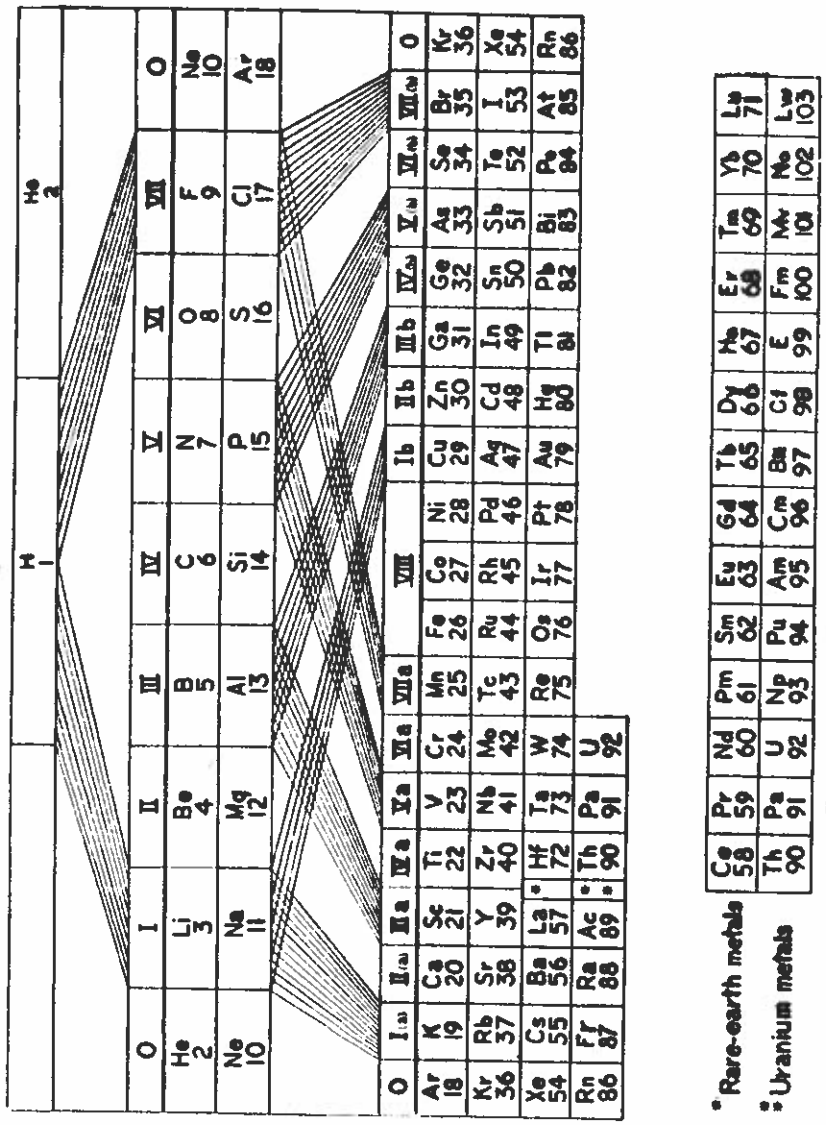

FIG. 2-15.—The periodic system of the elements.

Pauling "The Chemical Bond"

Spectroscopic measurements of the magnetic moment of atoms, involving the splitting of spectral lines into a number of components by the application of an external magnetic field to the emitting atoms, led to the discovery that often the magnetic moment is not related to the angular momentum in this simple way. The ratio is written $ge/2m_0c$, in which the g-factor has the value 1 if the angular momentum of the atom is due entirely to orbital motion of electrons. When it is due entirely to the spin of the electrons the value of the g-factor is 2. This value of the g-factor for spin cannot be explained in any simple way; it has to be accepted as part of the nature of the electron.

In case that the electronic state of the atom is such as to approximate closely to Russell-Saunders coupling the value of the g-factor can be calculated by consideration of the angles between the vectors representing the spin angular momentum, the orbital angular momentum, and the total angular momentum. It is found that the value of g is given by the equation

$$g = 1 + \frac{J(J+1) + S(S+1) - L(L+1)}{2J(J+1)}$$

Values of g are given in Appendix IV, Table 3.

The modern unit of magnetic moment is $he/4\pi m_0c$. This unit is called the Bohr magneton. Its value is 0.9273×10^{-20} erg gauss^{-1}. The magnetic moment of an atom with total angular momentum quantum number J is equal, in Bohr magnetons, to $g\sqrt{J(J+1)}$.

Values of the magnetic moments of molecules and ions can be determined experimentally by measuring the magnetic susceptibility of substances. These values may provide information about electronic structure. The magnetic moments of complexes are discussed in Chapter 5.

2-9. THE FORMAL RULES FOR THE FORMATION OF COVALENT BONDS

The formal results of the quantum-mechanical treatment of valence can be given the following simple statement: *an atom can form an electron-pair bond for each stable orbital*, the bond being of the type described for the hydrogen molecule and owing its stability to the same resonance phenomenon. In other words, for the formation of an electron-pair bond two electrons with opposed spins and a stable orbital of each of the two bonded atoms are needed.

The carbon atom, nitrogen atom, and other first-row atoms are limited to four covalent bonds using the four orbitals of the L shell. This re-

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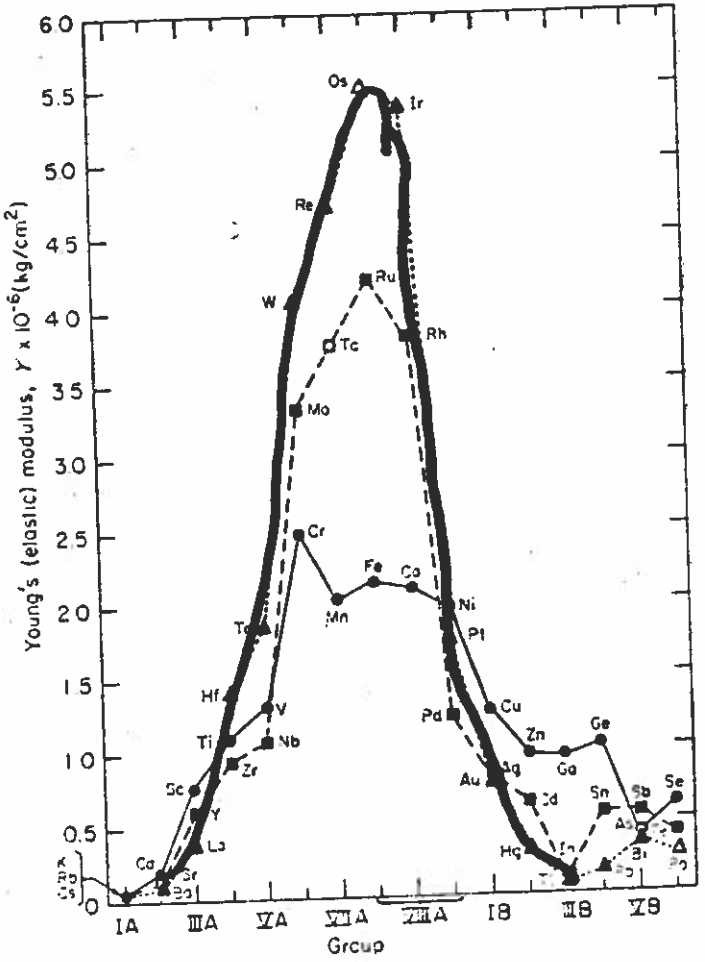

YOUNGS MODULUS

FIG. 1. Young's modulus of the elements of the fourth, fifth, and sixth periods of the Periodic Table. Open points are estimated values.

in many of their physical properties and in their alloying behaviors. Although the values for the elements in the second and third periods are not shown in Fig. 1, Young's modulus increases as one proceeds from lithium to beryllium to boron (or sodium to magnesium to aluminum) and