

Xerographic Copiers

Question:

If you were to cover the original document with a red transparent filter, would the copier still 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 copiers 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”

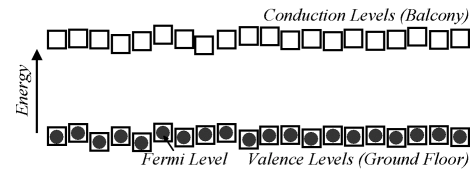
Metals

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



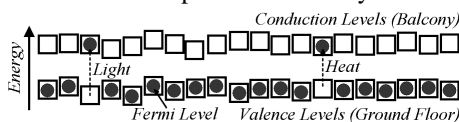
Insulators

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



Semiconductors

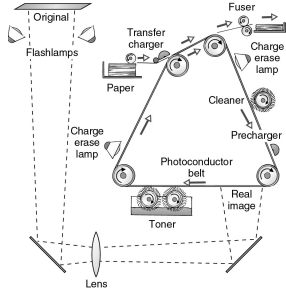
- Semiconductors are “poor insulators”
- Valence & conduction bands have narrow gap
- Like patrons in a theatre with a low balcony, electrons can hop into the balcony and move



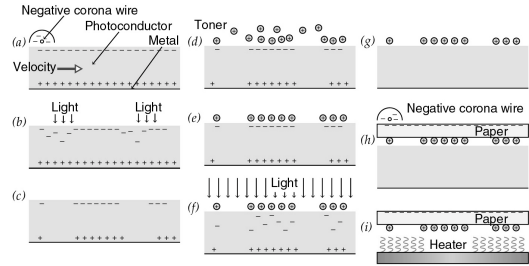
Photoconductors

- In the dark, a semiconductor is insulating
 - When polarized, it has an electric field in it
- In the light, a semiconductor may conduct
 - Will conduct if photon energy can bridge gap
 - Blue photons have more energy than red photons
 - If conducting, electric field makes charges move
 - In light, a “photoconductor” will depolarize

Copier Structure



Xerographic Process



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