chapter 2 summery

movments of charges can be due to thermal movment alone, or due to electric field or due to carries diffusion.

movment dues to thermal alone has net effect of zero, since movment is random, and carries ends up where it started.

the velosity due to themal alone can be found from:

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kinetic energy = average thermal energy
$1/2m_n v_{th}^2 =$ *average thermal energy ——-(1)*

but average thermal energy $= 1/2KT$ *per degree of freedom where* K *is Blotzmann constant, and* T *is absolute temp. since degrees of freedom = 3 then (1) can be written as*

$1/2m_n v_{th}^2 = 3/2KT$

$$\boxed{v_{th} = \sqrt{3_n KT/m}}$$

velosity due to electric field

force on carrier $= -qE$
momentum on carries $= -qE\tau_c$*(where* τ_c *is average time befor collision)*
so
$-qE\tau_c = m_n v_n$
so

$$\boxed{v_n = -\frac{q_c\tau}{m_n}E}$$

where $\frac{q_c\tau}{m_n}$ *is the electron mobility*

about mobility and temp. and doner concetration:
there is scattering sue to collision with lattic, and due to impurity scatering.
lattic scattering *results from thermal vibrations of the lattic atoms, these vibrations allow energy to be transfered from the carries and the lattic.*
impurity scattering: *results when a carries travels passed an ionized, carries path will deflect according to column law.*

impurity scattering less important at hight temps.
impurity scattering important at low temp. only if conctration is large. lattic scattering kicks in always at hight temp.

conductivity σ
$\sigma = qn\mu_n + qp\mu_p$
where μ *is mobility of electron and hole respectivly*
resistivity ρ
$\rho = 1/\sigma$
resisitivty measured usign the 4-point probe method
see page 37

hall effect
$E_h = \frac{J_p}{qn}B$
$E_h = R_h J_p B$
where R_h *is hall coeffient*
now $E_h = V_h/W (W$ *=width)*
$J_p = I/A$

so $V_h/W = R_h I/AB$
from the above, we can find the carries concetration by finding R_h*, since every thing else can be found or measured*
velosity due to diffusion:

diffusivity $= D_n = v_{th} l$
where l is the mean free path, v_{th} *is the thermal velosity*
diffusivity current $= J_n = qD_n dn/dx$
diffusivity current is proportional to the spatial drivative of the electron density. diffusion current results from random thermal motion of carriers in a concetration gradient.

$D_n = \frac{KT}{q}\mu_n$
derivation of the Einstien relation:
since
$1/2 m_n v_{th}^2 = 1/2KT(3)$
so
$v_{th}^2 = \frac{KT}{m_n} ---------(1)$
but
$D_n = v_{th} l --------(2)$
where
$l = v_{th}\tau_c$
so
$D_n = v_{th}^2 \tau_c$
but
$\mu_n = \frac{q_c \tau}{m_n}$

so $\tau_c = \mu_n m_n/q$

so $D_n = v_{th}^2 \frac{\mu_{nn} m}{q}$
but from (1) this leads to
$D_n = \frac{KT}{m_n}\frac{\mu_{nn} m}{q} = \frac{KT}{q}\mu_n$