

GENERAL CHEMISTRY

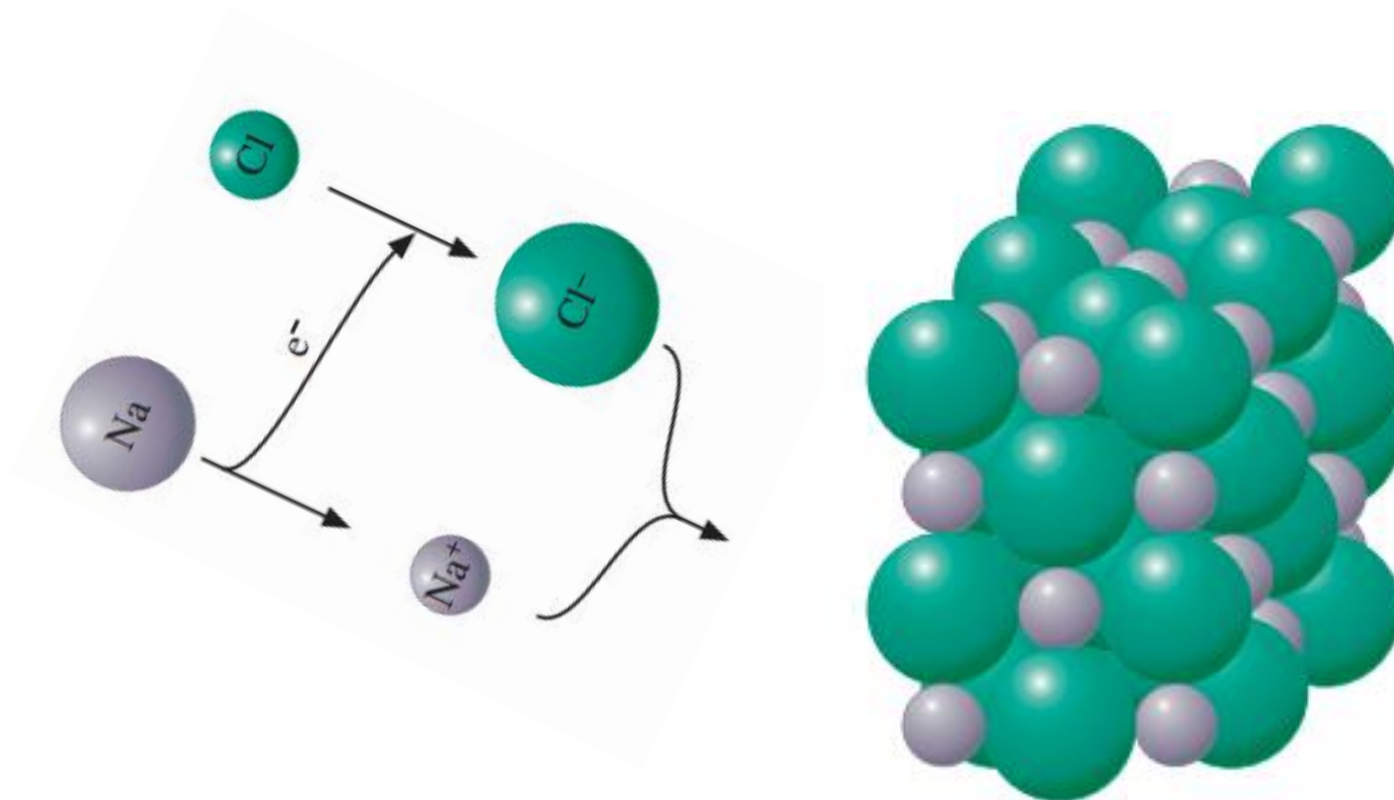
Ionic and Covalent Bonding

Ionic Bonding

- ✓ **Describing Ionic bonds**
- ✓ **Electron Configuration of Ions**

Covalent Bonds

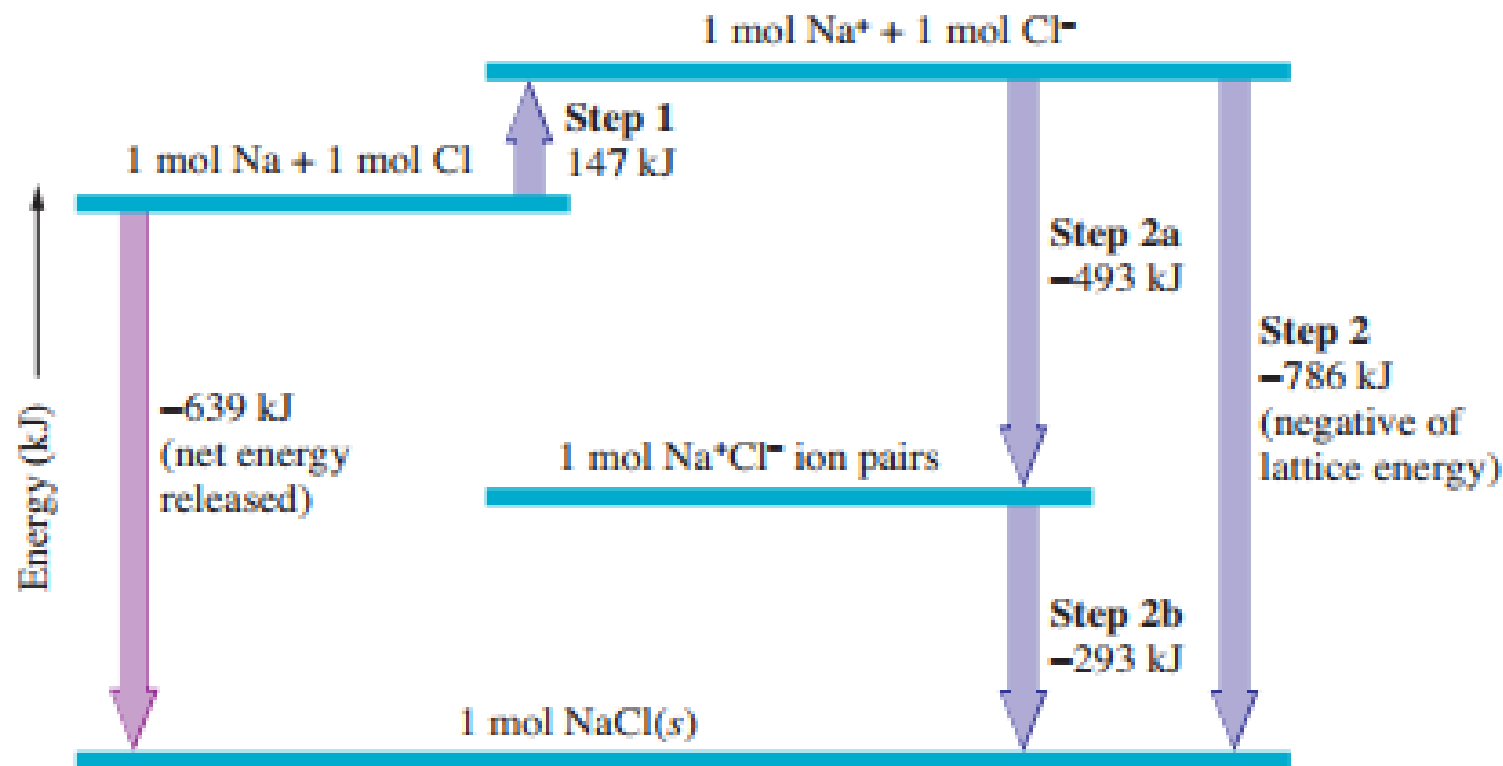
- ✓ **Describing Covalent Bonds**
- ✓ **Polar Covalent Bonds**
- ✓ **Delocalized Bonding**
- ✓ **Formal Charge and Lewis Formulas**
- ✓ **Bond Energy**



Lewis Electron-Dot Symbols for Atoms of the Second and Third Periods

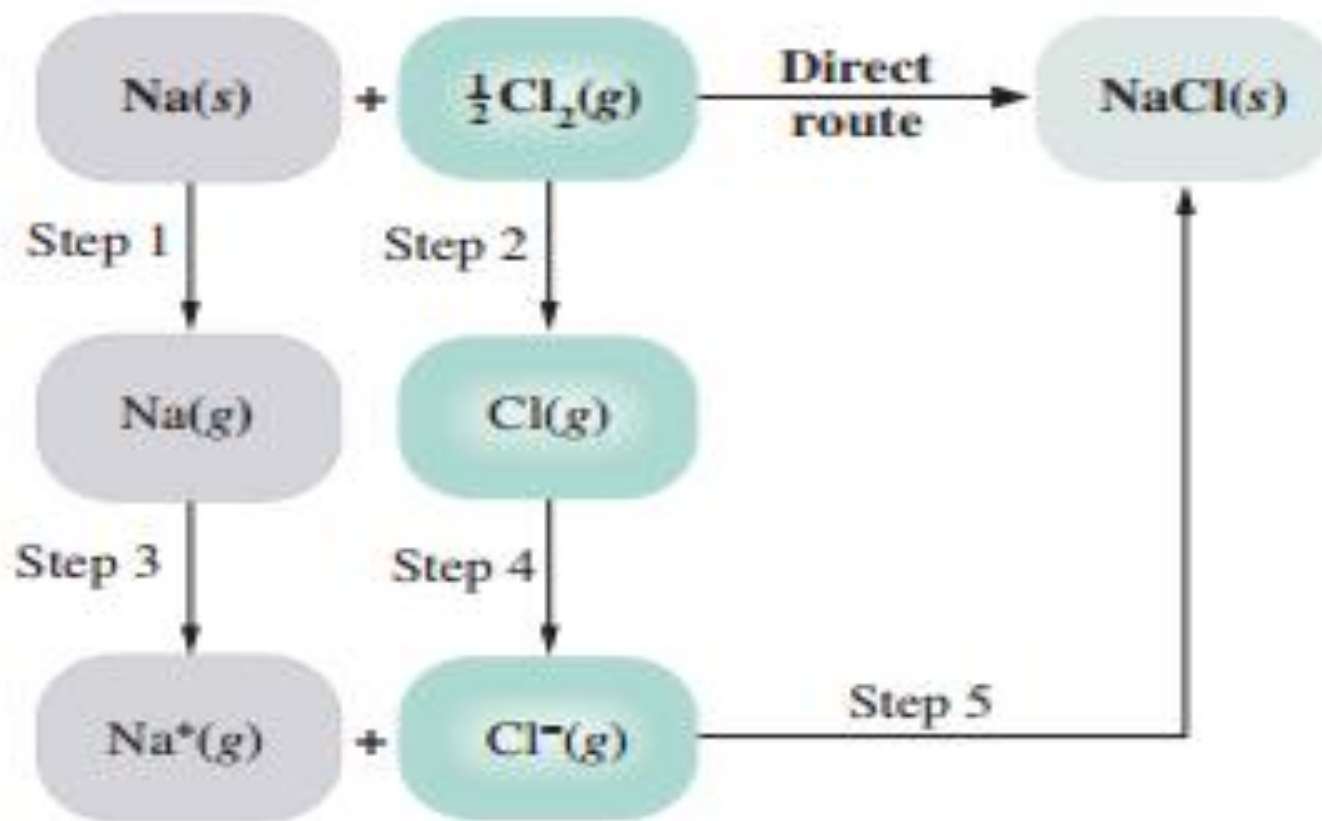
Period	IA ns^1	IIA ns^2	IIIA ns^2np^1	IVA ns^2np^2	VA ns^2np^3	VIA ns^2np^4	VIIA ns^2np^5	VIIIA ns^2np^6
Second	Li·	·Be·	·B·	·C·	:N·	:O·	:F·	:Ne:
Third	Na·	·Mg·	·Al·	·Si·	:P·	:S·	:Cl·	:Ar:

Energy Involved in Ionic Bonding



Energetics of ionic bonding

Lattice Energies from the Born–Haber Cycle



Born–Haber cycle for NaCl

Electron Configurations of Ions

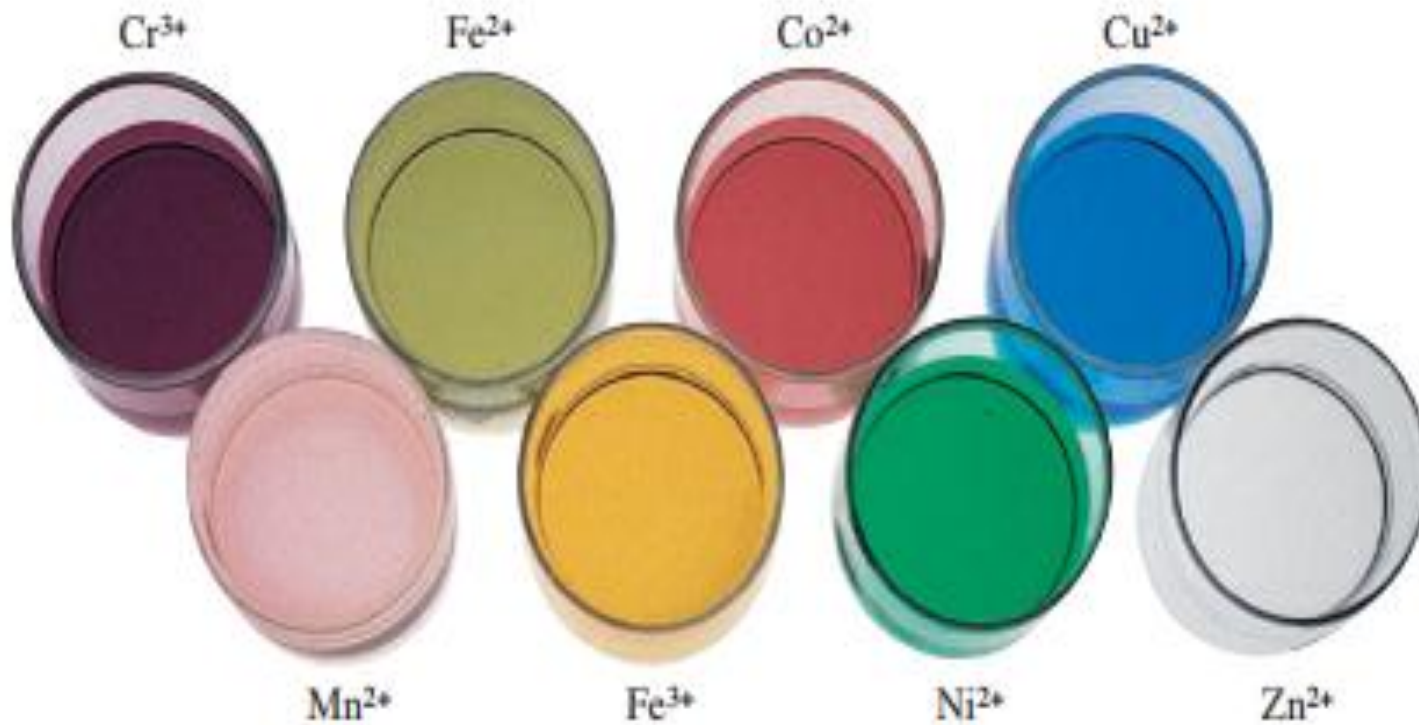
Ions of the Main-Group Elements

Ionization Energies of Na, Mg, and Al (in kJ/mol)*

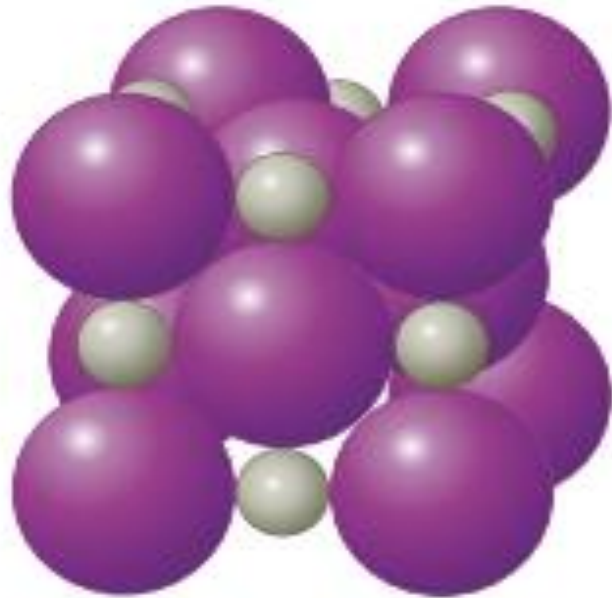
Element	Successive Ionization Energies			
	First	Second	Third	Fourth
Na	496	4,562	6,912	9,543
Mg	738	1,451	7,733	10,540
Al	578	1,817	2,745	11,577

*Energies for the ionization of valence electrons lie to the left of the colored line.

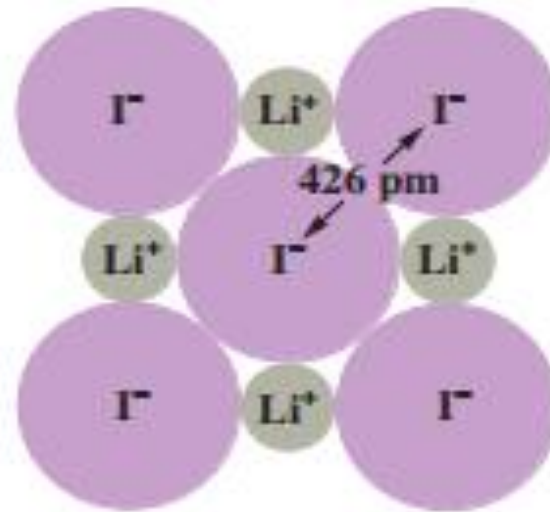
Transition-Metal Ions



Ionic Radii



A



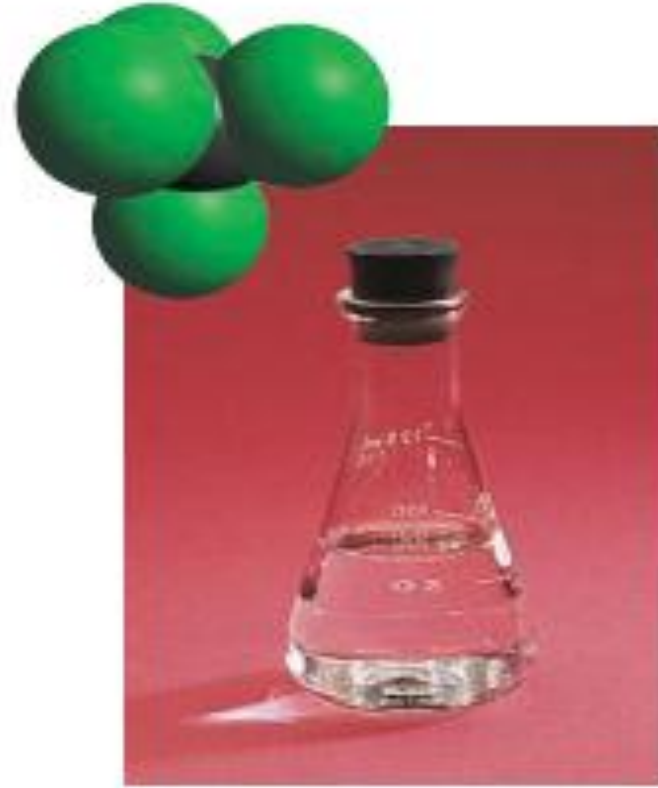
B

Determining the iodide ion radius in the lithium iodide (LiI) crystal

Ionic Radii (in pm) of Some Main-Group Elements

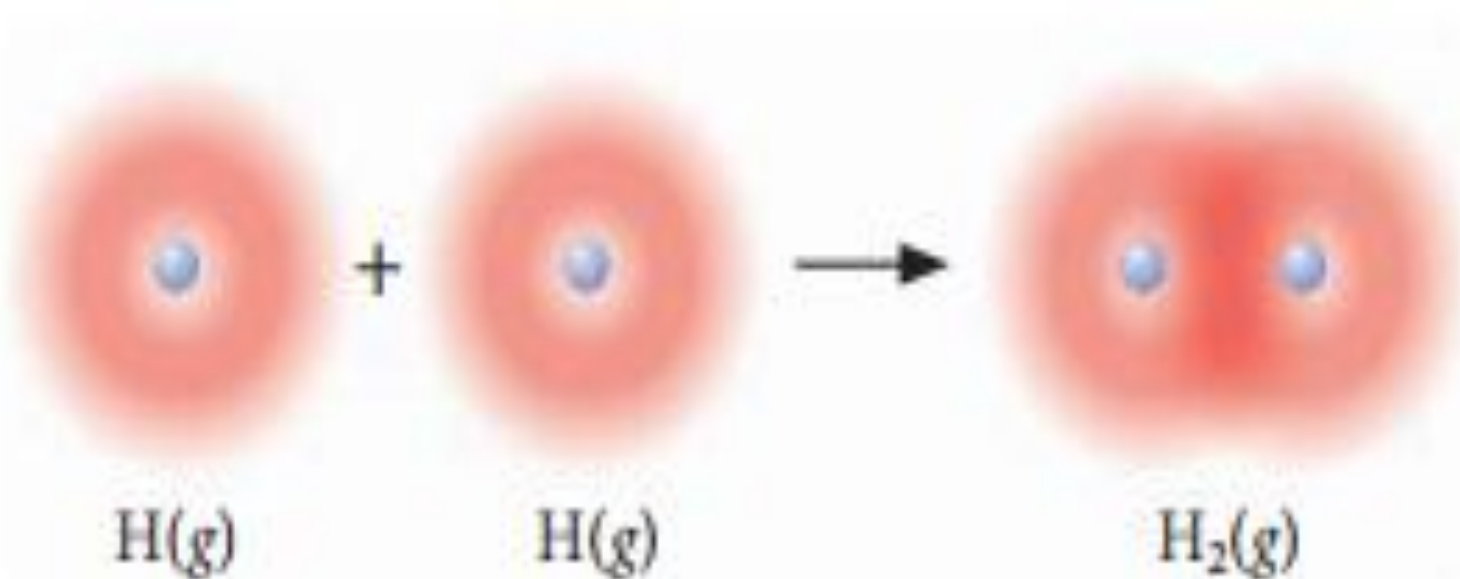
Period	IA	IIA	IIIA	VIA	VIIA
2	Li ⁺ 60	Be ²⁺ 31		O ²⁻ 140	F ⁻ 136
3	Na ⁺ 95	Mg ²⁺ 65	Al ³⁺ 50	S ²⁻ 184	Cl ⁻ 181
4	K ⁺ 133	Ca ²⁺ 99	Ga ³⁺ 62	Se ²⁻ 198	Br ⁻ 195
5	Rb ⁺ 148	Sr ²⁺ 113	In ³⁺ 81	Te ²⁻ 221	I ⁻ 216
6	Cs ⁺ 169	Ba ²⁺ 135	Tl ³⁺ 95		

Covalent Bonds



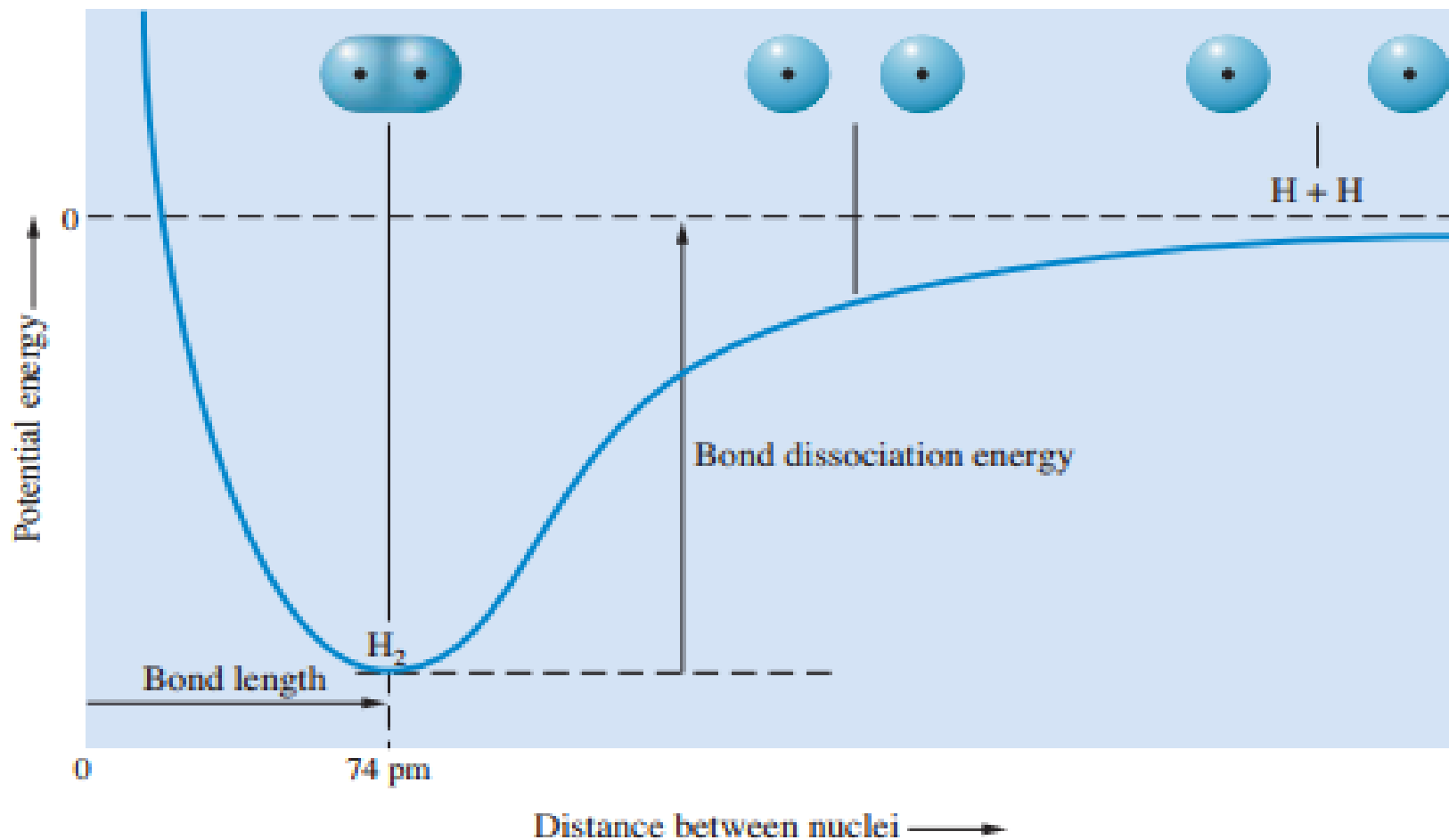
Two molecular substances

Describing Covalent Bonds

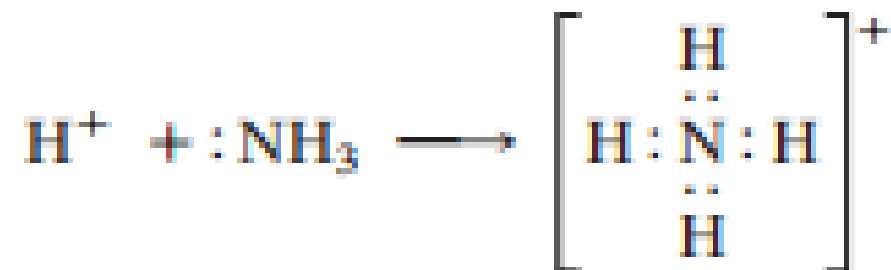


The electron probability distribution for the H₂ molecule

Potential-energy curve for H₂

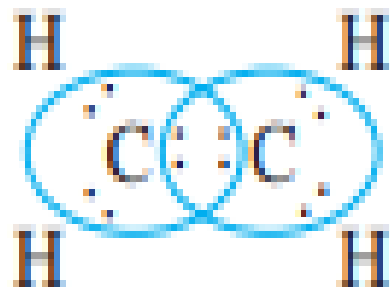


Coordinate Covalent Bonds

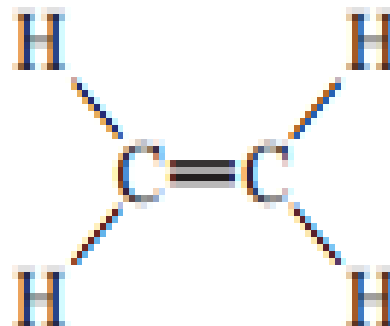


Octet Rules

Multiple Bonds



or



Ethylene



or

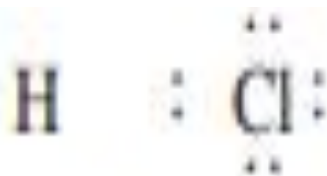


Acetylene

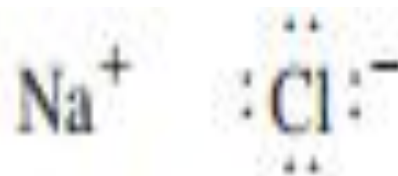
Polar Covalent Bonds; Electronegativity



Nonpolar covalent



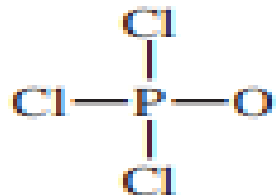
Polar covalent



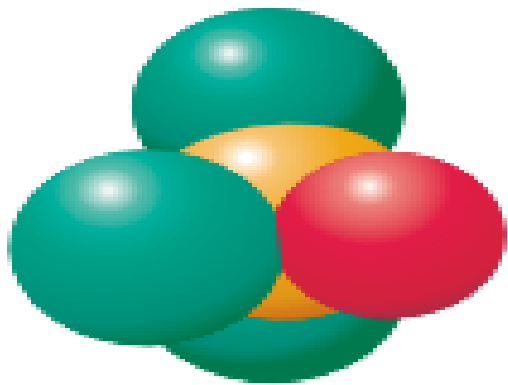
Ionic



Writing Lewis Electron-Dot Formulas



Phosphorus oxychloride
 POCl_3

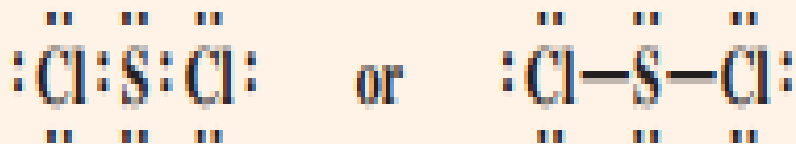
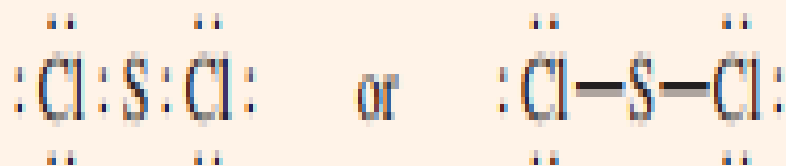


Lewis formula and molecular
model of
phosphorus oxychloride
molecule

Example: Writing Lewis Formulas (Single Bonds Only)

Sulfur dichloride, SCl_2 , is a red, fuming liquid used in the manufacture of insecticides. Write the Lewis formula for the molecule.

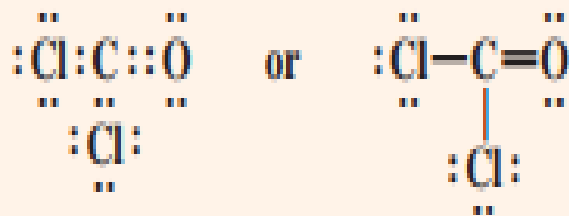
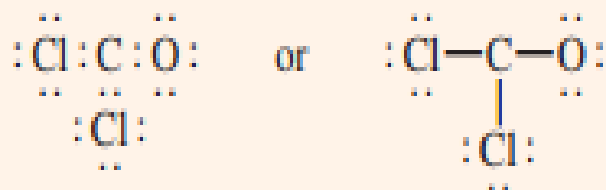
Solution:



Example: Writing Lewis Formulas (Including Multiple Bonds)

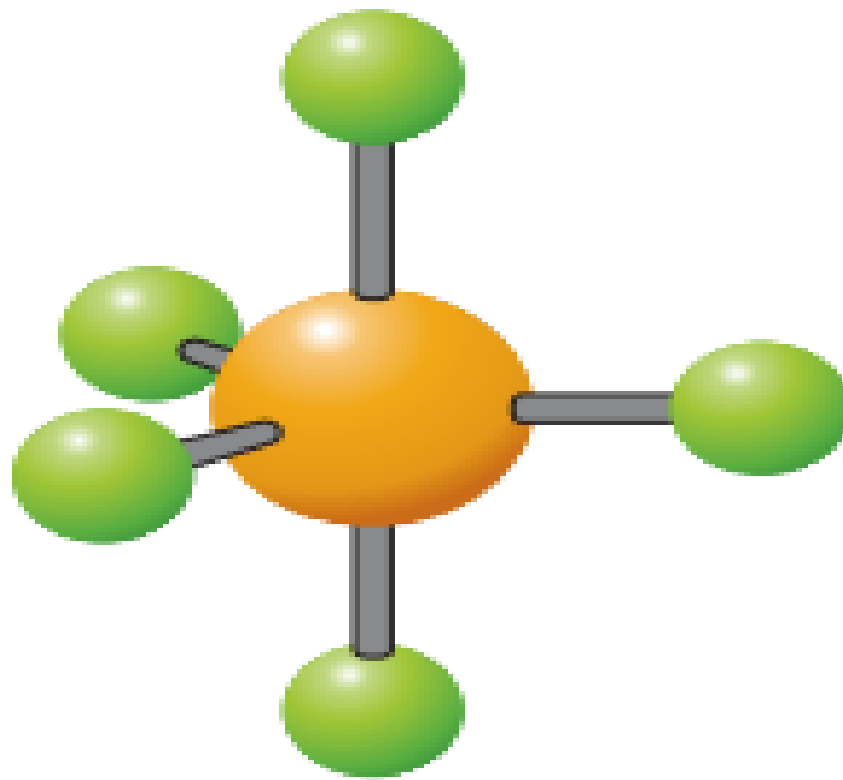
Carbonyl chloride, or phosgene, COCl_2 , is a highly toxic gas used as a starting material for the preparation of polyurethane plastics. What is the electron-dot formula of COCl_2 ?

Solution:



Exceptions to the Octet Rule

Phosphorus pentafluoride, PF₅



Bond Length and Bond Order

Single-Bond Covalent Radii for Nonmetallic Elements (in pm)

				H
				37
B	C	N	O	F
88	77	70	66	64
	Si	P	S	Cl
	117	110	104	99
		As	Se	Br
		121	117	114
			Te	I
			137	133

Bond Energy (in kJ/mol)*

	Single Bonds									
	H	C	N	O	S	F	Cl	Br	I	
H	432									
C	411	346								
N	386	305	167							
O	459	358	201	142						
S	363	272	—	—	226					
F	565	485	283	190	284	155				
Cl	428	327	313	218	255	249	240			
Br	362	285	—	201	217	249	216	190		
I	295	213	—	201	—	278	208	175	149	
Multiple Bonds										
C=C	602		C=N	615		C=O		745 (799 in CO ₂)		
C≡C	835		C≡N	887		C≡O		1072		
N=N	418		N=O	607		S=O (in SO ₂)		532		
N≡N	942		O=O	494		S=O (in SO ₃)		469		

*Data are taken from J. E. Huheey, Keiter, and Keiter, *Inorganic Chemistry*, 4th ed. (New York: HarperCollins, 1993), pp. A21–A34.

Explosion of nitrogen triiodide–ammonia complex



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