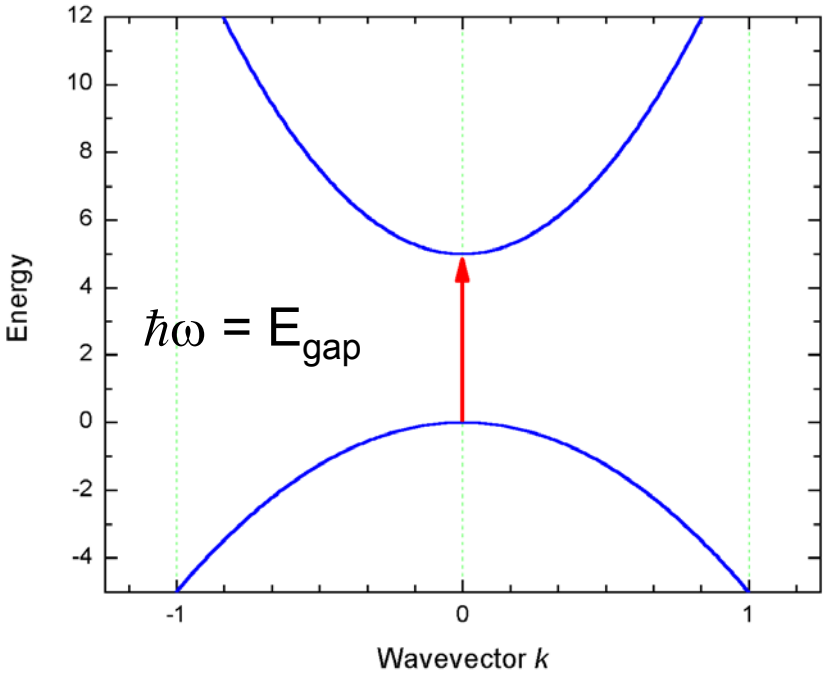
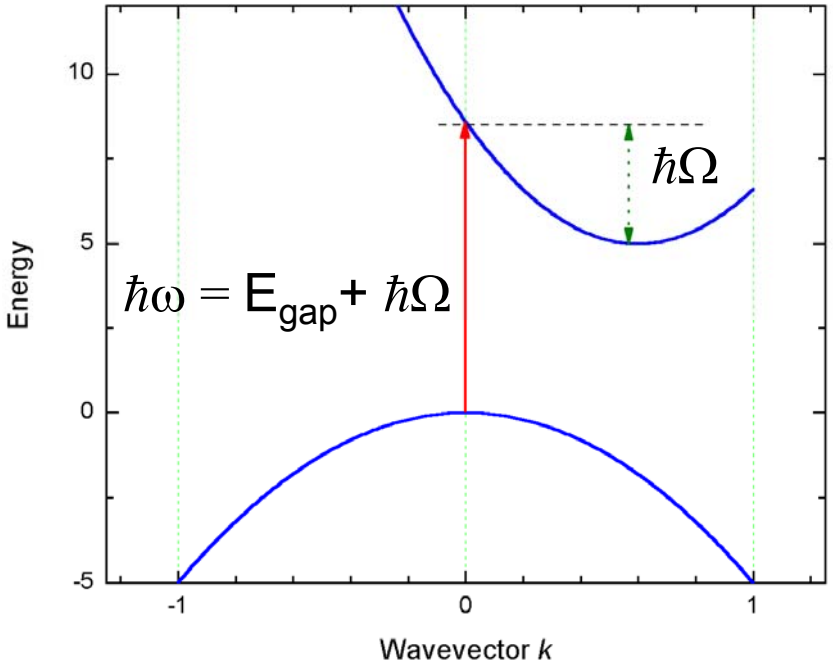
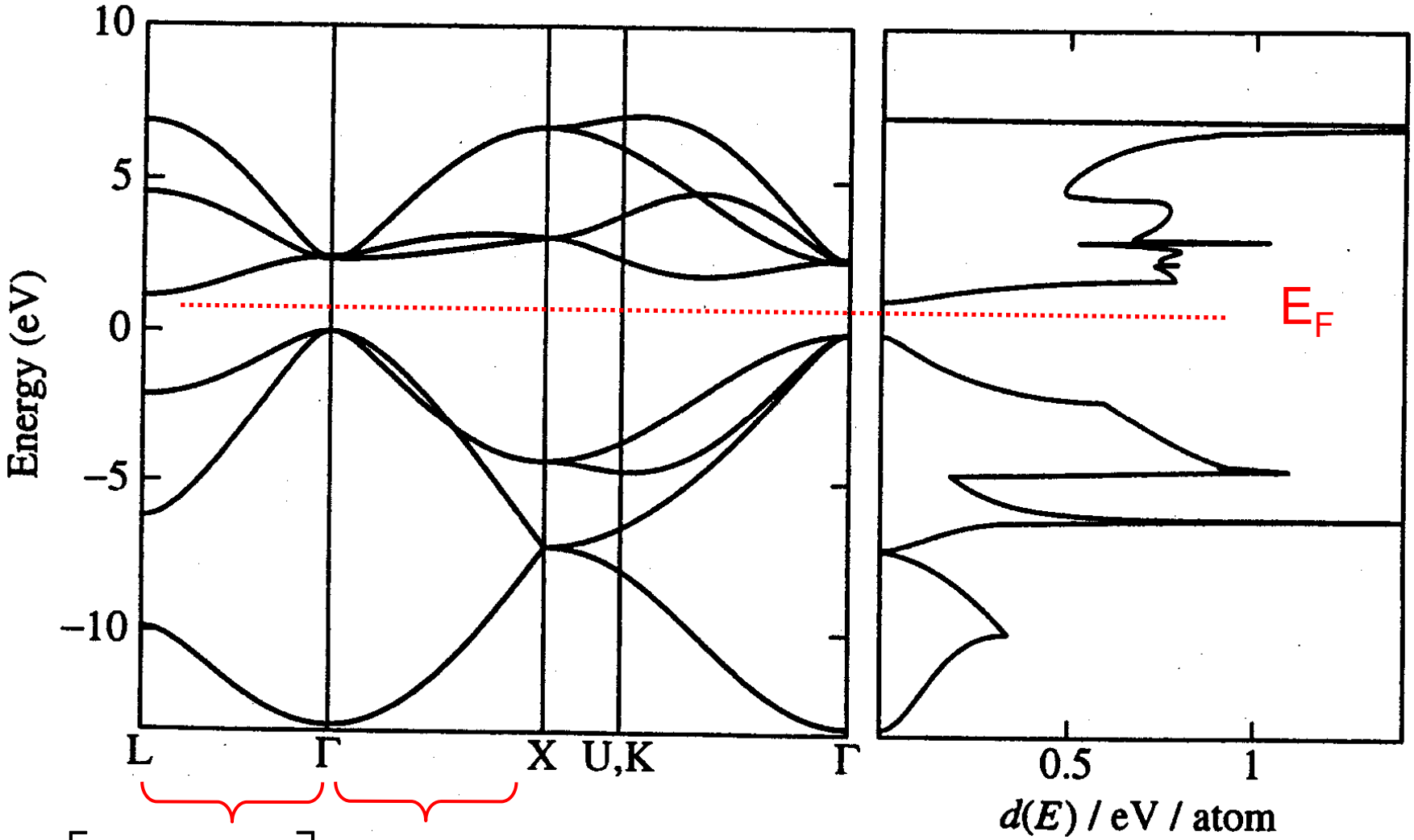
Direct Energy Gap



Indirect Energy Gap



Silicon



$$\vec{k}=\left[\frac{k}{\sqrt{3}},\frac{k}{\sqrt{3}},\frac{k}{\sqrt{3}}\right] \qquad \vec{k}=[k,0,0]$$

REVIEW

Part I – Classical Oscillators

- chain of atoms coupled by springs
- chain of pendulums

Natural frequencies, normal modes, wavenumbers, dispersion relations 1st Brillouin zone, what is a phonon, Bose-Einstein statistics, total classical vs. quantum energy stored in crystal, optic vs. acoustic phonon branches

REVIEW

Part II – Quantum Solid State Physics

The LCAO states are a good approximation to the actual electron eigenstates of coupled quantum well and covalently bound atomic systems.

- Write the Hamiltonian is the LCAO basis
- Write the eigenstates in LCAO basis (each k value → one eigenstate)
- Draw and predict the energy dispersion relations
- Know how to fill the bands with electrons, decide if a material is insulator, semiconductor or metal
- Discuss allowed optical processes
- Bloch's theorem
- Effective mass
- Density of states