

Counting Atoms Notes

Element Symbols:

- Elements are represented by letter symbols found on the periodic table.
- Each element begins with a capital letter.
- Some elements have two or more letters, but only the first is capitalized.
- In a chemical formula or equation, a new element is symbolized by a capital letter.
 - A chemical formula is a set of chemical symbols showing the elements and how many atoms of each element are present in the substance.
Example: H₂O is the chemical formula for water
 - A chemical equation is a set of symbols representing a chemical reaction.
Example: H₂ + O → H₂O is the chemical equation for the synthesis of water

Practice #1:

- 1) Tell how many elements are represented in each example.
Hint: The number of capital letters = the number of elements!
- 2) Use the periodic table and write the names of the elements the symbols stands for:
 - C: 1 element(s) - carbon
 - Ba: 1 element(s) - barium
 - Co: 1 element(s) - cobalt
 - CO: 2 element(s) - carbon and oxygen
 - NaCl: 2 element(s) - sodium and chlorine

Subscripts:

- A subscript is a number written at the lower right of an element symbol.
- A subscript is always written after the symbol.
- Tell what the subscript is for each element in Na₂SO₄: Na= 2 S= none O= 4
- If there is no subscript written after a symbol that means there is one atom of that element present.
- If the number 2 is written, that means there are 2 atoms of that element present.
- Subscripts are important! If you change the subscript, you change the substance.
Example: H₂O is water, H₂O₂ is hydrogen peroxide. One is healthy to drink, the other is deadly.
(Joke: Two scientists walk into bar. The bartender asks what they would like to drink. The first scientist says "I'll have a glass of H₂O please." The second scientist says "I'll have H₂O too." The second scientist dies.)
- The subscript only tells how many atoms there are of the element just before it.
Example: Na₂SO₄ tells us there are 2 atoms of sodium and 4 atoms of oxygen.



Practice #2:

1. Draw arrows showing the distribution of the subscripts.
2. Write how many atoms of each element are present in these formulas.

- O_2 : 2 atoms of oxygen
- H_2O : 2 atoms of hydrogen
1 atom of oxygen
- $C_6H_{12}O_6$: 6 atoms of carbon
12 atoms of hydrogen
6 atoms of oxygen
- Cl_2 : 2 atoms of chlorine

Subscripts at the end of Parenthesis:

- A subscript written at the end of a parenthesis gets distributed to all the elements inside the parenthesis.
- Multiply the subscript at the end of the parenthesis with all subscripts inside the parenthesis to determine the number of atoms for each element.
- Do not distribute to or multiply with elements outside of the parenthesis.

Practice #3:

1. Draw arrows showing the distribution of the subscripts.
2. Write how many atoms of each element are present in each formula:

- $(NO_3)_2$: Nitrogen: (1 x 2) = 2 atoms of nitrogen
Oxygen: (3 x 2) = 6 atoms of oxygen
- $Ca_3(PO_4)_2$: 3 atoms of calcium (The 2 does not apply to it because Ca is not in the parenthesis)
Phosphate: (1 x 2) = 2 atoms of phosphate
Oxygen: (4 x 2) = 8 atoms of oxygen

Coefficients:

- A coefficient is a number written in front of a chemical symbol or formula.
- A coefficient is always written before the symbol.
- The coefficient tells the number of atoms of that element that are present or how many of those molecules are present.
- When you change the coefficient, you change how much of the substance you have.
- Examples: C = 1 atom of carbon, 3C = 3 atoms of carbon
C₆H₁₂O₆ = 1 sugar molecule, 10C₆H₁₂O₆ = 10 sugar molecules
- The coefficient also helps determine how many atoms of each element are present in the compound.
- The coefficient number is distributed to all elements in the entire formula. (Remember, each element begins with a capital letter.)
- If an element symbol has both a coefficient and a subscript, multiply the two numbers together to determine the total number atoms of that element.
- Coefficients do not carry over into symbols or formulas after a + or \rightarrow sign in an equation.

Practice #4:

1. Draw arrows showing the distribution of the coefficients and subscripts.
2. Tell how many molecules and/or atoms of each element are present in each:

○ 5O : 5 atoms of oxygen

○ 5O_2 : 10 atoms of oxygen

○ 4NaCl : 4 molecules of salt
4 atoms of sodium
4 atoms of chlorine

○ $6\text{H}_2\text{O}$: 6 molecules of water
12 atoms of hydrogen
6 atoms of oxygen

○ $3\text{Na}_2\text{SO}_4$: 3 molecules of sodium sulfate
6 atoms of sodium
3 atoms of sulfur
12 atoms of oxygen

○ $5\text{Ca}_3(\text{PO}_4)_2$: 5 molecules of calcium phosphate
15 atoms of calcium
10 atoms of phosphate
40 atoms of oxygen

Remember to multiply the coefficient with the subscripts!

Element written twice in a formula:

- This is the only time you add numbers when counting atoms.
- Each time the element appears, determine the number of atoms using the guidelines already given.
- Add the values you determined together to get the total number of atoms of that element in the substance.

Practice #5: Determine the number of hydrogen atoms in the following formulas:

- $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$: first time H appears: 4
second time H appears: 3
total # of hydrogen atoms in this molecule: 7

- $2(\text{NH}_4)_3\text{H}$: first time H appears: 24
second time H appears: 2
total # of hydrogen atoms in this molecule: 26