Chemistry

Why It Matters

Section 6.1
Types of Chemical Bonding

Chemical bond:

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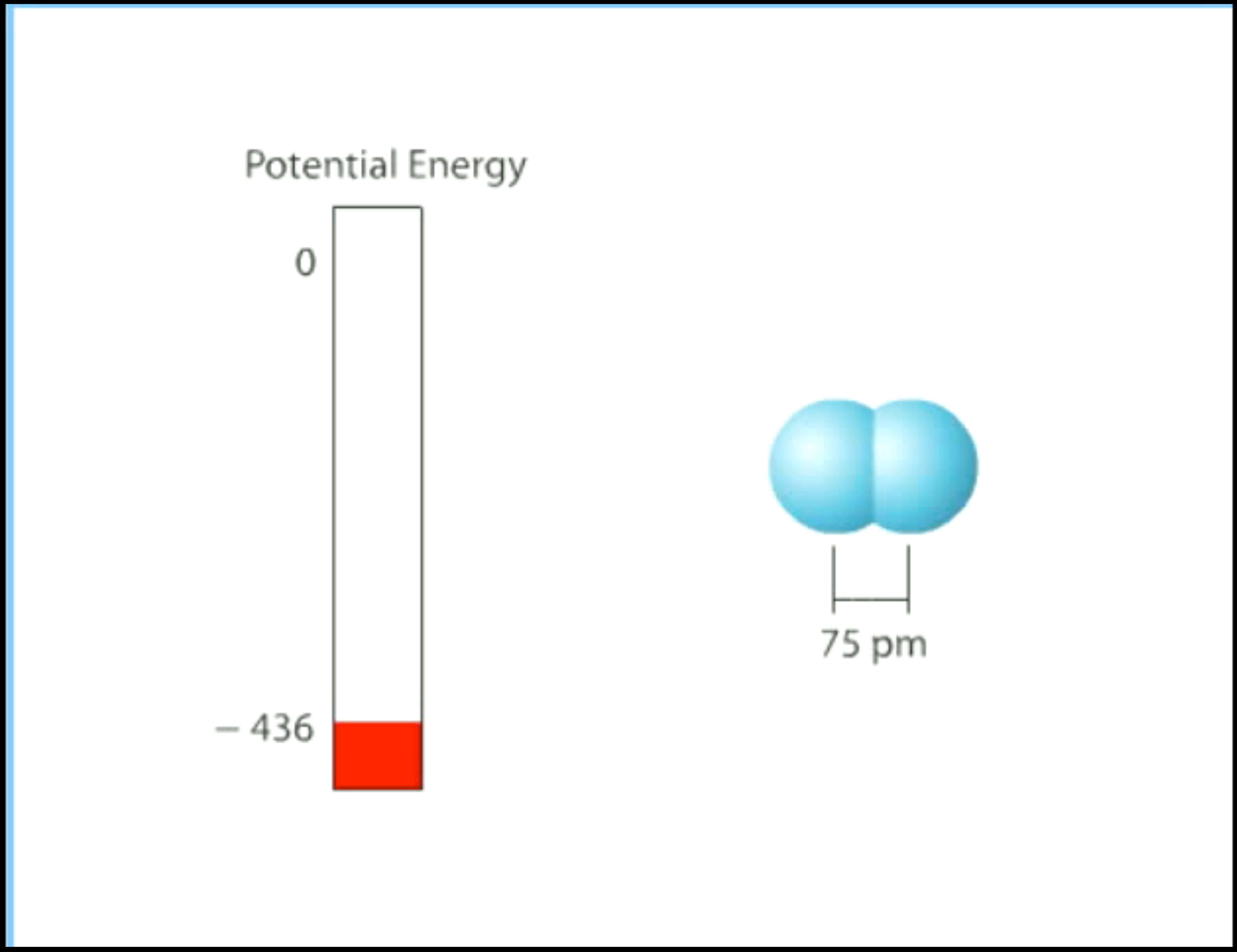
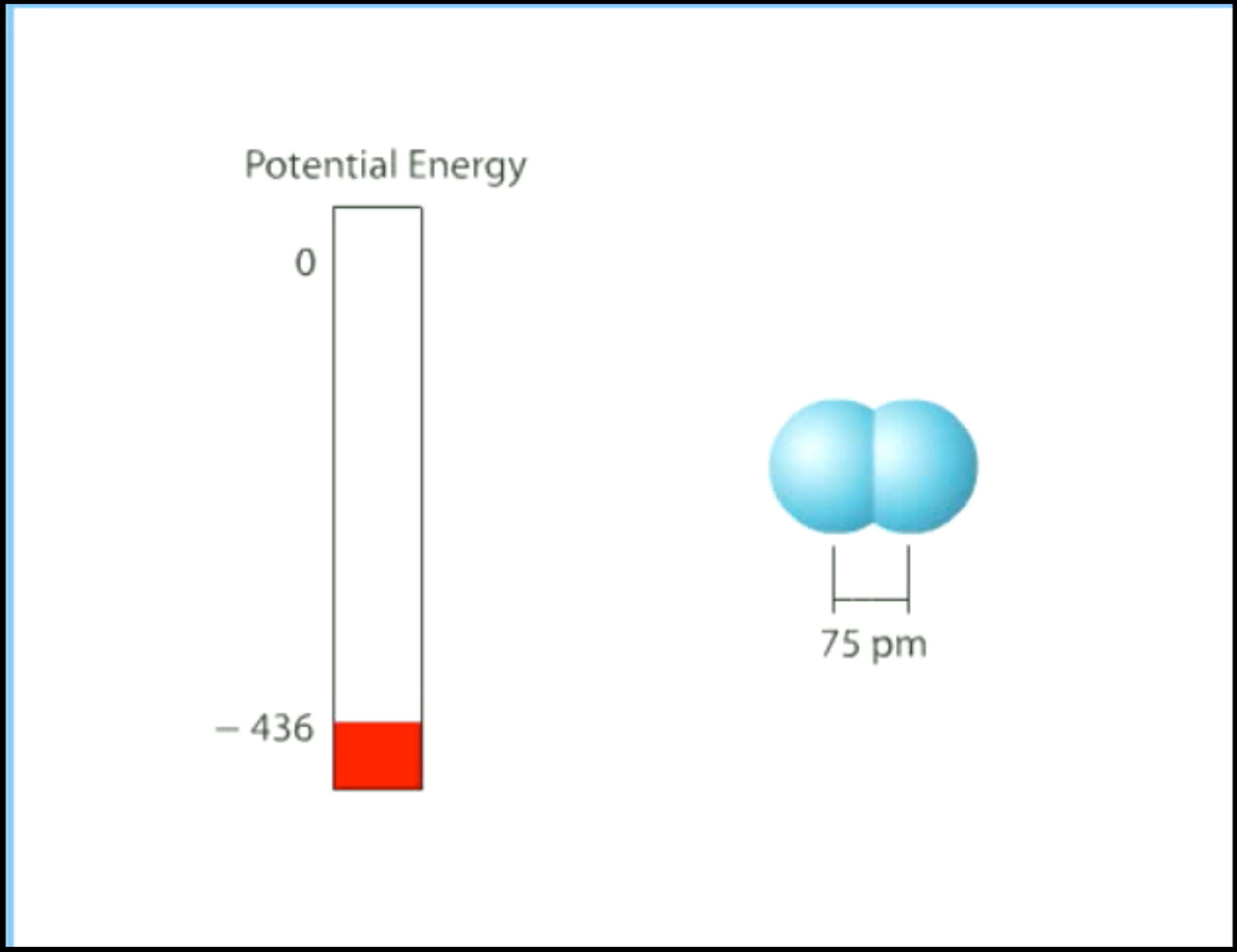


Chemical bond:

a mutual electrical attraction between the nuclei and valence electrons of different atoms that binds the atoms together.



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2. Covalent bonding:
results from the sharing of electron pairs between two atoms.

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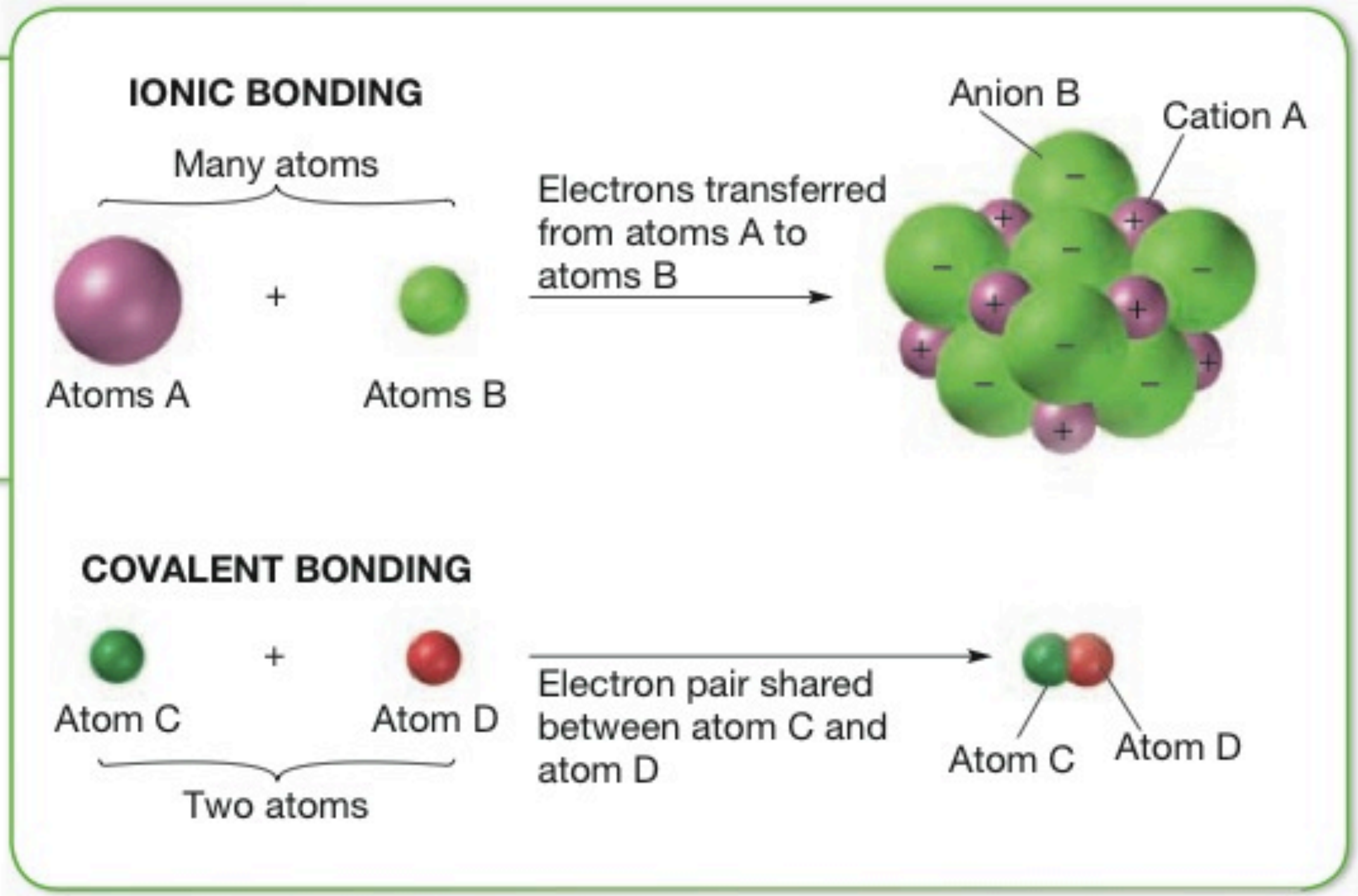
FIGURE 1.1

Ionic Bonding and Covalent Bonding In ionic bonding, many atoms transfer electrons. The resulting positive and negative ions combine due to mutual electrical attraction. In covalent bonding, atoms share electron pairs to form independent molecules.



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- covalent bonds form between nonmetals

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greater than 1.7	ionic
between 0.3 - 1.7	polar covalent
less then 0.3	nonpolar covalent

Predicting Bond Character from Electronegativity Differences

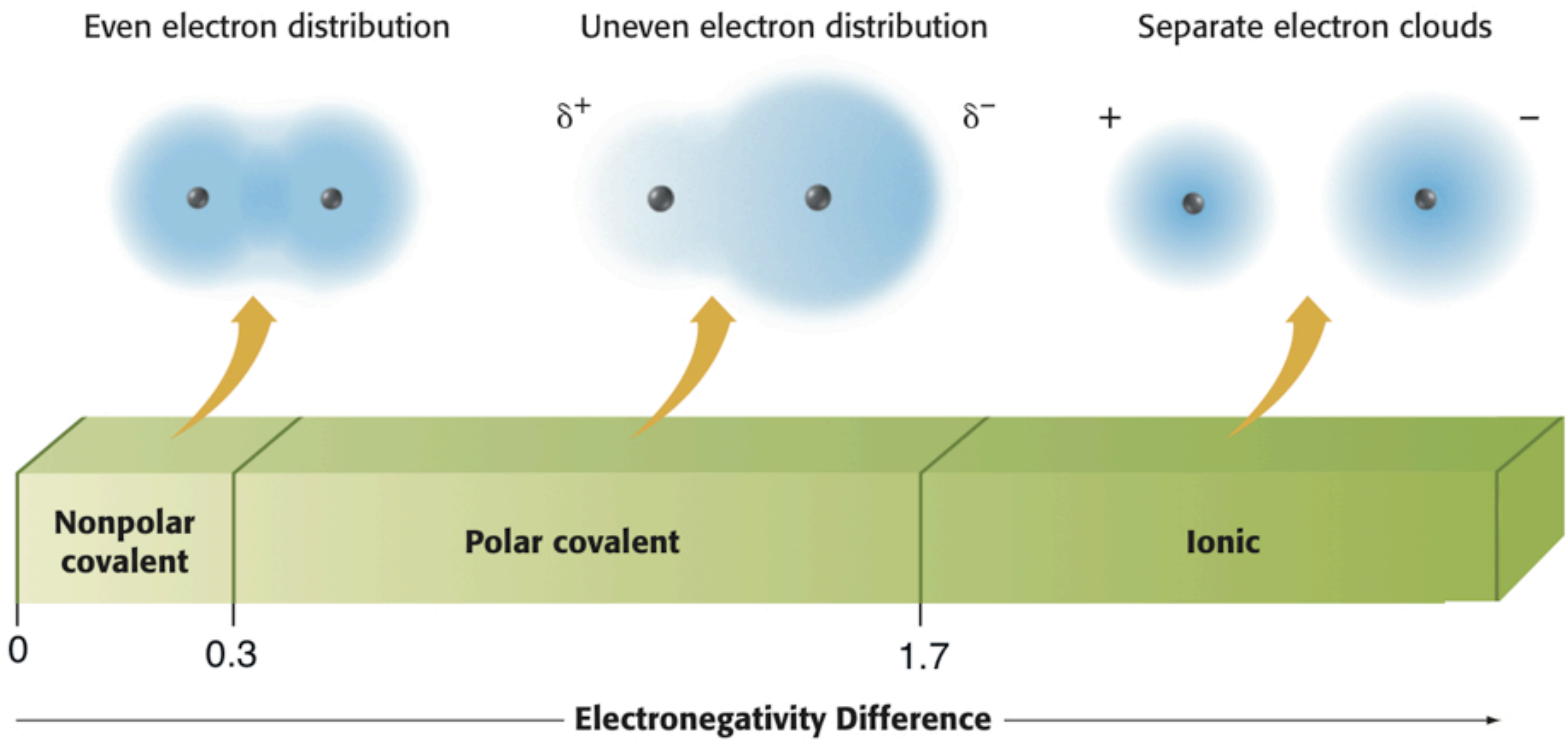

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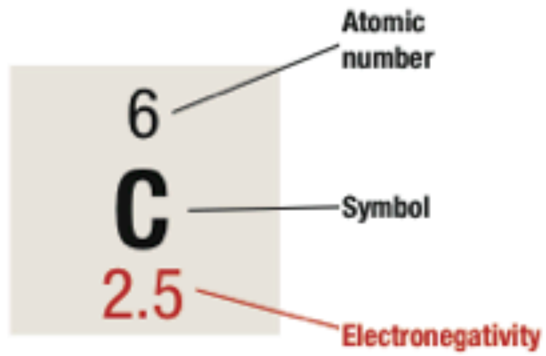
FIGURE 3.11

Periodic Table of Electronegativities Shown are the electronegativities of the elements according to the Pauling scale. The most-electronegative elements are located in the upper right of the *p*-block. The least-electronegative elements are located in the lower left of the *s*-block.



Period	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12	Group 13	Group 14	Group 15	Group 16	Group 17	Group 18
1	1 H 2.1																	2 He —
2	3 Li 1.0	4 Be 1.5											5 B 2.0	6 C 2.5	7 N 3.0	8 O 3.5	9 F 4.0	10 Ne —
3	11 Na 0.9	12 Mg 1.2											13 Al 1.5	14 Si 1.8	15 P 2.1	16 S 2.5	17 Cl 3.0	18 Ar —
4	19 K 0.8	20 Ca 1.0	21 Sc 1.3	22 Ti 1.5	23 V 1.6	24 Cr 1.6	25 Mn 1.5	26 Fe 1.8	27 Co 1.8	28 Ni 1.8	29 Cu 1.9	30 Zn 1.6	31 Ga 1.6	32 Ge 1.8	33 As 2.0	34 Se 2.4	35 Br 2.8	36 Kr 3.0
5	37 Rb 0.8	38 Sr 1.0	39 Y 1.2	40 Zr 1.4	41 Nb 1.6	42 Mo 1.8	43 Tc 1.9	44 Ru 2.2	45 Rh 2.2	46 Pd 2.2	47 Ag 1.9	48 Cd 1.7	49 In 1.7	50 Sn 1.8	51 Sb 1.9	52 Te 2.1	53 I 2.5	54 Xe 2.6
6	55 Cs 0.7	56 Ba 0.9	57 La 1.1	72 Hf 1.3	73 Ta 1.5	74 W 1.7	75 Re 1.9	76 Os 2.2	77 Ir 2.2	78 Pt 2.2	79 Au 2.4	80 Hg 1.9	81 Tl 1.8	82 Pb 1.8	83 Bi 1.9	84 Po 2.0	85 At 2.2	86 Rn 2.4
7	87 Fr 0.7	88 Ra 0.9	89 Ac 1.1	104 Rf —	105 Db —	106 Sg —	107 Bh —	108 Hs —	109 Mt —	110 Ds —	111 Rg —	112 Cn —	113	114	115	116	117	118

Lanthanide series

58 Ce 1.1	59 Pr 1.1	60 Nd 1.1	61 Pm 1.1	62 Sm 1.2	63 Eu 1.1	64 Gd 1.2	65 Tb 1.1	66 Dy 1.2	67 Ho 1.2	68 Er 1.2	69 Tm 1.3		71 Lu 1.3
90 Th 1.3	91 Pa 1.5	92 U 1.4	93 Np 1.4	94 Pu 1.3	95 Am 1.3	96 Cm 1.3	97 Bk 1.3	98 Cf 1.3	99 Es 1.3	100 Fm 1.3	101 Md 1.3		103 Lr —

Actinide series

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Classifying Bonds

Sample Problem A **Use electronegativity differences and Figure 1.2 to classify bonding between sulfur, S, and the following elements: hydrogen, H; cesium, Cs; and chlorine, Cl. In each pair, which atom will be more negative?**

SOLVE

From the Periodic Table of Electronegativities in the chapter "The Periodic Law," we know that the electronegativity of sulfur is 2.5. The electronegativities of hydrogen, cesium, and chlorine are 2.1, 0.7, and 3.0, respectively. In each pair, the atom with the larger electronegativity will be the more-negative atom.

Bonding between sulfur and	Electronegativity difference	Bond type	More-negative atom
hydrogen	$2.5 - 2.1 = 0.4$	polar-covalent	sulfur
cesium	$2.5 - 0.7 = 1.8$	ionic	sulfur
chlorine	$3.0 - 2.5 = 0.5$	polar-covalent	chlorine

Practice Answers in Appendix E

Use electronegativity differences and **Figure 1.2** to classify bonding between chlorine, Cl, and the following elements: calcium, Ca; oxygen, O; and bromine, Br. Indicate the more-negative atom in each pair.

Example Problem:

Use the electronegativity differences to classify the bonding between chlorine and the following elements: Ca, O, and Br.

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greater than 1.7	ionic
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Types of Bonds

Introduction | Feature | Understanding

Ionic Bonding (section 6.3)

Lewis dot structures: the use of dot to represent an atom's valence electrons.

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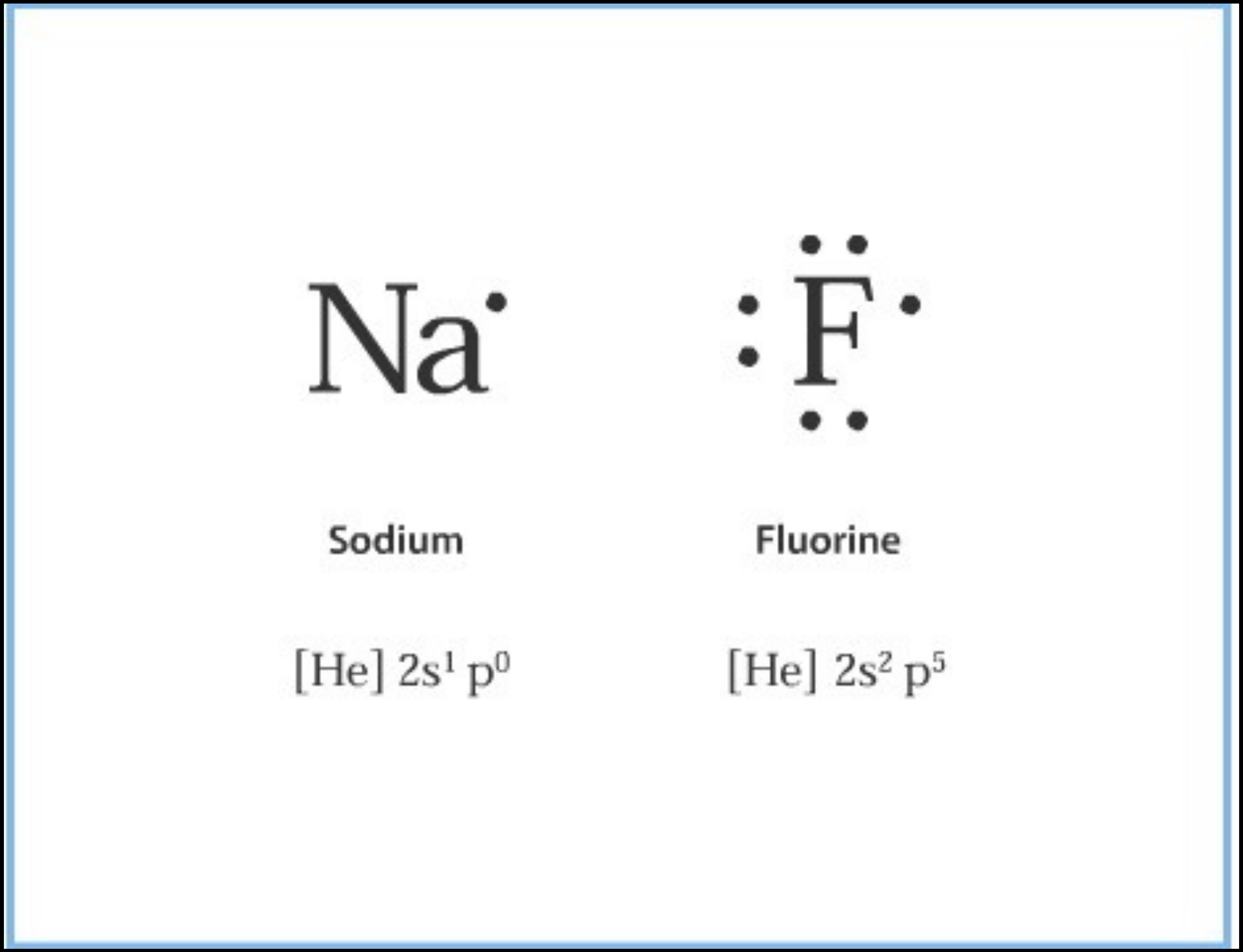

Lewis dot structures can be used to show the formation of ionic bonds:

Crystal Lattice

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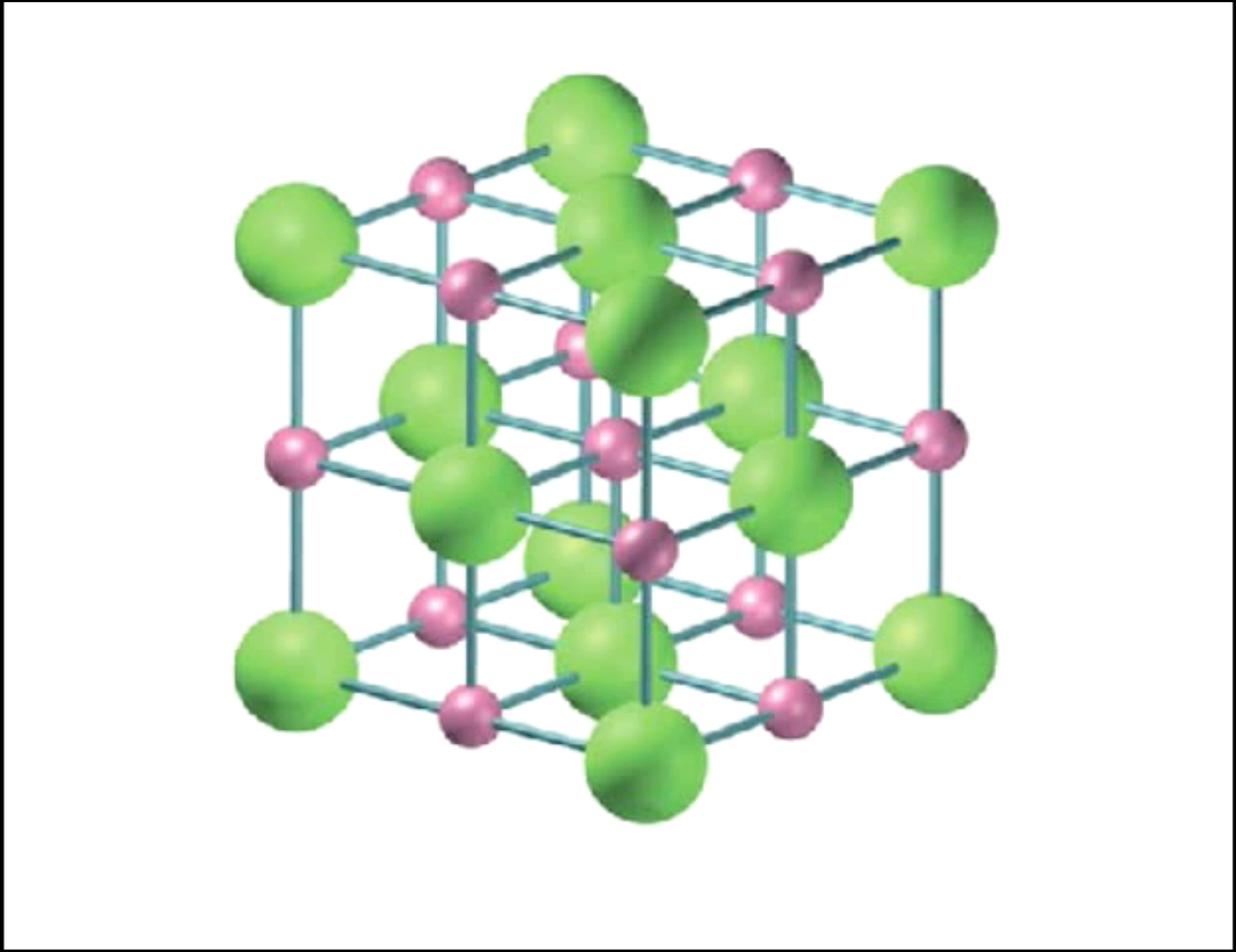
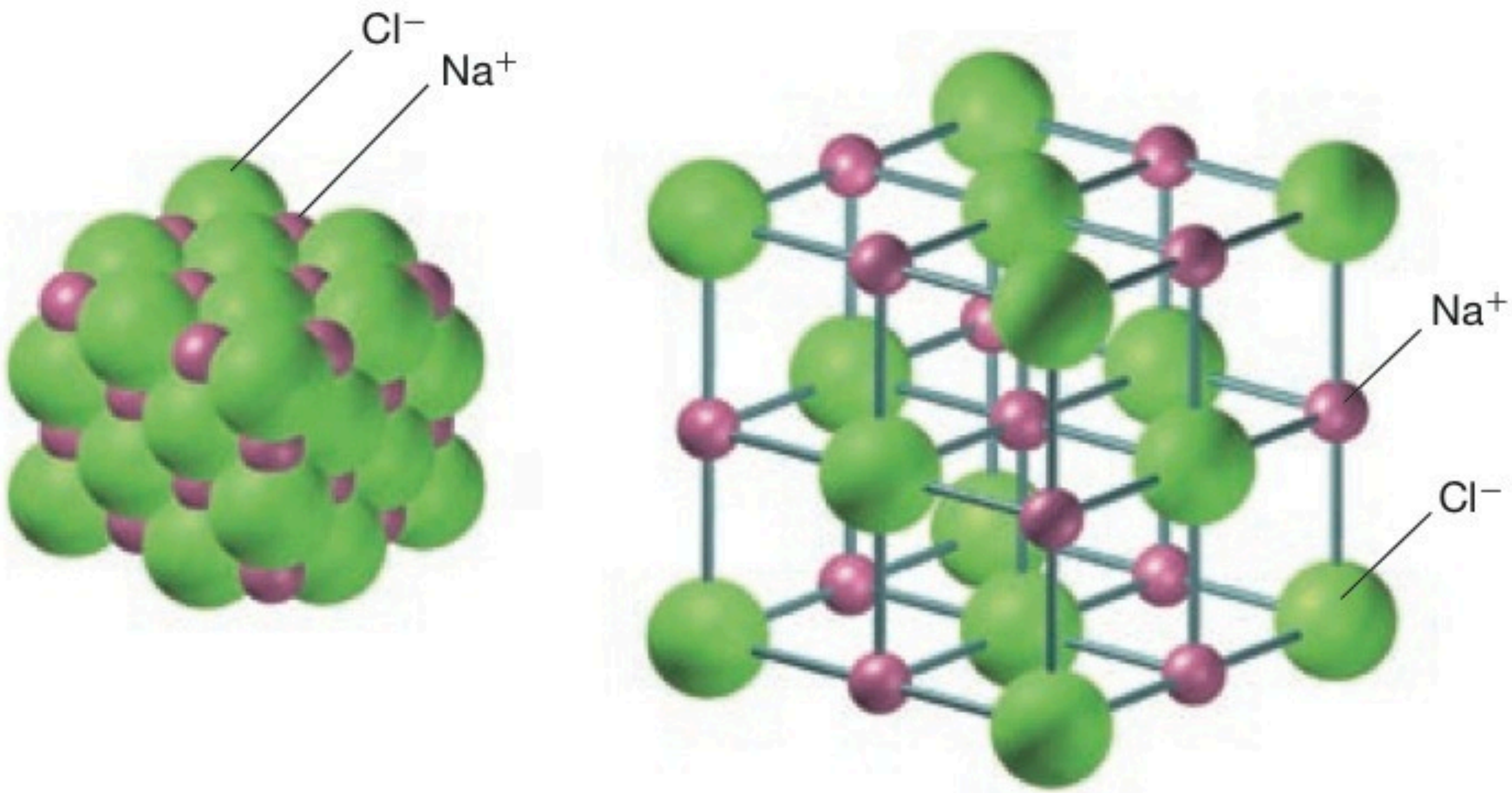


FIGURE 3.3

Crystal Structure of NaCl Two models of the crystal structure of sodium chloride are shown.



(a) To illustrate the ions' actual arrangement, the sodium and chloride ions are shown with their electron clouds just touching.

(b) In an expanded view, the distances between ions have been exaggerated in order to clarify the positioning of the ions in the structure.

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Lattice: structures having a regular geometrical arrangement.

Lattice Energy:

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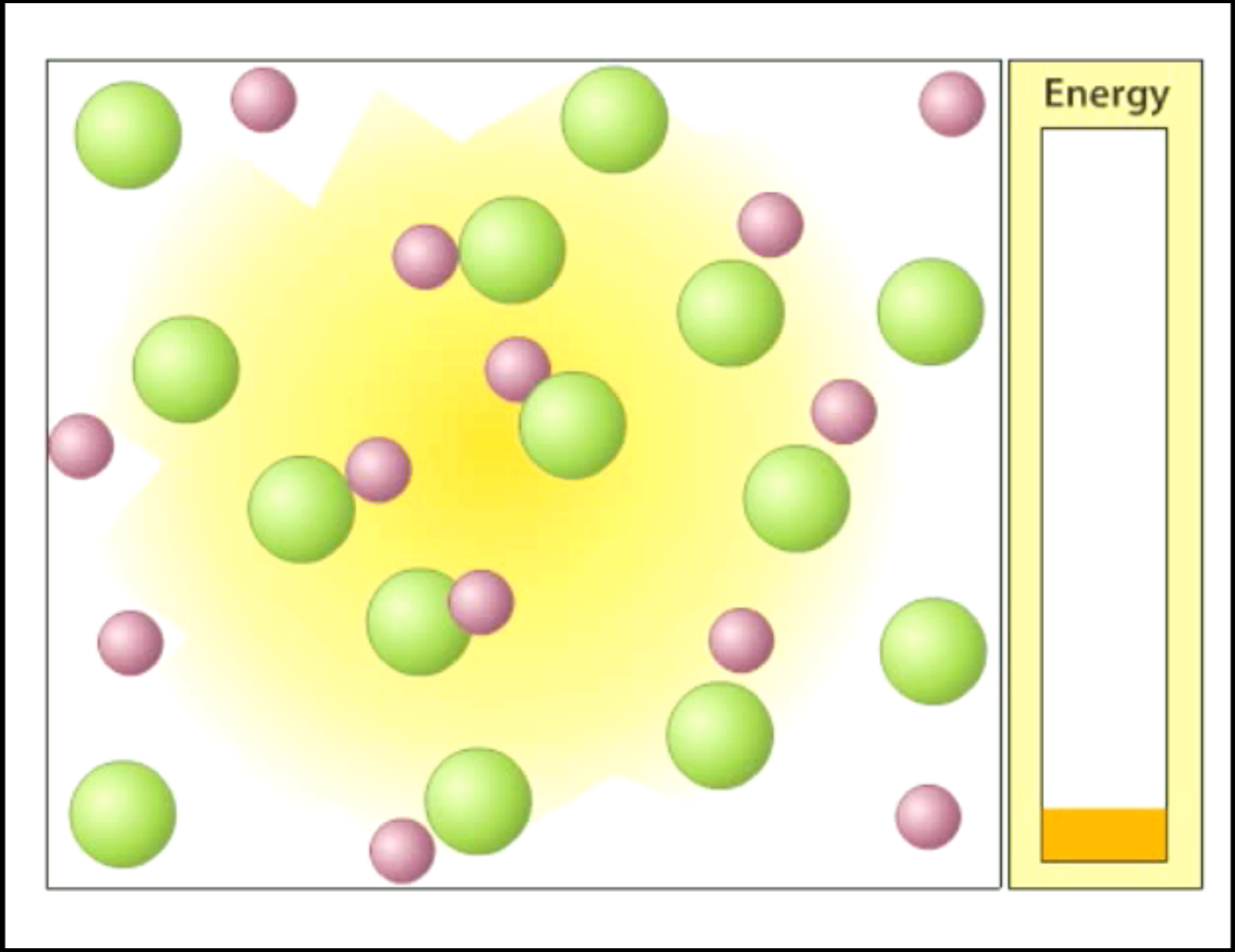

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Energy required to break apart a crystal lattice (positive value; requires energy)

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When a crystal lattice forms, energy is given off (negative value; loses energy).

Lattice Energy:

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FIGURE 3.6

LATTICE ENERGIES OF SOME COMMON IONIC COMPOUNDS

Compound	Lattice energy (kJ/mol)
NaCl	−787.5
NaBr	−751.4
CaF_2	−2634.7
LiCl	−861.3
LiF	−1032
MgO	−3760
KCl	−715

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The more negative the lattice energy, the higher the melting point.

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2. Inversely proportional to the size of an ion.

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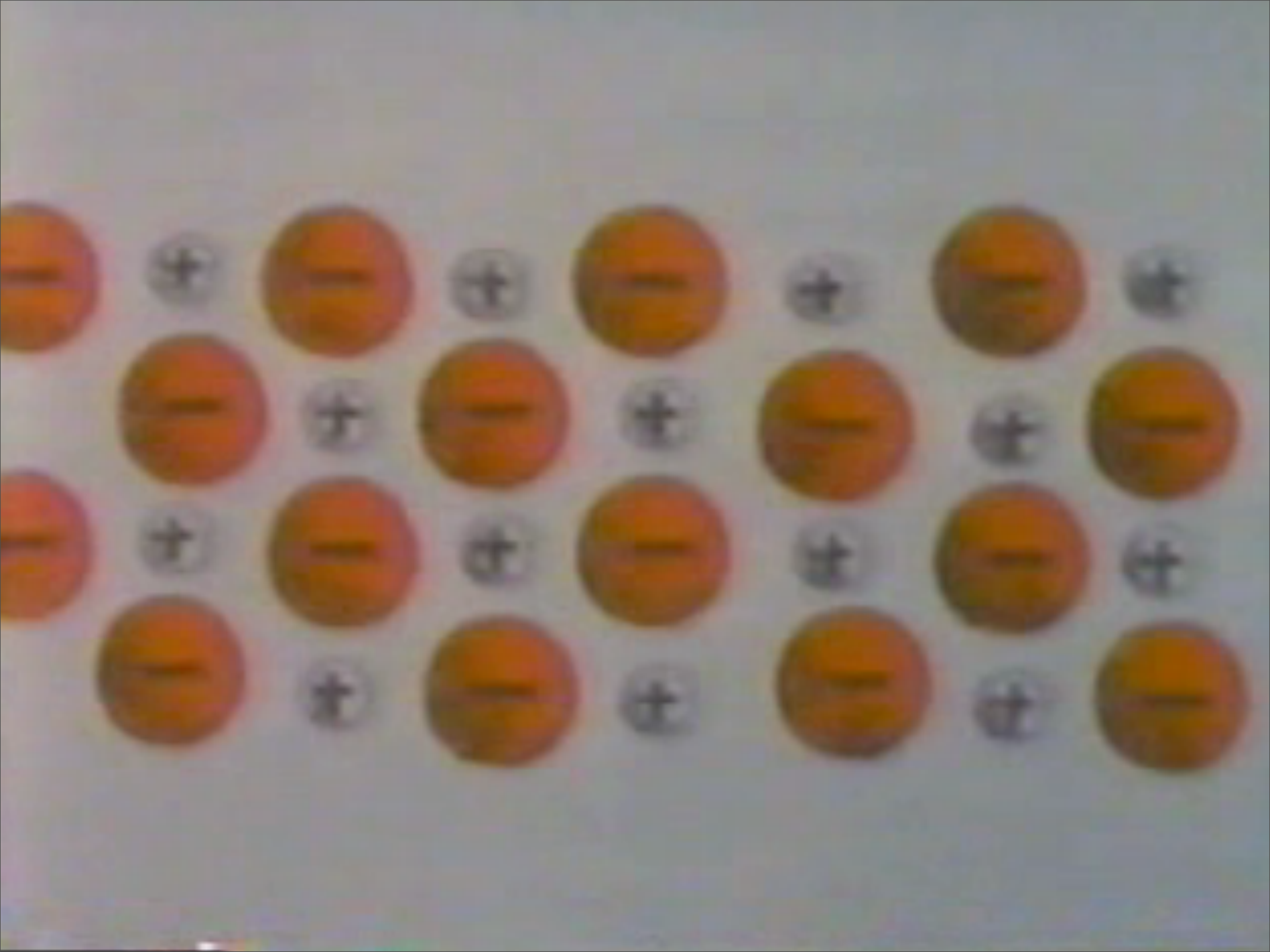
b. NaCl or MgS

c. CaO or $BaBr_2$



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3. Hard & brittle