Valence Electrons

Video Workbook with Dr. B

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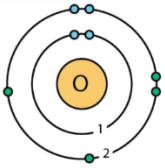
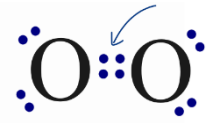
Valence electrons are the electrons in the highest energy level of an atom and *the ones that are involved in chemical bonding*.

You can think of valence electrons being in the outer shell around the nucleus of an atom.

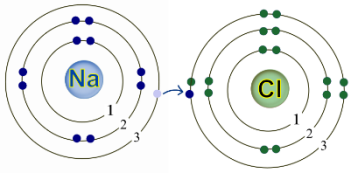


For example, Oxygen (O) is in Group 16 (6A) and has 6 valence electrons in its highest energy level.

Atoms either **share** or **transfer** valence electrons to form chemical bonds.



The O atoms are **sharing** four valence electrons in a **covalent/molecular bond**.

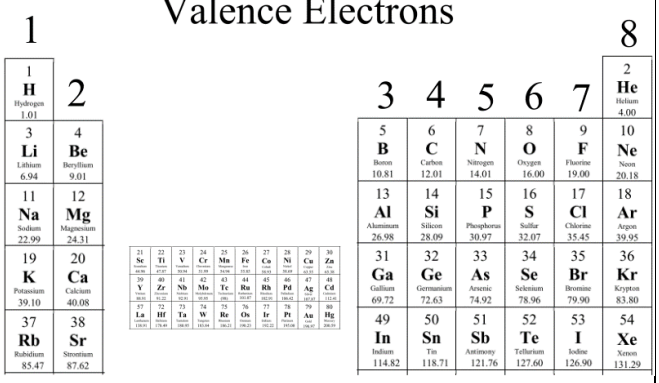


Na **transferred** its one valence electron to Chlorine to form an **ionic bond**.

On the Periodic Table you can find the number of valence electrons based on the Group Number.

Group (column)	Valence Electrons
1	1
2	2
13 (3A)	3
14 (4A)	4
15 (5A)	5
16 (6A)	6
17 (7A)	7
18 (8A)	8

Valence Electrons



[Finding Number of Valence Electrons]

Note: Helium (He) is an exception with 2 valence e⁻.

Practice

How many valence electrons?

H	C
O	Ca
F	He
Al	Ne

Answers

H = 1, C = 4
O = 6, Ca = 2
F = 7, He = 2
Al = 3, Ne = 8

Number of Valence Electrons for Molecules

We can find the number of valence electrons for a molecule by adding the valence electrons for each element.

For example, for H_2O:

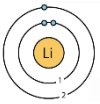
$H_2 = 2(1) = 2$
$O = 1(6) = 6$

So H_2O has a total of 8 valence electrons.

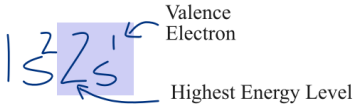
[Valence Electrons for Molecules]

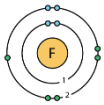
Electron Configurations & Valence Electrons

We can find the number of valence electrons by writing the electron configuration for an atom.

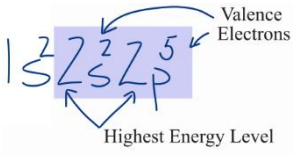


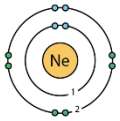
Lithium (Li) has only one valence electron.



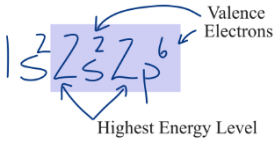


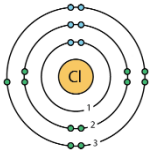
Fluorine (F) has seven valence electrons.



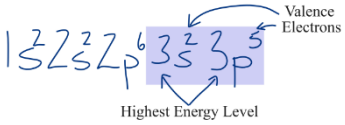


Neon (Ne) has eight and its highest energy level is full. It is a Nobel gas.



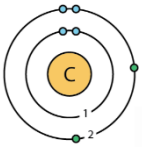


Chlorine (Cl) has seven valence electrons.



Practice

1. Based on the Bohr diagram, how many valence electrons does Carbon (C) have?



2. Based on the electron configuration, how many valence electrons does Sulfur (S) have?

$1s^2 2s^2 2p^6 3s^2 3p^4$

3. Write the electron configuration for Beryllium (it has one more valence electron than Lithium). How many valence electrons does Be have?

Li: $1s^2 2s^1$

4. Why are valence electrons the ones involved in forming chemical bonds?

5. Based on the number of valence electrons, how would Calcium and Chlorine bond to form $CaCl_2$?

Answers:

1. Four. They are the ones in the highest energy level (second energy level).
2. Six. They are the ones in the highest energy level (third energy level).
3. $1s^2 2s^2$. So there are two in the highest energy level (second energy level).
4. Because they are on the outside of the atom and come in contact with other atoms first.
5. See video explanation.

Transition Metals & Valence Electrons

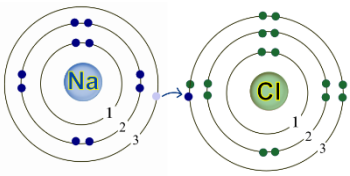
Determining the number of valence electrons for transition metals is more difficult because:

- In most elements valence electrons are in s and p orbitals. But transition metals there are also *d orbitals*, which can make it more difficult.
- Variability in oxidation states (e.g. Fe^{2+} vs Fe^{3+}).
- More complex electron configurations including partial filling of *d orbitals*.

For more help see:

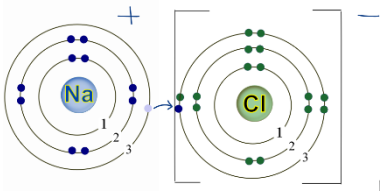
Valence Electrons for Transition Metals

Valence Electrons & Ionic Charge



Atoms will often lose or gain valence electrons and become ions.

Sodium (Na) lost an electron. The second energy level is now the highest and has an Octet. Sodium in now the Sodium ion (Na^+) a has a positive charge.



Chlorine gained an electron and now has eight in its highest energy level. This is called an Octet and is very stable. Chlorine is now the Chloride ion (Cl^-) and is negative.

Valence Electrons & Ionic Charge

Key Terms

A **valence electron** is an electron in the highest energy level or an atom.

A **chemical bond** forms when valence electrons are transferred (ionic) or shared (molecular) between atoms.

Bonds are formed to fill atoms' highest energy level (often called an **Octet**). Noble gases have octets.

Ionic Bond—a strong bond between a metal cation (positive ions) and non-metal anion (negative ions).

Ion—atoms that have a charge (+ or -).
Lost electron = **+** charge = cation.
Gained electron = **-** charge = anion.

Molecular (Covalent) Bond—a semi-strong bond between two non-metals.

If your time is extremely limited, watch these videos and do the practice problems:

Counting Valence Electrons: https://youtu.be/VBp7mKdcrDk
Lewis Structures Made Simple: https://youtu.be/1ZlnzyHahvo
More Lewis Structures Practice: https://youtu.be/DQclmBeIKTc
The Octet Rule: https://youtu.be/6Ecr7m-0E0E
Exceptions to the Octet Rule: https://youtu.be/Dkj-SMBLQzM
Lewis Structures for Ionic Compounds: https://youtu.be/2urppjeSfgA

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