AIM 8 | How can valence help us to write formulas?

There are millions of compounds. Each one has its own formula. No two compounds have the same formula.

Many formulas are very complicated. For example, the formula for a certain substance in your blood is $C_{3032}H_{4816}O_{872}N_{780}S_8F_4$. *This* is a complicated formula for a complicated molecule.

Many formulas, however, are very simple—like H_2O. Most people know that H_2O is the formula for water. Water contains only two kinds of atoms.

You can figure out the formula for any simple compound. All you need to know are the symbols and the valences of the elements that make up the compound. JUST CRISS-CROSS THE VALENCE NUMBERS.

This is how to write the formula for water:

Water is made up of hydrogen (H) and oxygen (O). The valence of hydrogen is +1 (H^{+1}). The valence of oxygen is −2 (O^{-2}).

Step 1 Write down the *symbol* of each element. List the + valence element first.

$$\mathbf{H\ \ O}$$

Step 2 Mark down the *valence* of each element next to the element like this:

$$\mathbf{H^{+1}O^{-2}}$$

Step 3 *Criss-cross* the valence numbers *only*. Leave out the signs.

$$\mathbf{H^{+1}O^{-2}}$$
$$\mathbf{H_2O_1 = H_2O_1}$$

One molecule of water, then, contains 2 atoms of hydrogen and 1 atom of oxygen.

In a final formula, we do not write any 1's. So the formula for water is $\mathbf{H_2O}$.

USING VALENCES TO FIND FORMULAS

Example #1

Table salt is made up of atoms of sodium (Na) and chlorine (Cl).

The valence of sodium is $^{+1}$ (Na^{+1}).

The valence of chlorine is $^{-1}$ (Cl^{-1}).

Write it down. $\mathbf{Na^{+1}Cl^{-1}}$

Cross over the signs. $\mathbf{Na^{+1}Cl^{-1}}$
$\mathbf{Na_1Cl_1}$

Cancel out the numbers. $\mathbf{Na_1Cl_1}$

The formula for table salt is **NaCl.**

Table salt is *sodium chloride.* One molecule of sodium chloride has 1 atom of sodium and 1 atom of chlorine. Altogether one molecule of salt contains 2 atoms.

Example #2

What do you do if *both* valence *numbers* (not the signs) are the same? This is the case when magnesium and oxygen combine.

$$\mathbf{Mg^{+2}O^{-2}}$$
$$\mathbf{Mg_2O_2} = \mathbf{Mg_2O_2}$$

In some compounds, the numbers are left alone. *But,* not in the compounds you will work with.

If you run across a case like this, cancel out *both* numbers like this: $\mathbf{Mg_2O_2}$.

The formula, then is **MgO**.

WRITING FORMULAS

Work these out by yourself. It's easy! Just do one step at a time.

Example A

Calcium (Ca) links up with iodine (I) to form a compound called *calcium iodide.*

- The valence of calcium is +2 (Ca^{+2}).
- The valence of iodine is −1 (I^{-1}).

1. Write down each element and its valence. (Remember, the + valence comes first.) **1.**

2. Cross over the signs. **2.**

3. Cancel out numbers. (Skip if not needed.) **3.**

4. Write the formula. **4.**

5. What is the *name* of this compound? _____

6. One molecule of calcium iodide has _____ atom(s) of calcium and _____ atom(s) of iodine.

7. Altogether, how many atoms does one molecule of calcium iodide have? _____

Example B

Gold and sulfur combine to form the compound *gold sulfide.*

- The valence of gold is +1 (Au^{+1}).
- The valence of sulfur is −2 (S^{-2}).

8. Write down each element and its valence. **8.**

9. Cross over signs. **9.**

10. Cancel out numbers. (Skip if not needed.) **10.**

11. Write the formula. **11.**

12. What is the name of this compound? _____

13. One molecule of gold sulfide has _____ atom(s) of gold and _____ atom(s) of sulfur.

14. Altogether, how many atoms does one molecule of gold sulfide have? _____

Example C

Iron (Fe) and oxygen (O) form a compound called *iron oxide*. You call it *rust*.

- The valence of iron in this compound is +3. (Fe^{+3}).
- The valence of oxygen is −2 (O^{-2}).

15. Write down each element and its valence. **15.**

16. Cross over signs. **16.**

17. Cancel out numbers. (Skip if not needed.) **17.**

18. Write the formula. **18.**

19. **a)** What is the *chemical* name of this compound? _____

b) What is its *common* name? _____

20. One molecule of iron oxide has _____ atom(s) of iron, and _____ atom(s) of oxygen.

21. Altogether, how many atoms does one atom of iron oxide have? _____

FILL IN THE CHART

Write the correct formulas in the spaces below. Three formulas have been written for you.

		NONMETALS				
		Cl^{-1}	S^{-2}	O^{-2}	I^{-1}	Br^{-1}
METALS	H^{+1}	1. ***HCl***	2.	3. ***H_2O***	4.	5.
	Al^{+3}	6.	7.	8.	9. ***AlI_3***	10.
	Ca^{+2}	11.	12.	13.	14.	15.
	Cu^{+1}	16.	17.	18.	19.	20.
	Mg^{+2}	21.	22.	23.	24.	25.
	Na^{+1}	26.	27.	28.	29.	30.

REACHING OUT

Valence can help you to find a formula. It goes the other way too.

A FORMULA CAN HELP YOU FIND THE VALENCES OF THE ELEMENTS IN A COMPOUND.

Example: NiI_2 is the formula for nickel iodide. The formula tells us that:

- The valence of nickel is +2. (Remember, the metal always goes first—and a metal has a positive (+) valence.)
- The valence of iodine is −1.

Six compounds are listed below. Figure out the valence of the elements in each compound. The first one has been done for you.

	Formula	Atoms and Their Valences	
1.	CaF_2	Ca^{+2}	F^{-1}
2.	KBr		
3.	Mg_3N_2		
4.	CCl_4		
5.	H_2S		
6.	$FeCl_3$		

SPELL THE MISSING WORD

Fill in the missing letters to spell the terms that fit the definitions.

When you have answered correctly, you will spell another term in the box.

1.		v		l		n		e
2.		e		a			
3.		l		s			
4.				i		u	

1. the number of electrons an atom lends or borrows
2. elements that lend electrons
3. *not* gain
4. opposite of plus