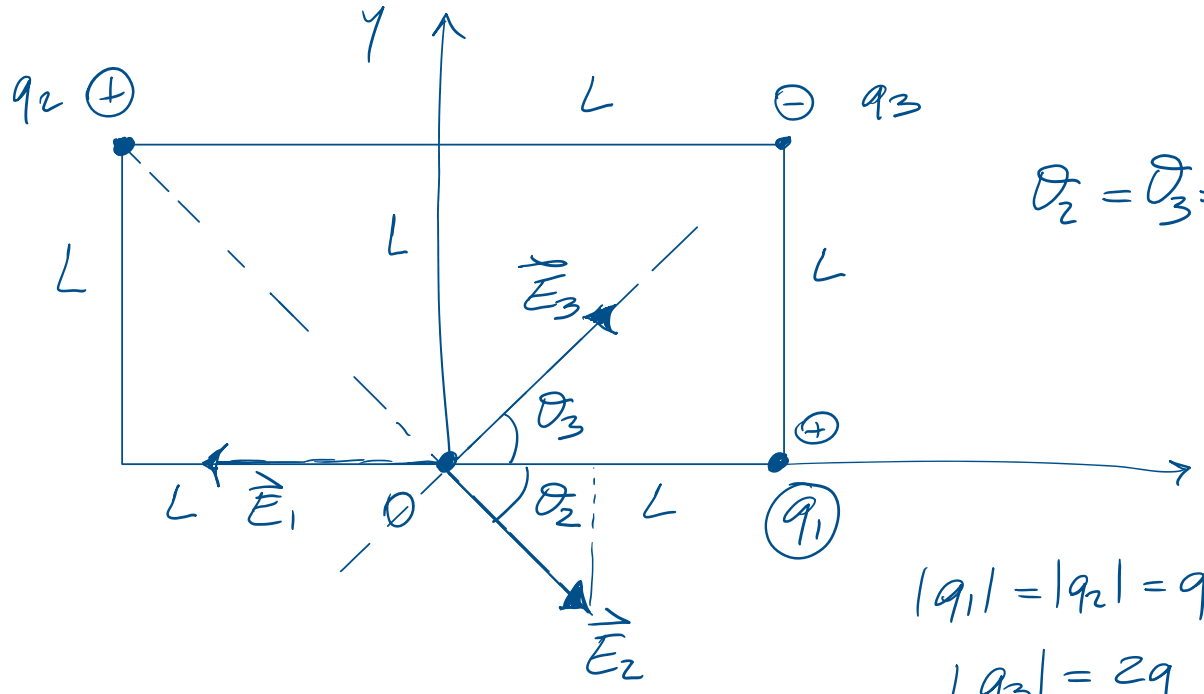
$$r_{12}^2 = 5L^2$$

$$\boxed{F_{12} = 5{,}2042\, 10^{-26}\ N}$$





2)



$\theta_2 = \theta_3 = \theta = 45°$

$|q_1| = |q_2| = q$

$|q_3| = 2q$

$q_3 < 0$

$$\begin{cases} E_x = E_3 \cos\theta + E_2 \cos\theta - E_1 \\ E_y = E_3 \sin\theta - E_2 \sin\theta \end{cases}$$

$r_1 = L$

$r_1^2 = L^2$

$$E_x = \frac{1}{4\pi\varepsilon_0}\left[\frac{2q}{2L^2}\cos\theta + \frac{q}{2L^2}\cos\theta - \frac{q}{L^2}\right]$$

$r_2 = \sqrt{L^2 + L^2}$

$r_2 = L\sqrt{2}$

$r_2^2 = 2L^2$

$$E_y = \frac{1}{4\pi\varepsilon_0}\left[\frac{2q}{2L^2}\sin\theta - \frac{q}{2L^2}\sin\theta\right]$$

$r_3^2 = 2L^2$

$\sin\theta = \cos\theta$ quando $\theta = 45°$

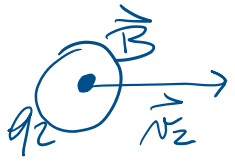
$\sqrt{2}$

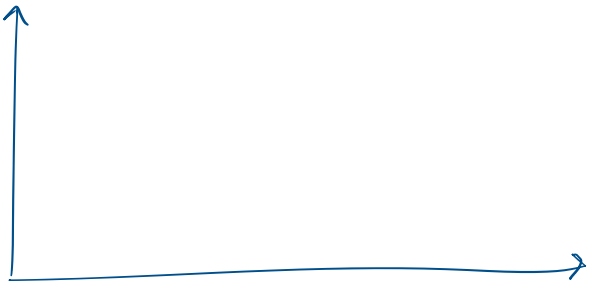
$\cos 45° = \frac{\sqrt{2}}{2}$ $\quad$ $\sin 45° = \frac{\sqrt{2}}{2}$

$$\begin{cases} E_x = \frac{1}{4\pi\varepsilon_0}\frac{q}{L^2}\left(\frac{3}{2}\sqrt{2} - 1\right) = 4{,}5591\cdot 10^{-6}\ N/C \\ E_y = \frac{1}{4\pi\varepsilon_0}\frac{q}{L^2}\left(\underbrace{\frac{2}{2}\left(\frac{\sqrt{2}}{2}\right)}_{\frac{1}{2}\ \frac{\sqrt{2}}{2}} - \frac{1}{2}\left(\frac{\sqrt{2}}{2}\right)\right) = 1{,}437\cdot 10^{-6}\ N/C \end{cases}$$

$$|\vec{E}| = \sqrt{E_x^2 + E_y^2} = 4{,}7809\cdot 10^{-6}\ N/C$$

3) $\vec{F}_2 = q_2 \vec{v}_2 \times \vec{B}$





$F_2 = q_2 v_2 B \underbrace{\sin\theta}_{1} = q_2 v_2 B$

$= (3{,}2\cdot 10^{-19})(2\cdot 10^{6})(5)$

$$F_c = 3{,}2\ 10^{-12}\ N$$