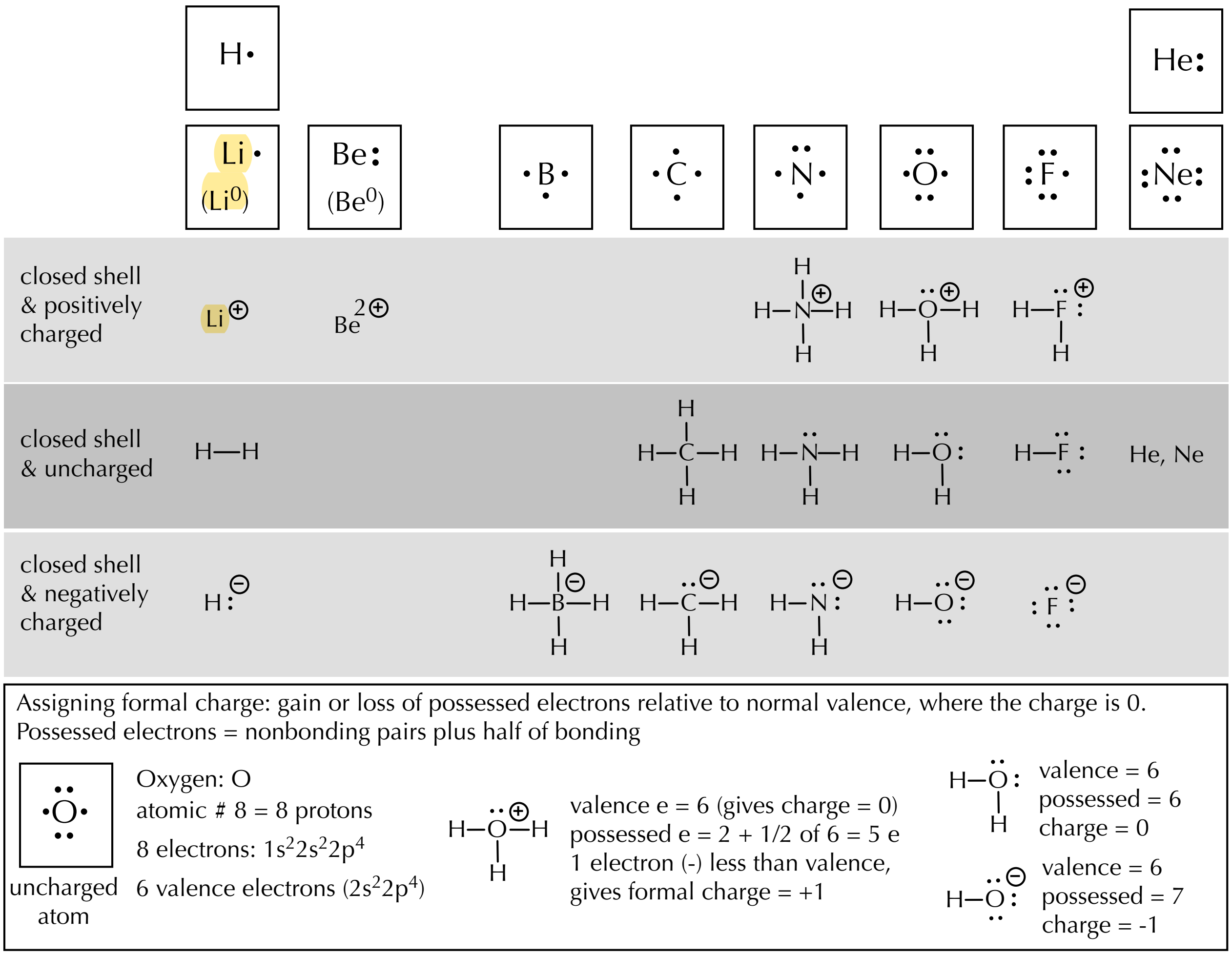
Figure AP0106

Valence and bonding in the main group elements (rows 1 and 2).



In the first row (H, He), the nearest closed shell electron configuration is that of helium (2 electrons in the "1s" level), also called the duet rule, typically achieved by H taking on 1 more electron through sharing or gaining.

In the second row (Li, Be, B, C, N, O, F, Ne), the nearest closed shell configuration is either that of helium (2 electrons, typically achieved by Li and Mg losing 1 or 2 electrons, respectively, giving the lithium cation, Li+, or beryllium dication, Be^{+2}) or that of neon, called the octet rule, typically achieved by the remaining atoms taking on the required number of electrons through sharing or gaining to get a total of 8 electrons: 2 from the 2s sublevel plus 6 electrons from the 2p sublevel.

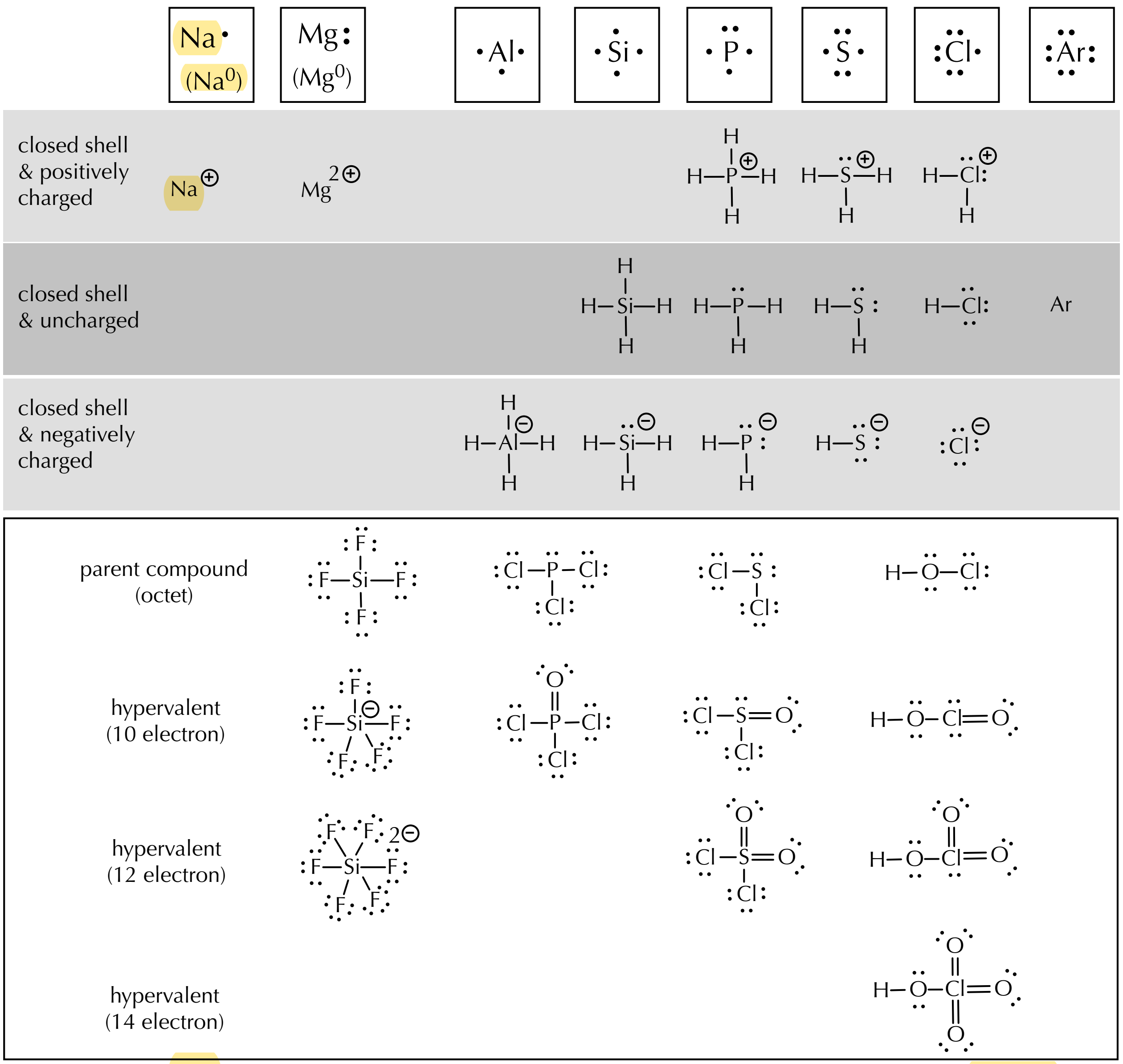
With atoms following a single rule (achieving a closed shell configuration), some broad generalizations about bonding result.

Compounds that include Group 1 and 2 metals are assumed to involve metal ions and to be ionic. Covalent compounds with uncharged, closed shell atoms have consistent and predictable bonding behavior: Hydrogen atoms have 1 shared electron bond; carbon atoms have 4; nitrogen atoms have 3 bonds, with 1 nonbonding electron pair (nbe); oxygen atoms have 2 bonds, with 2 nbe; and chlorine has 1 bond with 3 nbe. Any other situation for these atoms means, by definition, that the atom is open shell, or charged, or both. Although exceptions exist, atoms on the right-hand portion of the second row (B, C, N, O, F) rarely have formal charges other that -1, 0, or +1.

A shared electron pair bond does not have to arise from one electron being contributed from both atoms. An atom with a nonbonding electron pair can share that pair with an atom that needs two more to achieve its closed shell configuration. This type of bond, called coordinate covalent (also dative bond, coordinate bond), is commonly observed in the organic chemistry of boron, and when oxides form with individual oxygen atoms, as both of these atoms have 6 electrons and are in search of another pair to get to an octet.

Figure AP0107

Valence and bonding in the main group elements (row 3).



In the third row (Na, Mg, Al, Si, P, S, Cl, Ar), the nearest closed shell is either that of neon (sodium loses 1 electron to give the sodium ion, Na^{+}; magnesium loses 2 electrons to give the magnesium dication, Mg^{+2}, both of which are consistent with the octet rule), or that of argon, complete an octet of 2s + 6p electrons. For many chemical structures made up of the other atoms in this row, the octet generalization drives the formation of the molecules, and the compounds of aluminum mirror those of boron, silicon mirrors carbon, and so on.