6.4: The Ionic Crystal Lattice

Up to this point we have been considering what would happen if a single Li atom and a single H atom were combined. When a large number of atoms of each kind combine, the result is somewhat different. Electrons are again transferred, and ions are formed, but the ions no longer pair off in twos. Instead, under the influence of their mutual attractions and repulsions, they collect together in much larger aggregates, eventually forming a three-dimensional array like that shown in the Figure **6.4.1.** On the macroscopic level a crystal of solid lithium hydride is formed.

The formation of such an **ionic crystal lattice** results in a lower potential energy than is possible if the ions only group into pairs. It is easy to see from the figure of the crystal lattice why this should be so. In an ion pair each Li^+ ion is close to only one $H^–$ ion, whereas in the crystal lattice it is close to no less than *six* ions of opposite charge. Conversely each $H^–$ ion is surrounded by six Li^+ ions. In the crystal lattice therefore, more opposite charges are brought closer together than is possible for separate ion pairs and the potential energy is lower by an additional 227 kJ $mol^{–1}$. The arrangement of the ions in a crystal of LiH corresponds to the lowest possible energy. If there were an alternative geometrical arrangement bringing even more ions of opposite charge even closer together than that shown in the figure, the Li^+ ions and $H^–$ ions would certainly adopt it.

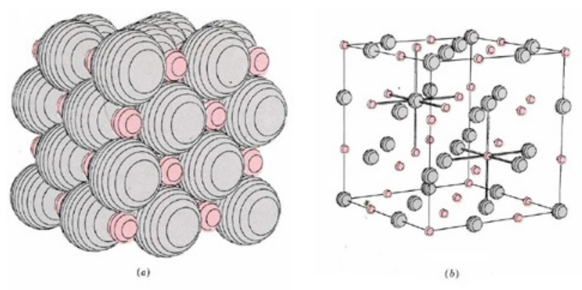

Figure 6.4.1: A portion of the ionic crystal lattice of lithium hydride, LiH. (a) Lithium ions, Li^+, (color) and hydride ions, $H^–$, (gray) are shown full size. In a macroscopic crystal the regular array of ions extends indefinitely in all directions. (b) "Exploded" view of the lattice, showing that each Li^+ ion (color) is surrounded by six $H^–$ ions (gray), and vice versa. (Computer-generated). (Copyright © 1976 by W. G. Davies and J. W. Moore.)