Conductor,Semiconductor and Insulator Notes For ECE of SSC Scientific Assistant Exam 2017

Conductors are generally substances which have the property to pass different types of energy. In the following, the conductivity of electricity is the value of interest.

Metals: The conductivity of metals is based on the free electrons (so-called Fermi gas) due to the metal bonding. Already with low energy electrons become sufficiently detached from the atoms and a conductivity is achieved.

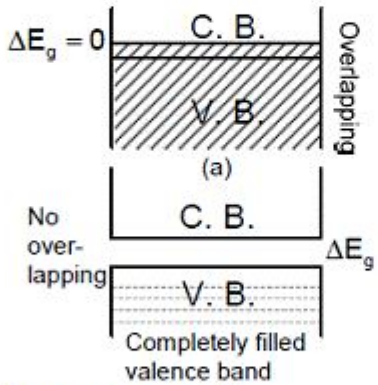
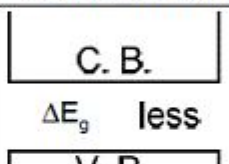
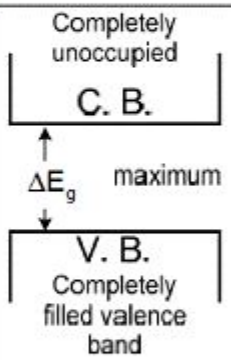
The conductivity depends, inter alia, on the temperature. If the temperature rises, the metal atoms swing ever stronger, so that the electrons are constrained in their movements. Consequence, the resistance increases. The best conductors, gold and silver, are used relatively rare because of the high costs (gold e.g. for the contacting of the finished chips). The alternatives in the semiconductor technology for the wiring of the individual components of microchips are aluminum and copper.

Salts: In addition to metals, salts can also conduct electricity. There are no free electrons, so the conductivity depends on ions which can be solved when a salt is melting or dissolving, so that the ions are free to move

Insulators: Glass, most polymers (plastics), rubber and wood are all examples of insulators. These are materials which will refuse to carry an electric current. They are useful for jobs like coating electric wires to prevent them from ‘shorting together’ or giving you a shock. Silk and cotton are also good

insulators (when they're dry!!) and some of the mains wiring in very old houses once used them – but by modern standards this was pretty dangerous since you could get a shock when wet or a spark would set them alight when dry. Modern insulators like PVC (PolyVinylChloride) are much better and safer.Insulators are also very useful to fill the 'gap' in between the metal plates of a capacitor.

Semiconductors are solids whose conductivity lies between the conductivity of conductors and insulators. Due to exchange of electrons – to achieve the noble gas configuration – semiconductors arrange as lattice structure. Unlike metals, the conductivity increases with increasing temperature. Increasing temperatures leads to broken bonds and free electrons are generated. At the location at which the electron was placed, a so-called defect electron ("hole") remains.

S.No.	Property	Conductors	Semi-conductors	Insulators
1.	Electrical conductivity and its value	Very high 10^{-7} mho/m	Between those of conductors and insulators i.e. 10^{-7} mho/m to 10^{-13} mho/m	Negligible 10^{-13} mho/m
2.	Resistivity and its value	Negligible Less than 10^{-5} Ω-m	Between those of conductors and insulators i.e. 10^{-5} Ω-m to 10^{5} Ω-m	Very high more than 10^{5} Ω-m
3.	Band structure			
4.	Energy gap and its value	Zero or very small	More that in conductors but less than that in insulators e.g. in Ge, ΔE_g =0.72 eV is Si, ΔE_g =1.1 eV in Ga As ΔE_g =1.3 eV	Very large e.g. in diamond ΔE_g = 7 eV

5.	Current carriers and current flow	Due to free electrons and very high	Due to free electrons and holes more than that in insulators	Due to free electrons but negligible.
6.	Number of current carriers (electrons or holes) at ordinary temperature	Very high	very low	negligible

7.	Condition of valence band and conduction band at ordinary temperature	The valence and conduction bands are completely filled or conduction band is some what empty (e.g. in Na)	Valence band in somewhat empty and conduction band is somewhat filled	Valence band is completely filled and conduction band is completely empty.
8.	Behaviour at 0 K	Behaves like a superconductor.	Behaves like an insulator	Behaves like an insulator
9.	Temperature coefficient of resistance (α)	Positive	Negative	Negative
10.	Effects of temperature on conductivity	Conductivity decreases	Conductivity increases	Conductivity increases
11.	On increasing temperature the number of current carriers	Decreases	Increases	Increases