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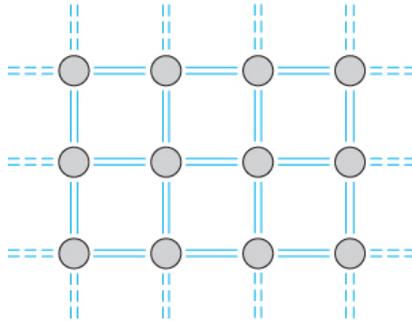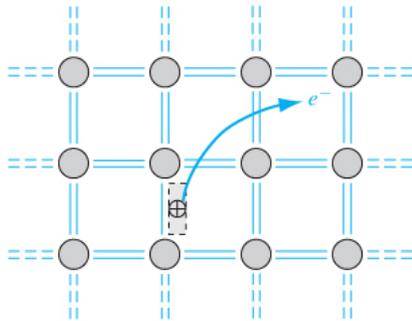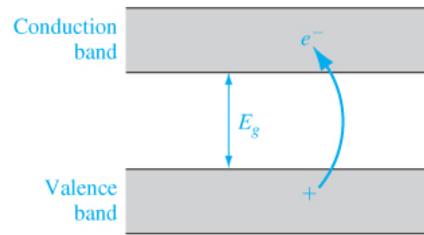

Figure 3.12 | Two-dimensional representation of the covalent bonding in a semiconductor at $T = 0$ K.

➢ Now, let temperature increase so that K.E. $= T > 0$

(a)   (b)

Figure 3.13 | (a) Two-dimensional representation of the breaking of a covalent bond. (b) Corresponding line representation of the energy band and the generation of a negative and positive charge with the breaking of a covalent bond.
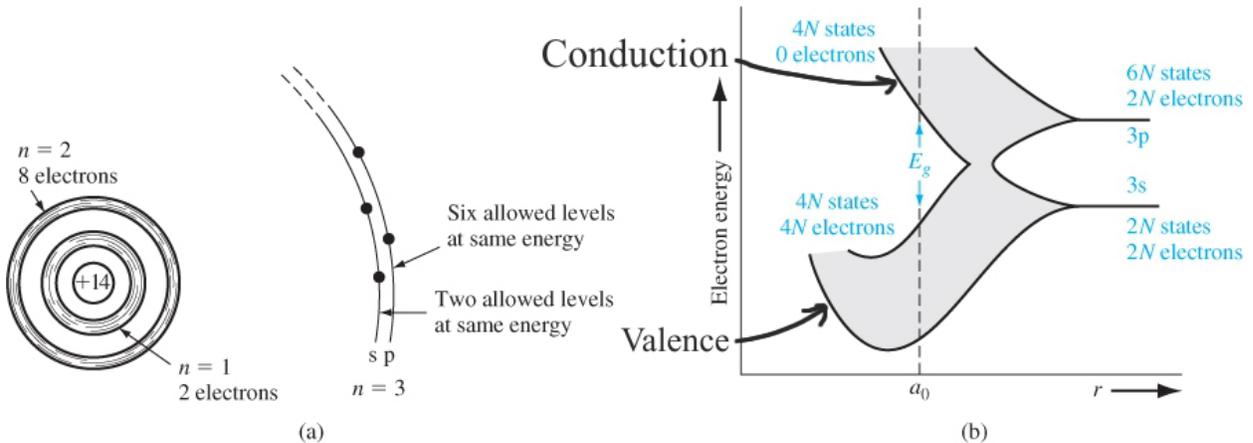
➢ For silicon, we might see

(a)   (b)

Figure 3.4 | (a) Schematic of an isolated silicon atom. (b) The splitting of the 3s and 3p states of silicon into the allowed and forbidden energy bands.
(From Shockley [6].)

➢ Looking at energy E versus k bands at a) 0 K and and b) > 0 K, we see that some of the valence electrons in the highest energy states move to some of the lowest energy conduction states.

➢ Note the distribution is shown as symmetric as we are assuming there is no externally applied forces or fields.
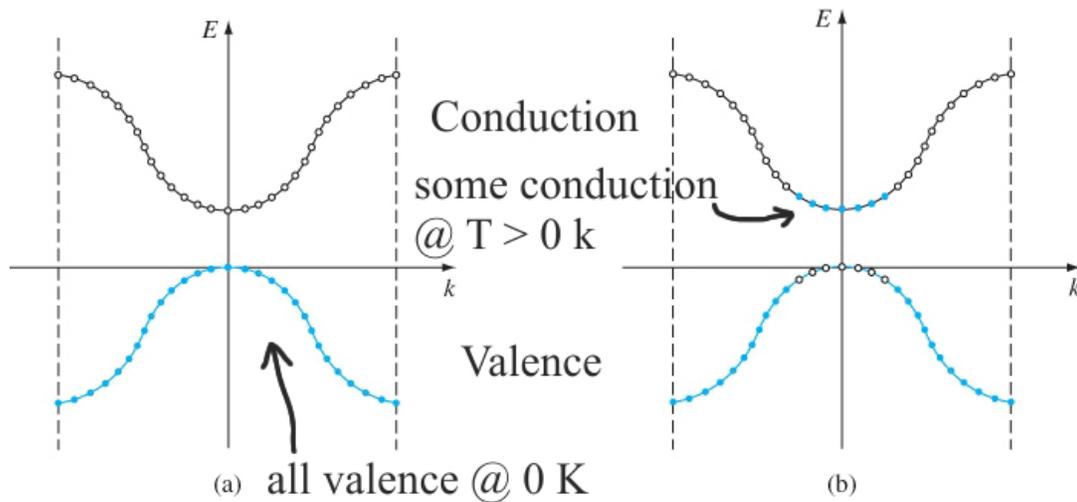

Conduction

some conduction
@ T > 0 k

Valence

(a) all valence @ 0 K   (b)

Figure 3.14 | The E versus k diagram of the conduction and valence bands of a semiconductor at (a) $T = 0$ K and (b) $T > 0$ K.