Chemical bonding & structure

Ionic bonding and structure

Covalent bonding

Covalent structures

Intermolecular forces

Metallic bonding

Ms. Thompson - SL Chemistry
Wooster High School

Topic 4.1
Ionic bonding & structure

- Positive ions (cations) form by metals losing valence electrons.
- Negative ions (anions) form by non-metals gaining electrons.
- The number of electrons lost or gained is determined by the electron configuration of the atom.
- The ionic bond is due to electrostatic attraction between oppositely charged ions.
- Under normal conditions, ionic compounds are usually solids with lattice structures.

Ionic bonding & structure

Nature of science

- Use theories to explain natural phenomena - molten ionic compounds conduct electricity but solid ionic compounds do not. The solubility and melting points of ionic compounds can be used to explain observations

Ionic bonding & structure

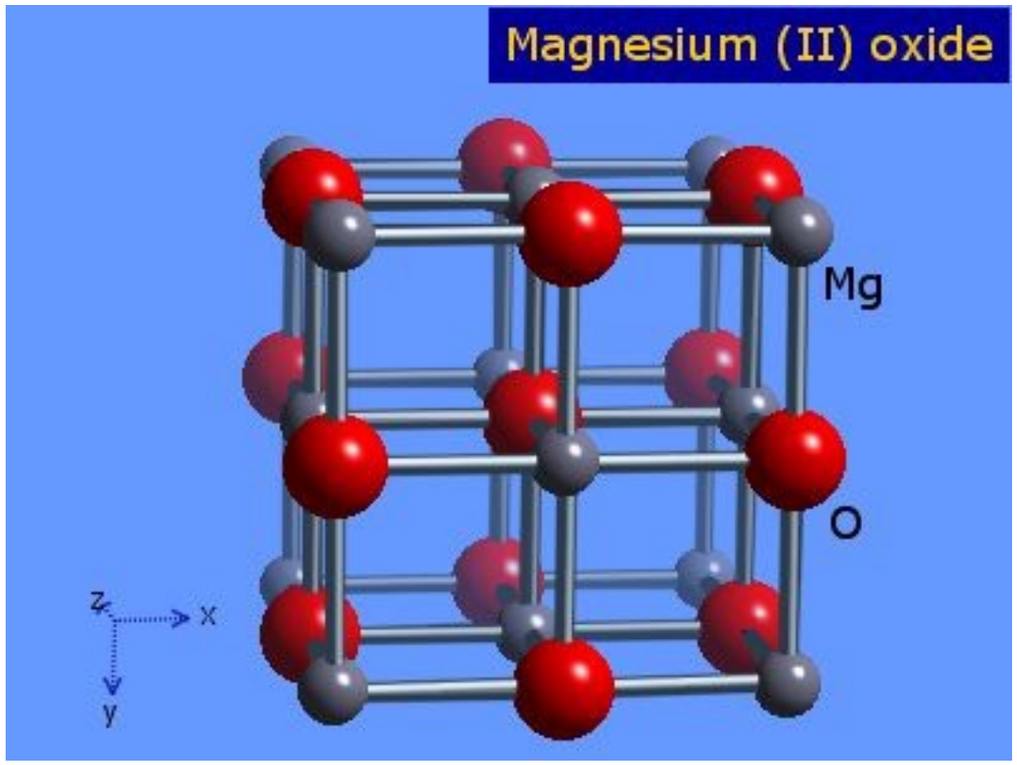
Ionic bonding

- Ions are formed when one or more electrons are transferred from one atom to another. The driving force for this electron transfer is usually the formation of a noble gas electron configuration.
  - Sodium has the configuration [Ne]$3s^1$ and Ne (the noble gas) is at its core.
    - Na has one valence electron - if it loses it, it gains the noble gas configuration: Na - e^- --> Na^+
    - Sodium is said to have been **oxidized** (it loses an electron)
  - Chlorine has the configuration [Ne]$3s^2 3p^5$ and it's much easier to gain the noble gas configuration of [Ar] by gaining one electron.
    - Cl has seven valence electrons and only needs one more to fill its outer energy level: Cl + e^---> Cl^-
    - Chlorine is said to have been **reduced** (it gains an electron)
- Sodium transfers it's one electron to chlorine to form the ionic compound, NaCl (table salt)

Ionic bonding & structure

Ionic bonding

- Occurs between metals and non-metals
- *BUT* Electrostatic attraction between a cation and anion
  - i.e. NH_4Cl is the attraction between the NH_4^+ cation and the Cl^- anion
    - Ionic bond ***but*** it is formed between two non-metals
- Under normal conditions, ionic compounds are solids and have a lattice-type structure that are three-dimensional repeating units of anions and cations.



Ionic bonding & structure

Ionic bonding

- Names of some common ions:

Ion	Name
NH_4^+	ammonium
OH^-	hydroxide
NO_3^-	nitrate
HCO_3^-	hydrogencarbonate
CO_3^{2-}	carbonate
SO_4^{2-}	sulfate
PO_4^{3-}	phosphate

Study Tip:
You should know the names of various ions, their formulas and charges, including some **oxoanions** (oxygen-containing anions)

When describing an ionic compound refrain from using the word 'molecule' and use 'formula units' to indicate that ions are involved in the lattice structure

Ionic bonding & structure

Quick question

Can you think of an example in which the octet rule is not obeyed?

BF_3

SF_6 --> Sulfur hexafluoride

Ionic bonding & structure

The octet rule

- The **octet rule** is a useful starting point in trying to understand how chemical bonds are formed.
- The rules state that elements tend to lose electrons (that is undergo oxidation), gain electrons (reduction) or share electrons in order to acquire a noble gas core electron configuration.
  - The gain or loss of electrons is the basis of ionic bonding.
  - The sharing of electrons is the basis of covalent bonding.

Practice Problem

... We Do ...

Deduce the formula and name of the ionic compounds formed between the following pairs of elements and/or polyatomic species:

a) magnesium and fluorine
b) aluminum and oxygen
c) sodium and oxygen
d) calcium and nitrate
e) ammonium and phosphate

Ionic bonding & structure

Physical properties of ionic compounds

- **Melting and boiling points**
  - Have high boiling and melting points due to strong electrostatic forces of attraction
  - Needs large input of energy to break apart electrostatic forces
- **Electrostatic force of attraction**, *F*, is directly proportional to the interacting charges, Q_1 and Q_2, and inversely proportional to the square of the distance between them, r^2. Known as **Coulomb's law of electrostatics**:

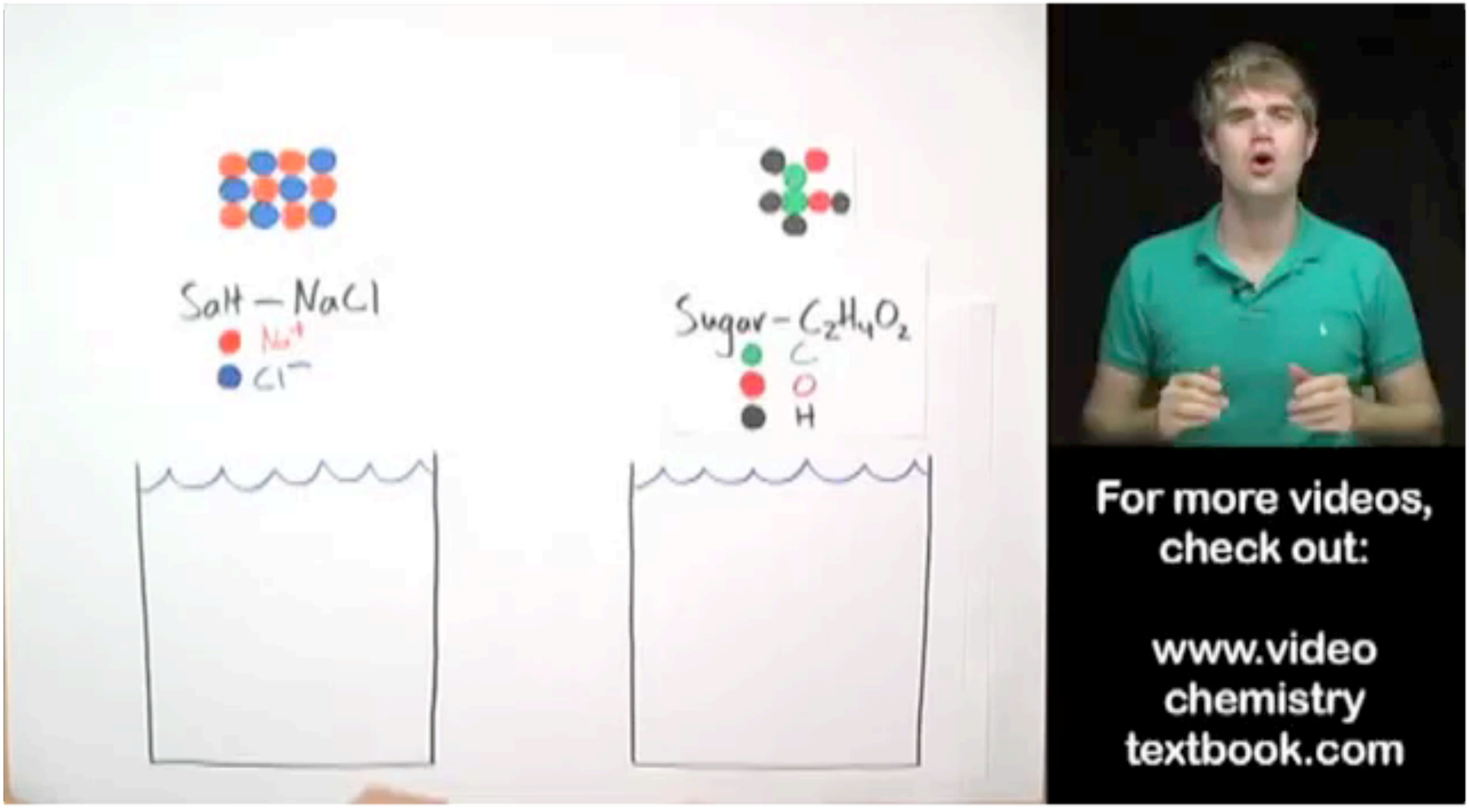
$$F \propto \frac{Q_1 \, Q_2}{r^2}$$

Ionic bonding & structure

Physical properties of ionic compounds

- **Volatility**
  - Tendency for a substance to vaporize. Volatility for ionic compounds is low due to electrostatic forces of attraction are so strong
- **Electrical conductivity**
  - In solid state ions occupy fixed positions so ions are not free to move and therefore do not conduct electricity. However, in their molten state ions are free to move around so they do conduct electricity
- **Solubility**
  - Dissolve in polar solvents such as water but do not dissolve in non-polar solvents such as hexane.

Physical properties of ionic compounds: Solubility



Topic 4.1
Ionic bonding & structure

- ➡Positive ions (cations) form by metals losing valence electrons.
- ➡Negative ions (anions) form by non-metals gaining electrons.
- ➡The number of electrons lost or gained is determined by the electron configuration of the atom.
- ➡The ionic bond is due to electrostatic attraction between oppositely charged ions.
- ➡Under normal conditions, ionic compounds are usually solids with lattice structures.