

From Atoms to Compounds

Using the atomic model to understand bonding

So far we have studied what kinds of substances our world is made up of. How do we describe the substances that are all around us in the world?

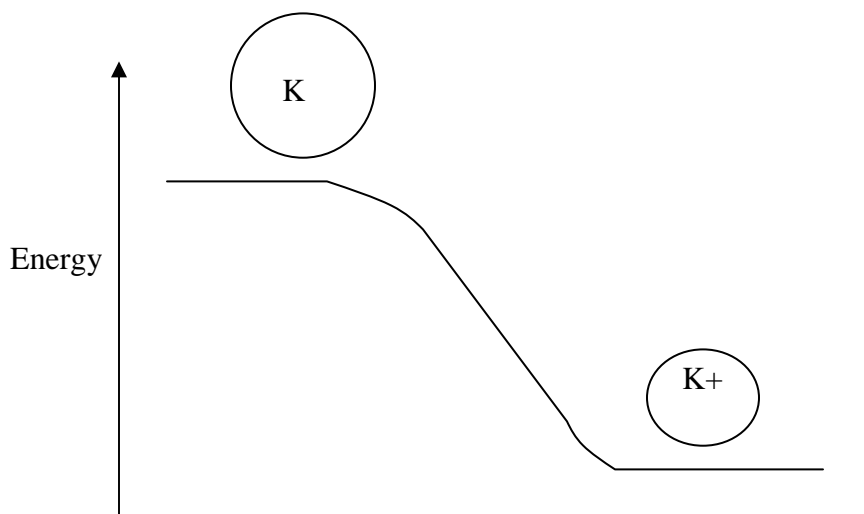
- Classification by properties (Physical and chemical)
- Basic kinds of matter (elements)
 - What makes the elements different?
 - What does matter look like at its smallest form?
 - **quantum mechanical model of the atom**: orbitals

Can we use this model to understand properties?

- The type of bond formed when an element is in the presence of another defines its chemical properties
- We can use type of bond to determine physical properties
- Type of bond comes from atomic structure

Why do substances bond?

- More stability
- Atoms want to achieve a **lower energy state**
- Think of this like potential energy, what is the potential energy of a book to fall off a desk?
 - $PE = mgh$
- Look at potential energy graph
- What is the potential for Potassium to form a potassium ion?



Why do some things form ionic bonds and some for covalent bonds?

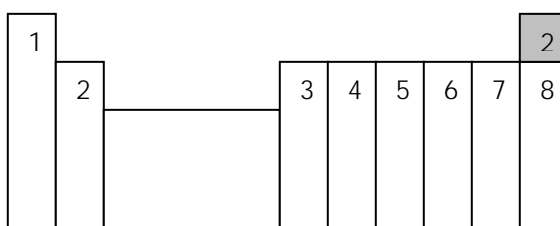
- Because some elements form ions more easily than other elements

What is an ion?

- An atom that has gained or lost an electron
- When an electron is gained or lost the atom is said to have a charge because charge of protons and electrons no longer cancel each other out
 - Example: Fluorine
 - Neutral Fluorine has 7 protons and 7 electrons
 - 7 (+1) charges and 7 (-1) charges
 - Add like integers to get **net charge**: $+7 + -7 = 0$
 - If it gains an electron it now has
 - 7 (+1) charges and 8 (-1) charges
 - Add like integers to get net charge: $+7 + -8 = -1$
 - \therefore , we write: **F⁻¹ or F⁻**
 - Lose electrons = Now positively charged
 - **Cations**, positively charged ions
 - *"Cations are plussy cats."*
 - Gain electrons = Negatively charged
 - **Anions**, negatively charged ions
 - *An has an "n" in it which is the first letter of negative*

Now that we know what ions are...

- Why do some atoms have a + charge and others have a +2 charge?
- Why do some have positive charge and others have negative charge?
 - Amazing rule in chemistry: **OCTET RULE**
 - Atoms gain stability when they have a full octet in their valence shell.
 - Except for Hydrogen and Helium which only need two or zero to be stable.
 - What is an octet?
 - Octet = 8 valence electrons, filled s and p orbitals
 - What is a valence?
 - Valence shell = the outermost energy level that contains electrons
 - Get this from periodic table by looking at the period
 - Valence electrons = the number of electrons in the valence shell
 - For elements other than transition metals, get this from the column number (do not count rows of transition metals)



1. Using periodic table to get valence

Example:

- Hydrogen, Column **1**, valence electrons = **1**
- Sodium, Column **1**, valence electrons = **1**
- Fluorine, Column **7**, valence electrons = **7**
- Argon, Column **8**, valence electrons = **8**

2. Using electron configuration to get Valence state and predict ion formed:

Example 1: Sodium

- Electron config: $1s^2 2s^2 2p^6 3s^1$
- Outer most energy level: 3
- Number of electrons in energy level 3: 1
- Valence electrons: 1
- To have filled octet, needs to lose 1 electron
- Loss of one electron $\rightarrow \text{Na}^+$

Example 2: Fluorine

- Electron config: $1s^2 2s^2 2p^5$
- Outer most energy level: 2
- Number of electrons in energy level 3: 7
- Valence electrons: 7
- To have filled octet, needs to gain 1 electron
- Gain 1 electron $\rightarrow \text{F}^-$

Example 3: Argon

- Electron config: $1s^2 2s^2 2p^6 3s^2 3p^6$
- Outer most energy level: 3
- Number of electrons in energy level 3: 8
- Valence electrons: 8
 - Filled octet!
 - All noble gases have filled octet!
 - This is why they are so unreactive! They do not need to gain or lose electrons to be stable!

3. Using noble gas configuration to get Valence state and predict ion formed:

Example: Sulfur

- Electron config: $[\text{Ne}] 3s^2 3p^4$
- Outer most energy level: 3
- Number of electrons in energy level 3: 6
- Valence electrons: 6
- To have filled octet, needs to gain 2 electrons
- Gain 2 e- $\rightarrow \text{S}^{2-}$