A. (2 pts) A silicon crystal has 2×10^{18} cm^{-3} phosphorus atoms. The donor level of a phosphorus atom is 0.045 eV below the bottom of the conduction band and the effective density of states in the conduction band is $N_C = 2.86 \times 10^{19}$ cm^{-3}. Assume a degeneracy factor of 2. Determine the room temperature electron concentration, the position of the Fermi energy, and the fraction of impurities that are ionized.

B. (2 pts) A semiconductor has a bulk energy gap of 1.5 eV and electron and hole effective masses equal to $0.1m_0$ ($m_0 = 9.11 \times 10^{-31}$ kg). Estimate the increase in the energy gap when the material is incorporated into a one-dimensional quantum well with $L_z = 10$ nm.

q	1.6×10^{-19} C	electron charge
ϵ_o	8.85×10^{-14} F/cm	permittivity of free space
K_s	11.8 (Si)	relative dielectric constant
K_o	3.9 (SiO_2)	relative dielectric constant
k_B	8.617×10^{-5} eV/K	Boltzman's constant
h	6.63×10^{-34} J s	Planck constant
m_o	9.11×10^{-31} kg	electron mass
k_BT/q	0.0259 V at 300 K	thermal voltage
c	3×10^8 m/s	speed of light