-21

MAX

C, då T=0K ligger alla elektroner i lägsta möjliga energinivå, energin hos de "högst belägna" elektron(erna) motsvarar därför fermienergin.

2/2

149-3

2/2

$E_c - E_F = 1eV$

$T \approx 300K$

$k = 8,62 \cdot 10^{-5} eV/K$

$$f(E) = \frac{1}{1 + e^{\frac{E_c - E_F}{kT}}} = \frac{1}{1 + e^{1/kT}} = \frac{1}{1 + e^{1/(8,62 \cdot 10^{-5} \frac{eV}{K} \cdot 300K)}}$$

$\approx 1,6 \cdot 10^{-17} \approx 10^{-17}$

$\boxed{\text{svar: D}}$

$\boxed{E49-9}$

$M_{Au} = 196.967\ g/mol$

$\rho_{Au} = 19.3\ g/cm^3$

$h = 6.626 \cdot 10^{-34}\ Js$

(Avogadros konst.) $N_A = 6.022 \cdot 10^{23}\ mol^{-1}$

$m_e = 9,109 \cdot 10^{-31}\ kg$

$$E_F = \frac{h^2}{8m}\left(\frac{3n}{\pi}\right)^{2/3}$$

n = densiteten av "conducting electrons":

$$n = \frac{\rho \cdot N_A}{M} = \frac{19,3\ g/cm^3 \cdot 6,022 \cdot 10^{23}\ mol^{-1}}{196.967\ g/mol} = \left[\frac{g}{cm^3} \cdot \frac{1}{\cancel{mol}} \cdot \frac{\cancel{mol}}{\cancel{g}} = c\right.$$

$$= 5,9 \cdot 10^{22}\ \frac{1}{cm^3} = 5,9 \cdot 10^{28}\ \frac{1}{m^3}$$

$$E_F = \frac{(6,626 \cdot 10^{-34}\ Js)^2}{8(9,109 \cdot 10^{-31}\ kg)}\left(\frac{3 \cdot 5,9 \cdot 10^{28}\ \frac{1}{m^3}}{\pi}\right)^{2/3} = \left[\frac{\frac{kg^2 m^4}{s^4} \cdot \cancel{s^2}}{\cancel{kg}} \cdot \frac{1}{\cancel{m^2}} =\right.$$

$$= 8,854 \cdot 10^{-19}\ J = \boxed{5,53\ eV}$$

3/3

49-14

$E_F = 7{,}06\,eV \quad m = m_e = 9{,}106 \cdot 10^{-31}\,kg$

$k = 8{,}62 \cdot 10^{-5}\,eV/K$

a) $T = 1050\,K$

$f(E) = 0{,}910$

$$f(E) = \frac{1}{1+e^{\frac{E-E_F}{kT}}}$$

$$e^{\frac{E-E_F}{kT}} = \frac{1}{f(E)} - 1$$

$$E = \ln\left(\frac{1}{f(E)} - 1\right) \cdot kT + E_F =$$

$$= \ln\left(\frac{1}{0{,}910} - 1\right) \cdot 8{,}62 \cdot 10^{-5}\,eV/K \cdot 1050 \cdot K + 7{,}06\,eV =$$

1/1

$$= \boxed{6{,}85\,eV}$$

b) $$n(E) = \frac{8\sqrt{2}\,\pi \cdot m^{3/2}}{h^3} \cdot \sqrt{E} = \frac{8\sqrt{2}\,\pi \cdot (9{,}106 \cdot 10^{-31}\,kg)^{3/2}}{(6{,}602 \cdot 10^{-34}\,J\,s)^3} \cdot$$

0/1

$$\cdot \sqrt{6{,}85 \cdot 1{,}602 \cdot 10^{-19}} = \boxed{1{,}11 \cdot 10^{4}\,\frac{1}{J\,m^3}}$$ — fel.

1/1

$$\left[\frac{m^{3/2}}{J^3 \cdot s^3} \cdot J^{1/2} \cdot s^{1/2} = \frac{1}{J\,m^3}\right]$$

c) på annat papper!

P49-1

$E_F = 11,66\,eV = 1,868 \cdot 10^{-16}\,J$, $\rho = 2,70\,g/cm^3 = 2700\,g/m^3$

$M = 27,0\,g\,mol^{-1}$

$m = m_e = 9,109 \cdot 10^{-31}\,kg$

$h = 6.602 \cdot 10^{-34}\,Js$

$N_A = 6.022 \cdot 10^{23}\,mol^{-1}$

$$E_F = \frac{h^2}{8m}\left(\frac{3n}{\pi}\right)^{2/3}$$

ρ

$$\boxed{n = \frac{m \cdot N_A}{M} \cdot C}$$

, där C är antalet fria elektroner per atom och n är laddningsdensiteten.

4/4

$$E_F = \frac{h^2}{8m}\left(\frac{3 \cdot \rho \cdot N_A}{\pi \cdot M} \cdot C\right)^{2/3} \Leftrightarrow C = \left(\frac{E_F \cdot 8m}{h^2}\right)^{3/2} \cdot \frac{\pi M}{3\rho \cdot N_A} =$$

$$= \left(\frac{1,868 \cdot 10^{-18}\,J \cdot 8 \cdot 9,109 \cdot 10^{-31}\,kg}{(6.602 \cdot 10^{-34}\,Js)^2}\right)^{3/2} \cdot \frac{\pi \cdot 27,0\,g/mol}{3 \cdot 2700\,g/m^3 \cdot 6,022 \cdot 10^{23}\,mol^{-1}}$$

$$= 3,002559$$

$$\left[\left(\frac{J}{J^2} \cdot \frac{kg}{s^2}\right)^{3/2} \cdot \frac{g}{mol} \cdot \frac{m^3}{g} \cdot mol = \left(\frac{s^2}{kgm^2} \cdot \frac{kg}{s^2}\right)^{3/2} \cdot m^3 = \frac{m^3}{m^3} = 1\right]$$

$\boxed{\text{Svar: Det finns 3 fria elektroner}}$

$\boxed{49-14}$

1/1

c) $n_0 = n(E) \cdot f(E)$

$n_0 = 1{,}11 \cdot 10^{47} \frac{1}{Jm^3} \cdot 0{,}910 = \boxed{1{,}01 \cdot 10^{47} \frac{1}{Jm^3}}$

1/1

tot 4/5

$\boxed{E49-12}$

$kT \gg E_F$

$E_F = 7.06 eV$

$k = 8{,}62 \cdot 10^{-5} eV/K$

$T \gg \frac{E_F}{k} = \frac{7{,}06 eV}{8{,}62 \cdot 10^{-5} eV/k} = \boxed{81902 K}$

Koppars kokpunkt: 2840K

$\boxed{T \gg 28 \cdot \text{kokpunkt för koppar.}}$

2/2

$\boxed{E49-27}$ $k = 8{,}62 \cdot 10^{-5}\, eV/K$, $T = 290K$

$E_g = 0{,}67 eV$

$E - E_F = \frac{E_g}{2} = 0{,}335\, eV$

$$f(E) = \frac{1}{1 + e^{\frac{E-E_F}{kT}}}$$

a) $$f(E) = \frac{1}{1 + e^{0{,}335 eV / 8{,}62 \cdot 10^{-5} eV/K \cdot 290K}} =$$

$$= \boxed{1{,}5 \cdot 10^{-6}}$$

b) $E - E_F = -0{,}335 eV$

Sannolikheten är $1 - f(E) =$

$$= 1 - \frac{1}{1 + e^{-0{,}335 eV / 8{,}62 \cdot 10^{-5} eV/K \cdot 290K}} = \boxed{1{,}5 \cdot 10^{-6}}$$

3/3

total: 20/21