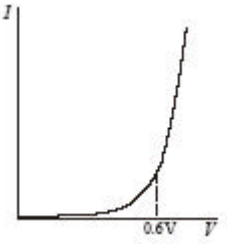
State Examinations Commission – Physics Higher Level, 2004.

Question 12d

A p-n junction is formed by taking a single crystal of silicon and doping separate but
adjacent layers of it. A depletion layer is formed at the junction.
(i) What is doping?
(ii) Explain how a depletion layer is formed at the junction. (15)
The graph shows the variation of current I with potential difference V for a p-n junction in
forward bias. Explain, using the graph, how the current varies with the potential difference.
Why does the p-n junction become a good conductor as the potential difference exceeds 0.6 V?
(13)



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The adding of very small controlled amounts of impurities to the crstal to increase its conductivity.

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Electrons drift from the region of high electron concentration in the n-type into the p-type where the recombine with holes. Likewise, at the same time, holes drift in the opposite direction. This leaves a region on either side of the boundary that is depleted of majority charge carriers. The drifting of the holes and electrons stops because of the build up of a pd across the boundary that opposes their further migration.

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The diode conducts very poorly until a voltage of approx 0.6V is reached, after which it conducts well. It becomes a good conductor after this voltage because then the voltage is exceeding the junction voltage (across the depletion layer) which prevented the movement of majority charge carriers.