1) A) Consider a Haynes-Shockley experiment on a p-type silicon bar. If a pulse of electrons I injected at x=0, t=0, and of the maximum of the electron pulse reaches a probe at x= 100μm at t=10 ns, determine electron mobility. Assume that a voltage of 100 V is maintained between the two ends of the 1 cm long bar. B) The doping level is increased. What happens to the mobility and why?

a)

$$\mathcal{E} = \frac{100\,V}{1\,cm} = 10^{+2+2}\,V/m = 10^{4}\,V/m$$

$$v = \frac{100\,\mu m}{10\,ns} = 10^{4}\,m/s$$

$$\mu = \frac{v}{\mathcal{E}} = \frac{10^{4}\,m/s}{10^{4}\,V/m} = \cancel{100}\;1\,m^2/V\text{-}s$$

$$= 10^{+4}\,cm^2/V\text{-}s$$

b) Increased doping ⇒ increased scattering

⇒ decreased mobility

2) A semiconductor is very heavily doped n-type. The Fermi energy lies at the conduction band edge. A) What is the probability of a state at the conduction band edge being occupied at T=300? B) How does that change with temperature?

A) $\frac{1}{2}$

B) Independent of temp.

3) In a 2d world, find the relationship between the electron density (#/cm^2) and the Fermi energy. Recall that the 2d DOS (from HW#1) is:

$$g(E)_{2D}\,dE = \frac{k\,dk}{\pi} = \sqrt{\frac{2mE}{\hbar^2}}\left(\frac{2mE}{\hbar^2}\right)^{-1/2}\frac{m}{\hbar^2}\,dE = \frac{m}{\pi\hbar^2}\,dE$$

$$n = \int_0^{E_F} \frac{m}{\pi\hbar^2}\,dE$$

$$= \frac{m\,E_F}{\pi\hbar^2}$$