ANEXO NASVILLE SCHOOL

CHEMISTRY 10th GRADE **MRSFIGUEROA**

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In chemistry, a **valence electron** is an outer shell electron that is associated with an atom, and that can participate in the formation of a chemical bond if the outer shell is not closed; in a single covalent bond, both atoms in the bond contribute one valence electron in order to form a shared pair. The presence of valence electrons can determine the element's chemical properties, such as its valence—whether it may bond with other elements and, if so, how readily and with how many. For a main group element, a valence electron can exist only in the outermost electron shell; in a transition metal, a valence electron can also be in an inner shell.

An atom with a closed shell of valence electrons (corresponding to an electron configuration s^2p^6) tends to be chemically inert. Atoms with one or two more valence electrons than are needed for a "closed" shell are highly reactive due to the following reasons:
1) It requires relatively low energy (compared to the lattice enthalpy) to remove the extra valence electrons to form a positive ion.
2) Because of their tendency either to gain the missing valence electrons (thereby forming a negative ion), or to share valence electrons (thereby forming a covalent bond).

Similar to an electron in an inner shell, a valence electron has the ability to absorb or release energy in the form of a photon. An energy gain can trigger an electron to move (jump) to an outer shell; this is known as atomic excitation. Or the electron can even break free from its associated atom's valence shell; this is ionization to form a positive ion. When an electron loses energy (thereby causing a photon to be emitted), then it can move to an inner shell which is not fully occupied.

The number of the valence electrons

The number of valence electrons of an element can be determined by the periodic table group (vertical column) in which the element is categorized. With the exception of groups 3–12 (the transition metals), the units digit of the group number identifies how many valence electrons are associated with a neutral atom of an element listed under that particular column.

Periodic table group	Valence electrons
Group 1 (I) (alkali metals)	1
Group 2 (II) (alkaline earth metals)	2
Groups 3-12 (transition metals)	3–12*
Group 13 (III) (boron group)	3
Group 14 (IV) (carbon group)	4
Group 15 (V) (pnictogens or nitrogen group)	5
Group 16 (VI) (chalcogens or oxygen group)	6
Group 17 (VII) (halogens)	7
Group 18 (VIII or 0) (noble gases)	8**

Electrical conductivity

Valence electrons are also responsible for the electrical conductivity of an element; as a result, an element may be classified as a metal, a nonmetal, or a semiconductor (or metalloid).

Metallic elements generally have high electrical conductivity when in the solid state. In each row of the periodic table, the metals occur to the left of the nonmetals, and thus a metal has fewer possible valence electrons than a nonmetal. However, a valence electron of a metal atom has a small ionization energy, and in the solid state this valence electron is relatively free to leave one atom in order to associate with another nearby. Such a "free" electron can be moved under the influence of an electric field, and its motion constitutes an electric current; it is responsible for the electrical conductivity of the metal. Copper, aluminium, silver, and gold are examples of good conductors.

A nonmetallic element has low electrical conductivity; it acts as an insulator. Such an element is found toward the right of the periodic table, and it has a valence shell that is at least half full (the exception is boron). Its ionization energy is large; an electron cannot leave an atom easily when an electric field is applied, and thus such an element can conduct only very small electric currents. Examples of solid elemental insulators are diamond (an allotrope of carbon) and sulfur.

A solid compound containing metals can also be an insulator if the valence electrons of the metal atoms are used to form ionic bonds. For example, although elemental sodium is a metal, solid sodium chloride is an insulator, because the valence electron of sodium is transferred to chlorine to form an ionic bond, and thus that electron cannot be moved easily.

A semiconductor has an electrical conductivity that is intermediate between that of a metal and that of a nonmetal; a semiconductor also differs from a metal in that a semiconductor's conductivity increases with temperature. The typical elemental semiconductors are silicon and germanium, each atom of which has four valence electrons. The properties of semiconductors are best explained using band theory, as a consequence of a small energy gap between a valence band (which contains the valence electrons at absolute zero) and a conduction band (to which valence electrons are excited by thermal energy).

THE OCTET RULE: The octet rule states that elements gain or lose electrons to attain an electron configuration of the nearest noble gas. Here is an explanation of how that works and why elements follow the octet rule.

Noble gases have complete outer electron shells, which make them very stable. Other elements also seek stability, which governs their reactivity and bonding behavior. Halogens are one electron away from filled energy levels, so they are very reactive.

Chlorine, for example, has seven electrons in its outer electron shell. Chlorine readily bonds with other elements so that it can have a filled energy level, like argon. +328.8 kJ per mole of chlorine atoms are released when chlorine acquires a single electron. In contrast, energy would be required to add a second electron to a chlorine atom.

From a thermodynamic standpoint, chlorine is most likely to participate in reactions where each atom gains a single electron. The other reactions are possible, but less favorable. The octet rule is an informal measure of how favorable a chemical bond is between atoms.

WHY DO ELEMENTS FOLLOW THE OCTET RULE? Atoms follow the octet rule because they always seek the most stable electron configuration. Following the octet rule results in completely filled s- and p- orbitals in an atom's outermost energy level. Low atomic weight elements (the first twenty elements) are most likely to adhere to the octet rule.

LEWIS ELECTRON DOT DIAGRAMS

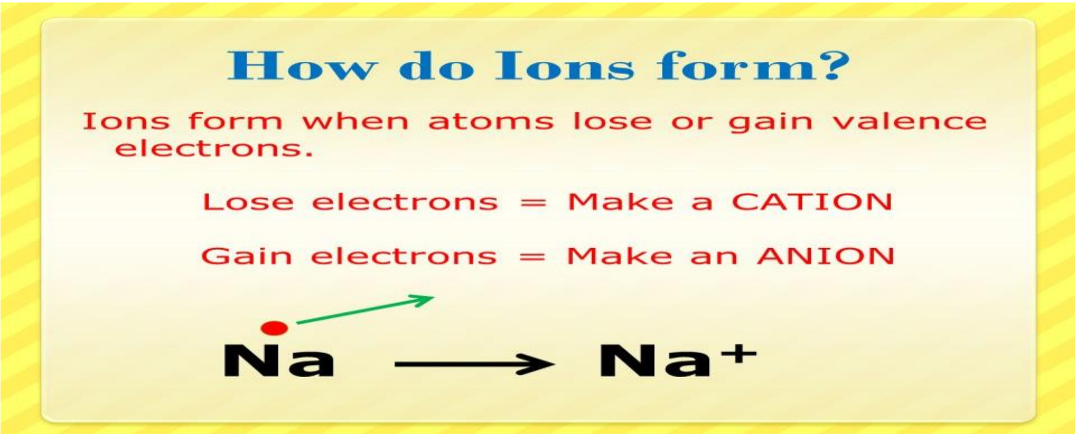
Lewis electron dot diagrams may be drawn to help account for the electrons participating in a chemical bond between elements. A Lewis diagram counts the valence electrons. Electrons shared in a covalent bond are counted twice. For the octet rule, there should be eight electrons accounted for around each atom.

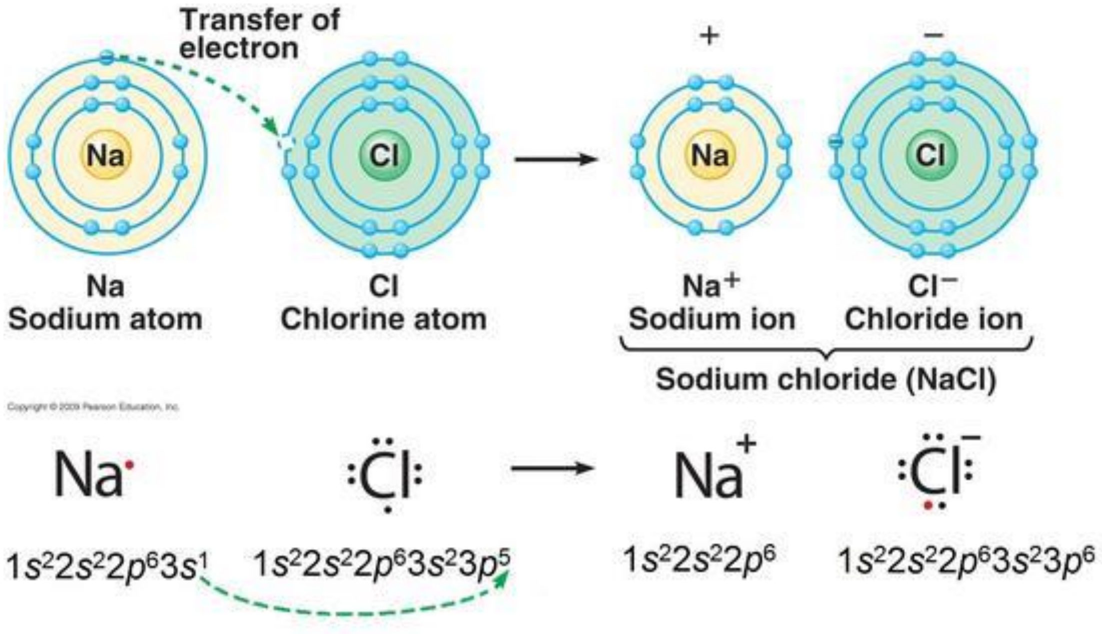
POSITIVE AND NEGATIVE IONS: CATIONS AND ANIONS

Cations (positively-charged ions) and *anions* (negatively-charged ions) are formed when a metal loses electrons, and a nonmetal gains those electrons. The electrostatic attraction between the positives and negatives brings the particles together and creates an ionic compound, such as sodium chloride.

- The alkali metals (the IA elements) lose a single electron to form a cation with a 1+ charge.
- The alkaline earth metals (IIA elements) lose two electrons to form a 2+ cation.
- Aluminum, a member of the IIIA family, loses three electrons to form a 3+ cation.
- The halogens (VIIA elements) all have seven valence electrons. All the halogens gain a single electron to fill their valence energy level. And all of them form an anion with a single negative charge.
- The VIA elements gain two electrons to form anions with a 2- charge.
- The VA elements gain three electrons to form anions with a 3- charge.

The first table hows the family, element, and ion name for some common monoatomic (one atom) cations. The second table gives the same information for some common monoatomic anions.



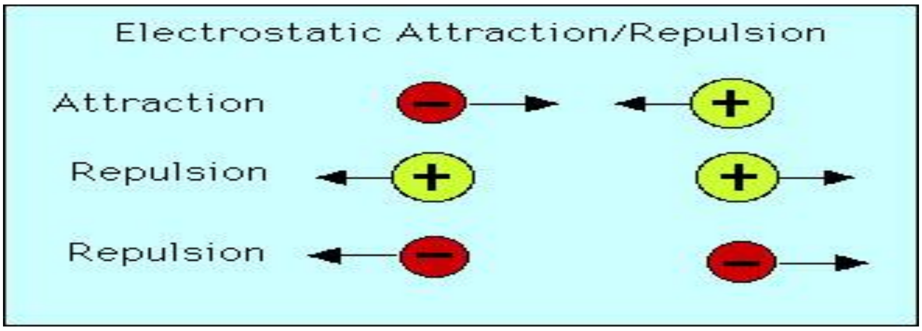


Formation of ionic compounds

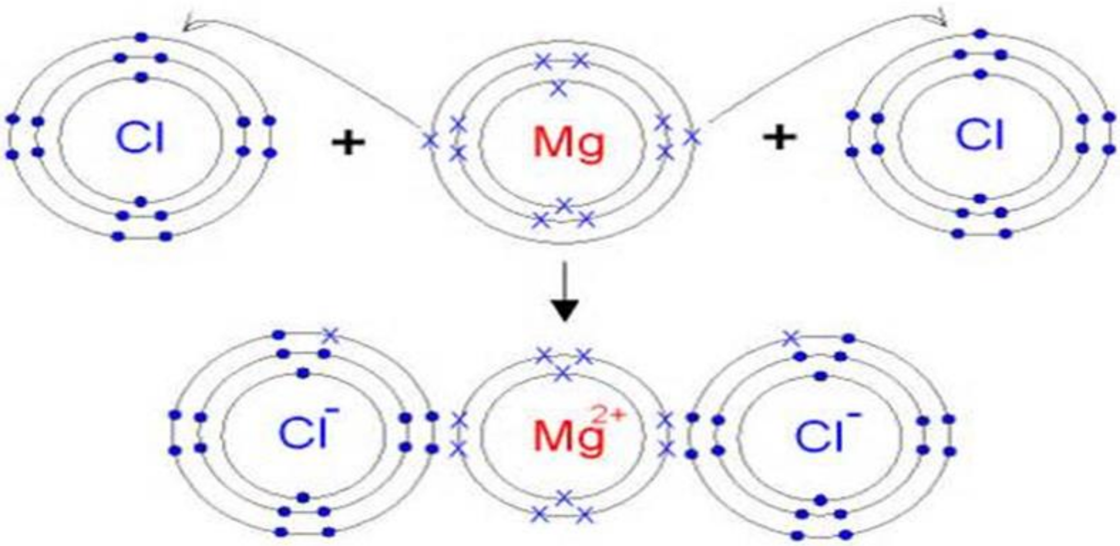
Most of the rocks and minerals that surround us are made of ions held together through ionic bonding, the electrical attraction between oppositely charged ions. Look closely at a crystal of salt. What does it look like? Look even closer. You know that table salt is composed of Na+ and Cl-, which combine with ionic bonds to make NaCl. But, do you see NaCl? No. You see Na and Cl all in a neat lattice structure.

Remember the Lewis dot structure for both Na and Cl. They are both originally neutral with their one and seven valence electrons respectively. The sodium, which is a metal, will easily lose that electron to become a positively charged cation. Chlorine, a non-metal, will happily gain one electron to become negatively charged. The sodium transfers its electron to chlorine, which makes both of them happy.

This is an example of an ionic compound. An **ionic compound** is a compound held together by ionic bonds. Examples of ionic compounds include pyrite, FeS2. Remember that an ionic bond is formed through the transfer of electrons. These compounds are usually formed between metals and non-metals. The ratio of cations to anions is always in a way that there is no net charge. What happens is the positively charged metal cation forms a bond with a negatively charged non-metal anion. This bond is electrically neutral and strong, but its strength varies depending on something called the lattice energy.

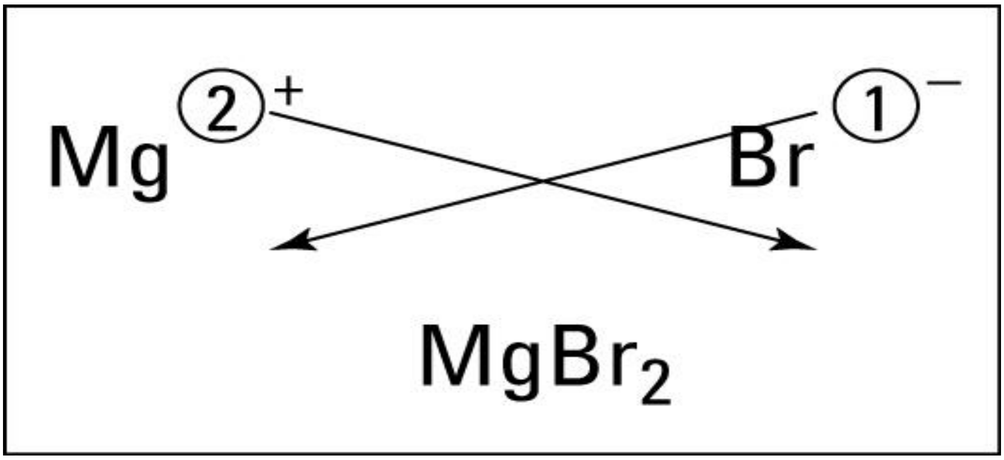


Magnesium atom has two electrons in its outermost shell. By losing two electrons from its M shell its L shell becomes the outermost shell which has a stable octet. The nucleus of this magnesium atom still has twelve protons but the number of electrons has decreased to ten. So, a net positive charge is developed on this magnesium atom, giving a magnesium cation Mg^{2+}. On the other hand, chlorine atom has seven electrons in its outermost shell. Therefore, it needs only one electron to complete its octet. It can gain this one electron from the electrons lost by magnesium atom to become magnesium ion. As two electrons are lost by magnesium atom while one chlorine atom can gain only one electron, two atoms of chlorine combine with one atom of magnesium to form magnesium chloride.



Chemical formula: A **chemical formula** is a way of expressing information about the proportions of atoms that constitute a particular chemical compound or molecule, using a single line of chemical element symbols, numbers, and sometimes also other symbols, such as parentheses, dashes, brackets, commas and *plus* (+) and *minus* (−) signs. These are limited to a single typographic line of symbols, which may include subscripts and superscripts. A chemical formula is not a chemical name, and it contains no words. Although a chemical formula may imply certain simple chemical structures, it is not the same as a full chemical structural formula. Chemical formulas can fully specify the structure of only the simplest of molecules and chemical substances, and are generally more limited in power than are chemical names and structural formulas.

To write the formula for ionic compound, write the symbol of the positive ion and then the symbol of the negative ion. Add the subscripts that are needed to balance the charges. If no subscript is written, it is understood that the subscript is 1. The formula NaCl tells you that there is a 1-to-1 ratio of sodium ions to chlorine ions.



For ionic compounds, the name of the positive ion comes first, followed by the name of negative ion.

Exercise

Solve this exercise, usin the periodic table.

a. **Name of the each element**
b. **Valence electrons of each element**
c. **Electron dot diagram**
d. **Ionic form (lose or gain of electrons)**
e. **The new compound formed**

- Write out the Ionic Notation, Formula and Names of the following ionic compounds:
  - Li and F
  - Na and S
  - K and Br
  - Rb and O
  - Ca and Cl
  - Mg and SO_3^{-2}
  - Al and NO_3^{-1}
  - Na and CO_3^{-2}
  - Li and OH^{-1}
  - NH_4^{+1} and Cl
  - Ca and SO_4^{-2}
  - NH_4^{+1} and OH^{-1}
  - Na and CN^{-1}
  - NH_4^{+1} and SO_4^{-2}