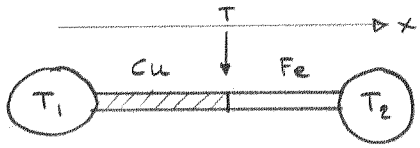
2007-12-16

Lösningar till tentamen i Fysik B för D2

①



Ur tabell: $\lambda_{Cu} = 400\ W/m\cdot K$, $\lambda_{Fe} = 75\ W/m\cdot K$ $\Rightarrow \frac{\lambda_{Cu}}{\lambda_{Fe}} = 4$

Värmeflödet $\Phi = -\lambda S \frac{dT}{dx}$

De båda stavarna har samma tjocklek och samma längd.

$\Rightarrow (T_1 - T)\cdot \lambda_{Cu} = (T - T_2)\lambda_{Fe}$

$\Rightarrow (T_1 - T)\,4\lambda_{Fe} = (T - T_2)\lambda_{Fe}$

$\Rightarrow \Delta T_{Cu} = \frac{1}{4}\Delta T_{Fe} = \frac{1}{4}\,70 = 17{,}5°C$

$\Rightarrow T_1 = 90 + 17{,}5 = \underline{107{,}5°C}$

②

Li^{2+}; $Z = 3 \Rightarrow E_{jon} = 13{,}6\cdot 3^2\ eV$

$n = 3 \to n = 1$ $\quad \Delta E = E_{jon}\left(1 - \frac{1}{9}\right) = 108{,}8\ eV$

$\Delta E = \frac{hc}{\lambda} \Rightarrow \frac{1}{\lambda} = \frac{\Delta E}{hc}$ i $p = \frac{h}{\lambda} = \frac{1{,}6\cdot 10^{-19}\cdot 108{,}8}{3\cdot 10^8} = 0{,}58\cdot 10^{-25}\ kgm$

H: $\Delta E = -13{,}6\left(\frac{1}{2^2} - \frac{1}{n_x^2}\right)$

$\lambda = \frac{hc}{\Delta E} = \frac{hc}{13{,}6\left(\frac{1}{4} - \frac{1}{n_x^2}\right)\cdot 1{,}6\cdot 10^{-19}}$ Rom R

$n_x = 3 \Rightarrow \lambda = 0{,}658\ \mu m$ ~ $0{,}6564\ \mu m$

He^+, $Z = 2 \Rightarrow E'_{jon} = 13{,}6\cdot 2^2\ eV$

$\lambda = \frac{hc}{4\cdot 13{,}6\left(\frac{1}{16} - \frac{1}{n_x^2}\right)\cdot 1{,}6\cdot 10^{-19}}\ m$ Rom R

$n_x = 6$ ger $\lambda = 0{,}658\ \mu m$ ~ $0{,}6562\ \mu m$

He^+ har större kärnmassa än H $\Rightarrow \lambda_{He} < \lambda_H$

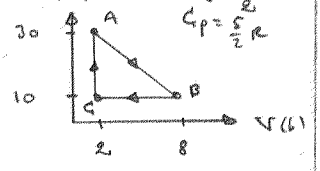
③

$pV = n'RT$

$Q_{BC} = n' C_p (T_C - T_B)$

$Q_{CA} = n' C_V (T_A - T_C)$

$\eta = \frac{W_{netto}}{Q_{tillf}}$



$C_V = \frac{3}{2}R$, $C_p = \frac{5}{2}R$

$W_{netto} = [\text{triangelns yta}] = \frac{1}{2}(30-10)\cdot 10^5 (8-2)\cdot 10^{-3} = 6000\ J$

$Q_{BC} < 0$ ty $T_C < T_B$

$Q_{tillf} = Q_{AB} + Q_{CA}$

$Q_{CA} = n' C_V \left(\frac{P_A V_A}{n'R} - \frac{P_C V_C}{n'R}\right) = \frac{3}{2}\left(30-10\right)\cdot 10^5 \cdot 2\cdot 10^{-3} = 6000\ J$

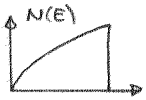
$Q_{AB} = \Delta U_{AB} + W_{AB} = \Delta U_{AB} + W_{netto} + W_{CB} =$

$= n' C_V \left(\frac{P_B V_B}{n'R} - \frac{P_A V_A}{n'R}\right) + W_{netto} + 10\cdot 10^5 + 6\cdot 10^{-3} =$

$= \frac{3}{2}(8000 - 6000) + 6000 + 6000 = 15000\ J$

$\therefore \eta = \frac{6000}{21000} = 0{,}28 = 28\%$

④ a) medianenergin för tredim. elektrongas vid $T = 0$



$\int_0^{E_M} konst\cdot E^{1/2}\cdot 1\cdot dE = \int_0^{E_F} konst\cdot E^{1/2}\cdot 1\cdot dE \Rightarrow E_M = 0{,}63 E_F = 63\%$ av E_F

b) i) $\int_0^\infty |\psi|^2 \cdot 4\pi r^2 \cdot dr = 1 \Rightarrow A^2 = \frac{1}{\int_0^\infty e^{-2r/a}\cdot 4\pi r^2\cdot dr}$

ii) $P(r = 2a) = A^2 \cdot e^{-2\cdot 2a/a}\cdot 4\pi (2a)^2 \cdot dr$

$P(r = a/2) = A^2 \cdot e^{-2\cdot \frac{a}{2}/a}\cdot 4\pi \left(\frac{a}{2}\right)^2 \cdot dr$

kvot $= \frac{e^{-4}\cdot 4a^2}{e^{-1}\cdot \frac{1}{4}a^2} = \underline{16e^{-3}} = 0{,}80$

⑤ a) Braggs lag $2\cdot d_{hkl}\cdot \sin\theta = \lambda$

$\Rightarrow 2\cdot d_{hkl}\cdot \Delta\theta\cdot \cos\theta = \Delta\lambda$

$\Delta\lambda$ konst: små vinklar ger $\cos\theta$ rel. stort $\Rightarrow \Delta\theta$ litet

b) $\lambda_x > 1{,}9340\ Å \Rightarrow \sin\theta_x > \sin\theta_{1{,}9340}$

$\therefore$ till $1{,}9340\ Å$ hör $\sin^2\theta = 0{,}1843$ $0{,}6703$

$0{,}2450$ $0{,}7314$

$0{,}4887$ $0{,}9739$

studie av kvoterna ger att strukturen är fcc.

c) $\sin^2\theta = 0{,}9739$ tillhör hkl = 400

$d_{hkl} = \frac{a}{\sqrt{h^2+k^2+l^2}}$ $\quad \therefore 2\cdot \frac{a}{4}\sqrt{0{,}9739} = 1{,}9340$

$\Rightarrow \underline{a = 3{,}92\ Å}$

d) $\frac{\lambda_x}{\lambda_{1{,}9340}} = \sqrt{\frac{0{,}9777}{0{,}9739}} \Rightarrow \lambda_x = \underline{1{,}938\ Å}$

⑥ odopat: $\eta_i = \frac{1}{\sigma_i}$ $\quad \sigma_i = n_i e\mu_e + p_i e\mu_h$

$n_i \cdot p_i = 4\cdot 10^{36}\ m^{-6} \Rightarrow n_i = p_i = 2\cdot 10^{18}\ m^{-3}$

$\Rightarrow \sigma_i = 2\cdot 10^{18}\cdot 1{,}6\cdot 10^{-19}(0{,}15 + 0{,}05) \Rightarrow \eta_i = \underline{15{,}6\ \Omega m}$

E_F: $p = 2{,}5\cdot 10^{25}\cdot e^{-E_F/kT}$

$\Rightarrow -E_F/kT = \ln\frac{2\cdot 10^{18}}{2{,}5\cdot 10^{25}} \Rightarrow E_F = 0{,}42\ eV$

$kT = 0{,}0259\ eV$ $\quad E_g = 2E_F$ $\quad \therefore E_g - E_F = \underline{0{,}42\ eV}$

$\Rightarrow E_g = 0{,}84\ eV$

dopat: donatordopning $N_d^+ = 2\cdot 10^{21}\ m^{-3}$

$\Rightarrow n = 2\cdot 10^{21}\ m^{-3}$ $\quad p = 2\cdot 10^{15}\ m^{-3}$ hålediv. försumm.

$\sigma = n e\mu_e = 2\cdot 10^{21}\cdot 1{,}6\cdot 10^{-19}\cdot 0{,}15$

$\Rightarrow \eta = \underline{0{,}02\ \Omega m}$

E_F: $p = 2{,}5\cdot 10^{25}\cdot e^{-E_F/kT} = 2\cdot 10^{15}$

$\Rightarrow E_F = 0{,}60\ eV \Rightarrow E_g - E_F = \underline{0{,}24\ eV}$