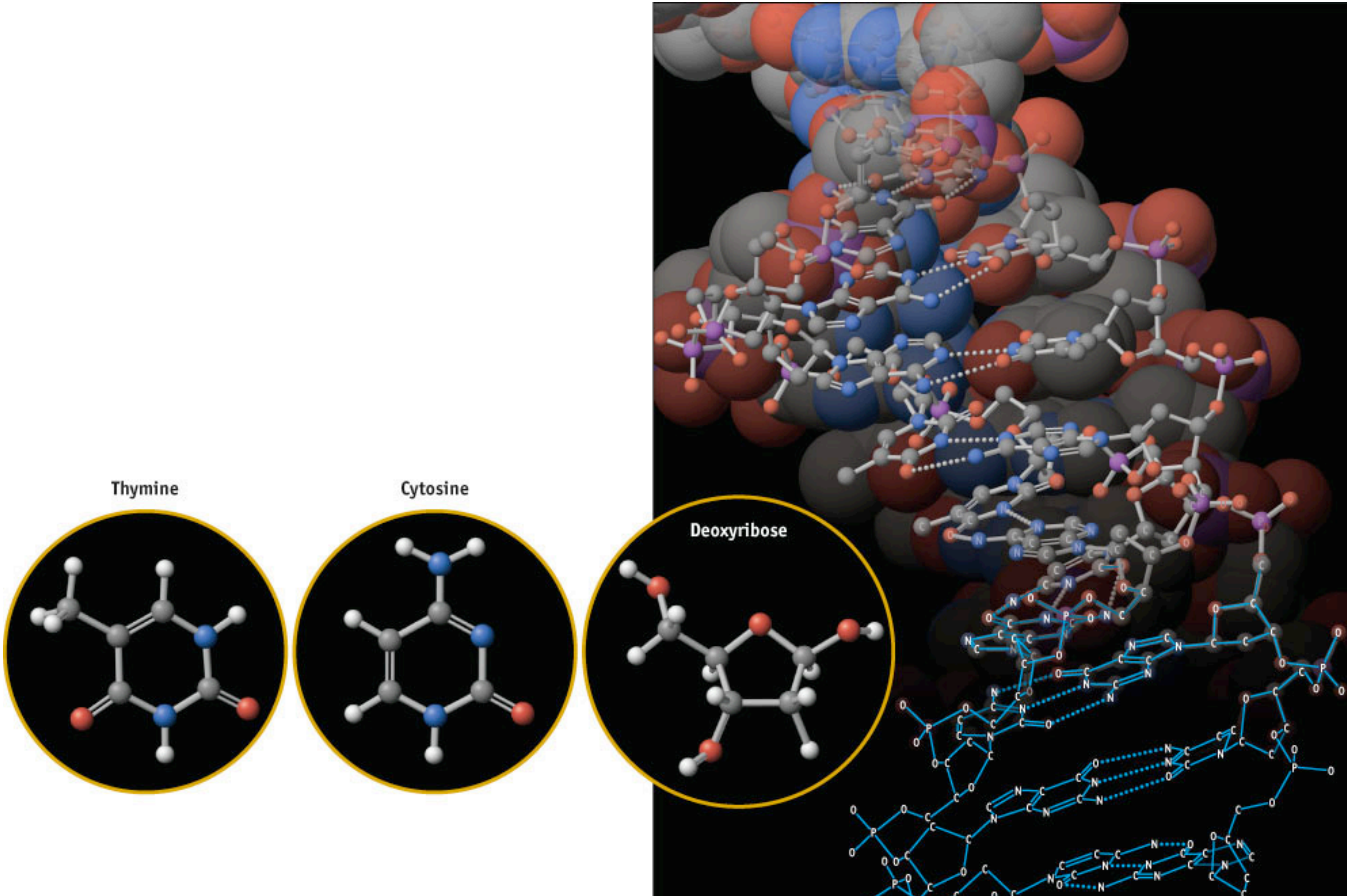
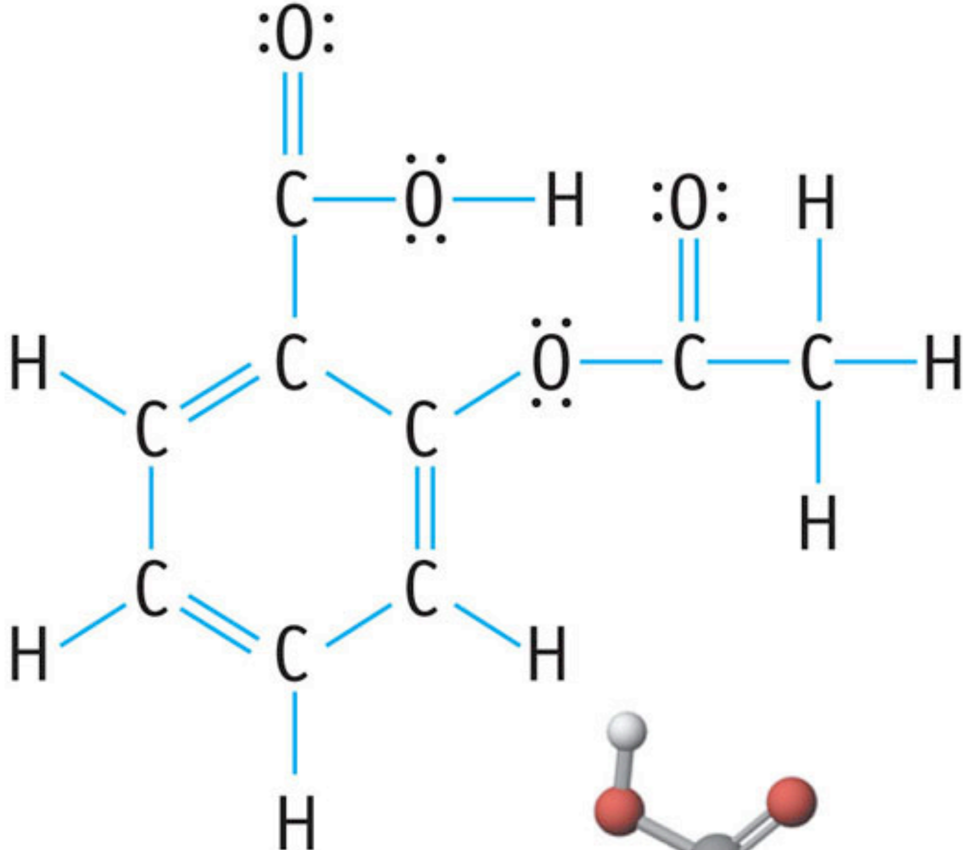
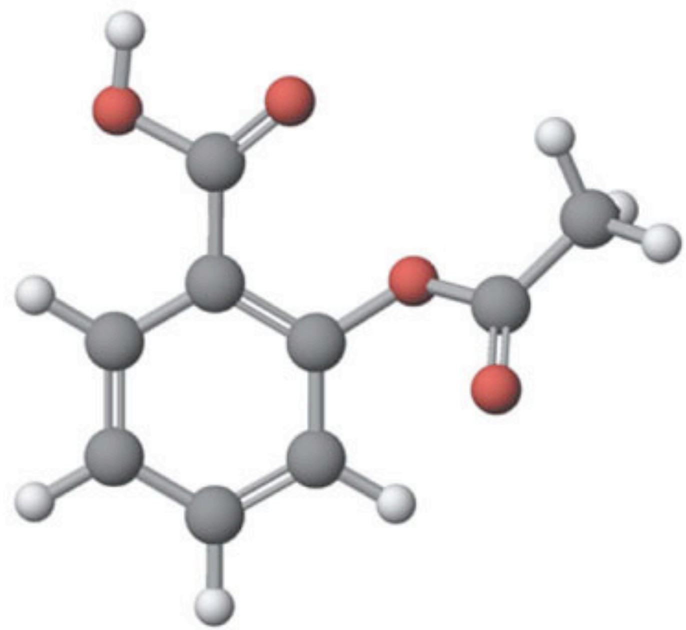


Fig. 8-CO, p. 348





Aspirin

NaCl

Na (1)

Cl (2)

Which has the higher ionization potential?

NaCl

Na

Cl

IE = 496 kJ mol^{-1}

(*steal* an e^-)

IE = 1251 kJ mol^{-1}

NaCl

Na (1)

Cl (2)

Which has the higher (more negative) electron affinity?

NaCl

Na		Cl
IE = 496 kJ mol^{-1}	(*steal* an e^-)	IE = 1251 kJ mol^{-1}
EA = -40 kJ mol^{-1}	(*add* an e^-)	EA= -300 kJ mol^{-1}

NaCl

Na $\xrightarrow{\text{Transfer an electron}}$ Cl

IE = 496 kJ mol^{-1} (*steal* an e^-) IE = 1251 kJ mol^{-1}

EA = -40 kJ mol^{-1} (*add* an e^-) EA= -300 kJ mol^{-1}

NaCl

Na $\xrightarrow{\text{Transfer an electron}}$ Cl

IE = 496 kJ mol^{-1} (*steal* an e^-) IE = 1251 kJ mol^{-1}

EA = -40 kJ mol^{-1} (*add* an e^-) EA= -300 kJ mol^{-1}

NaCl

Na $\xrightarrow{\text{Transfer an electron}}$ Cl

IE = 496 kJ mol^{-1} (*steal* an e$^-$) IE = 1251 kJ mol^{-1}

EA = -40 kJ mol^{-1} (*add* an e$^-$) EA= -300 kJ mol^{-1}

NaCl

Na $\xrightarrow{\text{Transfer an electron}}$ Cl

IE = 496 kJ mol^{-1}	(*steal* an e$^-$)	IE = 1251 kJ mol^{-1}
EA = -40 kJ mol^{-1}	(*add* an e$^-$)	EA= -300 kJ mol^{-1}

$$\begin{array}{r} +496\ \text{kJ mol}^{-1} \\ -300\ \text{kJ mol}^{-1} \\ \hline +196\ \text{kJ mol}^{-1} \end{array}$$

NaCl

Na $\xrightarrow{\text{Transfer an electron}}$ Cl

IE = 496 kJ mol^{-1} (*steal* an e$^-$) IE = 1251 kJ mol^{-1}

EA = -40 kJ mol^{-1} (*add* an e$^-$) EA= -300 kJ mol^{-1}

$$\begin{array}{r} +496 \text{ kJ mol}^{-1} \\ -300 \text{ kJ mol}^{-1} \\ \hline +196 \text{ kJ mol}^{-1} \end{array}$$

But also

$$Na^+ \underset{-xxx \text{ kJ mol}^{-1}}{\longleftrightarrow} Cl^-$$

NaCl

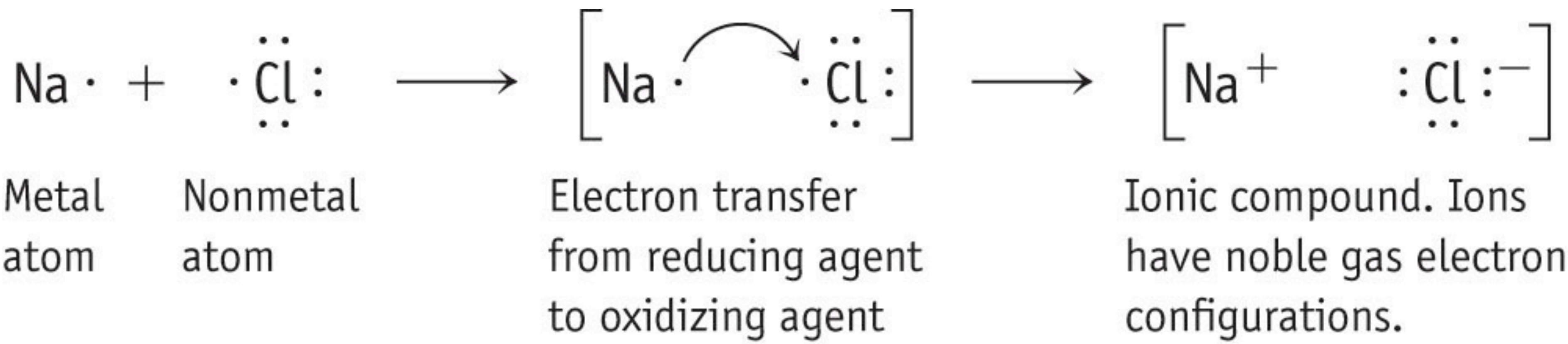
Na $\xrightarrow{\text{Transfer an electron}}$ Cl

IE = 496 kJ mol^{-1}	(*steal* an e^{-})	IE = 1251 kJ mol^{-1}
EA = -40 kJ mol^{-1}	(*add* an e^{-})	EA= -300 kJ mol^{-1}

$$
\begin{array}{r}
+496 \text{ kJ mol}^{-1} \\
-300 \text{ kJ mol}^{-1} \\
\hline
+196 \text{ kJ mol}^{-1} \\
-\text{xxx kJ mol}^{-1} \\
\hline
-\text{yyy kJ mol}^{-1}
\end{array}
$$

But also

$$Na^{+} \underset{-\text{xxx kJ mol}^{-1}}{\longleftrightarrow} Cl^{-}$$


Na
Cl
Metal atom
Nonmetal atom
Electron transfer from reducing agent to oxidizing agent
Ionic compound. Ions have noble gas electron configurations.

HF

H $\xrightarrow{\text{Transfer an electron}}$ F

IE = 1400 kJ mol^{-1}	(*steal* an e^-)	IE = 1680 kJ mol^{-1}
EA = -60 kJ mol^{-1}	(*add* an e^-)	EA= -290 kJ mol^{-1}

HF

H $\xrightarrow{\text{Transfer an electron}}$ F

IE = 1400 kJ mol^{-1} (*steal* an e$^-$) IE = 1680 kJ mol^{-1}

EA = -60 kJ mol^{-1} (*add* an e$^-$) EA= -290 kJ mol^{-1}

$$
\begin{array}{r}
+1400 \text{ kJ mol}^{-1} \\
-290 \text{ kJ mol}^{-1} \\
\hline
+1010 \text{ kJ mol}^{-1} \\
-\text{xxx kJ mol}^{-1} \\
\hline
-\text{yyy kJ mol}^{-1}
\end{array}
$$

But also

$$H^+ \longleftrightarrow F^-$$

-xxx kJ mol^{-1}

HF

H $\xrightarrow{\text{Transfer an electron}}$ F

IE = 1400 kJ mol^{-1} (*steal* an e^{-}) IE = 1680 kJ mol^{-1}

EA = -60 kJ mol^{-1} (*add* an e^{-}) EA= -290 kJ mol^{-1}

NaCl	HF
+496 kJ mol^{-1}	+1400 kJ mol^{-1}
-300 kJ mol^{-1}	-290 kJ mol^{-1}
+196 kJ mol^{-1}	+1010 kJ mol^{-1}
-vvv kJ mol^{-1}	-xxx kJ mol^{-1}
-zzz kJ mol^{-1}	-yyy kJ mol^{-1}

But also

$$H^{+} \longleftrightarrow F^{-}$$

-xxx kJ mol^{-1}

NaCl

$+496 \text{ kJ mol}^{-1}$

-300 kJ mol^{-1}

$\mathbf{+196} \text{ kJ mol}^{-1}$

$-vvv \text{ kJ mol}^{-1}$

$-zzz \text{ kJ mol}^{-1}$

HF

$+1400 \text{ kJ mol}^{-1}$

-290 kJ mol^{-1}

$\mathbf{+1010} \text{ kJ mol}^{-1}$

$-xxx \text{ kJ mol}^{-1}$

$-yyy \text{ kJ mol}^{-1}$

Ionic

NaCl	**HF**
$+496\ kJ\ mol^{-1}$	$+1400\ kJ\ mol^{-1}$
$-300\ kJ\ mol^{-1}$	$-290\ kJ\ mol^{-1}$
+196 $kJ\ mol^{-1}$	**+1010** $kJ\ mol^{-1}$
$-vvv\ kJ\ mol^{-1}$	$-xxx\ kJ\ mol^{-1}$
$-zzz\ kJ\ mol^{-1}$	$-yyy\ kJ\ mol^{-1}$

Ionic	Somewhat ionic
NaCl	**HF**
+496 kJ mol^{-1}	+1400 kJ mol^{-1}
-300 kJ mol^{-1}	-290 kJ mol^{-1}
+196 kJ mol^{-1}	**+1010** kJ mol^{-1}
-vvv kJ mol^{-1}	-xxx kJ mol^{-1}
-zzz kJ mol^{-1}	-yyy kJ mol^{-1}

Ionic	Somewhat ionic
NaCl	**HF**
+496 kJ mol^{-1}	+1400 kJ mol^{-1}
-300 kJ mol^{-1}	-290 kJ mol^{-1}
+196 kJ mol^{-1}	**+1010** kJ mol^{-1}
-vvv kJ mol^{-1}	-xxx kJ mol^{-1}
-zzz kJ mol^{-1}	-yyy kJ mol^{-1}

Somewhat covalent

We need another way to think about

We need another way to think about

Covalent Bonding!

Sharing electrons

Lewis Dot Structures – Good Bookkeeping

TABLE 8.2 Lewis Dot Symbols for Main Group Atoms

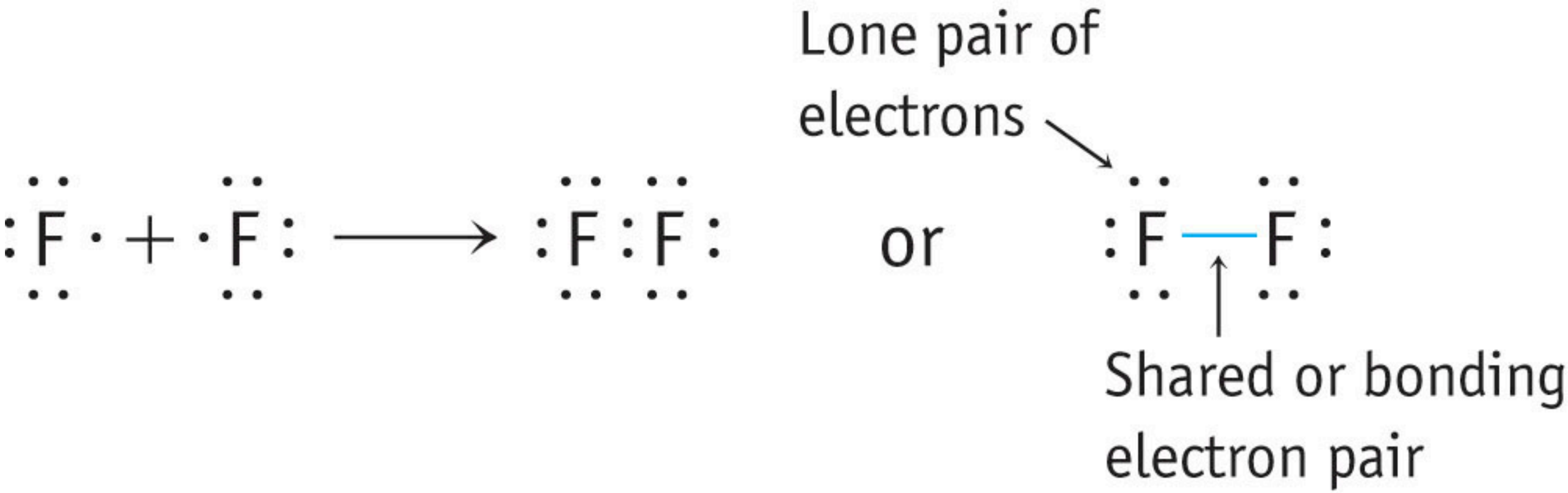
1A	2A	3A	4A	5A	6A	7A	8A
ns^1	ns^2	ns^2np^1	ns^2np^2	ns^2np^3	ns^2np^4	ns^2np^5	ns^2np^6
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
$[He]2s^1$	$[He]2s^2$	$[He]2s^22p^1$	$[He]2s^22p^2$	$[He]2s^22p^3$	$[He]2s^22p^4$	$[He]2s^22p^5$	$[He]2s^22p^6$
$[Ne]3s^1$	$[Ne]3s^2$	$[Ne]3s^23p^1$	$[Ne]3s^23p^2$	$[Ne]3s^23p^3$	$[Ne]3s^23p^4$	$[Ne]3s^23p^5$	$[Ne]3s^23p^6$
1 valence e-	2 valence e-	3 valence e-	4 valence e-	5 valence e-	6 valence e-	7 valence e-	8 valence e-

Table 8-2, p. 351

Electron pair bond

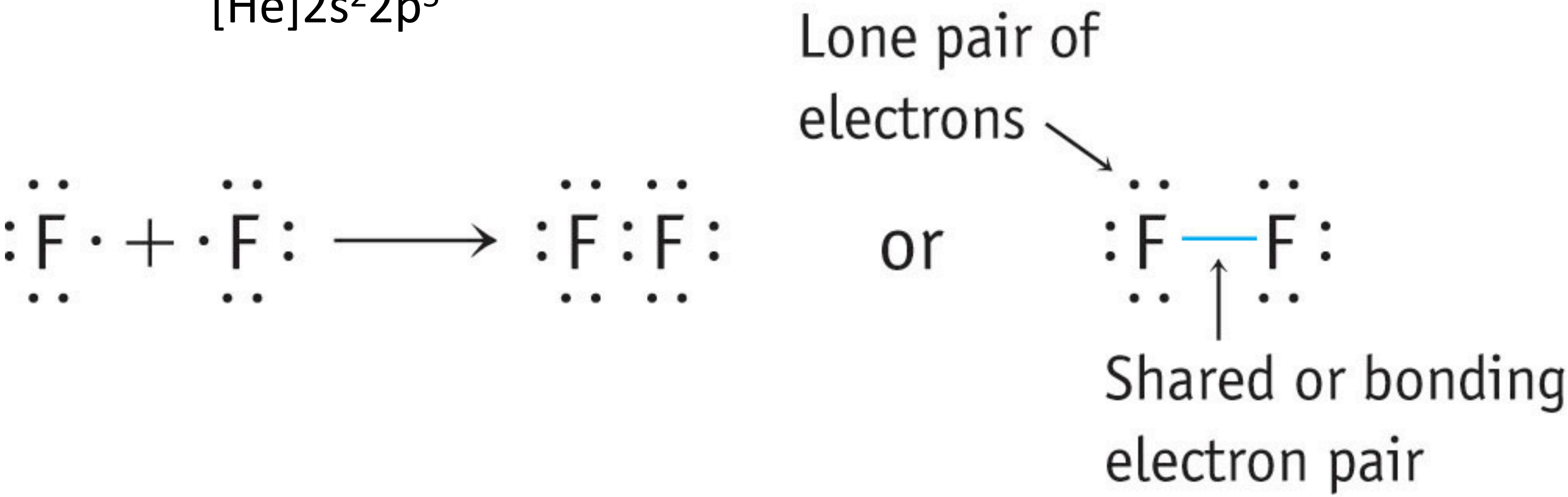
$H:H$ $\qquad\qquad$ $H\text{—}H$

p. 352



“Completing an octet around each atom”

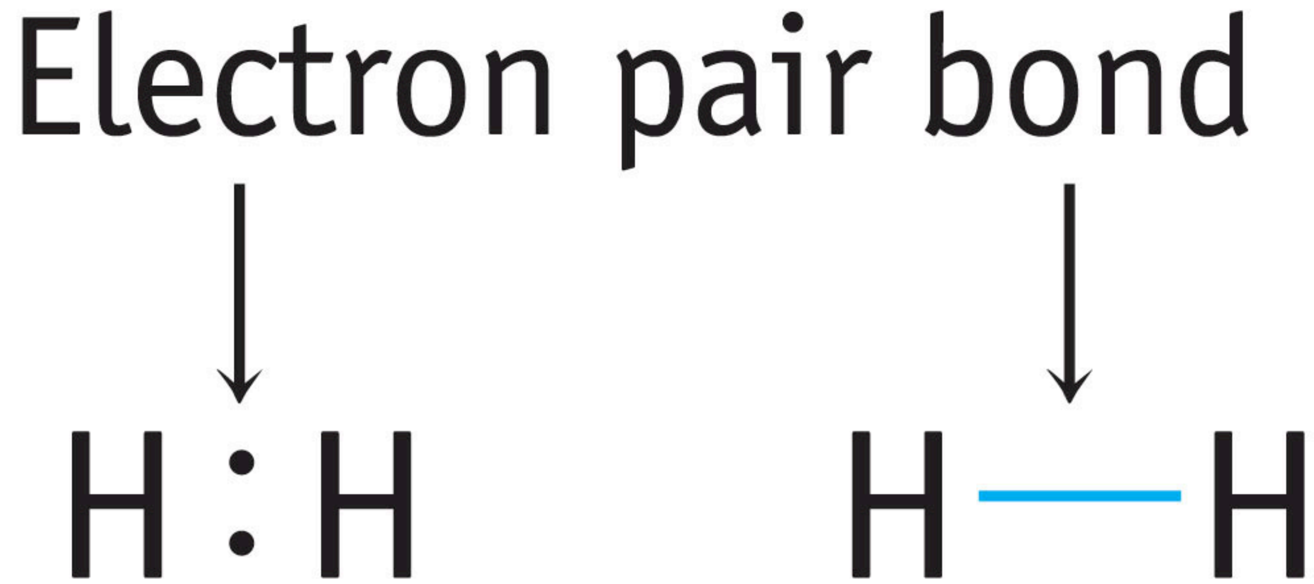
$[He]2s^22p^5$



“Completing an octet around each atom”

Share until you can’t share any more
(ie. Each atom’s n-level is full)

p. 352



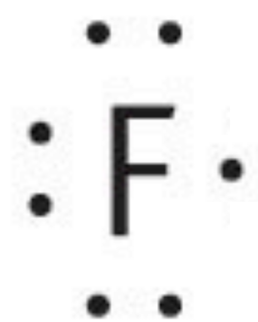
Why not an octet here?

Why not an octet here?

n=1, so there is only 1s and it fills up with 2 e-

p. 352

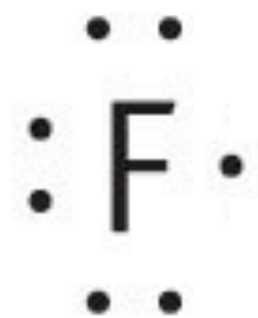
Why write electrons in 4 pairs?



Why write electrons in 4 pairs?

$[He]2s^2 2p^5$

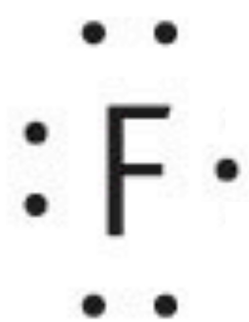
$[He]2s^2 2p_x^{\,2} 2p_y^{\,2} 2p_z^{\,1}$

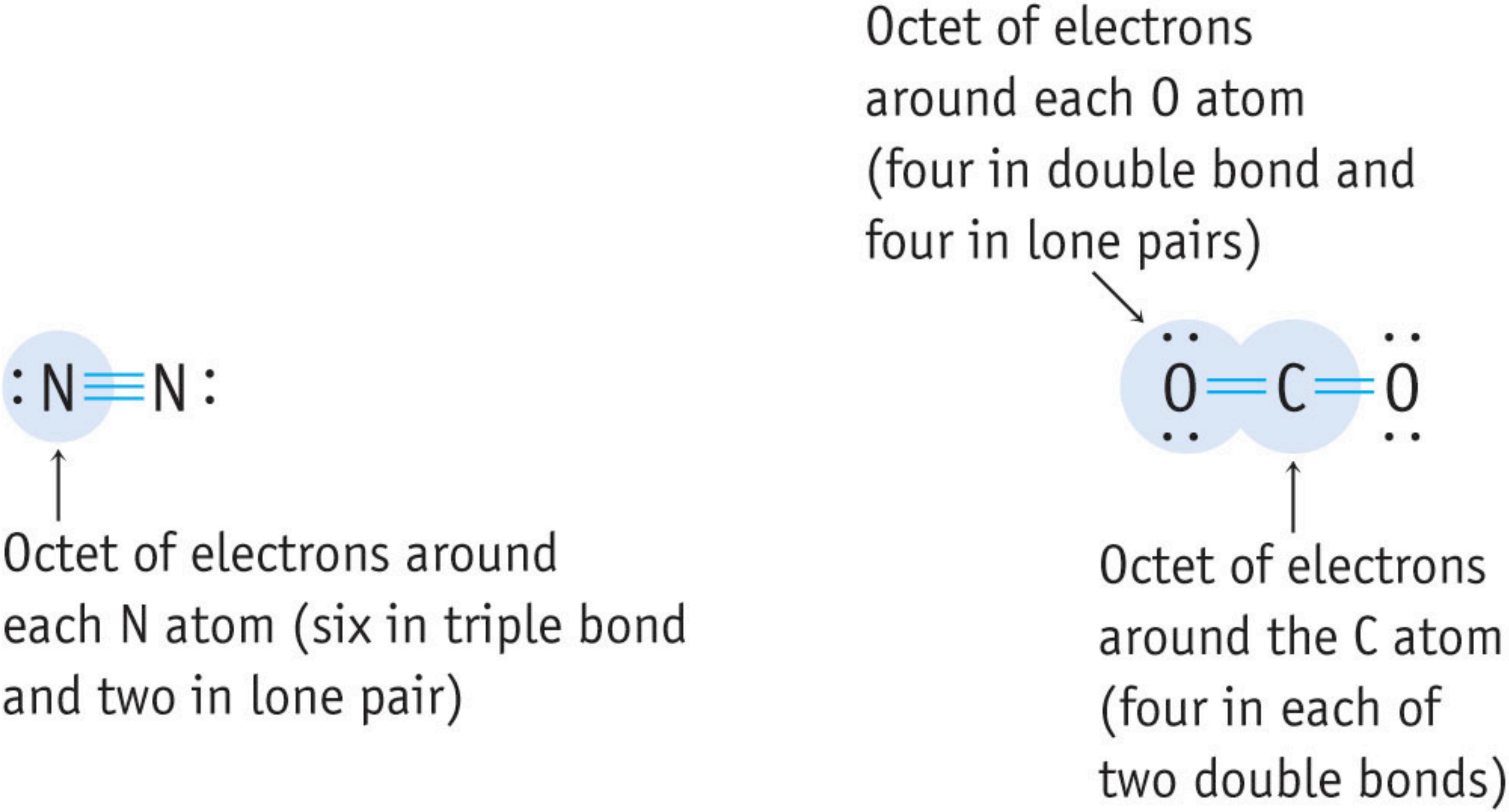


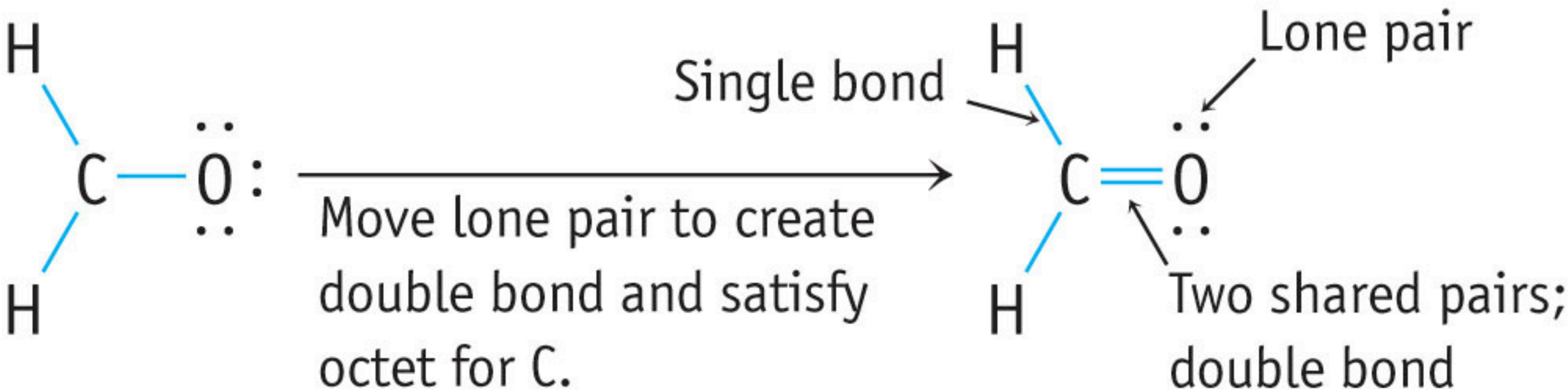
Why write electrons in 4 pairs?

$[He]2s^2 2p^5$

$[He]2s^2 2p_x{}^2 2p_y{}^2 2p_z{}^1$




Octet of electrons around each O atom (four in double bond and four in lone pairs)
:N≡N:
O=C=O
Octet of electrons around each N atom (six in triple bond and two in lone pair)
Octet of electrons around the C atom (four in each of two double bonds)


Single bond
Lone pair
Move lone pair to create double bond and satisfy octet for C.
Two shared pairs; double bond

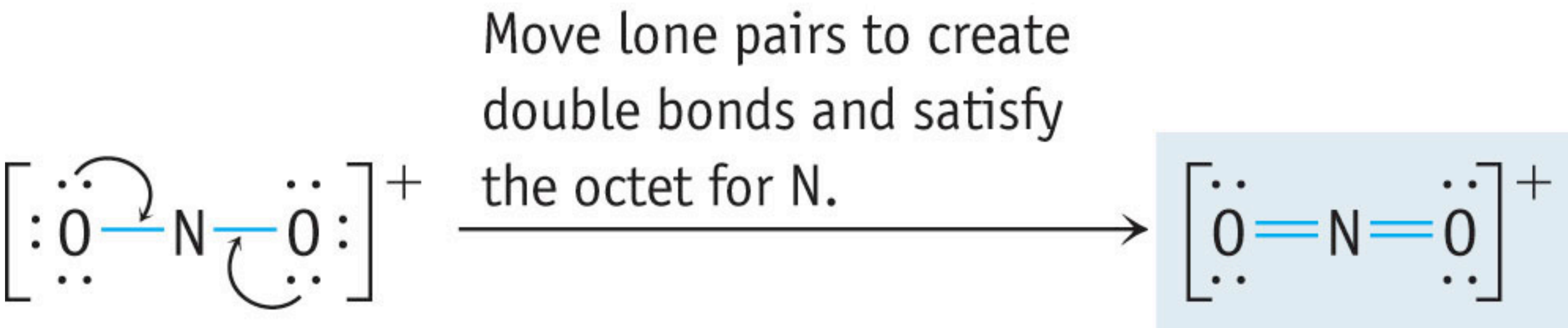
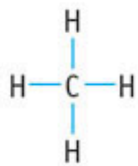
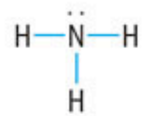
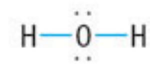
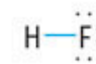
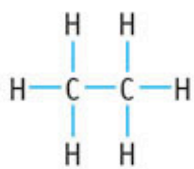
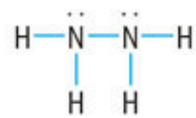
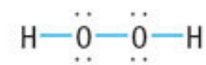
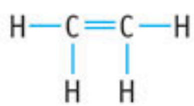
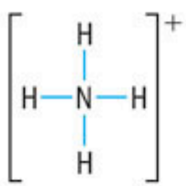
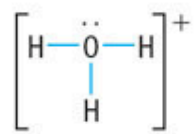
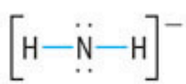
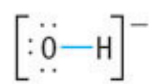
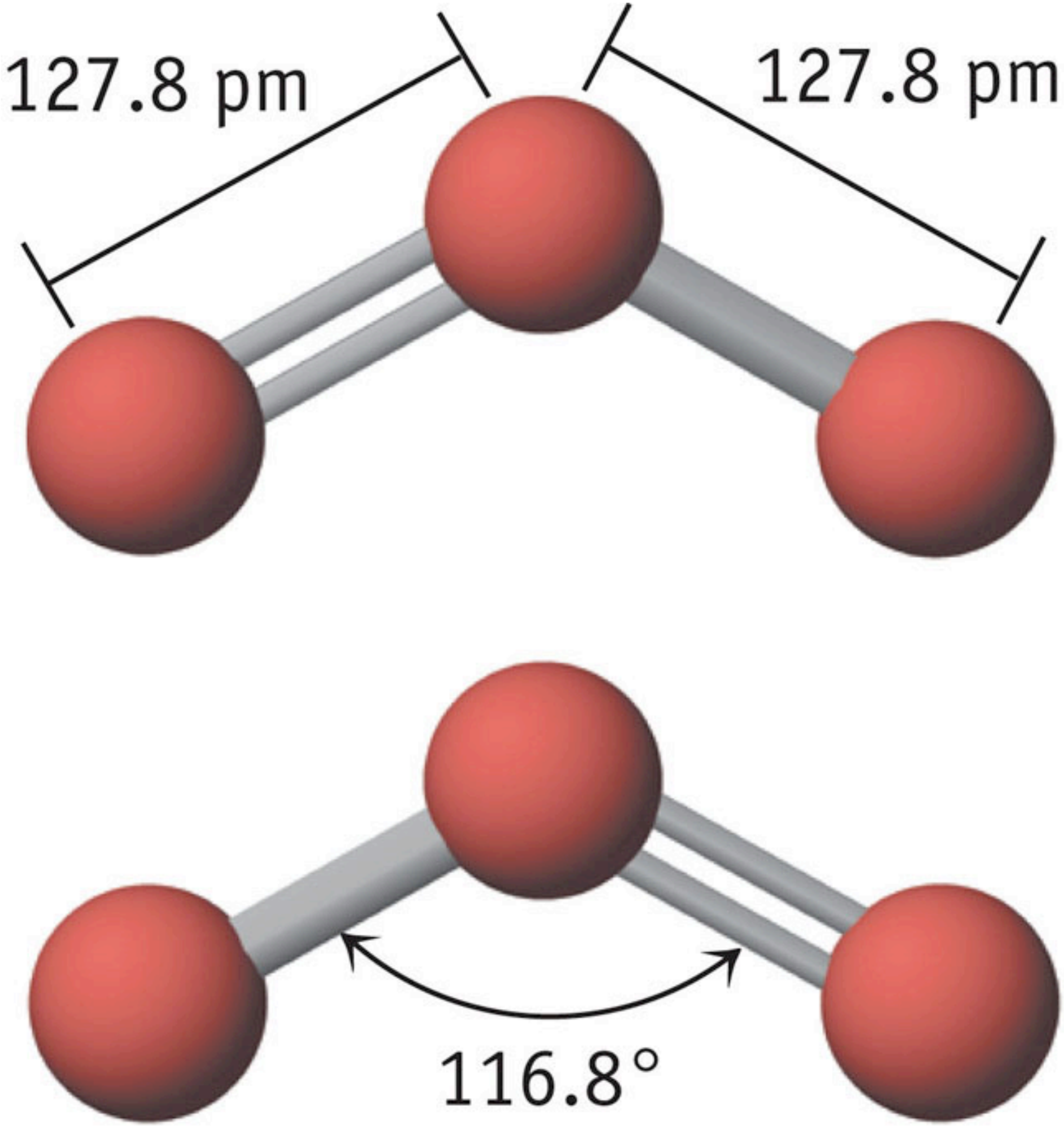

Move lone pairs to create double bonds and satisfy the octet for N.

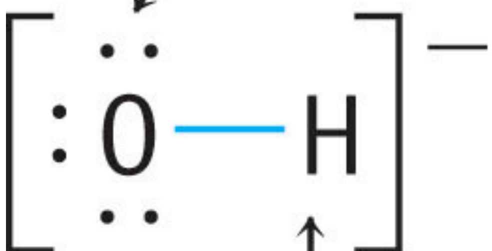
TABLE 8.3 Lewis Structures of Common Hydrogen-Containing Molecules and Ions of Second-Period Elements

Group 4A		Group 5A		Group 6A		Group 7A	
CH_4 methane		NH_3 ammonia		H_2O water		HF hydrogen fluoride	
C_2H_6 ethane		N_2H_4 hydrazine		H_2O_2 hydrogen peroxide			
C_2H_4 ethylene		NH_4^+ ammonium ion		H_3O^+ hydronium ion			
C_2H_2 acetylene		NH_2^- amide ion		OH^- hydroxide ion			


Group 4A
Group 5A
Group 6A
Group 7A
C
N
O
F


127.8 pm
127.8 pm
116.8°

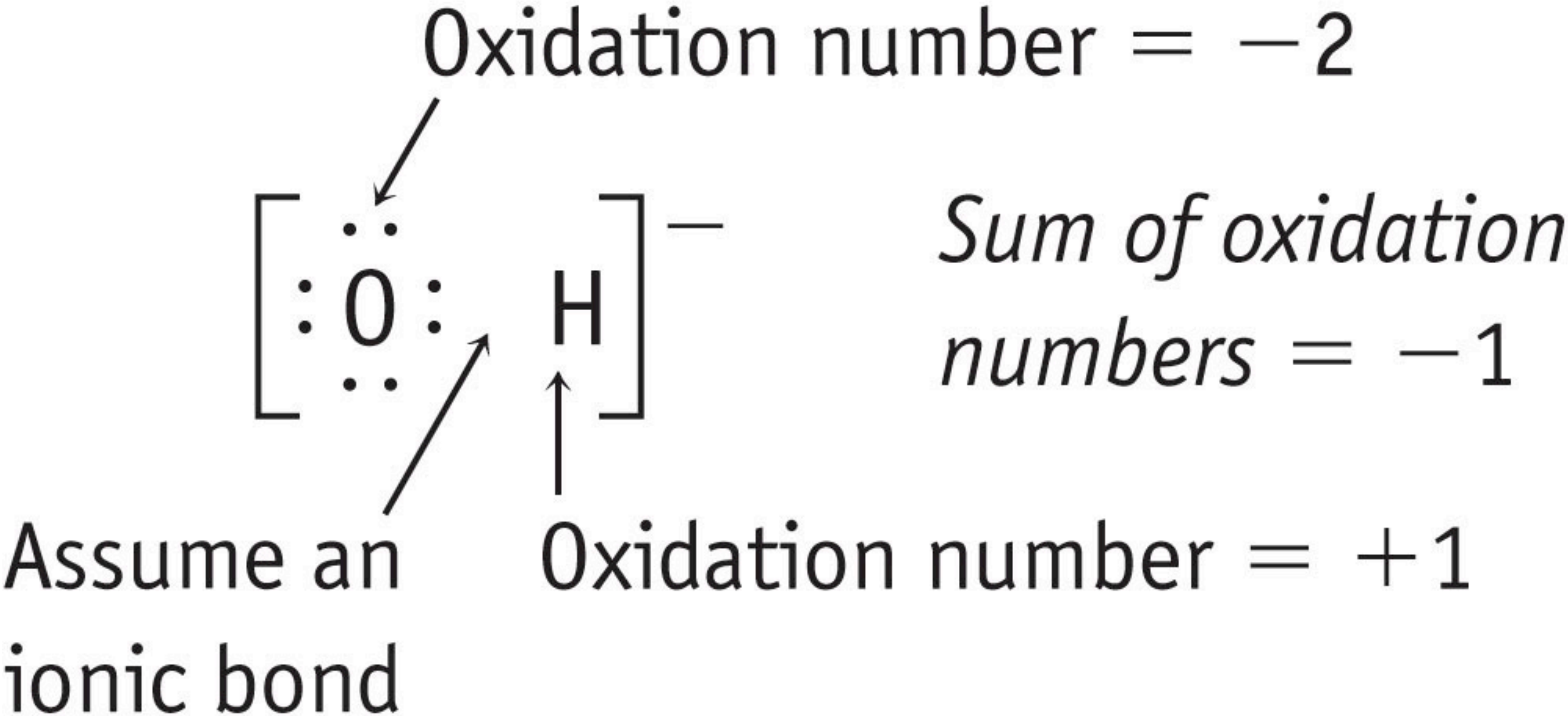
$$\text{Formal charge} = -1 = 6 - [6 + \tfrac{1}{2}(2)]$$



Sum of formal charges $= -1$

$$\text{Formal charge} = 0 = 1 - [0 + \tfrac{1}{2}(2)]$$

A Closer Look, p. 360



Oxidation number = −2
O
H
−
Sum of oxidation numbers = −1
Assume an ionic bond
Oxidation number = +1