

Atomic bonding and Molecular Structure: How and why atoms combine

Bond formation is EXOTHERMIC

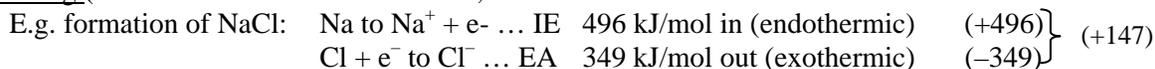
- When atomic-sized particles combine, they release energy and become more stable.
- When a bond between atomic sized particles is broken, they absorb energy and become less stable.

Temperature change can indicate what is happening at the atomic level.

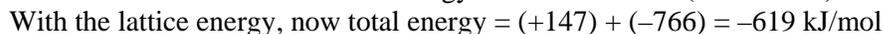
Bond breaking is ENDOTHERMIC

- When the temperature increases: Bond formation > Bond breaking
- When the temperature/energy decreases: Bond breaking > Bond formation

Ionic bonding (involves the transfer of electrons, and thus involves the IE of one atom and the EA of another atom)



“For any stable compound to form from its elements, there must be a net lowering of the energy. In other words energy must be released.” For NaCl to form spontaneously, the total energy must be a negative value (not +147). Thus, some other factor must contribute to the energy equation. That factor is called lattice energy.



Note: loss of another electron from Na coupled with gain by Cl is not favored energetically. Question: how many electrons are gained or lost in a reaction? Answer: when they form ions, atoms of most of the representative elements tend to gain or lose electrons until they have the same configuration as the nearest noble gas.”

7.1

What two types of bonds exist?	Ionic and covalent.
What is an ionic bond.	The bond between a positively charged ion and a negatively charged ion.
What energetic requirement is imposed on the formation of a compound?	For any stable compound to form from its elements, there must be a net lowering of energy (i.e. it must be exothermic).
What are the three (energy) factors that affect the formation of an ionic compound? Which are endothermic, which are exothermic?	Ionization energy (endothermic), electron affinity (exothermic), and lattice energy (exothermic).
How do the IE and EA compare for ionic compounds? What is the importance of this?	Generally the IE of one atom is greater than the EA of the other atom. This means that if these were the only energies involved, that the ionic compound would not form (since overall the reaction would be endothermic). This highlights the importance of the lattice energy.
What is lattice energy?	It is the energy released when negative ions attract positive ions.
Why does it make sense that nonmetals tend to form negative ions?	Because they have high IEs and EAs. Thus, it is energetically unfavorable to remove electrons, and energetically favorable to add electrons.
When representative elements (vs. transition elements) form ions, what is generally true about their electron configurations?	They obtain electron configurations that are identical to the nearest noble gas.
Why do transition elements frequently form ions with a charge of +2?	Because the valence electrons are in the s subshell. The loss of these two electrons results in a +2 charged ion.
Why can transition elements frequently form ions with different charges?	Because the outer s and d subshells are close in energy. Thus, after the loss of the 2 electrons in the s subshell, further losses from the partially filled d shell can occur.

Note (above)

What is true about the energies associated with forming and breaking bonds?	Bond formation releases energy (i.e. it is exothermic). Bond breaking requires the input of energy (i.e. it is endothermic)
When a chemical reaction occurs, what does a change in temperature reveal?	If the temperature increases then the energy released from bond formation is greater than the energy needed for bond breaking. If temperature decreases, than the opposite is true.

8.1 - 8.2

What two names are given to orbitals that contain electrons from different atoms (i.e. the electrons are shared)?	Hybrid orbitals or molecular orbitals.
What happens when electrons become paired in a hybrid orbital?	They must have different spins (-1/2 and 1/2) according to the Pauli Exclusion Principle.
Draw the molecular orbital representation of the combination of H with Cl.	<p>Note that the unfilled orbital in Cl could have been 3px, 3py, or 3pz. The specific 3p orbitals are labeled to indicate where they came from and that they are unaffected by the formation of the molecular/hybrid orbital.</p>