AIM 7 | What is valence?

Atoms of metals link up with atoms of nonmetals. They form compounds. When a compound forms, the metal lends outer-ring electrons to the nonmetal. The nonmetal borrows the electrons.

How many electrons does an atom lend or borrow? It depends upon the atom. It also depends upon the compound being formed. Some atoms give up or take on more electrons than others. The number of electrons an atom can lend or borrow is called its *valence*.

A valence is a number with a plus (+) or minus (−) sign in front of it. The valence is written next to the atom it describes, such as Al^{+3}, Mg^{+2}, Br^{-1}, and Se^{-2}.

The *sign* (+ or −) tells us whether the atom lends or borrows electrons.

> A plus (+) sign means that the atom *lends* electrons.
>
> A minus (−) sign means that the atom *borrows* electrons.

The *number* tells us *how many* electrons the atom lends or borrows.

Let's look at two valences.

- Sodium has a valence of +1 (Na^{+1}). This means that sodium can *lend one electron.*
- The valence of oxygen is −2 (O^{-2}). Oxygen can *borrow two electrons.*

Metals have *plus* valences. Metals *lend* electrons.

Nonmetals have *minus* valences. Nonmetals *borrow* electrons.

A nonmetal will borrow enough electrons to complete its outer shell.

Many elements have more than one valence. In fact, some elements have both plus *and* minus valences. Sometimes they lend electrons. Sometimes they borrow.

USING THE PERIODIC TABLE TO FIND VALENCE

You can find the valence of many elements by looking at the Periodic Table (pages 168–169).

Finding the Valence of a Metal

This is the simplest valence to find. In many cases, the valence of a metal is the same as the number of electrons in its outer shell.

A metal *lends* (loses) electrons. Therefore, its valence is *plus* (+).

Figure A shows an example.

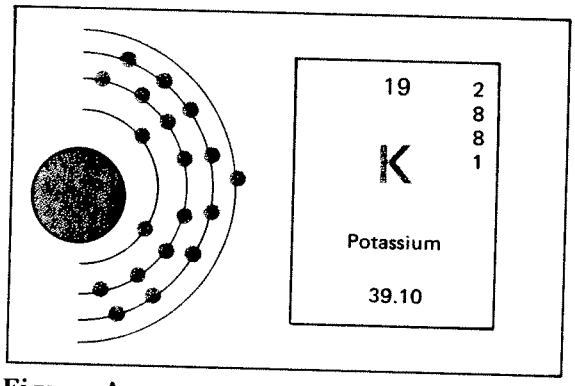

Figure A

Potassium has *1* outer-shell electron.

Potassium lends this single electron.

The valence of potassium is +1 (K^{+1}).

Finding the Valence of a Nonmetal

This is simple too. Here is what to do:

- Check the number of electrons in the outer shell.
- Figure out how many electrons that atom needs to make a complete outer shell (8 electrons). *That* number is the valence number.

A nonmetal will add (borrow) these electrons. Therefore, its valence is minus (−).

Figure B shows an example.

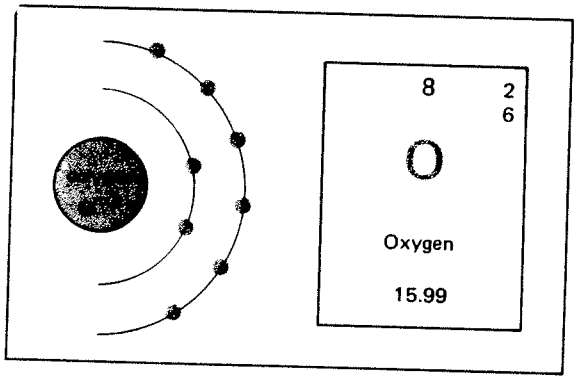

Figure B

Oxygen has 6 outer-shell electrons.

Oxygen needs 2 more electrons to fill its outer shell (8 − 6 = 2).

Oxygen will borrow (gain) these 2 electrons.

The valence of oxygen is $^{-2}$ (O^{-2}).

Now try these yourself

Figure C

1. How many outer-shell electrons does beryllium have? _____

2. Beryllium is a _____ (metal, nonmetal).

3. Beryllium _____ (lends, borrows) electrons.

4. How many electrons can beryllium lend? _____

5. What is the valence of beryllium? _____

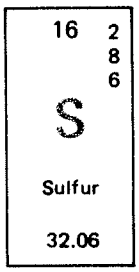

Figure D

6. **a)** How many outer-shell electrons does sulfur have? _____

   b) Is this a full shell? _____

   c) How many electrons are needed to make a full shell?

   _____

7. Sulfur is a _____ (metal, nonmetal).

8. Sulfur _____ (lends, borrows) electrons.

9. How many electrons can sulfur borrow? _____

10. What is the valence of sulfur? _____

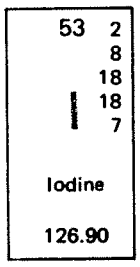

Figure E

11. **a)** How many outer-shell electrons does iodine have? _____

    b) Is this a full shell? _____

    c) How many electrons will make it a full shell? _____

12. Iodine is a _____ (metal, nonmetal).

13. Iodine _____ (loses, gains) electrons.

14. How many electrons can iodine gain? _____

15. What is the valence of iodine? _____

COMPLETING SENTENCES

Complete the sentences with the choices below.

lend	lends or borrows	number
more than one	borrow	outer shell
how many	loses	compounds
eight	+ or − sign	gains
valence		

1. Metals link up with nonmetals to form _____.
2. When forming compounds, metals _____ electrons. Nonmetals _____ electrons.
3. The ability of an atom to lend or borrow electrons is called its _____.
4. A valence is written as a _____ followed by a _____.
5. The *number* tells us _____ electrons an atom gains or loses.
6. The *sign* tells us whether the atom _____ electrons.
7. An atom with a plus (+) valence lends electrons. Another way of saying that is: An atom with a plus valence _____ electrons.
8. An atom with a minus (−) valence borrows electrons. Another way of saying this is: An atom with a minus valence _____ electrons.
9. A nonmetal will borrow enough electrons to complete its _____. A complete outer shell usually has _____ electrons.
10. Many elements have _____ valence.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

1. _____	compound	a)	an atom's combining ability
2. _____	a total of 8 outer-shell electrons	b)	lends electrons
3. _____	valence	c)	at least one metal and one nonmetal
4. _____	+ valence atom	d)	borrows electrons
5. _____	− valence atom	e)	needed to form a compound

WORKING WITH VALENCES

Ten elements and their valences are listed below. Study each one. Then fill in the chart. The first line has been filled in for you.

	Element	Symbol and valence number	Metal or nonmetal	Lends or borrow electrons?	Lends or borrows how many electrons?
1.	Oxygen	O^{-2}	***Nonmetal***	***borrows***	***2***
2.	Calcium	Ca^{+2}			
3.	Aluminum	Al^{+3}			
4.	Bromine	Br^{-1}			
5.	Nitrogen	N^{-3}			
6.	Zinc	Zn^{+2}			
7.	Lithium	Li^{+1}			
8.	Sulfur	S^{-2}			
9.	Phosphorus	P^{-3}			
10.	Silver	Ag^{+1}			

TRUE OR FALSE

Write T on the line next to the number if the sentence is true
Write F if the sentence is false.

1. _____ Valence is the number of electrons an atom has.
2. _____ Every element has the same valence.
3. _____ Some elements have more than one valence.
4. _____ An atom with a plus (+) valence lends electrons.
5. _____ An atom with a minus (−) valence borrows electrons.
6. _____ An atom with a +2 valence can borrow two electrons.
7. _____ An atom with a valence of +2 can lend two electrons.
8. _____ An atom with 6 outer-ring electrons can lend 3 electrons.
9. _____ An atom with 7 outer-ring electrons has a valence of −1.
10. _____ An atom with 7 outer-ring electrons can borrow 1 electron.