

Name: _____ Period: _____ Date: _____

Lewis Structures for Molecules

Learning goal

I can draw Lewis structures for molecules, including double and triple bonds.

Part 1 · Notes

Fill in each blank using the word bank for that section.

Section A · Counting Valence Electrons

Word bank

2 · one dot · 8 · 6 · line · 16 · 4 · two dots · circle

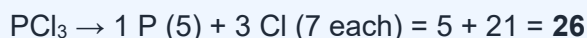
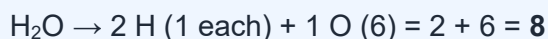
- In C7.01 you drew dots around single atoms. A **Lewis structure** does the same for a whole **molecule**. It shows every **valence electron**: each **bonding pair** is drawn as a _____, and each **lone pair** (two electrons that belong to just one atom) is drawn as _____.
- Only valence electrons are drawn, because they're the only ones that take part in bonding. For the main-group elements, the group number tells you how many:

H	C, Si	N, P	O, S	F, Cl, Br, I
1	4	5	6	7

- Step 1 is always counting.** Add the valence electrons of every atom in the formula.

Remember

Worked examples



- Each oxygen atom brings _____ valence electrons. NH_3 has _____ valence electrons in all.

Section B · Single Bonds

Word bank

center · 4 · 2 · 0 · 1 · outside · 8

- **From dots to lines:** two electrons shared between two atoms (C7.01) are drawn as one line. H:H and H–H mean the same thing.



H–H: one line = one shared pair (2 electrons)

Remember

Steps: drawing a Lewis structure

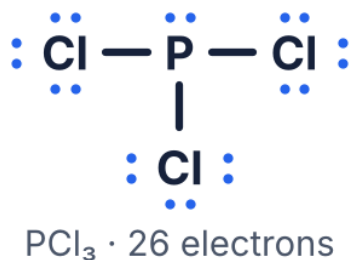
1. **Count** the total valence electrons.
2. **Place** the central atom (the one there's only one of; never H). Put the other atoms around it.
3. **Connect** each outer atom with a single bond (2 electrons each).
4. **Fill** the outer atoms with lone pairs until they have 8. Hydrogen gets none.
5. **Leftovers** go on the central atom as lone pairs.
6. **Check:** does every atom have 8 (H: 2)? Does the total match step 1?

- **Worked example: H₂O (8 electrons).** O goes in the middle; two O–H bonds use 4 electrons. Each H is full with its one bond (2 electrons). 4 electrons are left, so O gets **2 lone pairs**.
Check: O has 4 shared + 4 lone = 8 ✓ · total used 4 + 4 = 8 ✓



H₂O · 8 electrons

- **Worked example: PCl_3 (26 electrons).** P goes in the middle; three P–Cl bonds use 6. Each Cl gets 3 lone pairs: $3 \times 6 = 18$ electrons. $26 - 6 - 18 = 2$ left, so P gets **1 lone pair**. Check: P has $6 + 2 = 8 \checkmark$ · each Cl has $2 + 6 = 8 \checkmark$ · total $6 + 18 + 2 = 26 \checkmark$



- **A line counts for both atoms.** In H–Cl, the 2 bonding electrons count toward hydrogen's 2 **and** chlorine's 8.
- In CH_4 (carbon tetrahydride), carbon has _____ lone pairs. Hydrogen is full with _____ electrons.
- Hydrogen is always on the _____. It makes one bond and never has a lone pair.

Section C · Double and Triple Bonds

Word bank

3 · 4 · 8 · 6 · remove an atom · add more electrons ·
make a double bond · 2

- Sometimes you run out of electrons before the central atom has 8. You can't add electrons (step 1 fixed the total), so you **share more**. Move a lone pair from an outer atom into the bond. Now that pair is shared, so it counts for **both** atoms.
- Two shared pairs between the same atoms make a **double bond** (_____ electrons, drawn =). Three shared pairs make a **triple bond** (_____ electrons, drawn $\equiv$).

Remember

Step 6, in full: if the central atom is short of 8, move a lone pair from an outer atom into its bond. Repeat until the central atom has 8. The total never changes.

- **Worked example: CO₂ (16 electrons).** C in the middle: O—C—O uses 4. Each O gets 3 lone pairs: 12 more. That's all 16, and nothing is left for C. Check C: only 4 electrons. Move one lone pair from **each** O into its bond: **O=C=O**, with 2 lone pairs on each O. Check: C has 8 ✓ · each O has 4 shared + 4 lone = 8 ✓ · total 8 + 8 = 16 ✓



Before: C has only 4 After: 8 on every atom

- If the central atom is short of 8 and no electrons are left, you _____.

Part 2 · Lewis Builder

Card 1 · Count the valence electrons (do this after Section A)

Write each atom's valence electrons, then add them. Count every atom: H₂O has two H atoms. The first row is done for you.

Formula	Each atom's valence electrons	Total
Ex: H ₂ O	H 1 + H 1 + O 6	8
NH ₃		
CO ₂		
PCl ₃		
CCl ₄		

Why do Lewis structures show only the valence electrons, not every electron in the atom?

Sentence stem: "Only valence electrons are drawn because _____. The inner electrons _____."

Card 2 · Single bonds (do this after Section B)

Each mat shows the atoms in place. Draw a line for each bond and two dots for each lone pair (or use the cut-out pieces on the last page of Part 2). Follow the steps: connect, fill the outer atoms, put leftovers on the center, then check. H₂O is done for you.

Example: H₂O  done for you	HCl  draw it	NH₃  draw it
CH₄  draw it	PCl₃  draw it	

Molecule	Total e ⁻ (step 1)	e ⁻ in bonds	e ⁻ in lone pairs	Every atom 8? (H: 2)
<i>Ex:</i> H ₂ O	8	4	4	✓ O 8, H 2
HCl				
NH ₃				
CH ₄				
PCl ₃				

In NH₃, nitrogen has a lone pair but each hydrogen has none. Explain why.

Sentence stem: "Nitrogen needs ____ electrons, so _____. Hydrogen is full with _____, so _____."

Card 3 · Double and triple bonds (do this after Section C)

Same steps. When the central atom is still short and no electrons are left, move a lone pair into a bond. O₂ is done for you.

Example: O ₂	CO ₂	N ₂	CS ₂
			
done for you	draw it	draw it	draw it

Molecule	Total e ⁻	Center short after step 5?	What did you move?	Bond made
<i>Ex: O₂</i>	12	<i>yes: one O had 6</i>	<i>1 lone pair into the bond</i>	<i>double</i>
CO ₂				
N ₂				
CS ₂				

How did you know O₂ needed a double bond instead of a single bond?

Sentence stem: "With a single bond, _____. Moving a lone pair into the bond _____."

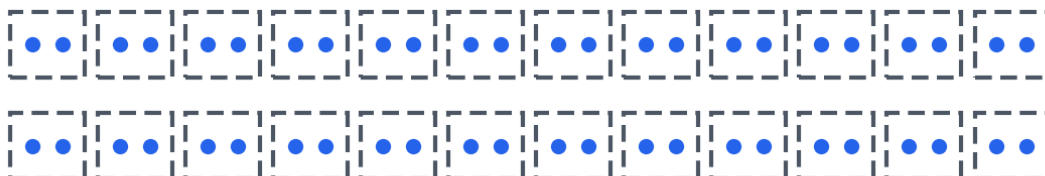
Lewis Builder pieces · cut along the dashed lines (optional)

Use these on the mats instead of drawing. Count the electrons as you place each piece: every piece is 2 electrons.

Bond strips · each line = 1 shared pair (2 electrons). Stack 2 for a double bond, 3 for a triple bond.



Lone-pair chips · each chip = 2 electrons on one atom.



Cut along the dashed lines. Keep the pieces in an envelope for the next class.

Part 3 · Checkpoints

How to use this section

1. Answer the ▲ main questions for each checkpoint.
2. Check your answers with your teacher.
3. Your teacher may give you a ● or ■ page for that checkpoint. Finish it before you move on.

Checkpoint 1 · Count valence electrons

▲ Main questions

T1.1. How many valence electrons are in CO_2 ?

- A. 16
- B. 18
- C. 12
- D. 10

T1.2. How many valence electrons are in PCl_3 ?

- A. 12
- B. 26
- C. 24
- D. 22

T1.3. How many electrons does one single bond use?

- A. 4
- B. 8
- C. 2
- D. 1

T1.4. Which atom goes in the center of NF_3 ?

- A. none; NF_3 has no center
- B. F
- C. either one
- D. N

Checkpoint 2 · Single-bond molecules

▲ Main questions

T2.1. How many lone pairs are in the whole NH_3 molecule?

- A. 0
- B. 3
- C. 1
- D. 4

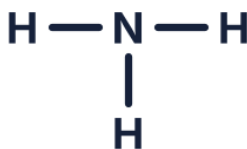
T2.2. In CCl_4 , how many lone pairs does each chlorine have?

- A. 2
- B. 1
- C. 4
- D. 3

T2.3. How many lone pairs are in the whole PCl_3 molecule?

- A. 10
- B. 9
- C. 12
- D. 13

T2.4. A student drew NH_3 like this. What's wrong?



A student's drawing of NH_3

- A. Nothing is wrong
- B. Nitrogen has only 6 electrons; it needs a lone pair to reach 8
- C. Each H needs a lone pair
- D. N needs a double bond

Checkpoint 3 · Multiple bonds

▲ Main questions

T3.1. In O_2 , how many lone pairs does each oxygen have?

- A. 1
- B. 0
- C. 2
- D. 3

T3.2. Which is the correct Lewis structure for CS_2 (16 electrons)?

- A. $S=C=S$, with 2 lone pairs on C
- B. $S-C-S$, with 3 lone pairs on each S
- C. $S-C-S$, with 2 lone pairs on C
- D. $S=C=S$, with 2 lone pairs on each S

T3.3. How many electrons are shared in a triple bond?

- A. 6
- B. 3
- C. 8
- D. 4

T3.4. When should you try a double bond?

- A. When electrons are left over
- B. When the central atom is short of 8 and no electrons are left
- C. Every time carbon is in the middle
- D. When there's a hydrogen

Part 4 · Claim, Evidence, Reasoning

Question: Nitrogen gas is N_2 . Explain why the two nitrogen atoms must share a triple bond.

Bond tried	Shared e^-	e^- left for lone pairs (of 10)	Does each N have 8?
N–N (single)	2	8	No
N=N (double)	4	6	No
N≡N (triple)	6	4	Yes: 6 shared + 1 lone pair each

Also: the $N\equiv N$ bond takes about 945 kJ/mol to break; an $N-N$ single bond takes about 163 kJ/mol. N_2 makes up 78% of the air and rarely reacts.

Sentence stems (use them if you need them)

I claim that N_2 needs a triple bond because ____.

My evidence is that N_2 has ____ valence electrons. With a single bond, _____. With a triple bond, _____.

This works because shared electrons count for _____.

Evidence bank: 10 valence electrons · 5 each · 6 shared · 1 lone pair each · $6 + 2 = 8$ · counts for both atoms · 945 kJ/mol

Claim:

Evidence:

Reasoning:

■ Take it further

Someone says N_2 could just have a single bond with 3 lone pairs on each N. Respond using electron counts.

Glossary · Glosario · Bảng thuật ngữ

English	Español	Tiếng Việt
Lewis structure: a drawing of a molecule that shows every valence electron: bonding pairs as lines and lone pairs as dots	estructura de Lewis: un dibujo de una molécula que muestra todos los electrones de valencia: los pares enlazantes como líneas y los pares solitarios como puntos	công thức Lewis: hình vẽ một phân tử thể hiện mọi electron hóa trị: cặp electron liên kết là gạch nối, cặp electron tự do là dấu chấm
bonding pair: two electrons shared between two atoms, drawn as one line; also called a shared pair	par enlazante: dos electrones compartidos entre dos átomos, dibujados como una línea; también se llama par compartido	cặp electron liên kết: hai electron dùng chung giữa hai nguyên tử, vẽ bằng một gạch nối; còn gọi là cặp electron dùng chung
lone pair: two valence electrons on one atom that are not shared	par solitario: dos electrones de valencia en un átomo que no se comparten	cặp electron tự do: hai electron hóa trị trên một nguyên tử không được dùng chung
double bond: two shared pairs (4 electrons) between the same two atoms	enlace doble: dos pares compartidos (4 electrones) entre los mismos dos átomos	liên kết đôi: hai cặp electron dùng chung (4 electron) giữa cùng hai nguyên tử
triple bond: three shared pairs (6 electrons) between the same two atoms	enlace triple: tres pares compartidos (6 electrones) entre los mismos dos átomos	liên kết ba: ba cặp electron dùng chung (6 electron) giữa cùng hai nguyên tử
central atom: the atom in the middle of a molecule that the other atoms bond to	átomo central: el átomo en el centro de una molécula al que se unen los otros átomos	nguyên tử trung tâm: nguyên tử ở giữa phân tử mà các nguyên tử khác liên kết vào

Key directions · Instrucciones · Hướng dẫn

English	Español	Tiếng Việt
Count the valence electrons.	Cuenta los electrones de valencia.	Đếm số electron hóa trị.
Drag a bond between two atoms.	Arrastra un enlace entre dos átomos.	Kéo một liên kết giữa hai nguyên tử.
Give every atom 8 electrons (hydrogen: 2).	Dale a cada átomo 8 electrones (hidrógeno: 2).	Cho mỗi nguyên tử 8 electron (hiđro: 2).
Write a claim, evidence, and reasoning.	Escribe una afirmación, evidencia y razonamiento.	Viết nhận định, bằng chứng và lập luận.

Name: _____ Period: _____ Date: _____

Checkpoint 1 · Count valence electrons

- Your teacher gave you this page. Finish it before you move on to the next section.

• Need a boost?

Valence electrons: H 1 · C, Si 4 · N, P 5 · O, S 6 · F, Cl, Br, I 7

S1.1. How many valence electrons does one oxygen atom have?

- A. 8
- B. 6
- C. 2

S1.2. How many valence electrons are in H₂O in all?

- A. 3
- B. 7
- C. 8

S1.3. How many valence electrons are in NH₃ in all?

- A. 8
- B. 6
- C. 5

Name: _____ Period: _____ Date: _____

Checkpoint 2 · Single-bond molecules

- Your teacher gave you this page. Finish it before you move on to the next section.

• Need a boost?

S2.1. In the Lewis structure of H_2O , how many lone pairs are on oxygen?

- A. 4
- B. 2
- C. 1

S2.2. How many bonds does each hydrogen atom make?

- A. 4
- B. 2
- C. 1

S2.3. In HCl , how many lone pairs are on chlorine?

- A. 3
- B. 1
- C. 4

Name: _____ Period: _____ Date: _____

Checkpoint 3 · Multiple bonds

- Your teacher gave you this page. Finish it before you move on to the next section.

• Need a boost?

Steps: 1 Count · 2 Place (never H in the middle) · 3 Connect · 4 Fill outer atoms (H gets none) · 5 Leftovers on the center · 6 Check: 8 each (H 2), same total

S3.1. How many electrons are shared in a double bond?

- A. 2
- B. 4
- C. 6

S3.2. In O_2 , after one single bond and the lone pairs, one O has only 6 electrons and none are left. What do you do?

- A. Remove the bond
- B. Add 2 more electrons
- C. Move a lone pair from the other O into the bond

S3.3. Which molecule has a double bond?

- A. O_2
- B. H_2
- C. Cl_2

Name: _____ Period: _____ Date: _____

Checkpoint 1 · Count valence electrons

■ Your teacher gave you this page. Try these after your main questions.

■ Take it further

H1.1. How many valence electrons are in HCN?

- A. 12
- B. 11
- C. 9
- D. 10

H1.2. CCl_4 has 32 valence electrons. After the four single bonds are drawn, how many electrons are left for lone pairs?

- A. 24
- B. 28
- C. 32
- D. 16

H1.3. Explain why hydrogen can never be the central atom.

Name: _____ Period: _____ Date: _____

Checkpoint 2 · Single-bond molecules

■ Your teacher gave you this page. Try these after your main questions.

■ Take it furtherH2.1. Which molecule's central atom has 3 bonds and 1 lone pair, like NH_3 ?

- A. PCl_3
- B. SiCl_4
- C. H_2S
- D. CCl_4

H2.2. NF_3 has 26 valence electrons. How many of them are in lone pairs?

- A. 24
- B. 20
- C. 18
- D. 6

H2.3. Explain how you can tell the Lewis structure of CCl_4 is complete.

Name: _____ Period: _____ Date: _____

Checkpoint 3 · Multiple bonds

■ Your teacher gave you this page. Try these after your main questions.

■ Take it furtherH3.1. Which describes the Lewis structure of CO_2 ?

- A. Two single bonds, with 3 lone pairs on each O
- B. Two double bonds, with 2 lone pairs on each O
- C. Two double bonds, with 1 lone pair on each O
- D. Two double bonds, with a lone pair on C

H3.2. In N_2 , how many lone pairs does each nitrogen have?

- A. 0
- B. 2
- C. 1
- D. 3

H3.3. HCN has 10 valence electrons. Describe its Lewis structure and explain why it needs a triple bond.
