

Solution

Consider electrons in a semiconductor, e.g., silicon. In a perfect crystal at $T=0$ the valence bands are filled and the conduction bands are empty \Downarrow no conduction. Which of the following could be done to make the material conductive?

- a. heat the material
- b. shine light on it
- c. add foreign atoms that change the number of electrons

a and b: Both of these add energy to the material, exciting some of the electrons into the conduction band.

c: Adding foreign atoms (called “doping”) will either cause the material to have too many electrons to fit into the valence band (some will go into the conduction band), or cause the valence band to have unfilled states. In either case, some electrons will have nearby (in energy) states to which they can be excited.