Why write electrons in 4 pairs?
Why write electrons in 4 pairs?

[He]2s^22p^5  

[He]2s^22p_x^22p_y^22p_z^1
Why write electrons in 4 pairs?

[He]2s^22p^5  [He]2s^22p_x^22p_y^22p_z^1

F
1. Determine the arrangement of atoms in the molecule
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5. Place electrons around the central atom. If you run out, “share” electron pairs from terminal atoms
Drawing Lewis Structures

The Octet Rule

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\[ \text{H}_2\text{CO} \]

\[ \text{H} \quad \text{H} \quad \text{C} \quad \text{O} \]
Drawing Lewis Structures

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H₂CO

H – terminal
Up to 4 bonds

C – internal
Up to 2 bonds

O – internal?

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\[ \text{H}_2\text{CO} \]

H – terminal
C – internal
  Up to 4 bonds
O – internal?
  Up to 2 bonds
  *So try C in middle*
Drawing Lewis Structures

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\[ H_2CO \]

\[ H \rightarrow 1s^1 \]
\[ H \rightarrow 1s^1 \]
\[ C \rightarrow [\text{He}]2s^22p^2 \]
\[ O \rightarrow [\text{He}]2s^22p^4 \]

12 e⁻
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\[
\text{H}_2\text{CO}^{12 \text{ e}^-}
\]

\[
\text{H}-\text{C} \quad \text{O}
\]

\[
\text{H}
\]
Drawing Lewis Structures

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\[-\text{H}_2\text{C}=\text{O}^{12}\text{e}^->\]
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Slightly alternate route
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H₂CO

12 e⁻
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H₂CO

12 e⁻
Octet of electrons around each N atom (six in triple bond and two in lone pair)

Octet of electrons around each O atom (four in double bond and four in lone pairs)

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

Octet of electrons around each O atom (four in double bond and four in lone pairs)

Octet of electrons around the C atom (four in each of two double bonds)
\[ \text{Octet of electrons around each N atom (six in triple bond and two in lone pair)} \]

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Octet of electrons around each O atom (four in double bond and four in lone pairs)

Octet of electrons around the C atom (four in each of two double bonds)
Move lone pair to create double bond and satisfy octet for C.

Single bond

Lone pair

Two shared pairs; double bond
Move lone pairs to create double bonds and satisfy the octet for N.
Which is the best Lewis structure

1) :C ≡ O:

2) :C ≡ Ō:

3) :C ≡ Ō:
Which is the best Lewis structure

1) C ≡ O: 10 e⁻  
   C – [He]2s²2p²  
   O – [He]2s²2p⁴

2) C ≡ O: 12 e⁻  
   Too many electrons

3) C ≡ O: 10 e⁻  
   Incomplete Octet (6)
Which is the best Lewis structure

1) \[ :C \equiv \equiv N:\]

2) \[ :C \equiv N:\]

3) \[ :C \equiv N:\]
Which is the best Lewis structure

1) [\(:C\equiv\equiv N:\)] 10 e\(^{-}\)

C – [He]2s\(^2\)2p\(^2\)
N – [He]2s\(^2\)2p\(^3\)

2) [\(:C\equiv\equiv N:\)] 12 e\(^{-}\)

Plus 1 e\(^{-}\)
Too many electrons

3) [\(:C\rightarrow N:\)] 14 e\(^{-}\)

Too many electrons
Isoelectronic species
(10 electrons)

\[
\begin{align*}
\text{N} & \equiv \text{N} & & \equiv \text{O} & & \equiv \text{N} \\
\text{N} & \equiv \text{N} & & \equiv \text{O} & & \equiv \text{N} \\
\text{C} & \equiv \text{O} & & \equiv \text{C} & & \equiv \text{N} \\
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\text{N} & \equiv \text{N} & & \equiv \text{O} & & \equiv \text{C} \\
\end{align*}
\]

N – [He]2s\(^2\)2p\(^3\)  
N – [He]2s\(^2\)2p\(^3\)  
C – [He]2s\(^2\)2p\(^2\)  
C – [He]2s\(^2\)2p\(^2\)  
N – [He]2s\(^2\)2p\(^3\)  
C – [He]2s\(^2\)2p\(^2\)  
N – [He]2s\(^2\)2p\(^3\)  
C – [He]2s\(^2\)2p\(^2\)  

2+3+2+3  
2+2+2+4  
2+2+2+3+1  

Plus 1 e\(^-\)
### Table 8.3  Lewis Structures of Common Hydrogen-Containing Molecules and Ions of Second-Period Elements

<table>
<thead>
<tr>
<th>Group 4A</th>
<th>Group 5A</th>
<th>Group 6A</th>
<th>Group 7A</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₄ methane</td>
<td>NH₃ ammonia</td>
<td>H₂O water</td>
<td>HF hydrogen fluoride</td>
</tr>
<tr>
<td>C₂H₆ ethane</td>
<td>N₂H₄ hydrazine</td>
<td>H₂O₂ hydrogen peroxide</td>
<td></td>
</tr>
<tr>
<td>C₂H₄ ethylene</td>
<td>NH₄⁺ ammonium ion</td>
<td>H₃O⁺ hydronium ion</td>
<td></td>
</tr>
<tr>
<td>C₂H₂ acetylene</td>
<td>NH₂⁻ amide ion</td>
<td>OH⁻ hydroxide ion</td>
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</table>
Start to think about the common elements like this

Group 4A

\[ \text{C} \]

Group 5A

\[ \text{N} \]

Group 6A

\[ \text{O} \]

Group 7A

\[ \text{F} \]

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