ELECTRON THEORY

Subject Name: Electrical Fundamentals

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Approved By:

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3.1 Electron Theory

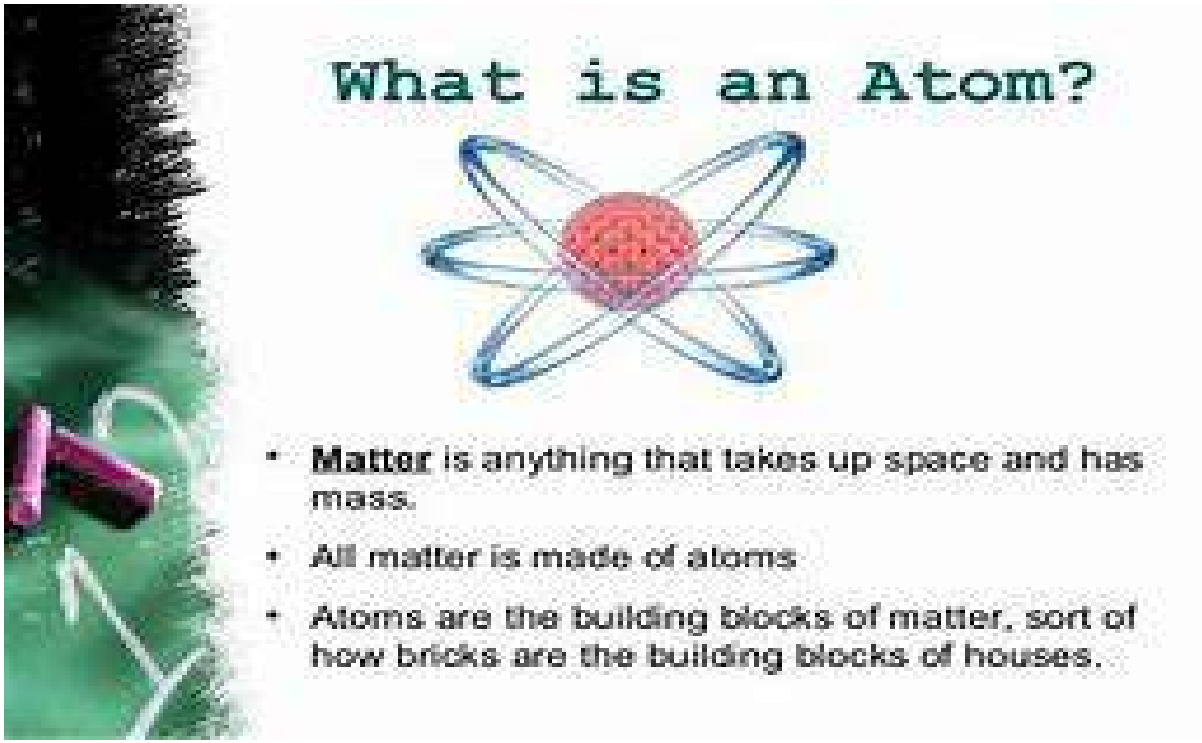
a. Structure & Distribution of electrical Charges within :

Atoms

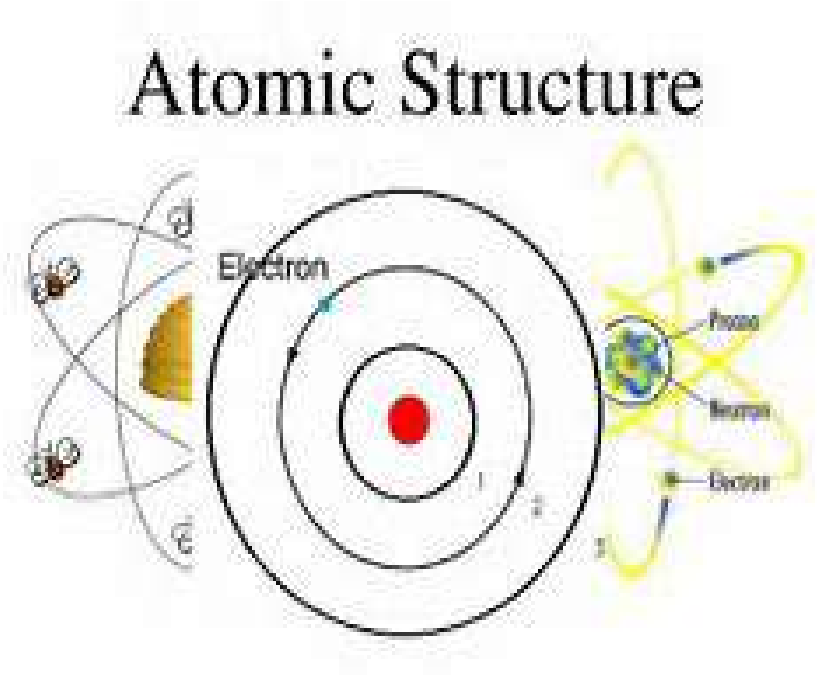
Molecules

b. Molecular Structure of Conductors, Semiconductors and Insulators

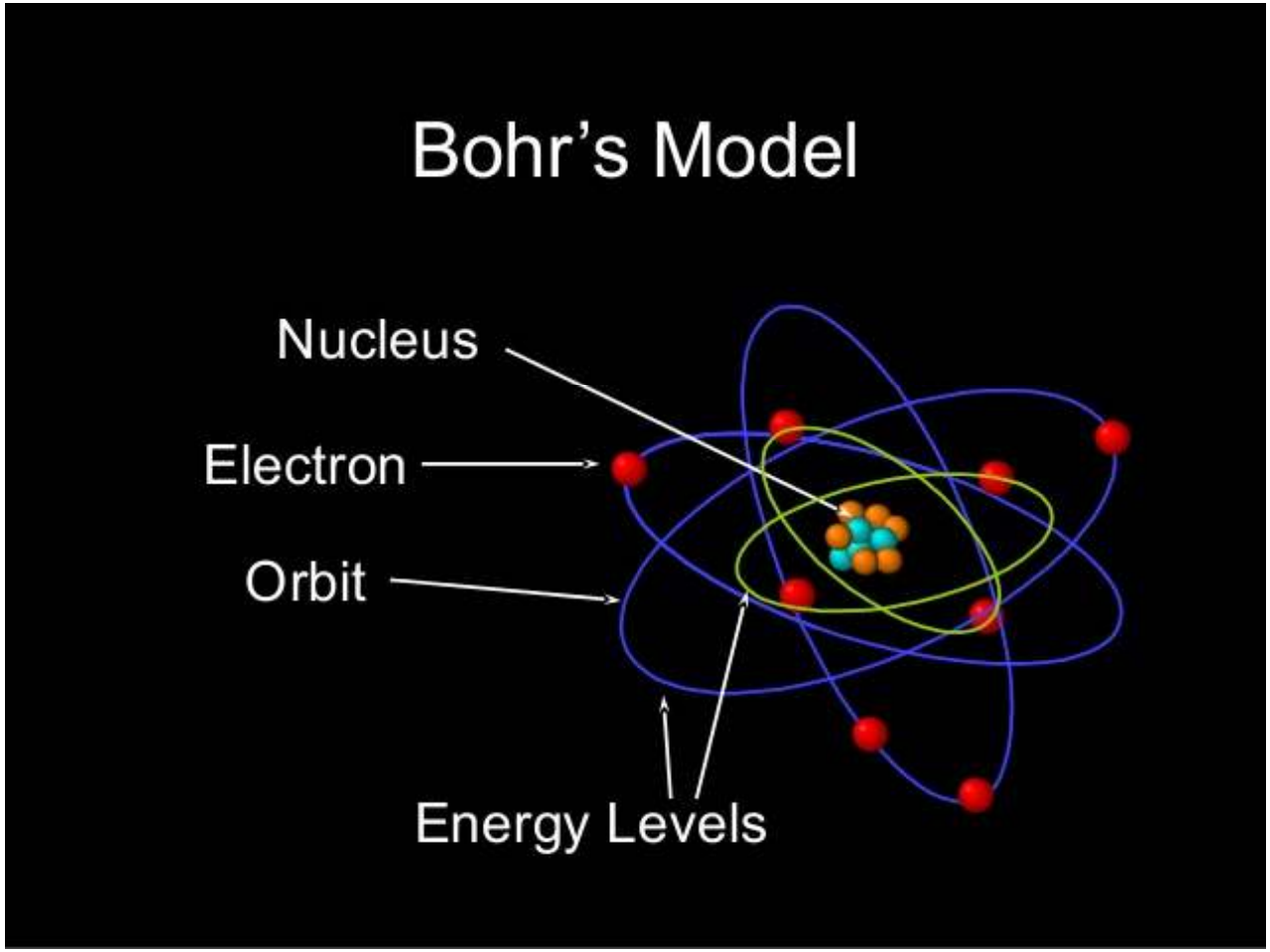
WHAT IS AN ATOM?



ATOMIC STRUCTURE



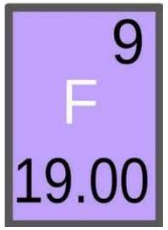
BOHR’S MODEL : NUCLEUS,ELECTRON,ORBIT,ENERGY LEVELS

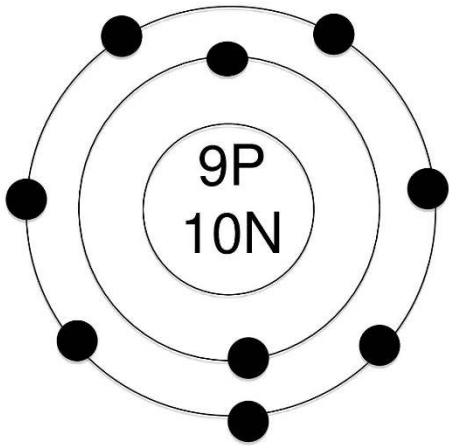


ATOMIC STRUCTURE : FLUORINE

Bohr's Model of the Atom

- electrons fills the orbits closest to the nucleus





e.g. fluorine:

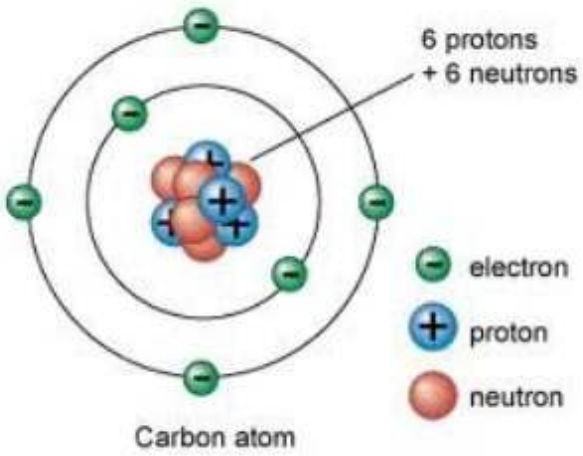
#P = 9

#e^- = 9

#N = 10

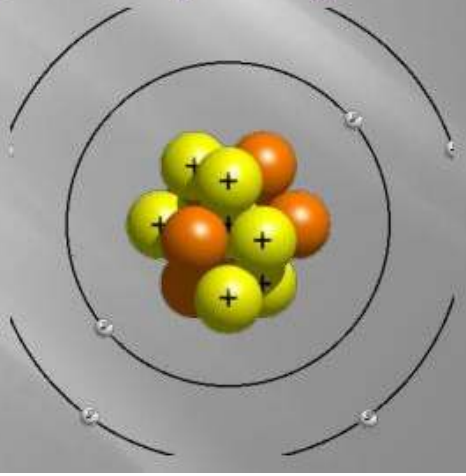
Bohr's Model of the Atom

- electrons orbit the nucleus like planets orbit the sun



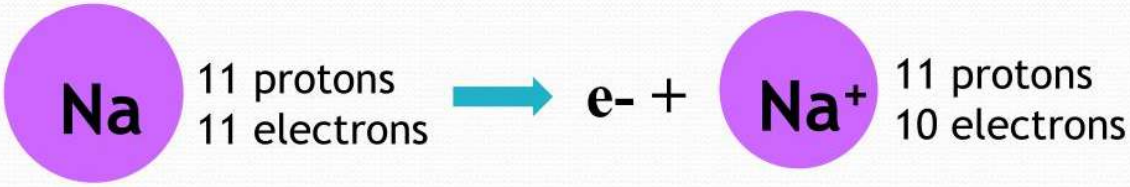
Protons

- Discovered by Eugen Goldstein who observed particles traveling in the opposite direction of negatively charged cathode rays
- Protons are positively charged subatomic particles

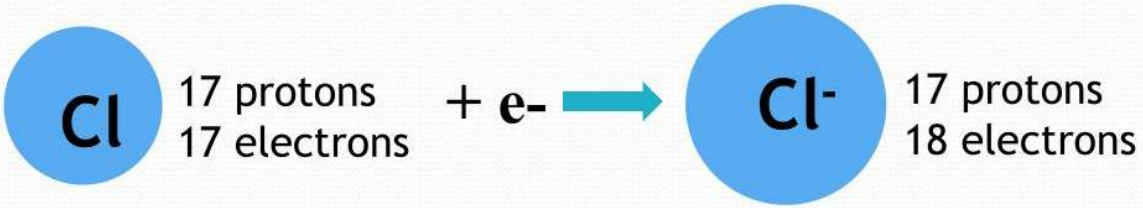


Atomic Structure

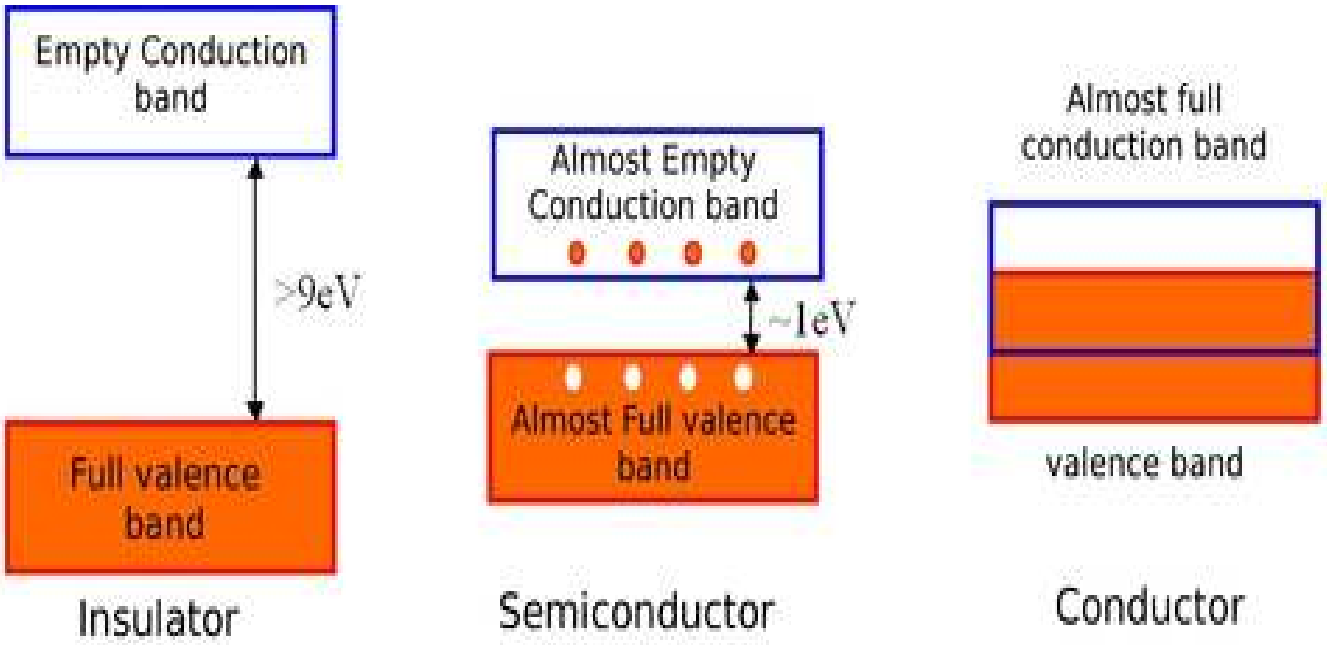
If a neutral atom **looses** one or more electrons it becomes a **cation**.



If a neutral atom **gains** one or more electrons it becomes an **anion**.



SEMICONDUCTOR , CONDUCTOR & INSULATORS



semiconductor

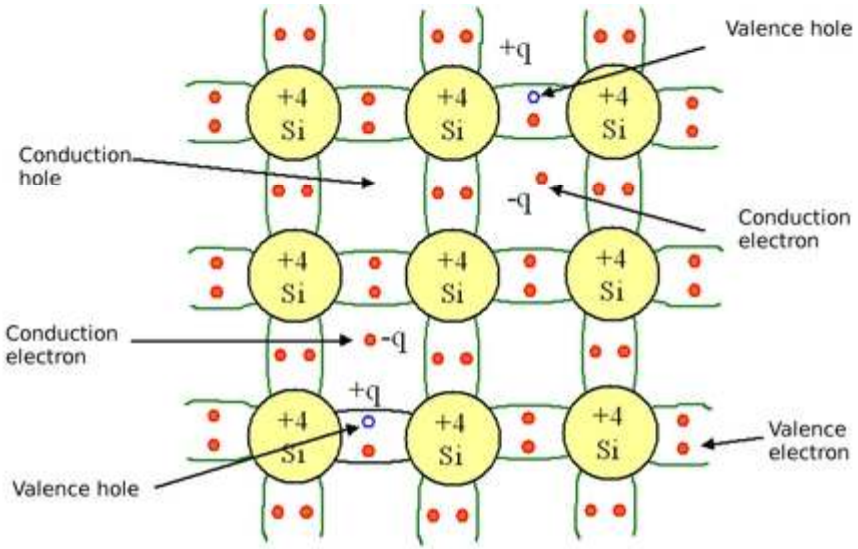
- A semiconductor is primarily an insulator at 0K. However, since the energy gap is lower compared to insulators (~1eV), the valence band is slightly thermally populated at room temperature, whereas the conduction band is slightly depopulated. Since electrical conduction is directly connected to the number of electrons in the “almost empty” conduction band and to the number of holes in the “almost fully occupied” valence band, it can be expected that the electrical conductivity of such an intrinsic semiconductor will be very small.

Conductor

- For a conductor, conduction bands and valence bands are not separated and there is therefore no energy gap. The conduction band is then partially occupied (even at low temperatures), resulting in a “high” electrical conductivity

- **Doped (extrinsic) semiconductors**
- An extrinsic semiconductor is a semiconductor doped by a specific impurity which is able to deeply modify its electrical properties, making it suitable for electronic applications (diodes, transistors, etc.) or optoelectronic applications (light emitters and detectors).

Intrinsic Semiconductor



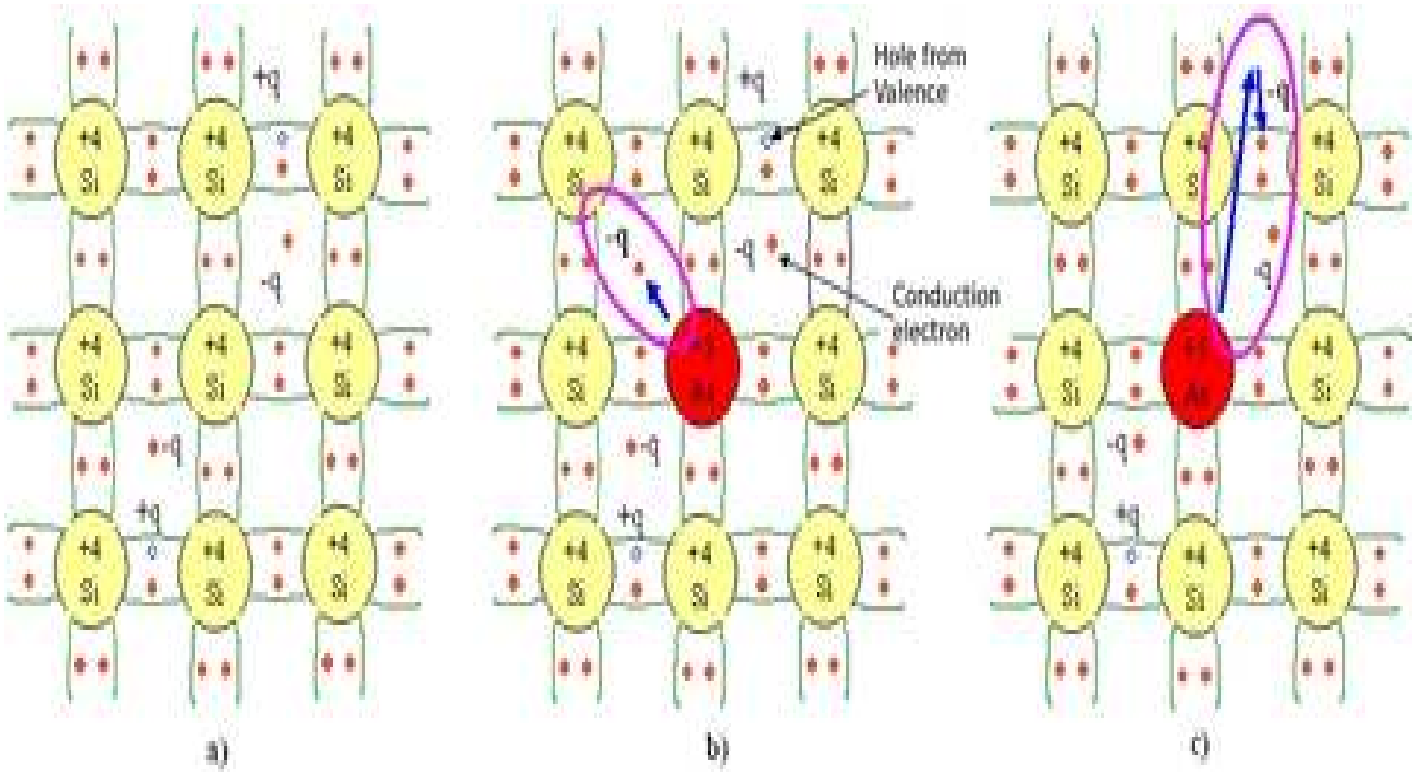
Extrinsic Semiconductor

- An extrinsic semiconductor is a semiconductor doped by a specific impurity which is able to deeply modify its electrical properties, making it suitable for electronic applications (diodes, transistors, etc.) or optoelectronic applications (light emitters and detectors).

P TYPE MATERIALS

- A P-type semiconductor is an intrinsic semiconductor (like Si) in which an impurity acting as an acceptor (like e.g. boron B in Si) has been intentionally added. These impurities are called acceptors since once they are inserted in the crystalline lattice, they lack one or several electrons to realize a full bonding with the rest of the crystal.

P TYPE MATERIALS



N TYPE MATERIALS

- A N-type semiconductor is an intrinsic semiconductor (e.g. silicon Si) in which a donor impurity (e.g. arsenic As in Si, or Si in GaAs) has been intentionally introduced. The impurities are called donor impurities since they have to give an extra electron to the conduction band in order to make all the bonds with neighboring atoms (As is pentavalent while Si is tetravalent).

N TYPE MATERIALS