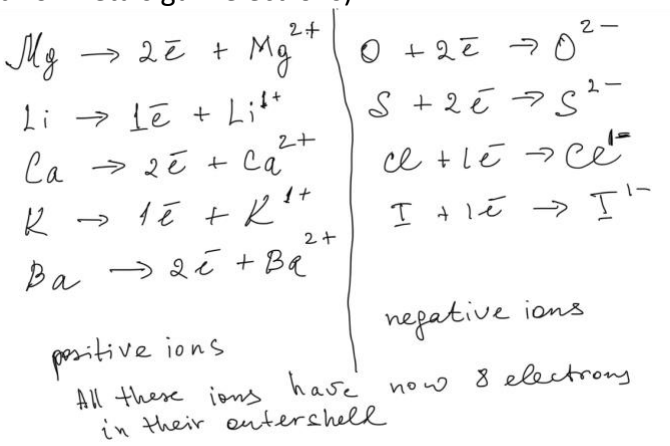
HW 8

Ionic bond. Ionic compounds. Generally, when metal and non-metal elements form a bond, they form ionic compounds. When a metal transfers one or more electrons to a nonmetal, they form an ionic bond.

Natural ion examples (on the left metal elements lose electrons, on the right nonmetals gain electrons):

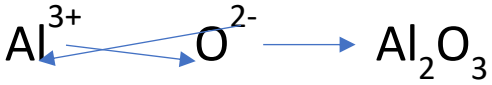


This is how we can work out the formulas of ionic compounds:

We can figure out the number of electrons lost and gained by atoms, based on their electron configuration.

We should consider that the overall charge on the compound is zero, so the ion charges should cancel each other, $Na^{+}Cl^{-}$ (NaCl, sodium chloride), $Ca^{2+}(Cl^{-})_2$ ($CaCl_2$, sodium chloride)

Or we can "switch" over the charges on the ions



In other words:

1. Write the natural ions. For example, magnesium's natural ion is Mg^{2+} and oxygen natural ion is O^{2-}
2. Next, swap the superscripts to make subscripts. If there are any ones (1), do not write them. For example, Mg^{2+} and Cl^{-} combine to form $MgCl_2$, the superscript 2+ from magnesium ion became the subscript 2 for Cl_2, while the superscript "-" from Cl^{-} became the subscript 1 for Mg (remember we do not write 1 in the chemical formulas).
3. Finally, check if your answer can be reduced. For example, we do not write Ca_2O_2, instead we write CaO (calcium oxide).

Remember, the number of valence electrons is the number of electrons in the atom outer shell (highest energy level).

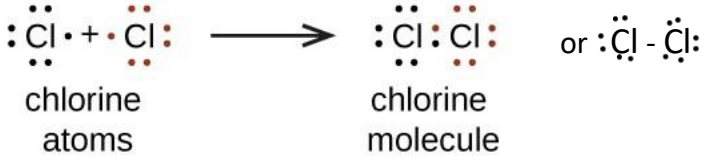
Lewis structures, also known as Lewis dot diagrams, Lewis dot formulas, electron dot structures, or Lewis electron dot structures (LEDS), are diagrams that represent the bonding between atoms within a molecule, focusing exclusively on outer (valence) shell electrons. Originally Lewis structures were invented to demonstrate covalent bonds.

A covalent bond is a type of chemical bond formed when two atoms share one or more pairs of electrons between them. Atoms form covalent bonds to achieve a more stable configuration (usually to fill their outmost electron shell, they "want" to have 8 electrons there). Covalent bonds typically occur between nonmetal atoms. Compounds can have single bond - one pair of electrons is shared, e.g. H-H in hydrogen gas (H_2); double bond – two pairs of electrons are shared, O=O in oxygen gas (O_2); triple bond – three pairs of electrons are shared, e.g. N≡N in nitrogen gas (N_2). H_2, O_2, N_2 – chemical formulas for the compounds, number 2 shows the number of elements in the compounds.

Lewis structures show electrons involved in bond formation, which are shared between atoms in covalent bonds, as well as non-bonding (lone) pairs of electrons present in the molecule valence shell.
Let's define some main features of Lewis structures: Atoms are represented by their chemical symbols (H for hydrogen etc.); Valence electrons are shown as dots around the symbols (one dot – one electron); Shared pairs of electrons (bonds) between atoms are shown as two dots or a dash; Unshared (lone) pairs of electrons are shown as pairs of dots on individual atoms.

In other words, in a Lewis structure, each atom is represented by its chemical symbol, with lines drawn between atoms to indicate bonds. (Pairs of dots may also be used to represent bonds instead of lines.) Lone pairs of electrons (valence electrons not involved in a bond formation) are shown as pairs of dots placed next to the relevant atoms.

For example, the Lewis structures for chlorine molecule (Cl_2) is:



or :Cl - Cl:

On the left you see the Lewis structure for Chlorine atoms. On the write you see the Lewis structure for chlorine gas. Note that chlorine outer shell configuration is ... $3s^2 3p^5$. Each atom has 7 valence electrons, it includes 3 pairs of electrons, that are not going to be shared (lone pairs) and 1 electron that will be shared with other atom to form a chemical bond.

Structural formulas show locations of chemical bonds between the atoms of a molecule. They consist of symbols for the atoms connected by short line that represent chemical bonds (each short line represents 2 shared electrons):
Chlorine gas Cl-Cl, hydrogen gas H-H, magnesium chloride Cl-Mg-Cl

When detailed information is not needed chemical formulas are used. In chemical formulas the number on the right of the element symbol shows how many atoms of this element is present in a molecule.
E.g. for Cl-Cl the chemical formula is Cl_2, for Cl-Mg-Cl it is $MgCl_2$

Answer the following questions:

1. Write the Lewis dot structures for the following elements: Potassium, Calcium, Silicon, Selenium, Iodine. Example to start, for hydrogen element the Lewis dot structure will look like H ·
2. Write the Lewis structure for bromine gas (Br_2).
3. Based on the electron configurations of carbon (C, atomic number 6), hydrogen (H, atomic number 1), and the octet rule, write the Lewis formula for a compound containing one carbon atom and four hydrogen atoms. Also, write its structural formula.
4. Indicate whether each of the following bonds is covalent or ionic: H_2O, F_2, Na_2O, CO_2.