

**Prirodno-matematički fakultet
OLIMPIJADA ZNANJA 2024**

**Takmičenje iz FIZIKE
za II razred srednje škole**

RJEŠENJA

1. Pretpostavimo da se čestice kreću duž x-ose brzinama u_1 i u_2 i da je u brzina sistema dvije čestice poslije neelastičnog sudara. Kinetička energija transformisana u toplotu je:

$$\Delta E_k = \frac{m_1 v_1^2}{2} + \frac{m_2 v_2^2}{2} - \frac{(m_1 + m_2) v^2}{2} \quad (1) \quad (5 \text{ bodova})$$

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v \quad (2) \quad (5 \text{ bodova})$$

Zamjenom u iz izraza 2 u 1 dobijamo:

$$\Delta E_k = \frac{m_1 m_2 (v_1 - v_2)^2}{2(m_1 + m_2)} \quad (8 \text{ bodova})$$

$$\frac{m_1 m_2}{m_1 + m_2} = \frac{3}{4} g \quad (1 \text{ bod})$$

$$v_1 - v_2 = v_r \quad (5 \text{ bodova})$$

$$\Delta E_k = \frac{m_1 m_2 v_r^2}{2(m_1 + m_2)} = 3,75 J \quad (1 \text{ bod})$$

2.

- a) Primjenom Bernulijeve jednačine i proglašavanjem tačke C za nulti nivo potencijalne energije dobijamo:

$$p_d = p_c$$

$$p_{0d} + \rho g(d + h_2) + \frac{\rho v_d^2}{2} = p_{0c} + \rho g h_c + \frac{\rho v_c^2}{2}$$

Kako je:

$$h_c = 0$$

$$p_{0d} = p_{0c} = p_0 \text{ i}$$

$$S_d \gg S_c \rightarrow v_d \approx 0 \frac{m}{s} \text{ dobijamo:}$$

$$\rho g(d + h_2) = \frac{\rho v_c^2}{2}$$

$$g(d + h_2) = \frac{v_c^2}{2}$$

$$v_c = \sqrt{2g(d + h_2)}$$

$$v_c = 3,46 \frac{m}{s} \quad (10 \text{ bodova})$$

$$\text{b) } p_b = p_c$$

$$p_{0b} + \rho g(d + h_1 + h_2) + \frac{\rho v_b^2}{2} = p_{0c} + \rho g h_c + \frac{\rho v_c^2}{2}$$

Kako je:

$$h_c = 0$$

$$p_{0c} = p_0 \text{ i}$$

$$v_{0c} = v_{0b} \text{ dobijamo:}$$

$$p_{0b} + \rho g(d + h_1 + h_2) = p_0$$

$$p_{0b} = -\rho g(d + h_1 + h_2) + p_0$$

$$p_{0b} = 9,2 * 10^4 \text{ Pa}$$

(7 bodova)

c) Da bi sifon mogao da izvlači vodu pritisak u tački B mora biti veći ili jednak nuli.

$$p_{0b} \geq 0$$

$$-\rho g(d + h_1 + h_2) + p_0 \geq 0$$

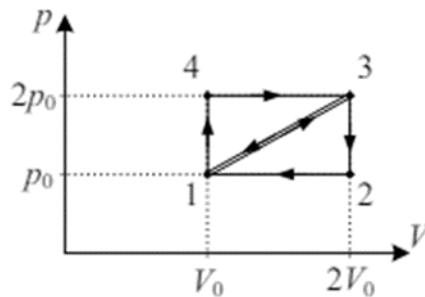
$$\rho g(d + h_1 + h_2) \leq p_0$$

$$h_1 \leq \frac{p_0}{\rho g} - d - h_2$$

$$h_{1\max} = \frac{p_0}{\rho g} - d - h_2 = 9,4 \text{ m}$$

(8 bodova)

3.



Za ciklus 1-3-2-1, toplota se dovodi gasu u procesu 1-3, a odvodi od gasa u procesima 3-2 i 2-1.

$$Q = \Delta U + A$$

$$\Delta U = \frac{jn_m R \Delta T}{2}$$

$$Q_{13} = \frac{jn_m R (T_3 - T_1)}{2} + \frac{3}{2} p_0 V_0$$

$$Q_{13} = \frac{j(4p_0 V_0 - p_0 V_0)}{2} + \frac{3}{2} p_0 V_0$$

(3 boda)

$$Q_{13} = \frac{j3p_0 V_0}{2} + \frac{3}{2} p_0 V_0$$

$$Q_{13} = \frac{3}{2} p_0 V_0 (j + 1) = Q_{do} \quad (1 \text{ bod})$$

$$Q_{32} = n_m \frac{j}{2} R (T_2 - T_3) = -j p_0 V_0; \quad (4 \text{ boda})$$

$$Q_{21} = n_m \frac{j+2}{2} R (T_1 - T_2) = -\frac{j+2}{2} p_0 V_0; \quad (4 \text{ boda})$$

$$Q_{od} = Q_{32} + Q_{21} = -\frac{3j+2}{2} p_0 V_0. \quad (1 \text{ bod})$$

Stepen korisnog dejstva ciklusa 1-3-2-1 iznosi:

$$\eta_{1321} = \frac{Q_{do} - |Q_{od}|}{Q_{do}} = \frac{1}{3(j+1)}. \quad (1 \text{ bod})$$

Za ciklus 1-4-3-1, toplota se dovodi gasu u procesima 1-4 i 4-3, a odvodi od gasa u procesu 3-1:

$$Q_{14} = n_m \frac{j}{2} R (T_4 - T_1) = \frac{j}{2} p_0 V_0; \quad (4 \text{ boda})$$

$$Q_{43} = n_m \frac{j+2}{2} R (T_4 - T_3) = (j+2) p_0 V_0; \quad (4 \text{ boda})$$

$$Q_{do} = Q_{14} + Q_{43} = \frac{3j+4}{2} p_0 V_0.$$

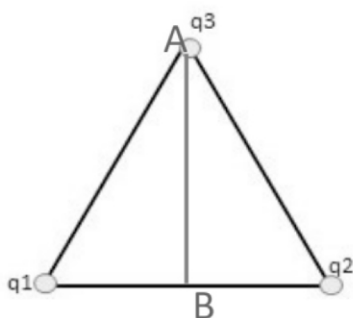
Stepen korisnog dejstva ciklusa 1-4-3-1 iznosi:

$$\eta_{1431} = \frac{Q_{do} - |Q_{od}|}{Q_{do}} = \frac{1}{3(j + \frac{4}{3})}.$$

Traženi odnos iznosi:

$$\frac{\eta_{1321}}{\eta_{1431}} = \frac{j + \frac{4}{3}}{j + 1} = \frac{3 + \frac{4}{3}}{3 + 1} = \frac{13}{12} = 1.08. \quad (3 \text{ boda})$$

4.



$$A = q_3 (\varphi_A - \varphi_B)$$

$$q_1 = q_2 = q$$

$$\varphi_A = \frac{kq_1}{a} + \frac{kq_2}{a} = 2 \frac{kq}{a} \quad (5 \text{ bodova})$$

$$\varphi_A = \frac{kq_1}{\frac{a}{2}} + \frac{kq_2}{\frac{a}{2}} = 4 \frac{kq}{a} \quad (5 \text{ bodova})$$

$$A = q_3 (\varphi_A - \varphi_B) = q_3 \left(2 \frac{kq}{a} - 4 \frac{kq}{a} \right) \quad (5 \text{ bodova})$$

$$A = -q_3 2 \frac{kq}{a} = 0,675J$$

(5 bodova)

Rad je pozitivan, što znači da ga vrši sam sistem naelektrisanja.

(5 bodova)