When searching for a replacement for SiO_2 in silicon MOSFETs, the semiconductor industry wanted to use an insulator with conduction and valence band offsets that are both at least one electron volt. Consider a structure consisting of such an oxide on top of silicon. The bandgap of the oxide is 3.12 eV (1.12 eV + 1 eV + 1 eV). Assume that the interface is ideal (i.e. no defects). There are some constants listed in the table below that might help you answer the following. Also note, it you are unable to complete any part of the problem and this makes solutions of subsequent parts difficult, write the equations you would use to solve the remaining parts.

a) If the silicon is doped 10^{17} cm^{-2} n-type, Find the position of the Fermi energy of silicon with respect to the silicon conduction band edge (0.8 points).

b) Find the probability of occupancy for a conduction band state with exactly enough energy that an electron occupying this state would have no energy barrier to go into the oxide (0.8 points).

c) Assuming the parabolic band approximation (not a very good approximation for such a large distance from the band edge, but use it anyway), find the density of states at the same energy as described in part b (0.8 points).

d) Now multiply parts b) and c) together to get the concentration of electrons per electron volt that have enough energy to get over the barrier. Multiply this by kT, to get a rough estimate of the concentration of electrons with enough energy (0.8 points).

e) Finally assume that the electrons are traveling at the saturation velocity for electrons in silicon at room temperature, find the leakage current density (0.8 points).

h	6.63×10^{-34} J-sec
m_n^*	$1.09 * m_o = 10^{-30}$ kg
Eg (silicon)	1.12 eV
kT	0.0257 eV
Nc (Silicon)	3.2×10^{19} cm^{-3}
μ_{eff} (silicon), electrons	801 cm2/V-sec
V_{sat} (silicon) , electrons	10^7 cm/sec
1 eV = 1.6×10^{-19} J	