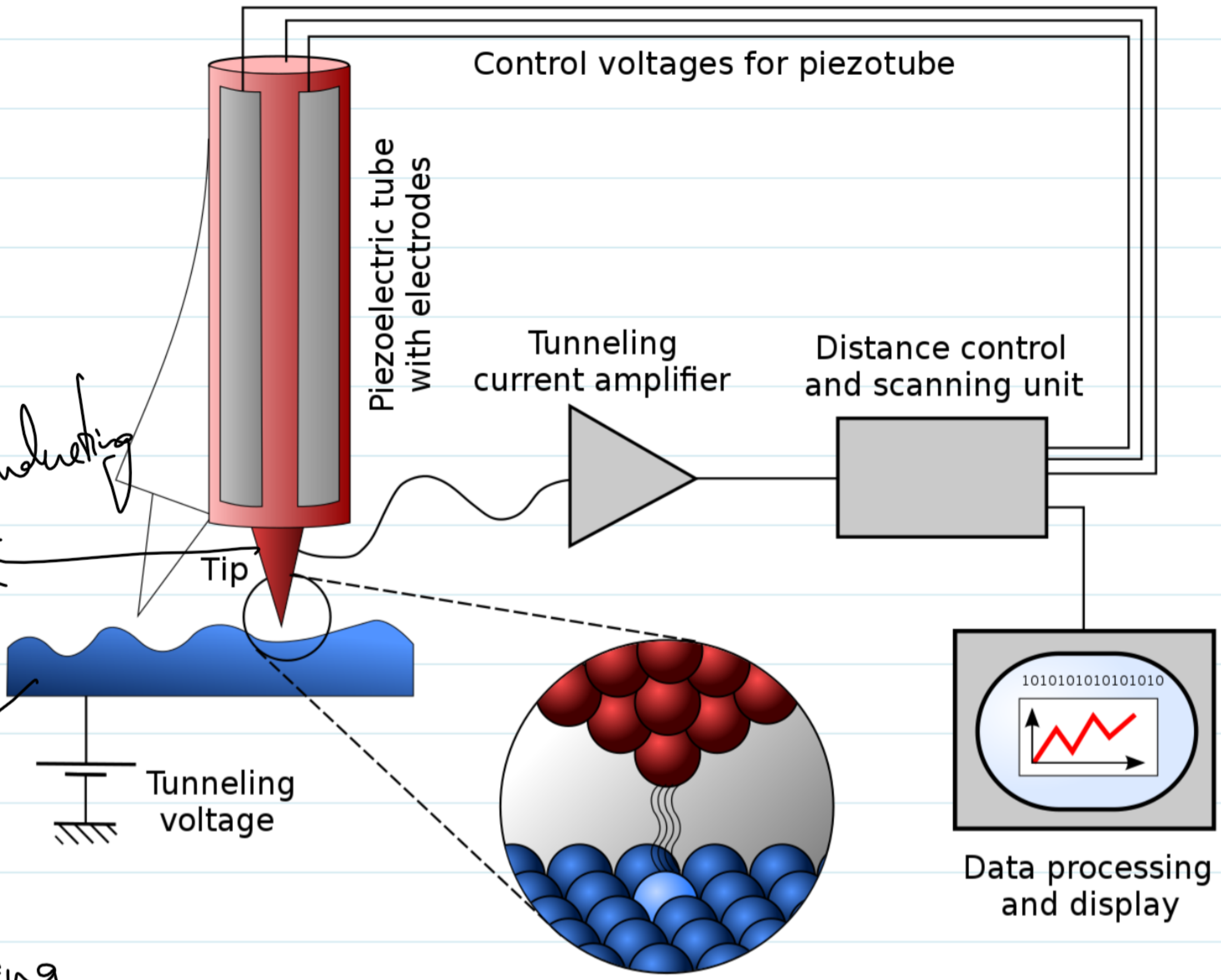
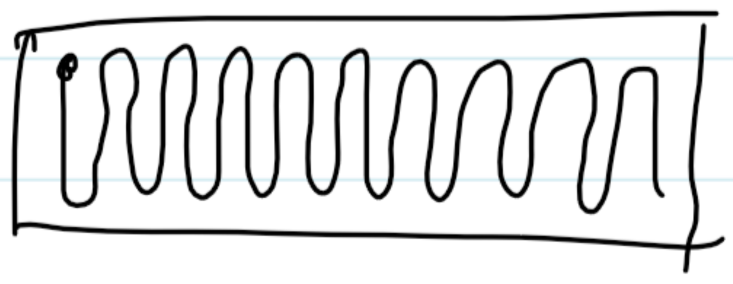
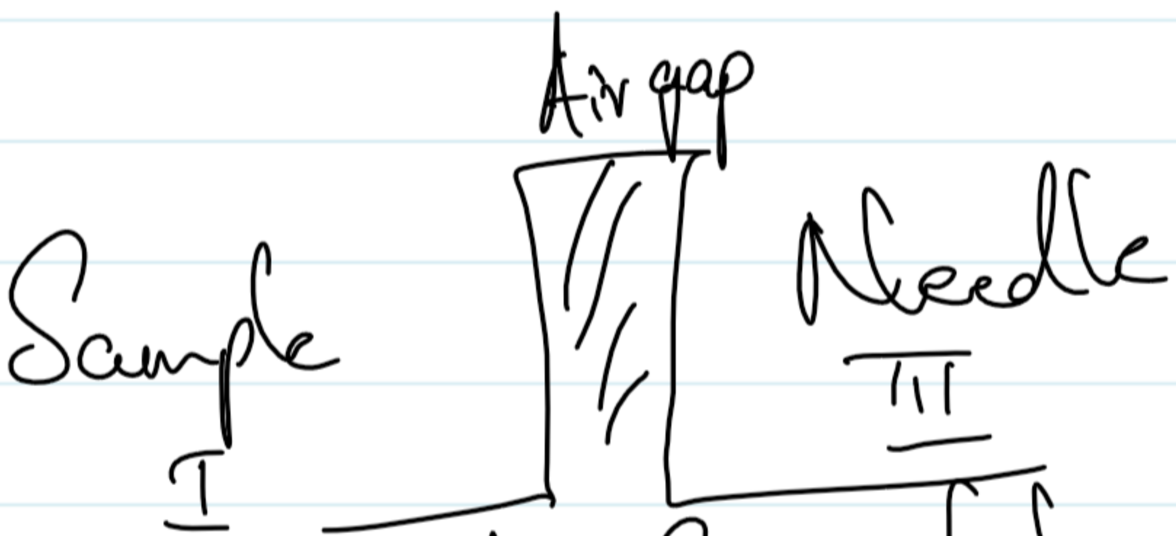
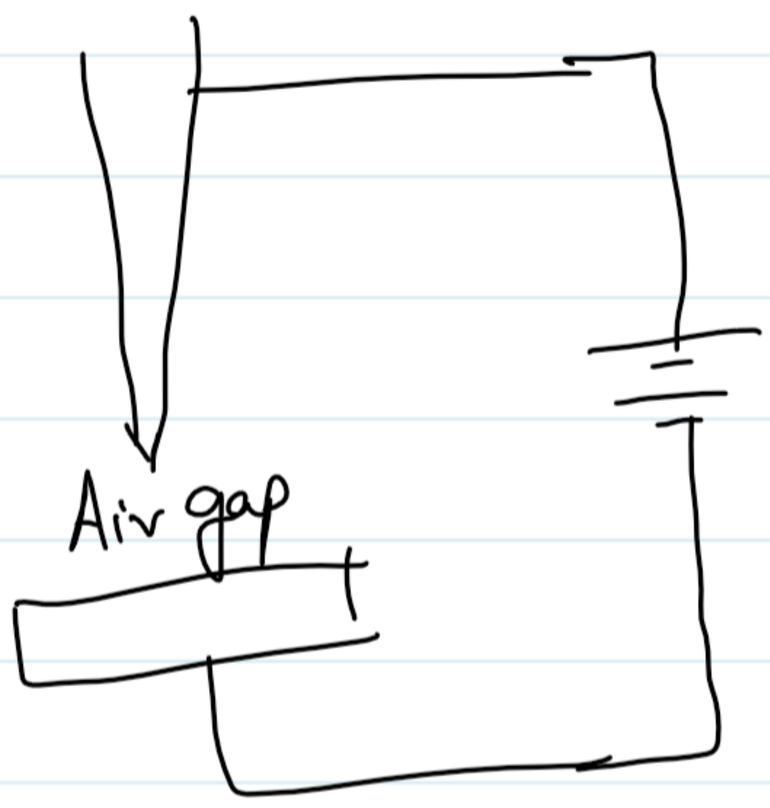
Sharp conducting needle



Sample (magnify) Conducting







Tunnelling current flows between the sample and the needle

Amount of tunnelling current depends on the thickness of air gap

Electron Microscopes

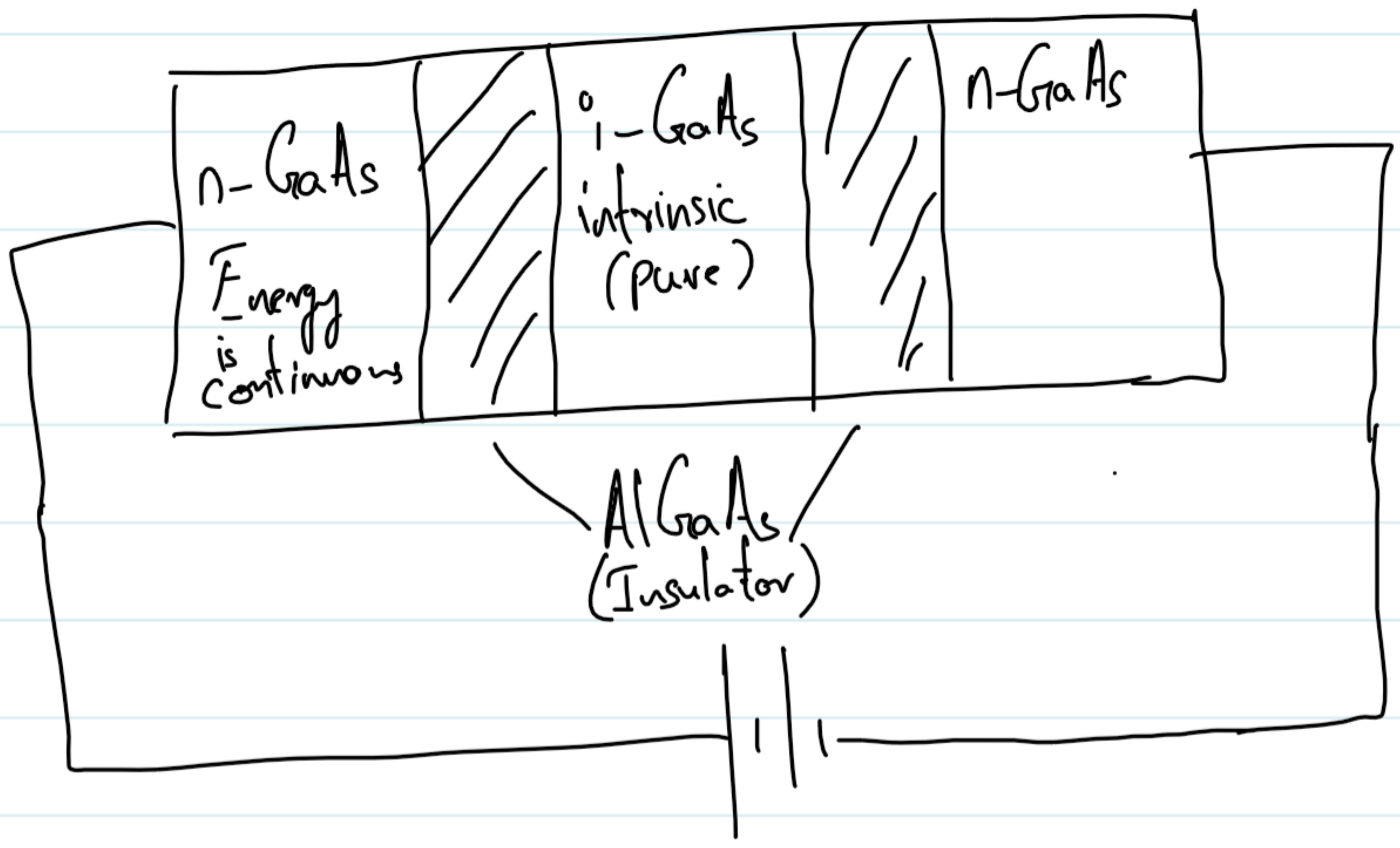
(i) Scanning Tunnelling Microscope

(ii) Scanning Transmission electron microscope

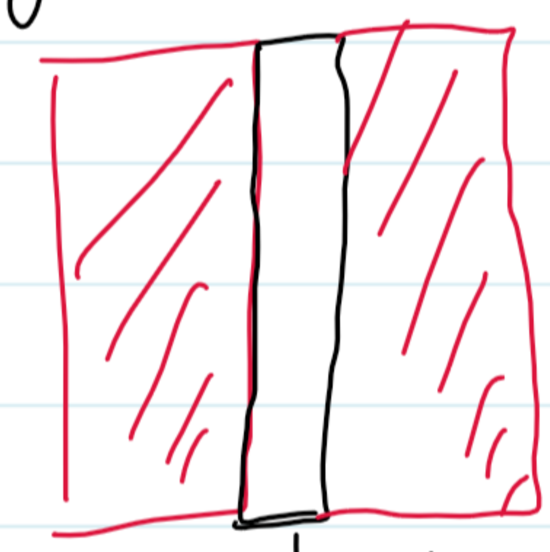
(iii) Scanning electron microscope

Resonant Tunnelling Diode

Special kind of PN junction diode.

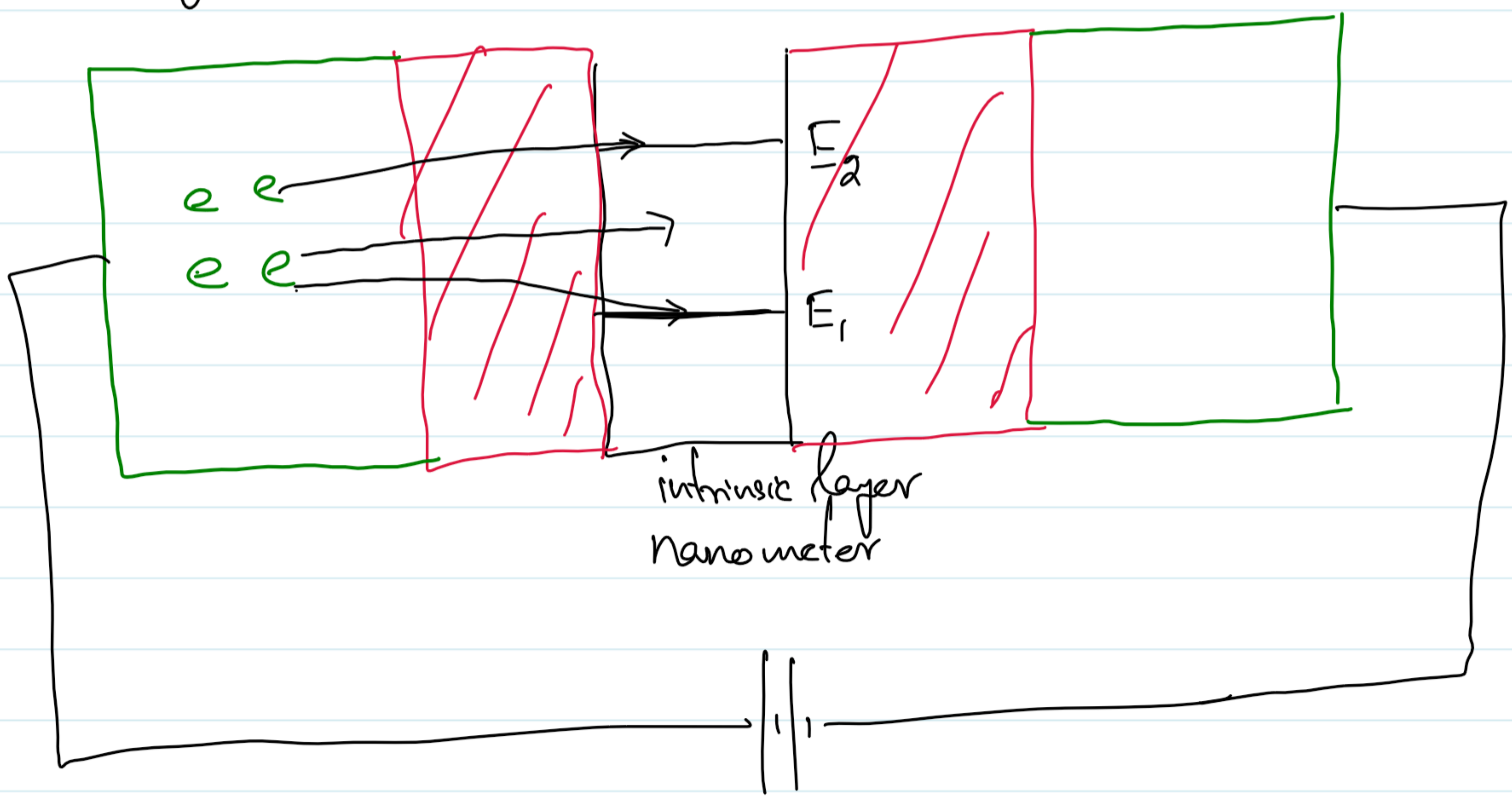


Doping is done to increase the conductivity at room temperature
Intrinsic layer of GaAs is sandwitched between the two insulating layers



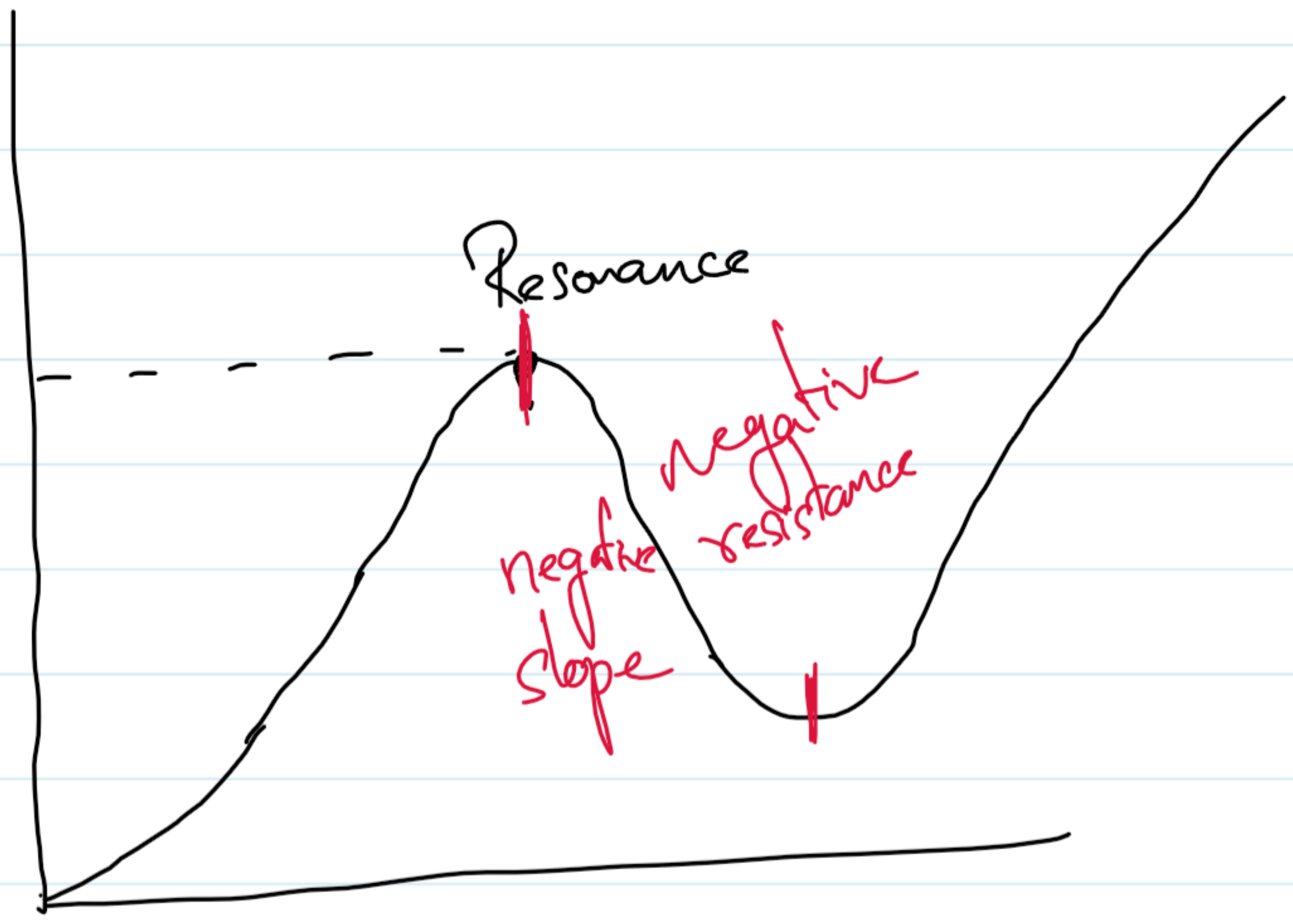
thin intrinsic layer of GaAs.

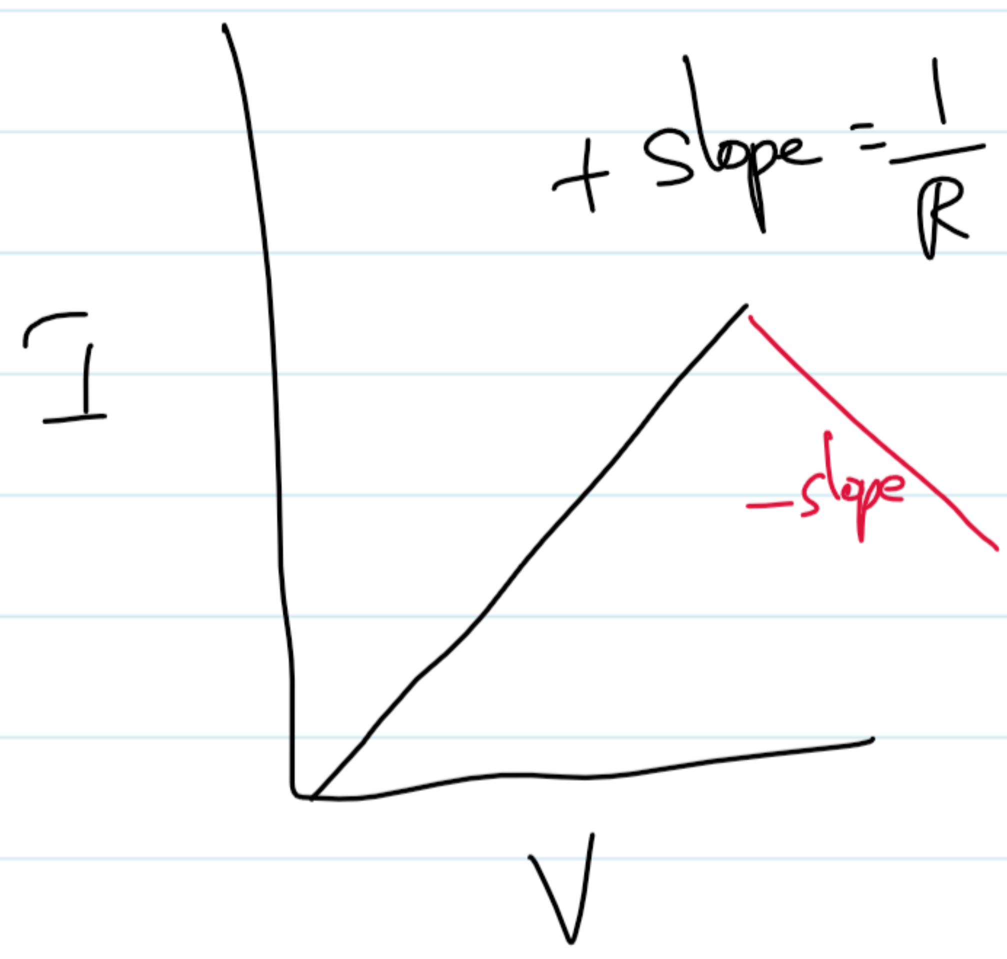
Reduction in the size of materials makes the physical properties change.
Energy levels become discontinuous. Discrete energy levels



Resonant tunnelling diode

Current
I





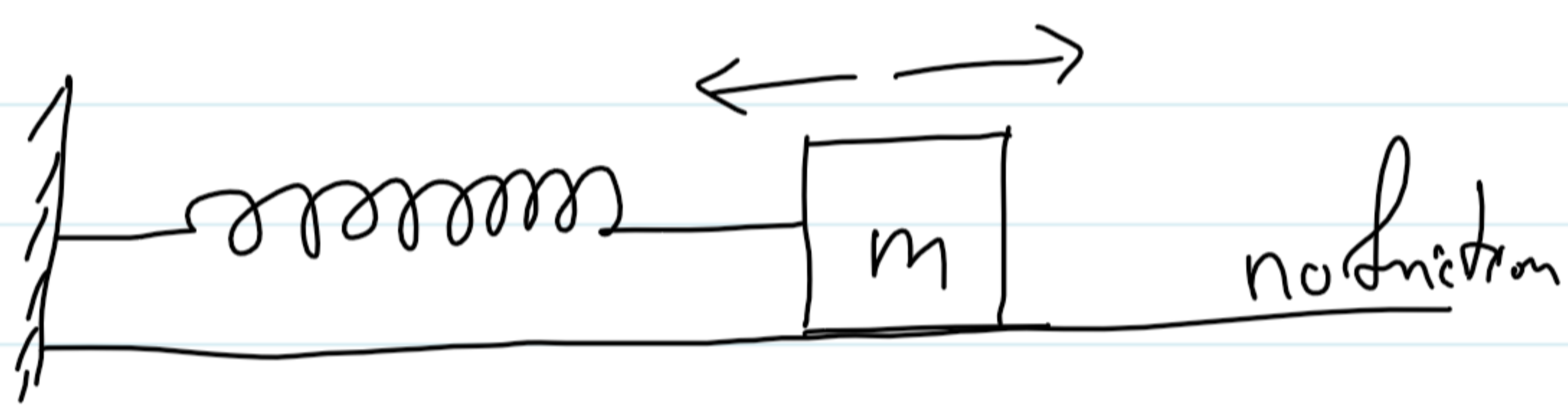
Voltage V

Resonant tunnelling diode operate at much faster speeds than the conventional diode.

Resonant tunnelling diode has a negative resistance region.

Simple Harmonic Oscillator

Restoring Force $= -kx$



where 'k' spring constant.

'x' displacement from the equilibrium

Quantum Simple harmonic oscillator

Potential energy of a simple harmonic oscillator

$$U = -\int F\,dx = \text{Workdone}$$

$$U = -\int -kx\,dx$$

$$U = +\frac{kx^2}{2} = \frac{1}{2}kx^2$$

Total energy of a simple harmonic oscillator is

$$E = P.E + K.E$$

$$E = \frac{1}{2} k x^2 + \frac{1}{2} m v^2$$

$$E = \frac{1}{2} k A^2$$

$x = A \sin(\omega t + \delta)$

$V = \frac{dx}{dt} = \omega A \cos(\omega t + \delta)$

$\omega = \sqrt{\frac{k}{m}} \Rightarrow$ angular frequency

$A \rightarrow$ Amplitude of oscillation

Total energy E is a constant.

Schrodinger's equation.

$$\frac{d^2\psi_0}{dx^2} + \frac{2m}{\hbar^2}(E - U)\psi_0 = 0$$

$U = \frac{1}{2} k x^2 \Rightarrow$ Varying potential energy

$$\frac{d^2\psi_0}{dx^2} + \frac{2m}{\hbar^2}\left(E - \frac{1}{2} k x^2\right)\psi_0 = 0$$