University of Virginia

Department of Physics

Physics 606: How Things Work II

Lecture #11 Slides:

Xerographic Copiers

Xerographic Copiers

Question:

If you were to cover the original document with a red transparent filter, would the copier still be be able to produce reasonable copies?

Observations About Copiers

- Copies consist of black stuff stuck on paper
- After jams, the stuff sometimes wipes off
- Copiers often run out of “toner”
- Copies are often warm after being made
- Copies are staticy, particular transparencies
- Some copies scan a light, some use a flash

Electric Fields 1

- Two views of charge forces:
- Charge/Charge:
  - Charge 1 pushes directly on Charge 2
- Charge/Field/Charge:
  - Charge 1 creates an “Electric Field”
  - Electric Field pushes on Charge 2
- Electric Fields are *Real!*

Electric Fields 2

- An electric field is a structure in space that pushes on electric charge
- The magnitude of the field is proportional to the magnitude of the force on a test charge
- The direction of the field is the direction of the force on a positive test charge

Quantum Physics 1

- All things *travel* as waves
- All things *interact* as particles
- Example 1: Light
  - Travels as waves – electromagnetic waves
  - Emitted and absorbed as particles – photons
- Example 2: Electrons
  - Detected as particles
  - Travel as waves

Quantum Physics 2

- Bosons: Photons
  - Many indistinguishable bosons can share a wave
  - Such sharing leads to lasers & superconductors
- Fermions: Electrons, Protons, Neutrons
  - One indistinguishable fermion allowed per wave
  - "Pauli Exclusion Principle"

Electrons in Solids

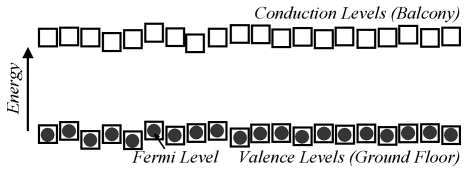
- Only certain electron waves fit in a solid
- Each allowed wave has an energy "level"
- The electrons "occupy" levels two at a time
  - Electrons have two spin states: up and down
  - Spin-up is distinguishable from spin-down
- Levels are filled from lowest to highest energy
- Last (highest) filled level is the "Fermi level"

Metals

- The Fermi level has empty levels just above it
- Like patrons in a partly fill theatre, electrons can move in response to electric fields

Insulators

- The Fermi level has no empty levels nearby
- Like patrons in a full theatre, electrons can't move in response to forces



Semiconductors

- Semiconductors are "poor insulators"
- Valence & conduction bands have narrow gap
- Like patrons in a theatre with a low balcony, electrons can hop into the balcony and move