1. Semiconductors are materials that allow electric current to pass depending on factors such as temperatures or magnetic field they are subjected to. They have a conductivity between conductors and non-conductors or insulators. Semiconductors are employed in the manufacture of various kinds of electronic devices including diodes ,transistors and integrated circuits. They have a wide range of current- and voltage-handling capabilities .Semiconductors can be components like ,gallium arsenide or pure elements such as germanium or silcon.
2. Fermi distribution is a probability distribution function that explains the distribution of particles over energy levels in a system of non-interacting fermions. Fermions are particles with half-integer spin, such as electrons protons and neutrons. The Fermi-Dirac dis­tri­b­u­tion ex­plains why: only the elec­trons within a dis­tance com­pa­ra­ble to  of the Fermi en­ergy pick up the ad­di­tional  of ther­mal en­ergy. This is only a very small frac­tion of the to­tal num­**ber of elec­trons, so the con­tri­bu­tion to the heat ca­pac­ity is usu­ally neg­li­gi­ble.**

3)The P-type Semiconductor is formed when a trivalent (having three valence electrons) impurity such as Gallium and Indium is added to a pure semiconductor in a small amount, and as a result, a large number of holes are created in it. The N-type semiconductor is described as a type of extrinsic semiconductor doped with a pentavalent (having five valence electrons) impurity element. The pentavalent impurity or dopant elements are added in the N-type semiconductor so as to increase the number of electrons for conduction.

4) The semiconductor fabrication process is a complex and highly specialized series of steps that transform raw materials into functional electronic components. This process involves a multitude of techniques and technologies, with each stage requiring precise control and attention to detail. P-type fabrication, material selection ;materials from group 3 elements of periodic table, doping process ,to create a p-type a small amount of trivalent impurity is added ,doping concentration ,crystal growth .N-type material selection ,are typically fabricated from elements in group 5 of periodic table such as arsenic ,doping process a pentavalent impurity is added to the semiconductor material.

5) A **p–n junction** is a boundary or interface between two types of [semiconductor materials](https://en.wikipedia.org/wiki/Semiconductor_material), [p-type](https://en.wikipedia.org/wiki/P-type_semiconductor) and [n-type](https://en.wikipedia.org/wiki/N-type_semiconductor), inside a single [crystal](https://en.wikipedia.org/wiki/Crystal) of semiconductor. The "p" (positive) side contains an excess of [holes](https://en.wikipedia.org/wiki/Electron_hole), while the "n" (negative) side contains an excess of [electrons](https://en.wikipedia.org/wiki/Electron) in the outer shells of the electrically neutral [atoms](https://en.wikipedia.org/wiki/Atom) there. This allows electric current to pass through the junction only in one direction. The p- and n-type regions creating the junction are made by [doping](https://en.wikipedia.org/wiki/Doping_%28semiconductor%29) the semiconductor, for example by [ion implantation](https://en.wikipedia.org/wiki/Ion_implantation), [diffusion](https://en.wikipedia.org/wiki/Diffusion) of [dopants](https://en.wikipedia.org/wiki/Dopant), or by [epitaxy](https://en.wikipedia.org/wiki/Epitaxy%22%20%5Co%20%22Epitaxy) (growing a layer of crystal doped with one type of dopant on top of a layer of crystal doped with another type of dopant).

6) The two concepts Photoelectric effect and Photovoltaic effect explain how substances react upon the exposure to light. Photoelectric effect describes the emission of [electrons](https://pediaa.com/difference-between-proton-neutron-and-electrons/)from the surface of a substance in response to incident light. Metals often show this property. Photovoltaic effect is the process in which two dissimilar materials in close contact produce an electrical voltage when struck by light. The main difference between Photoelectric Effect and Photovoltaic Effect is that **the electrons in Photoelectric Effect are emitted to open space** whereas **the electrons in Photovoltaic Effect enter a different material.**

**7)Batteries store chemical energy and convert it into electrical energy while photo voltaic cells generate electrical energy from light ;photo voltaic cell is a device that generates electricity when exposed to photons ,this conversion is called photovoltaic effect . solar panels are made up of photovoltaic cells that absorb sunlight and use that light energy to create electrical current. Batteries is a device that stores chemical energy and converts it into electrical energy. Batteries are used to power a wide range of devices including automobiles.**

**8)** Improve material quality: By using higher-quality materials such as mono- or polycrystalline silicon wafers and carefully-selected dopants. Increase antireflection coating (ARC): The ARC layer on top of the solar cell reduces reflectivity and allows more light onto its surface by acting like a mirror so fewer photons escape out from underneath the panel’s surface area due to reflection from below it – thus increasing available power output from each panel considered individually. Optics design & concentration techniques: Using lenses/mirrors with different focal lengths and angles makes efficient light collection possible by concentrating incident radiation onto specific spots within the panel thereby extracting more power that was until now wasted due to low exposure levels at either too close/long distances relative to this particular concentrator design used. Optics design & concentration techniques

9)Multi junction cell is a type of photovoltaic cell that consists of multiple semiconductor layers each designed to absorb different wavelengths of light due to this ;it is able to capture a large spectrum of sunlight and convert it into electrical energy. A cell’s efficiency is improved because of addition of more junctions for example there will be reduced thermal losses ;when a photon is absorbed by a semiconductor material ,it can be transfer its energy to an electron therefore creating an electron-hole-pair.

10) The Shockley–Queisser limit is the maximum theoretical efficiency of a solar cell using a single p-n junction to collect power from the cell where the only loss mechanism is radiative recombination in the solar cell.In deeper context; Refers to the maximum theoretical efficiency of a Solar cell of around 33.7% assuming a p-n junction band gap of 1.1 eV (for silicon). In other words only 33.7% of all the power contained in sunlight falling on a silicon Solar cell, could ever be turned into electricity. In this model excitation energy above the bandgap is lost to heating and excitation energy below the band gap is not absorbed.

11) Solar cell working is based on Photovoltaic Effect. The N-type layer is thin and transparent. The P-type layer is thick. When sunlight strikes the N-type thin layer, the light waves penetrate up to the P-type layer. The energy from photons in the light waves is important to the molecules and atoms in the N-P junction resulting in liberation of electron-hole pairs. Electrons are released from N-type material and holes are created in P-type material. Electrons are negative charges and holes are positive charges. The construction and working of solar cell is shown below.

When the external electric circuit is completed by connecting electrodes to the load, the electrons flow in the closed external circuit from the N-type terminal (-) to the P-type terminal (+). The direction of current is from the +ve terminal (P-type) to the -ve terminal (N-type) in the external circuit.

12) Power is delivered by a single solar cell or panel is the product of its output current and voltage. if the multiplication is done, point for point, for all voltages from short-circuit to open-circuit conditions, the power curve above is obtained for a given radiation level. Another way to visualize the I-V curve is to convert it to a relationship between **power** and **voltage**. In this case, we can call it (P-V) curve of PV module, as shown in Figure below. Similar to an I-V curve, the highest voltage occurs at the open-circuit condition and the current is zero and the short-circuit voltage is zero at the origin of the curve, but . If we observe the power and voltage starting at the open-circuit condition (where the voltage is maximum and power is zero), and as we increase the load of the circuit, the power starts increasing and the voltage falls down until it reaches the value at MPP (where power is maximum). If we increase the load further, the voltage keeps falling down. However, the power will decrease as well until it reaches the value of zero at short-circuit condition (where the both voltage and power are zero). It can be seen that it is much easier to find the peak power on the P-V curve in comparison to the I-V curve, as it resembles a hump. The power at MPP is referred to as "Pmpp."

