This Worksheet provides evidences for the GC 1.1, 1.2 and 1.3

GC	GC1.1	Define semiconductors, and list two of the most common semiconductor material used to build electronic devices.
GC	GC1.2	Explain how a semiconductor material can be classified in to (n-type) or (p-type) based on the type of impurities added.
GC	GC1.3	Explain with the aid of diagrams, how a PN – junction diode is formed using n-type and p-type layers.

Q1) fill in the blanks with the correct word from the bank below. You may use one word twice.

[impurities, Germanium , donor, n-type, increases, free electrons, Doping, Semiconductors, good, acceptor, four, hole, improved, High, Silicon, free protons]

……………….are Materials such as conductors, Silicon (Si) and …………….have electrical properties somewhere in the middle, between those of a "conductor" and an "insulator". They are not good …………………. nor …………………. insulators (hence their name "semi"-conductors). They have very few "…………………" because their atoms are closely grouped together in a crystalline pattern but electrons are still able to flow, but only under special conditions.
The ability of those materials to conduct electricity can be greatly …………….. by replacing or adding certain …………….. or acceptor atoms to this crystalline structure thereby, producing more free electrons than holes or vice versa. That is by adding a small percentage of another element to the base material, either ………… or germanium.

This process of adding donor or acceptor atoms to semiconductor atoms is called …………….. as the doped silicon is no longer pure, these donor and acceptor atoms are collectively referred to as "……………………", and by doping these silicon materials with a sufficient number of impurities, we can turn it into an …………… or p-type semi-conductor material.

The most commonly used semiconductor basics material by far is ………………. . It has ……………. valence electrons in its outermost shell which it shares with its neighboring atoms to form full orbital's of eight electrons.

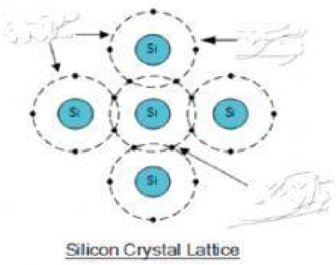
An impurity that ……………… the number of free electrons is called n-type. Antimony (Sb), Arsenic and Phosphorus (P) are n-type impurities. A semiconductor doped with n-type impurities is known as an n-type material. Also, adding an impurity with 3- electron structure, means that one electron has nothing to bond with. This deficiency is called a ………… and such as Aluminum, Boron and Indium, is known as p-type impurity.

Q2) Mach the illustration with correct part in the figure.
a-

Co-valent Bonds

Shared Electrons

Valence Shell (m)



Silicon Crystal Lattice

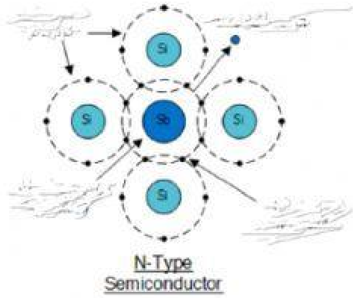
b- Drag then drop the item to its correct place in the graph.

Co-valent Bonds

Free Electron

Impurity Atom (Donor)

Shared Electrons



c- Drag then drop the item to its correct place in the graph.

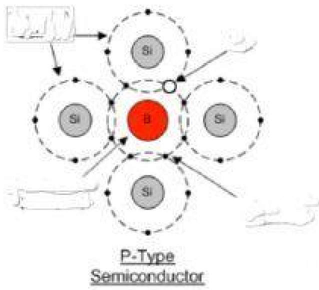
Impurity Atom (Acceptor)

Hole

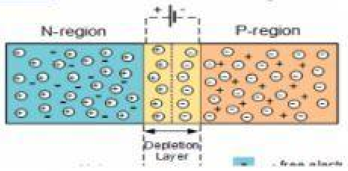
Co-valent Bonds

Shared Electrons

Free Electron



Q3) Watch the video [PN Junction](#) then order the steps of PN junction formation.



- Finally, the charge density of the P-type along the junction is filled with negatively charged acceptor ions (NA), and the charge density of the N-type along the junction becomes positive.
- This process continues until charge equilibrium state is reached (electrically neutral situation) and Depletion Layer is established.
- This charge transfer of electrons and holes across the PN junction is known as diffusion. The width of these P and N layers depends on how heavily each side is doped with acceptor density N_A, and donor density N_D.
- N-type semiconductor and P-type semiconductor materials are first joined together
- Some free electrons from the donor impurity atoms begin to migrate across this newly formed junction to fill up the holes in the P-type material producing negative ions.
- Because the electrons have moved across the PN junction from the N-type silicon to the P-type silicon, they leave behind positively charged donor ions (ND) on the negative side. Also, the holes from the acceptor impurity migrate across the junction in the opposite direction into the region where there are large numbers of free electrons.