1. $V = 1\ m^3$

$p = 10\ Pa$

$t = 20^\circ C \rightarrow T = 273{,}15 + 20 = 293{,}15\ K$

a) $m = ?$

b) $p = ?$, jeśli $T_i = T_o = 10^5\ K$

a) $pV = nRT$ $\quad n = \frac{m}{M}$, $R = 8{,}314\ J/K\,mol$

$\Rightarrow m = \frac{M \cdot p \cdot V}{R \cdot T} = 4{,}1 \cdot 10^{-6}\ kg$ $\quad M_{wodór} = 10^{-3}\ kg/mol$

b) $p = \frac{nRT}{MV} = 3408{,}74\ Pa$

2. $n = 10^{20}\ /m^3$

$k_B T_i = k_B T_e = 10\ keV$

a) ω_{pe}? $\omega_{pe} = \sqrt{\frac{n_e e^2}{m_e \varepsilon_0}}\ [\ ]^{-1}$

b) η_D? $\eta_D = \sqrt{\frac{\varepsilon_0 k_B T}{n_{0e} e^2}}\ [m]$ → premisliti u J

c) N_D? $N_D = \frac{4}{3}\pi \eta_D^3\, n_{0e}$

3. $\frac{n_i}{n_n} \simeq 2.4 \cdot 10^{21} \frac{T^{\frac{3}{2}}}{n_i} e^{\left(-\frac{v_i}{kT}\right)}$ → $v_i = 14.5$ → doprinos sudarnoj ionizaciji

$1eV = 11605\ K$ tj. $k = 1.38 \cdot 10^{-23}\ J/K$

$T = 300\ K$

$v_i = 14.5\ eV$ (dušik) → energija ionizacije

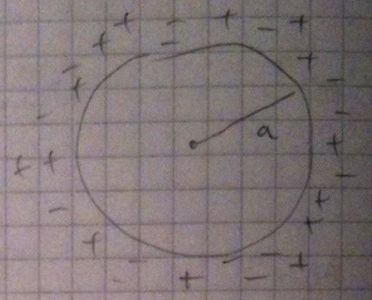
$\frac{v_i}{kT} \to 0.059$

e^{-560}

Član $e^{-\left(\frac{v_i}{kT}\right)}$ predstavlja doprinos sudarnoj ionizaciji, a pošto je e^{-560} jako mali broj, nema dovoljno mjesta ionizirajućih čestica ($\frac{n_i}{n_n} \approx 10^{-112}$), pa se plin ne može smatrati plazmom

4. a) $n = n_0 e^{\frac{e\phi_s}{k_B T_e}}$

$e\phi_s << k_B T_e$



$n_e \sim n_0 \left(1 + \frac{e\phi}{k_B T_e}\right)$

$\rho = e(n_i - n_e)$

$\nabla^2 \cdot \phi = \frac{\rho}{\varepsilon_0} = -\frac{n_0}{\varepsilon_0}\left(1 - \left(1 + \frac{e\phi}{k_B T_e}\right)\right)e$ $\quad n_i = n_0$

$\nabla^2\phi + \frac{n_0}{\varepsilon_0}\left(\frac{e^2\phi}{k_B T_e}\right) = 0 \qquad \lambda_D^2 = \frac{\varepsilon_0 T_e}{n_0 e^2}$

$\nabla^2\phi - \frac{1}{\lambda_D^2}\phi = 0$

PRETPOSTAVLJENA FUNKCIJA

$\phi = \frac{A}{r} e^{\frac{r}{\lambda_D}} + \frac{B}{r} e^{\frac{r}{\lambda_D}}$

početni uvjeti $\quad r \to \infty, \ \phi = 0 \Rightarrow B = 0$

$r \to a, \ \phi = \phi_s$ ili $\phi_s = \frac{A}{a} e^{-\frac{a}{\lambda_D}}$

$\Rightarrow A = \frac{a\phi_s}{e^{-\frac{a}{\lambda_D}}} = a\phi_s e^{\frac{a}{\lambda_D}}$

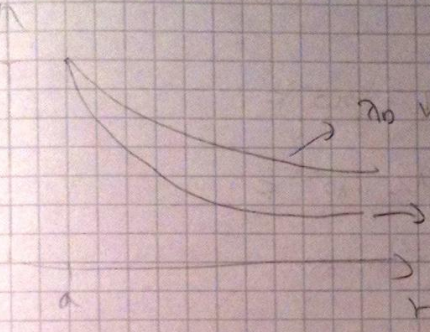
$\Rightarrow$ konačno rješenje

$\phi = \frac{a\phi_s}{r} \cdot e^{\frac{a}{\lambda_D}} \cdot e^{-\frac{r}{\lambda_D}}$

NACRTATI ϕ u ovisnosti o r za 2 slučaja

1 $\lambda_D << a$, $\lambda_D >> a$

$\phi = \frac{a}{r} \phi_s e^{\frac{a-r}{\lambda_D}}$ $\quad \phi = \frac{a}{r} \phi_s e^{\frac{a}{\lambda_D}} \approx \frac{a}{r} \phi_s a^{-\frac{r}{\lambda_D}}$



b) vrijedi na sferi

$$\oint_S \vec{E} \, d\vec{A} = \frac{1}{\varepsilon_0} \iiint_V \rho \, dV$$

$$E \cdot 4a^2\pi = \frac{1}{\varepsilon_0} \cdot Q_{SFERE}$$

$$\vec{E} = -\vec{\nabla} \phi \quad , \phi = \frac{a\phi_s}{r} e^{\frac{a}{\lambda_D}} e^{-\frac{r}{\lambda_D}}$$

$$E = -\frac{\partial \phi}{\partial r} = -\left(-\frac{a}{r^2} e^{\frac{a}{\lambda_D}} \phi_s e^{-\frac{r}{\lambda_D}} + \frac{a}{r} \phi_s e^{\frac{a}{\lambda_D}} \left(-\frac{1}{\lambda_D}\right) e^{-\frac{r}{\lambda_D}} \right)$$

$$= \frac{a}{r^2} e^{\frac{a}{\lambda_D}} \phi_s e^{-\frac{r}{\lambda_D}} \left(1 + \frac{r}{\lambda_D}\right)$$

$$Q_{SFERE} = 4\pi a^2 \varepsilon_0 \left(\frac{a}{a^2} e^{\frac{a}{\lambda_D}} \phi_s e^{-\frac{a}{\lambda_D}} \right) \left(1 + \frac{a}{\lambda_D}\right)$$

$$= 4\pi \varepsilon_0 a \phi_s \left(1 + \frac{a}{\lambda_D}\right)$$

CAPACITET

$$C = \frac{Q}{\phi_s - \phi_\infty} = \frac{4\pi\varepsilon_0 a \phi_s \left(1 + \frac{a}{\lambda_D}\right)}{\phi_s} = 4\pi\varepsilon_0 a \left(1 + \frac{a}{\lambda_D}\right)$$

$$\lambda_D^2 \sim \frac{1}{n_0}$$

$\lambda_{D1} = 2.35 \cdot 10^{-3}$ cm $\quad C_1 = 4.7 \cdot 10^{-8}$ F

$\lambda_{D2} = 23.5$ cm $\quad C_2 = 1.6 \cdot 10^{-11}$ F

$\lambda_D \gg a \Rightarrow C = 4\pi\varepsilon_0 a \left(1 + \frac{a}{\lambda_D}\right)$ zavedeného

$\lambda_D \ll a \Rightarrow C = 4\pi\varepsilon_0 a \left(1 + \frac{a}{\lambda_D}\right)$ kovového

u kuličky $C = \frac{Q}{V}$, $\phi_s = \frac{Q}{4\pi\varepsilon_0 a} = 1.11 \cdot 10^{-11}$ F