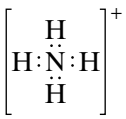
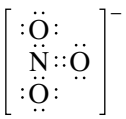
Polyatomic Ions

Certain atoms bond covalently with each other to form a group of atoms that has both molecular and ionic characteristics. *A charged group of covalently bonded atoms is known as a* **polyatomic ion.** Polyatomic ions combine with ions of opposite charge to form ionic compounds. The charge of a polyatomic ion results from an excess of electrons (negative charge) or a shortage of electrons (positive charge). For example, an ammonium ion, a common positively charged polyatomic ion, contains one nitrogen atom and four hydrogen atoms and has a single positive charge. Its formula is NH_4^+, sometimes written as $[NH_4]^+$ to show that the group of atoms *as a whole* has a charge of 1+. The seven protons in the nitrogen atom plus the four protons in the four hydrogen atoms give the ammonium ion a total positive charge of 11+. An independent nitrogen atom has seven electrons, and four independent hydrogen atoms have a total of four electrons. When these atoms combine to form an ammonium ion, one of their electrons is lost, giving the polyatomic ion a total negative charge of 10–.

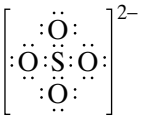
Lewis structures for the ammonium ion and some common negative polyatomic ions—the nitrate, sulfate, and phosphate ions—are shown below. To find the Lewis structure for a polyatomic ion, follow the steps of Sample Problem D, with the following exception. If the ion is negatively charged, add to the total number of valence electrons a number of electrons corresponding to the ion's negative charge. If the ion is positively charged, subtract from the total number of valence electrons a number of electrons corresponding to the ion's positive charge.



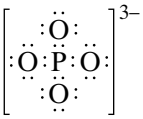
Ammonium ion



Nitrate ion



Sulfate ion



Phosphate ion

extension

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Keyword: HC6BNDX

SECTION REVIEW

1. Give two examples of an ionic compound.
2. Use electron-dot notation to demonstrate the formation of ionic compounds involving the following:
   a. Li and Cl
   b. Ca and I
3. Distinguish between ionic and molecular compounds in terms of the basic units that each is composed of.
4. Compound B has lower melting and boiling points than compound A. At the same temperature, compound B vaporizes faster than compound A. If one of these compounds is ionic and the other is molecular, which would you expect to be molecular? ionic? Explain your reasoning.

Critical Thinking

5. **ANALYZING DATA** The melting points for the compounds Li_2S, Rb_2S, and K_2S are 900°C, 530°C, and 840°C, respectively. List these three compounds in order of increasing lattice energy.