From *Semiconductor Physics and Devices: Basic Principles* (4th Edition), Donald A. Neamen, McGraw Hill, 2012, ISBN 978-0-07-352958-5.

For a **donor dopant** (AKA type *n*)

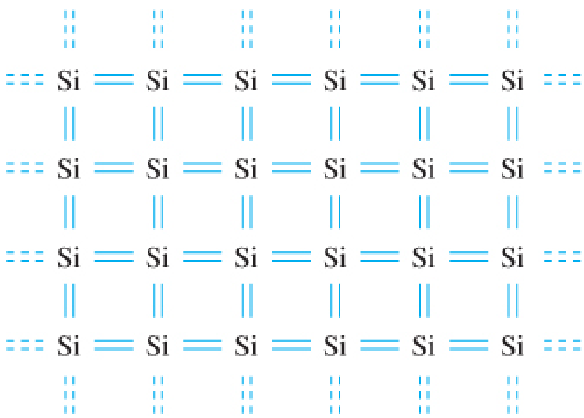

Figure 4.3 | Two-dimensional representation of the intrinsic silicon lattice.

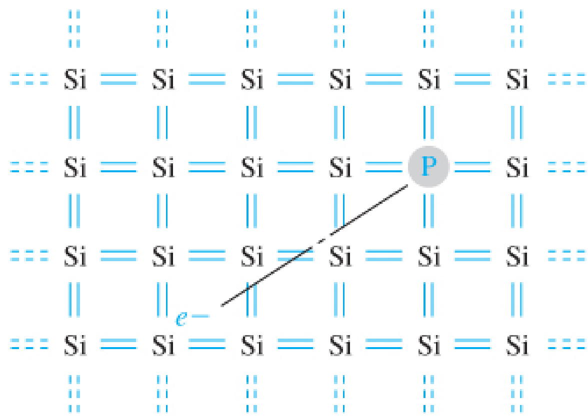

Figure 4.4 | Two-dimensional representation of the silicon lattice doped with a phosphorus atom.

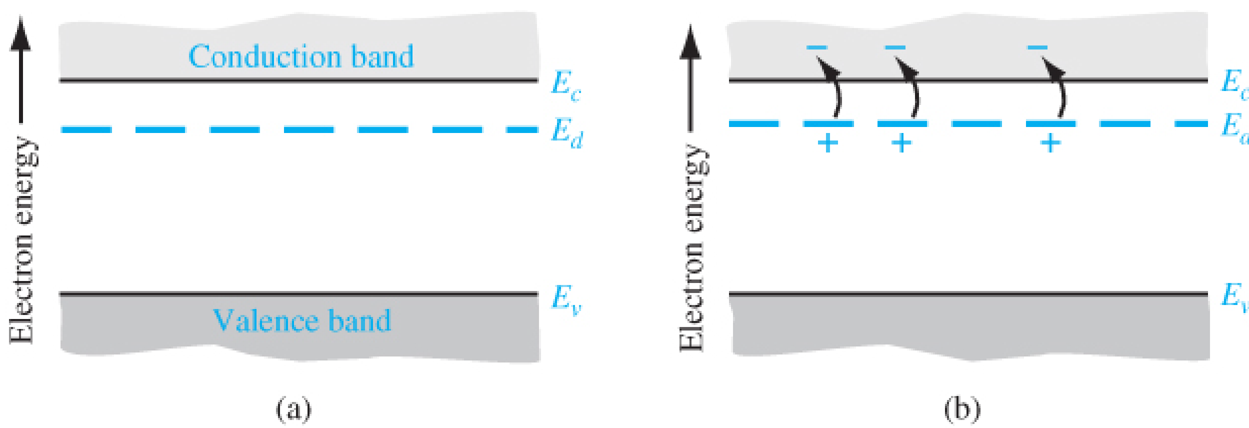

Figure 4.5 | The energy-band diagram showing (a) the discrete donor energy state and (b) the effect of a donor state being ionized.

- Intuitively assume that the extra electron not needed for covalent bonding by the donor will not need as much energy to be lifted into conduction band.

For an **acceptor dopant** (AKA type *p*)

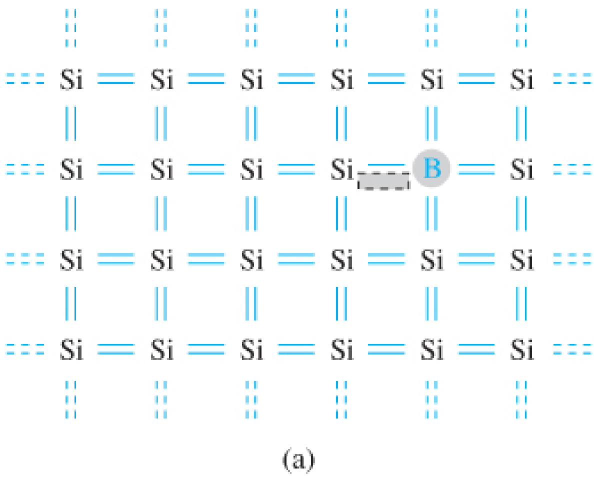

Figure 4.6 | Two-dimensional representation of a silicon lattice (a) doped with a boron atom and (b) showing the ionization of the boron atom resulting in a hole.

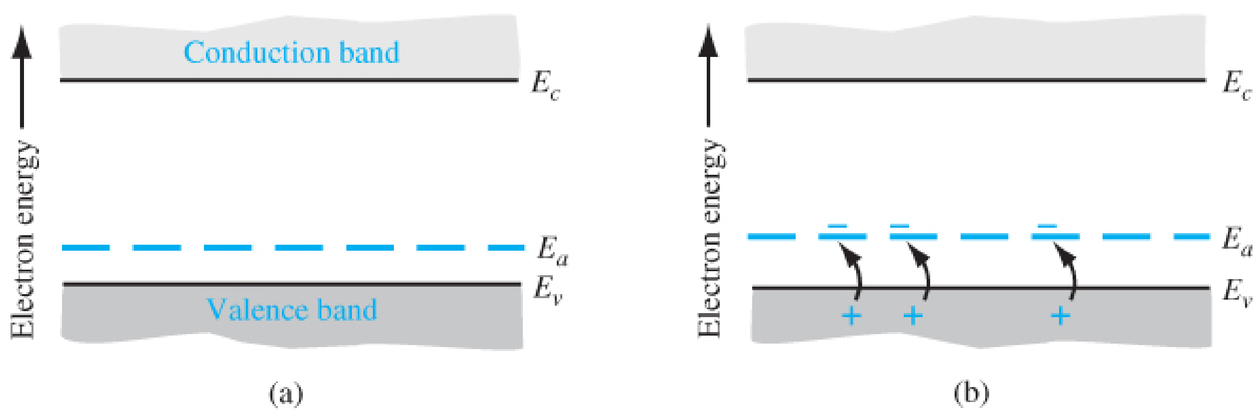

Figure 4.7 | The energy-band diagram showing (a) the discrete acceptor energy state and (b) the effect of an acceptor state being ionized.

- Intuitively assume that the extra electron needed for covalent bond by the acceptor will not need as much energy to be lifted from valence band, creating a hole.