

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

# Covalent Bonding & Molecular Naming

## Learning goal

I can name covalent (molecular) compounds using prefixes, and write the formula from the name.

## Part 1 · Notes

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

### Section A · Molecules and Prefixes

#### Word bank

must show the number of atoms     ·     3     ·     6

- When two nonmetals bond, neither one gives up electrons. They share them in a **covalent bond**: each **shared pair** is two electrons held between the two atoms. A group of atoms held together by shared pairs is a **molecule**, and a compound made of molecules is a **molecular compound**.
- Ionic names worked because the charges decide the ratio (C7.05). Molecules have no ions, so nothing fixes the ratio. Carbon and oxygen form **two** different molecules, CO and CO<sub>2</sub>, so the name has to say how many atoms there are. In a molecular compound, the name \_\_\_\_\_.
- We show the number with a **prefix**:

| 1    | 2  | 3   | 4     | 5     | 6    | 7     | 8    | 9    | 10   |
|------|----|-----|-------|-------|------|-------|------|------|------|
| mono | di | tri | tetra | penta | hexa | hepta | octa | nona | deca |

- The prefix “tri” means \_\_\_\_\_, and “hexa” means \_\_\_\_\_.

#### Remember

Some molecules keep common names: H<sub>2</sub>O is water, NH<sub>3</sub> is ammonia, CH<sub>4</sub> is methane.

## Section B · Naming Molecules

### Word bank

carbon tetrachloride · trioxide

### Remember

#### Steps: naming a molecule

1. Name the elements in the order of the formula.
2. First element: add a prefix only if there's more than one atom. **Never “mono” first.**
3. Second element: always a prefix, then the -ide ending.
4. Before “oxide,” drop the prefix's final a or o: monoxide, tetroxide, pentoxide.

- **Worked examples:** CO → carbon **monoxide** · CO<sub>2</sub> → carbon **dioxide** · N<sub>2</sub>O<sub>4</sub> → **dinitrogen tetroxide** · PCl<sub>5</sub> → phosphorus **pentachloride** · SF<sub>6</sub> → sulfur **hexafluoride**
- CCl<sub>4</sub> is named \_\_\_\_\_. The name of SO<sub>3</sub> is sulfur \_\_\_\_\_.

### Remember

Ionic names never use prefixes (C7.05); molecular names always use them for the second element. Ask first: two nonmetals? Then prefixes.

## Section C · Formulas from Names

### Word bank

N<sub>2</sub>O<sub>4</sub>

- Going the other way, the prefixes **are** the subscripts. There are no charges to balance.
- **Worked example: dinitrogen pentoxide.** di → 2 N; pent(a) → 5 O → **N<sub>2</sub>O<sub>5</sub>**.
- **Worked example: phosphorus trichloride.** no prefix → 1 P; tri → 3 Cl → **PCl<sub>3</sub>**.

### Remember

**Never reduce a molecular formula.** Dinitrogen tetroxide is a real molecule with 2 N and 4 O atoms. NO<sub>2</sub> is a **different** molecule, nitrogen dioxide. Reducing would change the compound.

- The formula for dinitrogen tetroxide is \_\_\_\_\_.

## Part 2 · Practice

### Card 1 · Prefix match (do this after Section A)

Write the prefix for each number. Then write how many atoms each word shows.

| Number | Prefix | Number | Prefix |
|--------|--------|--------|--------|
| 3      |        | 8      |        |
| 10     |        | 1      |        |
| 5      |        | 6      |        |
| 2      |        | 9      |        |
| 7      |        | 4      |        |

| Word       | How many atoms? | Word          | How many atoms? |
|------------|-----------------|---------------|-----------------|
| dinitrogen |                 | tetrachloride |                 |
| monoxide   |                 | hexafluoride  |                 |

Why do molecular names need prefixes when ionic names like calcium chloride don't?

Sentence stem: "Ionic names don't need prefixes because \_\_\_\_\_. Molecular names need them because \_\_\_\_\_."

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## Card 2 · Name it (do this after Section B)

Count the atoms. Never “mono” first; always a prefix on the second element; drop a or o before “oxide.”

| Formula                       | Atoms of each element | Name |
|-------------------------------|-----------------------|------|
| CO                            |                       |      |
| CO <sub>2</sub>               |                       |      |
| N <sub>2</sub> O <sub>4</sub> |                       |      |
| PCl <sub>5</sub>              |                       |      |
| SF <sub>6</sub>               |                       |      |
| CCl <sub>4</sub>              |                       |      |

CO is carbon monoxide, but it isn't “monocarbon monoxide.” When does a molecule's name skip “mono”?

Sentence stem: “Mono is skipped when \_\_\_\_\_. It's used on the second element because \_\_\_\_\_.”

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**Card 3 · Write the formula (do this after Section C)**

The prefixes are the subscripts. No prefix on the first element means 1. Never reduce.

| Name                   | Atoms of each element | Formula | Did I reduce? (never!)      |
|------------------------|-----------------------|---------|-----------------------------|
| dinitrogen pentoxide   |                       |         | <input type="checkbox"/> No |
| phosphorus trichloride |                       |         | <input type="checkbox"/> No |
| carbon disulfide       |                       |         | <input type="checkbox"/> No |
| dinitrogen tetroxide   |                       |         | <input type="checkbox"/> No |
| nitrogen trifluoride   |                       |         | <input type="checkbox"/> No |
| sulfur dioxide         |                       |         | <input type="checkbox"/> No |

Dinitrogen tetroxide is  $\text{N}_2\text{O}_4$ . Why can't you reduce it to  $\text{NO}_2$  the way you reduced  $\text{Mg}_2\text{O}_2$  to  $\text{MgO}$ ?

Sentence stem: " $\text{Mg}_2\text{O}_2$  could be reduced because \_\_\_\_\_.  $\text{N}_2\text{O}_4$  can't because \_\_\_\_\_."

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## 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 · Prefixes

### ▲ Main questions

T1.1. Which prefix means 5?

- A. penta
- B. deca
- C. hexa
- D. tetra

T1.2. In “dinitrogen trioxide,” how many atoms are in one molecule?

- A. 6
- B. 5
- C. 3
- D. 2

T1.3. Why do molecular compounds need prefixes but ionic compounds don't?

- A. Ionic compounds are always 1 : 1
- B. Prefixes are only for gases
- C. Molecules have no ions, so nothing else fixes how many atoms there are
- D. Molecules have bigger charges

T1.4. Which name shows 10 oxygen atoms?

- A. tetraphosphorus octoxide
- B. tetraphosphorus pentoxide
- C. phosphorus dioxide
- D. tetraphosphorus decoxide

## Checkpoint 2 · Name molecules

### ▲ Main questions

T2.1. Name  $\text{N}_2\text{O}_4$ .

- A. nitrogen tetroxide
- B. dinitrogen tetroxide
- C. dinitrogen tetraoxide
- D. nitrogen dioxide

T2.2. Name  $\text{SF}_6$ .

- A. sulfur heptafluoride
- B. monosulfur hexafluoride
- C. sulfur hexafluoride
- D. sulfur fluoride

T2.3. Name  $\text{CCl}_4$ .

- A. carbon tetrachlorine
- B. tetracarbon chloride
- C. carbon chloride
- D. carbon tetrachloride

T2.4. Name  $\text{N}_2\text{O}$ .

- A. dinitrogen monoxide
- B. nitrogen dioxide
- C. nitrogen oxide
- D. dinitrogen oxide

## Checkpoint 3 · Formula from name

### ▲ Main questions

T3.1. What is the formula for dinitrogen pentoxide?

- A.  $\text{N}_5\text{O}_2$
- B.  $\text{N}_2\text{O}_4$
- C.  $\text{N}_2\text{O}_5$
- D.  $\text{NO}_5$

T3.2. What is the formula for phosphorus pentachloride?

- A.  $\text{PCl}_4$
- B.  $\text{P}_5\text{Cl}$
- C.  $\text{P}_2\text{Cl}_5$
- D.  $\text{PCl}_5$

T3.3. What is the formula for carbon disulfide?

- A.  $\text{CS}_2$
- B.  $\text{C}_2\text{S}$
- C.  $\text{C}_2\text{S}_2$
- D.  $\text{CS}$

T3.4. What is the formula for dinitrogen tetroxide?

- A.  $\text{NO}_2$
- B.  $\text{N}_2\text{O}_4$
- C.  $\text{N}_4\text{O}_2$
- D.  $\text{N}_2\text{O}_2$

## Part 4 · Claim, Evidence, Reasoning

Question: CO and CO<sub>2</sub> are both made of only carbon and oxygen. Explain why they are different compounds and why their names must be different.

|                            | CO                   | CO <sub>2</sub>                    |
|----------------------------|----------------------|------------------------------------|
| <b>Atoms per molecule</b>  | 1 C, 1 O             | 1 C, 2 O                           |
| <b>At room temperature</b> | colorless gas, toxic | colorless gas, what we breathe out |
| <b>Name</b>                | carbon monoxide      | carbon dioxide                     |

### Sentence stems (use them if you need them)

I claim that CO and CO<sub>2</sub> are different compounds because \_\_\_\_.

My evidence is that a CO molecule has \_\_\_\_ and a CO<sub>2</sub> molecule has \_\_\_\_\_. They also \_\_\_\_\_.

This means the names need prefixes because \_\_\_\_\_.

Evidence bank: 1 C and 1 O · 1 C and 2 O · CO is toxic · we breathe out CO<sub>2</sub> · no ions · shared electrons · mono- = 1 · di- = 2

Claim:

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Evidence:

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Reasoning:

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### ■ Take it further

Someone says CO<sub>2</sub> should be reduced to “CO” to match the ionic rules. Respond.

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## Glossary · Glosario · Bảng thuật ngữ

| English                                                                                                                 | Español                                                                                                                                      | Tiếng Việt                                                                                                                    |
|-------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>shared pair:</b> two electrons shared between two atoms in a covalent bond                                           | <b>par compartido:</b> dos electrones compartidos entre dos átomos en un enlace covalente                                                    | <b>cặp electron dùng chung:</b> hai electron được hai nguyên tử dùng chung trong liên kết cộng hóa trị                        |
| <b>molecule:</b> a group of atoms held together by covalent bonds                                                       | <b>molécula:</b> un grupo de átomos unidos por enlaces covalentes                                                                            | <b>phân tử:</b> một nhóm nguyên tử liên kết với nhau bằng liên kết cộng hóa trị                                               |
| <b>molecular compound:</b> a compound made of molecules, usually two or more nonmetals; also called a covalent compound | <b>compuesto molecular:</b> un compuesto formado por moléculas, por lo general de dos o más no metales; también se llama compuesto covalente | <b>hợp chất phân tử:</b> hợp chất được tạo từ các phân tử, thường gồm hai hay nhiều phi kim; còn gọi là hợp chất cộng hóa trị |
| <b>prefix:</b> a word part at the start of a name that shows a number, like di- (2) in carbon dioxide                   | <b>prefijo:</b> una parte al inicio de un nombre que indica un número, como di- (2) en dióxido de carbono                                    | <b>tiền tố:</b> phần đứng đầu một tên gọi để chỉ số lượng, như đi- (2) trong cacbon đioxit                                    |

## Key directions · Instrucciones · Hướng dẫn

| English                              | Español                                       | Tiếng Việt                               |
|--------------------------------------|-----------------------------------------------|------------------------------------------|
| Match each number to its prefix.     | Une cada número con su prefijo.               | Nối mỗi số với tiền tố của nó.           |
| Use prefixes to show how many atoms. | Usa prefijos para mostrar cuántos átomos hay. | Dùng tiền tố để chỉ số nguyên tử.        |
| Never reduce a molecular formula.    | Nunca simplifique una fórmula molecular.      | Không bao giờ rút gọn công thức phân tử. |

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## Checkpoint 1 · Prefixes

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

### • Need a boost?

Prefix chart: 1 mono · 2 di · 3 tri · 4 tetra · 5 penta · 6 hexa · 7 hepta · 8 octa · 9 nona · 10 deca

S1.1. What number does “di” mean?

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

S1.2. Which prefix means 4?

- A. penta
- B. tri
- C. tetra

S1.3. In “sulfur hexafluoride,” how many fluorine atoms are there?

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

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

**Checkpoint 2 · Name molecules**

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

**• Need a boost?**

Prefix chart: 1 mono · 2 di · 3 tri · 4 tetra · 5 penta · 6 hexa · 7 hepta · 8 octa · 9 nona · 10 deca

S2.1. Name  $\text{CO}_2$ .

- A. monocarbon dioxide
- B. carbon dioxide
- C. carbon oxide

S2.2. Name  $\text{PCl}_3$ .

- A. triphosphorus chloride
- B. phosphorus chloride
- C. phosphorus trichloride

S2.3. Name  $\text{CO}$ .

- A. carbon monoxide
- B. carbon oxide
- C. monocarbon monoxide

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

**Checkpoint 3 · Formula from name**

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

**• Need a boost?**

Prefix chart: 1 mono · 2 di · 3 tri · 4 tetra · 5 penta · 6 hexa · 7 hepta · 8 octa · 9 nona · 10 deca

S3.1. What is the formula for carbon tetrachloride?

- A.  $\text{C}_4\text{Cl}$
- B.  $\text{CCl}_4$
- C.  $\text{CCl}$

S3.2. What is the formula for sulfur dioxide?

- A.  $\text{SO}$
- B.  $\text{S}_2\text{O}$
- C.  $\text{SO}_2$

S3.3. What is the formula for nitrogen trifluoride?

- A.  $\text{NF}_3$
- B.  $\text{N}_3\text{F}$
- C.  $\text{NF}$

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

## Checkpoint 1 · Prefixes

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

### ■ Take it further

H1.1. CO and CO<sub>2</sub> are both “carbon oxides.” What do their names have to show?

- A. Nothing; “carbon oxide” names both
- B. Which one is a gas
- C. The charges on carbon
- D. How many oxygen atoms each molecule has

H1.2. Which is the correct way to say “one oxygen” at the end of a name?

- A. monoxide
- B. monooxide
- C. unoxide
- D. oxide

H1.3. Explain why “calcium dichloride” is wrong but “carbon dioxide” is right.

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Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

**Checkpoint 2 · Name molecules**

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

**■ Take it further**

H2.1. Which name is written correctly?

- A. dichlorine monoxide ( $\text{Cl}_2\text{O}$ )
- B. dichlorine monooxide ( $\text{Cl}_2\text{O}$ )
- C. chlorine oxide ( $\text{Cl}_2\text{O}$ )
- D. monochlorine dioxide ( $\text{ClO}_2$ )

H2.2. A student names  $\text{N}_2\text{O}_5$  “nitrogen pentoxide.” What's wrong?

- A. Nitrogen should come second
- B. The first element has 2 atoms, so it needs “di”: dinitrogen pentoxide
- C. Pentoxide should be pentaoxide
- D. Nothing is wrong

H2.3. Name  $\text{P}_4\text{O}_{10}$  and explain each prefix.

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Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

**Checkpoint 3 · Formula from name**

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

**■ Take it further**H3.1. Which pair is two **different** molecules?

- A.  $\text{N}_2\text{O}_4$  and dinitrogen tetroxide
- B.  $\text{N}_2\text{O}_4$  and  $\text{NO}_2$
- C.  $\text{CO}_2$  and carbon dioxide
- D.  $\text{SF}_6$  and sulfur hexafluoride

H3.2. What is the formula for tetraphosphorus decoxide?

- A.  $\text{P}_2\text{O}_5$
- B.  $\text{P}_{10}\text{O}_4$
- C.  $\text{P}_4\text{O}_{10}$
- D.  $\text{P}_4\text{O}_4$

H3.3. A student writes dinitrogen tetroxide as  $\text{NO}_2$  “because you always reduce.” Explain the mistake.

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