Problem 1.

a) Ga → acceptors. Majority carriers are holes.

b) $p_0 = N_a = 3 \times 10^{15}\ cm^{-3}$

c) $n_i = 2.4 \times 10^{13}\ cm^{-3}$ (room temp.)

$$n_0 = \frac{n_i^2}{p_0} = 1.9 \times 10^{11}\ cm^{-3}$$

d) $p_0 \gg n_0 \rightarrow \sigma_0 \approx q \mu_h p_0$ $\mu_h = 1900\ cm^2/V \cdot cm$ for Ge

$\sigma_0 \approx 0.91\ mho/cm$

e) Arsenic → donors. $N_d - N_a = 7 \times 10^{15}\ cm^{-3}$ Sample → n-type.

$n_0 \approx 7 \times 10^{15}\ cm^{-3}$ $p_0 = \frac{n_i^2}{n_0} = 8.2 \times 10^{10}\ cm^{-3}$

$\mu_e = 3900\ cm^2/V \cdot cm$ for Ge. $\sigma_0 \approx q \mu_e n_0 = 0.44\ mho/cm$.

Problem 2.

a) $\frac{1}{2} m^* v^2 = \frac{3 k_B T}{2}$ $v = \sqrt{\frac{3 k_B T}{m^*}} = 2.3 \times 10^5\ m/sec$.

b) $v_{drift} = \mu_e E = 1.5 \times 10^3\ cm^2/V\ sec \cdot 10^3\ V/cm$

$= 1.5 \times 10^6\ cm/sec = 1.5 \times 10^4\ m/sec$

Problem 3.

a) $\sigma_0 = q \mu_e n_0$. $\mu_e = \frac{\sigma_0}{q n_0} = 37.5\ cm^2/V \cdot sec$.

Mobility is much lower compared w/ mobilities in semiconductors.

b) $I_x = J_x A = q n_0 v_x A \rightarrow v_x = \frac{I_x}{q n_0 A} \rightarrow v_x = 0.0025\ cm/sec$.