Physics Collectanea

A Personal Compendium of Physics Notes

eyeS

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Contents

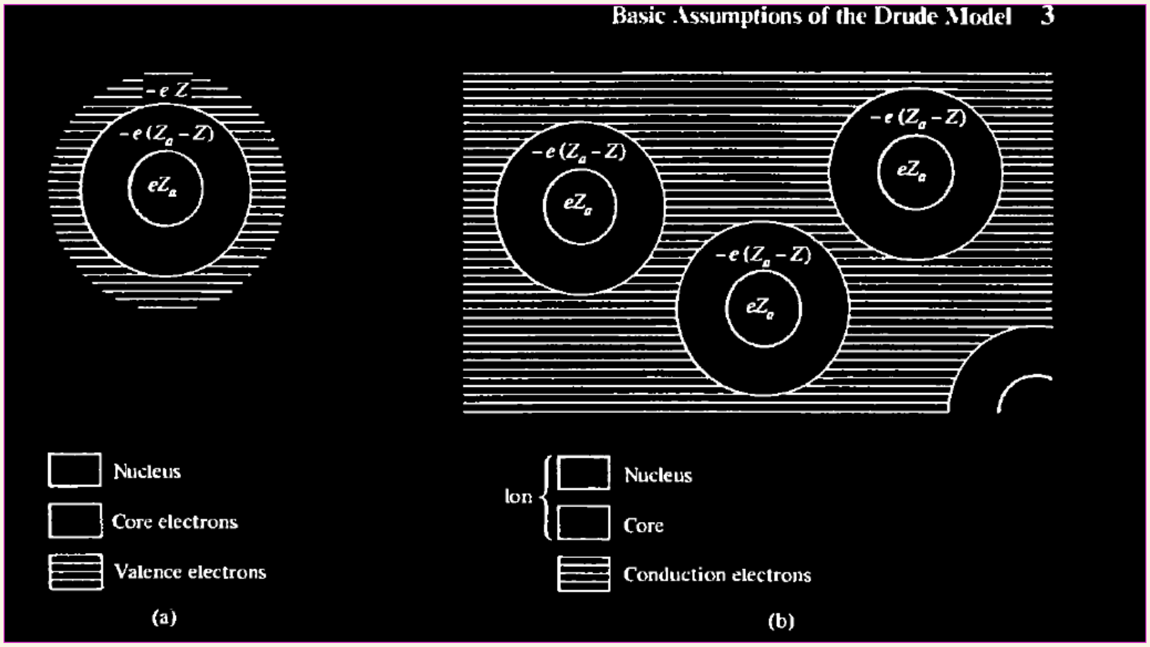
Part I

Condensed Matter

Chapter 1

Basic Models of Metals

1.1 The Drude Model



The Drude model assumes that we have immovable nucleus with most extern electons free. A nucleus of some element, has Z protons, and subsequently Z electrons with total charge $-eZ$.

Let's try to derive somethings. We know that electrical force $\vec{F} = -e\vec{E}$ and $\vec{F} = m\vec{a}$. Thus we have:

$$\vec{a} = \frac{-eE}{m} \tag{1.1}$$

After a collision, the electron accelerates for a time t, gaining velocity:

$$\Delta\vec{v} = \vec{a} \cdot t = \frac{-eEt}{m} \tag{1.2}$$

So the final velocity is:

$$\vec{v}(t) = \vec{v_0}(t) + \Delta\vec{v} \tag{1.3}$$

Well, we assume that the collision randomize $\vec{v_0}$ (it's isotropic), its **average is zero**:

$$\langle \vec{v_0} \rangle = 0 \rightarrow \langle \vec{v}(t) \rangle = \frac{-eE\langle t \rangle}{m}$$

We know that $\mathbf{j} = -ne\mathbf{v}$, so we have:

$$\mathbf{j} = -nev_{avg} = -ne\left(\frac{-eE\tau}{m}\right) = \left(\frac{ne^2\tau}{m}\right)E \tag{1.4}$$

Let's define the **conductivity** (σ) that tell us how easily a material allows electric charges to move when you apply an electric field (that's created when you make a differential in potential). Then:

$$\mathbf{j} = \sigma\mathbf{E} \tag{1.5}$$

Notice that conductivity is the inverse of resistivity:

$$\sigma = \frac{1}{\rho} \tag{1.6}$$

We can determine the relaxation time τ usgin the resistivity:

$$\tau = \frac{m}{\rho ne^2} \tag{1.7}$$