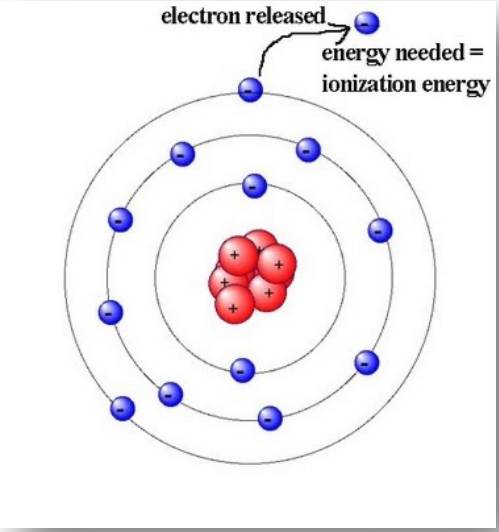
Chapter 3
Chemical Bonds I

Lecture 5



General Chemistry

- **OUTLINE**

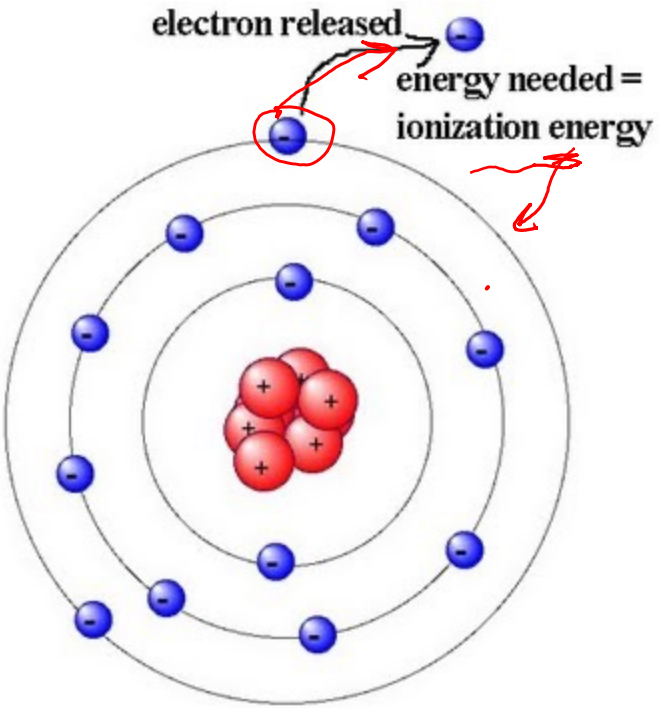
- Octet Rule
- Noble gas Configuration
- Name of cation and anions
- Polyatomic ions
- Forming chemical bonds

Objectives

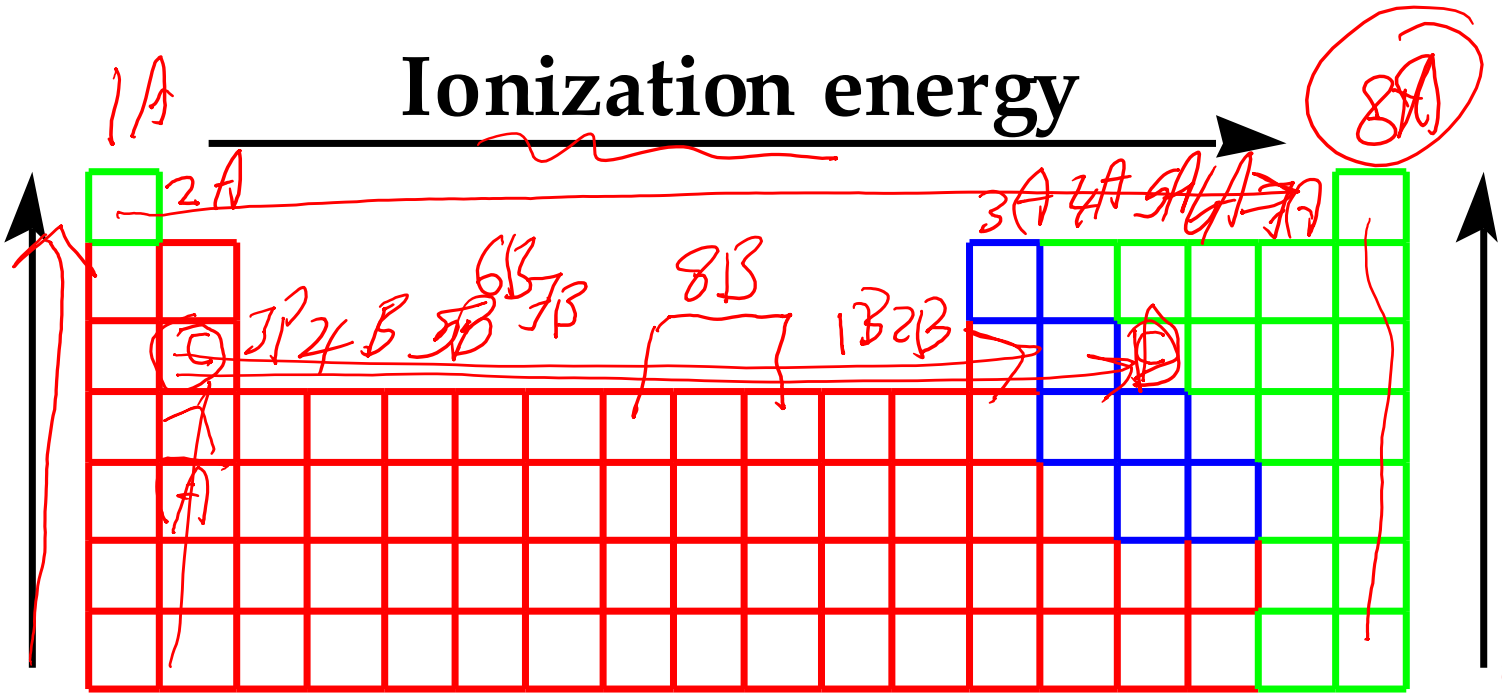
- By the end of this lecture the student should be able to:
- Understand the basic concept of noble gas configuration
- Understand and apply the **Octet Rule**
- Define and distinguish the terms of Anions and Cations

Ionization Energy

Energy required to remove outermost electron (most loosely held)



Ionization Energy

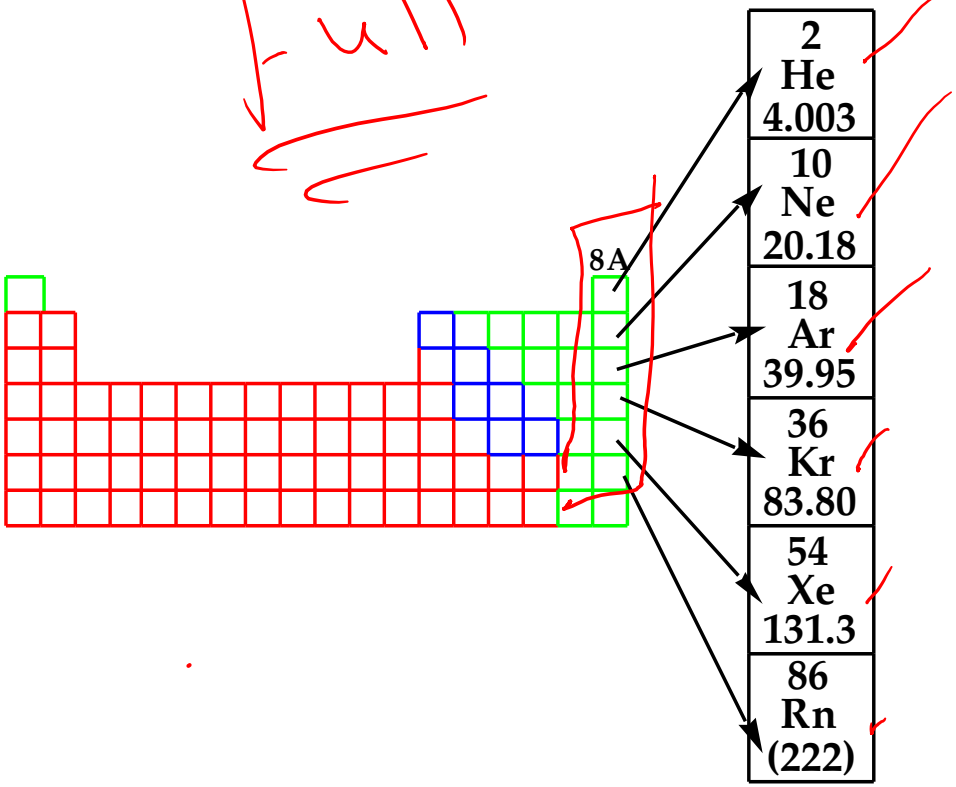


periodic table 2.swf

Noble Gas Configurations

Noble gas configuration s^2p^6 very stable

Noble gas	Noble gas notation
He	$1s^2$
Ne	$[He]2s^2\,2p^6$
Ar	$[Ne]3s^2\,3p^6$
Kr	$[Ar]4s^2\,4p^6$
Xe	$[Kr]5s^2\,5p^6$



The Octet Rule

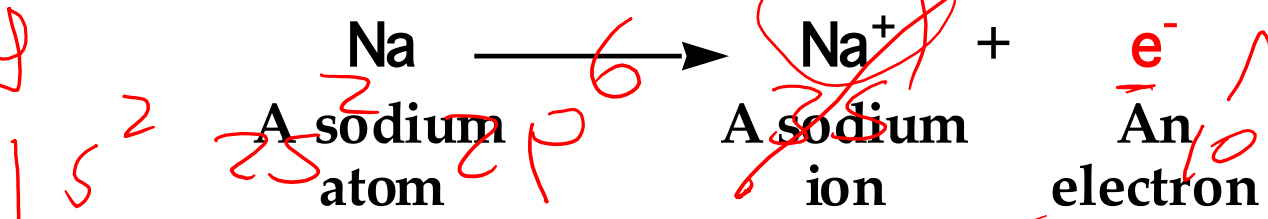
- Octet rule: Group 1A-7A elements to achieve an outer shell of eight valence electrons

- Anion: Negative ion formed when an atom gains electrons

- Cation: Positive ion formed when an atom loses electrons

The Octet Rule—Cations

Cation: Sodium atom loses an electron to form a sodium ion, which has the same electron configuration as neon

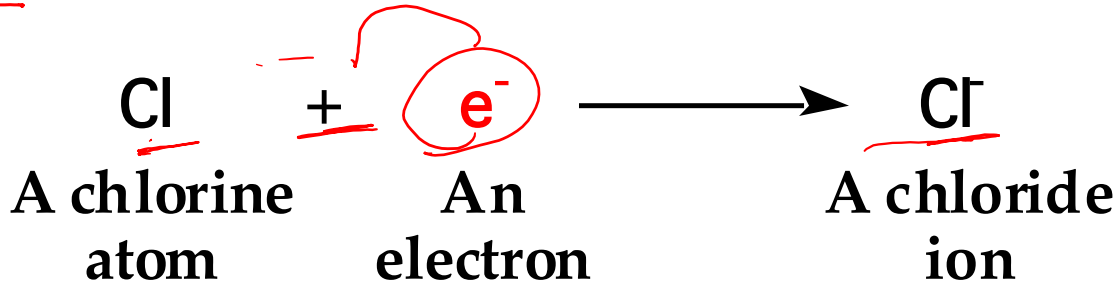


Na (11 electrons): $1s^2\ 2s^2\ 2p^6\ 3s^1$

Na^+ (10 electrons): $1s^2\ 2s^2\ 2p^6$: [Ne]

The Octet Rule—Anions

Anion: Chlorine atom gains an electron to form a chloride ion, which has the same electron configuration as argon



chlorine atom (17 electrons): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

chloride ion (18 electrons): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

Cation Names

- Groups 1A, 2A, and 3A
  - The name of the element followed by the word "ion"

Group 1A		Group 2A		Group 3A	
Ion	Name	Ion	Name	Ion	Name
H^+	Hydrogen ion	Mg^{2+}	Magnesium ion	Al^{3+}	Aluminum ion
Li^+	Lithium ion	Ca^{2+}	Calcium ion		
Na^+	Sodium ion	Sr^{2+}	Strontium ion		
K^+	Potassium ion	Ba^{2+}	Barium ion		

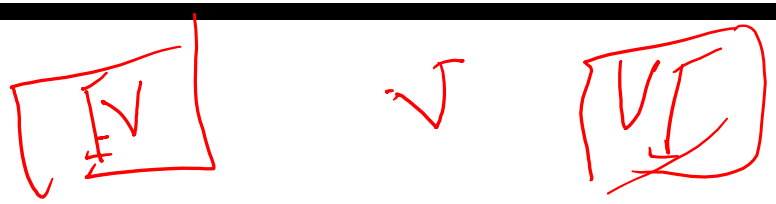
Fe^{+2} Fe^{+3}

Transition Metal Cations

- Cations derived from transition and inner transition elements more than one type of cation
- Stock System (IUPAC):
  - Use Roman numerals to show charge:
  - Fe^{2+} is Iron (II) Fe^{3+} is Iron (III)
  - Cu^{+} is Copper (I) Cu^{2+} is Copper (II)
- Old System:
  - Use the suffix -ous to show the lower positive charge and the suffix -ic to show the higher positive charge
  - Fe^{2+} is Ferrous Fe^{3+} is Ferric
  - Cu^{+} is Cuprous Cu^{2+} is Cupric

Transition Metal Ion Names

Ion	Systematic name	Common name	Origin of the symbol of the element or the common name of the ion
Cu^{+}	Copper(I) ion	Cuprous ion	Cupr- from *cuprum*, the Latin name for copper
Cu^{2+}	Copper(II) ion	Cupric ion	
Fe^{2+}	Iron(II) ion	Ferrous ion	Ferr- from *ferrum*, the Latin name for iron
Fe^{3+}	Iron(III) ion	Ferric ion	
Hg^{+}	Mercury(I) ion	Mercurous ion	Hg from *hydrargyrum*, the Latin name for mercury
Hg^{2+}	Mercury(II) ion	Mercuric ion	
Sn^{2+}	Tin(II) ion	Stannous ion	Sn from *stannum*, the Latin name for tin
Sn^{4+}	Tin(IV) ion	Stannic ion	

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Anion Names

- Add "ide" to the root name of the element

Anion	Stem name	Anion name
F^-	fluor	fluoride
Cl^-	chlor	chloride
Br^-	brom	bromide
I^-	iod	iodide
O^{2-}	ox	oxide
S^{2-}	sulf	sulfide

H^- hydride

N^{-3} nitride

Polyatomic Ions

- Contain two or more atoms
- Common names often used (in parentheses)

Ion	Name	Ion	Name
NH_4^+	Ammonium	HCO_3^-	Hydrogen carbonate (Bicarbonate)
OH^-	Hydroxide	SO_3^{2-}	Sulfite
NO_2^-	Nitrite	HSO_3^-	Hydrogen sulfite (Bisulfite)
NO_3^-	Nitrate	SO_4^{2-}	Sulfate
CH_3COO^-	Acetate	HSO_4^-	Hydrogen sulfate (Bisulfate)
CN^-	Cyanide	PO_4^{3-}	Phosphate
MnO_4^-	Permanganate	HPO_3^{2-}	Hydrogen phosphate
CrO_4^{2-}	Chromate	$H_2PO_4^-$	Dihydrogen phosphate
CO_3^{2-}	Carbonate		

The valency of some positive ions:(Cations)

Monovalent		Divalent		Trivalent	
Li^+	lithium	Ca^{++}	Calcium	Al^{+++}	Aluminium
Na^+	sodium	Mg^{++}	Magnesium	Fe^{+++}	Iron(III), Ferric
K^+	potassium	Ba^{++}	Barium		
Ag^+	Silver	Fe^{++}	Iron(II), Ferrous		
Cu^+	Copper(I)	Cu^{++}	Copper(II)		
NH_4^+	ammonium	Pb^{++}	Lead(II)		

The valency of some negative ions:(Anions)

Monovalent		Divalent		Trivalent	
OH^-	Hydroxide	O^{--}	Oxide	PO_4^{---}	Phophate
F^-	Fluoride	CO_3^{--}	Carbonate		
Cl^-	Chloride	S^{--}	Sulphide		
Br^-	Bromide	SO_4^{--}	Sulphate		
I^-	Iodide				
NO_3^-	Nitrate				
NO_2^-	Nitrite				
HCO_3^-	bicarbonate				

Naming Ionic Compounds

$NaBr$	Sodium bromide
Al_2O_3	Aluminum oxide
$MgSO_4$	Magnesium sulfate
K_2S	Potassium sulfide
$(NH_4)_3PO_4$	Ammonium phosphate

$NaCl$

Sodium Chloride

K_2O

NH_4OH

$Al_2(SO_4)_3$

Aluminum sulfate

$CaCO_3$

KCN

H_2O

$CaCl_2$

Forming an Ionic Bond--NaCl

- Formation of sodium chloride, NaCl

$Na(1s^2 2s^2 2p^6 3s^1) + Cl(1s^2 2s^2 2p^6 3s^2 3p^5) \longrightarrow$

Sodium atom **Chlorine atom**

$Na^+(1s^2 2s^2 2p^6) + Cl^-(1s^2 2s^2 2p^6 3s^2 3p^6)$

Sodium ion **Chloride ion**

Single-headed curved arrow used to show the transfer of the electron

ionic_bond.swf

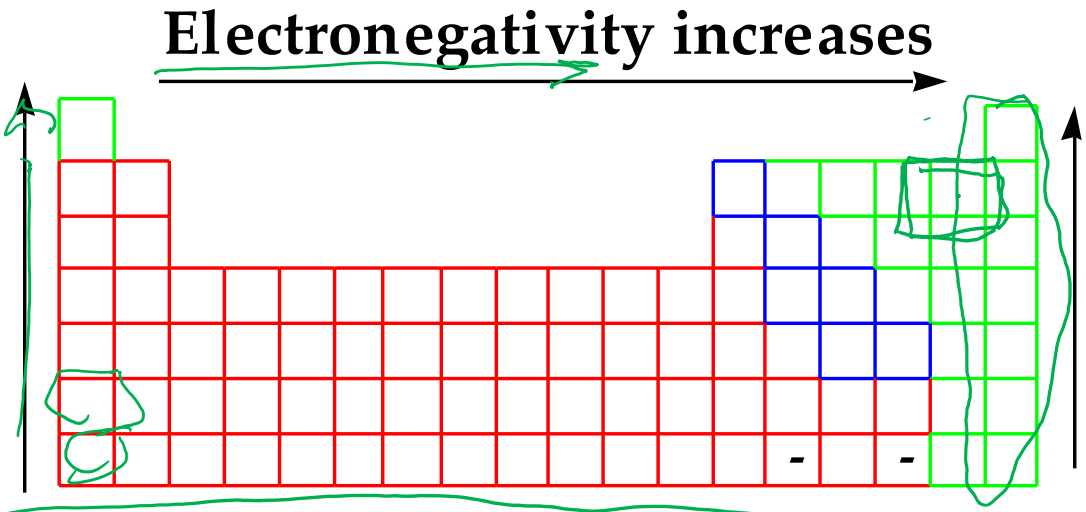
Forming Chemical Bonds

- Ionic bond: the force of electrostatic attraction between a cation and an anion
  - Atom loses or gains electrons to make a filled valence shell (octet) and become an ion.

- Covalent bond: a pair of electrons that are shared by two atoms
  - Atom shares electrons to make a filled valence shell (octet)

Ionic Bonds

- Force of attraction between a cation and an anion.
- Depends on electronegativity
  - measure of an atom's attraction for shared pair of electrons in chemical bond with another atom)



Covalent Bonds

- Result of one or more pairs of electrons that are shared by two atoms
  - Each atom has full valence shell (octet)
- In H_2, each hydrogen contributes one electron to the single bond

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مع تحيات
د. عبدالله محمد

End of the lecture

دعواتكم لجميع الموتى والأحياء