Ionic and Covalent Bonds

Octet rule

Naming and writing formulas

Definitions

- The ***octet rule*** states that atoms are most stable when they have a full shell of **8** electrons in the **OUTERMOST** shell
- **Ionic bonding** forms between a **metal** and **non-metal** and involves the **gain** and **loss** of electrons.
- **Covalent bonding** is where atoms **share** electrons to achieve their full octet
- A **valence e^-** is one that is in the **outer** electron shell.

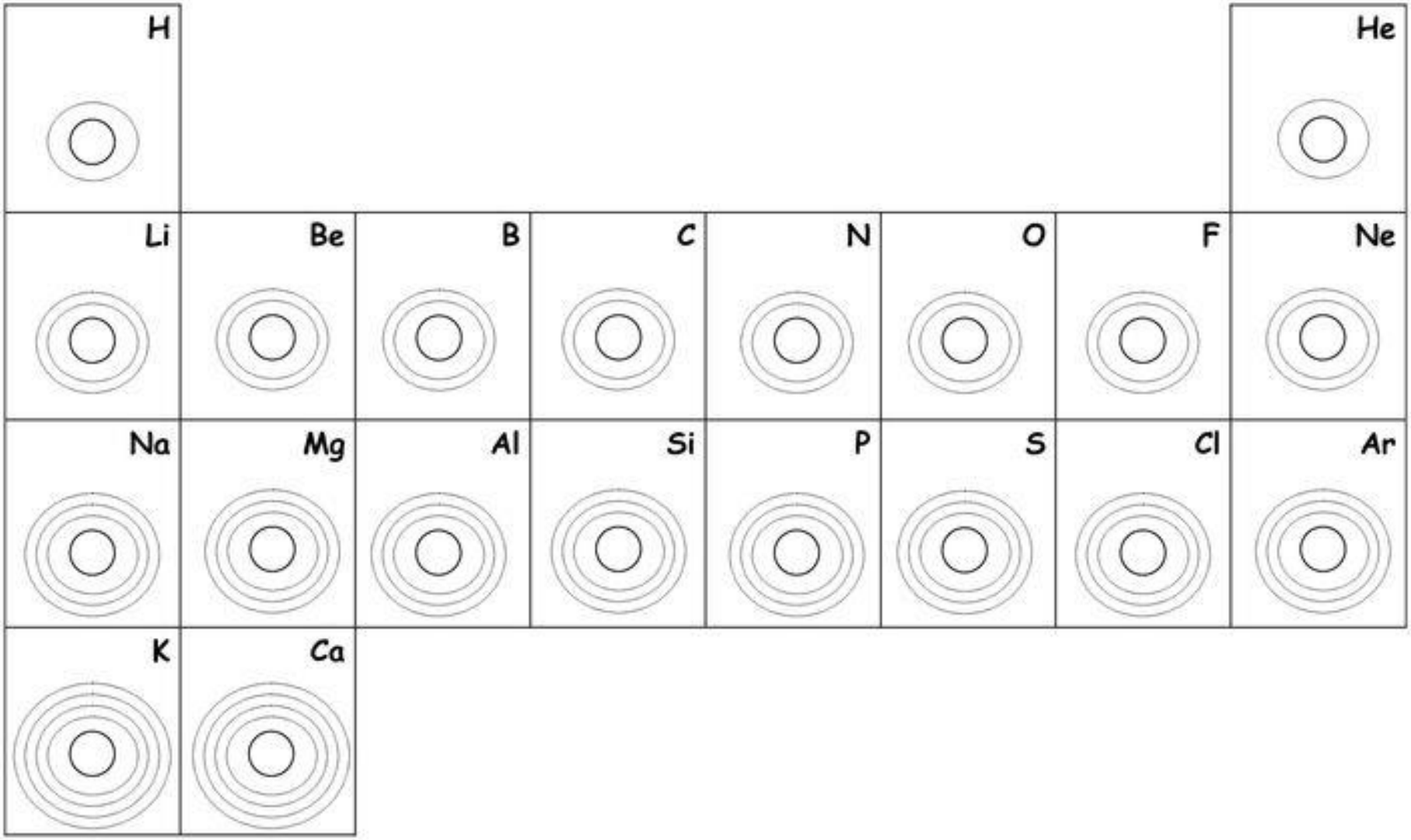
Ions – what are they?

- An **ion** is an atom that has either **GAINED** of **LOST** an e^-
- A **positively** charged ion is an atom that **loses** an e^- (**cation**)
- A **negatively** charged ion is an atom that **gains** an e^- (**anion**)
- Remember atoms are normally **neutral** (equal # of p^+ and e^-

Let's Try it!

- Draw Bohr-Rutherford diagrams (on the next slide) for the 1st 20 elements
- Apply the octet rule to all of them!
- Do you notice any trends?

Bohr – Rutherford Diagrams for the first 20 Elements



Trends..

- **Groups:** Alkali/Alkali Earth metals

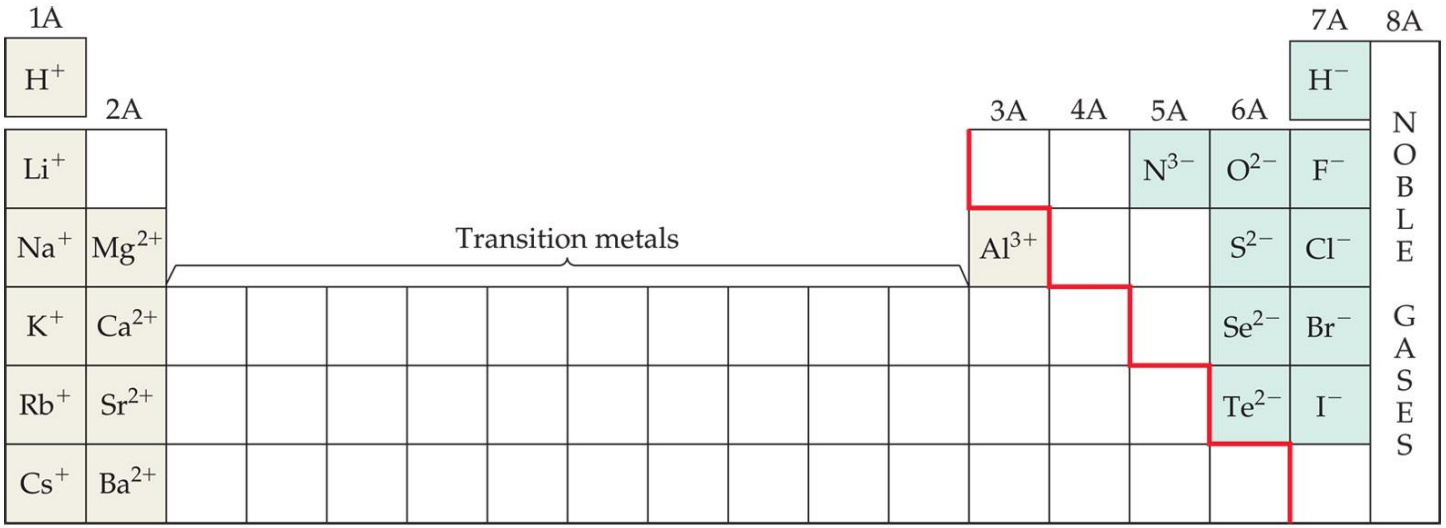
  Alkali metals always **lose 1 e^-**

  Alkali Earth metals always **lose 2 e^-**

- **Metals** are usually **+ ve** ions (**Cations**) – **Left** side of the P.T. (Periodic Table)

- **Non-metals** are usually **– ve** (**anions**) – **Right** side of P.T.

Ions



- Cations are positive (left side)
- Anions are negative (right side)

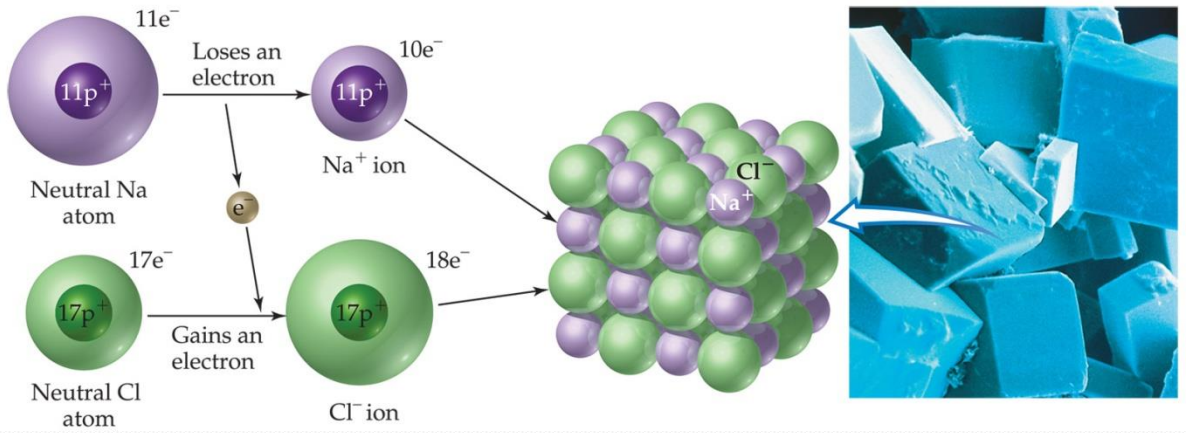
Learning Check – Counting

State the number of protons, neutrons, and electrons in each of these ions.

$^{39}_{19}K^{+}$	$^{16}_{8}O^{-2}$	$^{41}_{20}Ca^{+2}$
$\#p^{+}$ _____	_____	_____
$\#n^{0}$ _____	_____	_____
$\#e^{-}$ _____	_____	_____

Ionic Bonds

Ionic compounds (such as NaCl) are formed between **metals** and **nonmetals.**



How Ionic Bonding works….

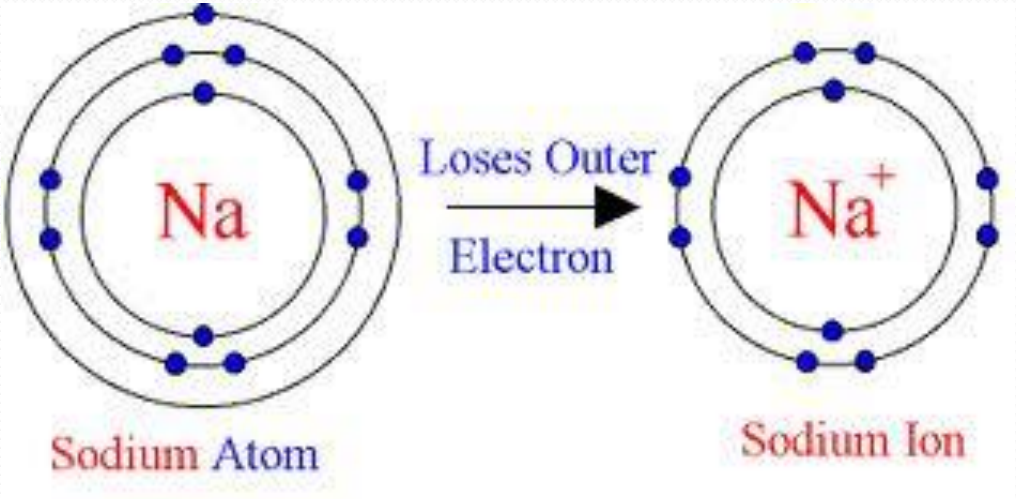
1) The <u>metal</u> **loses** a valence **e^-** (or 2 or 3) so that it has a full valence shell but a **+ ve** charge

2) The <u>non-metal</u> **gains** a valence **e^-** (or 2 or 3) so that it has a full valence shell but a **– ve** charge

3) The – ve and + ve charged ions are **attracted** to each other (**electrostatic attraction**)

Metals in Ionic Bonds

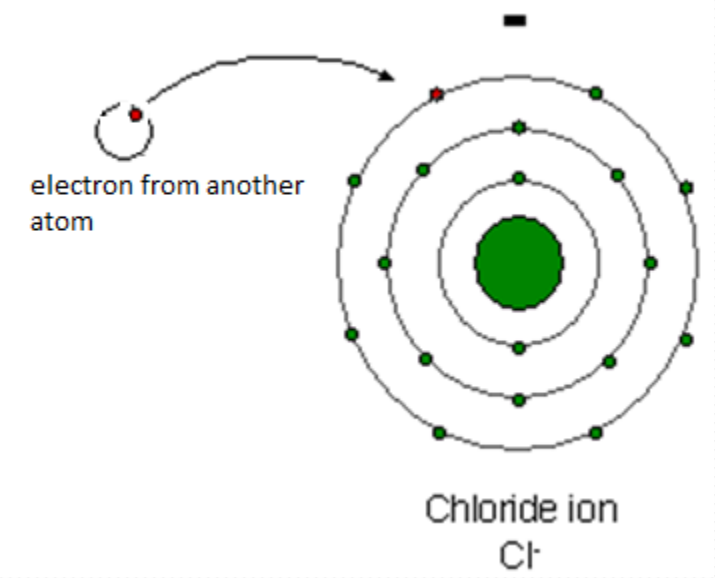
- Always the **Cation** (+ve)
- Have only 1, 2 or 3 valence
- Very easy to **lose** these and become **+ vely charged**



Non-metals in Ionic Bonding

- Always the **anion** (with the exception of hydrogen) in ionic bonds

- All have **4 or more** valence e^-, so it is very easy for them to **gain** an e^- to get a **full** valence shell

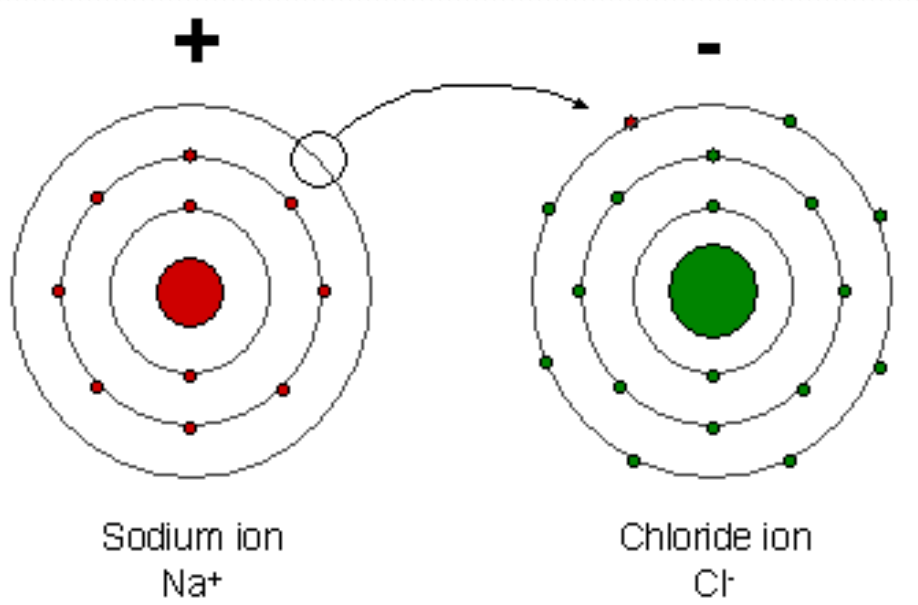


So .. Remember in Ionic Bonding..

- Metal **loses** e^-

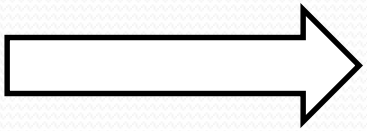
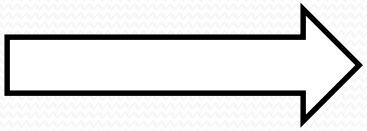
Non-metal **gains**

- Individual atoms will have a charge but overall compound is **neutral**

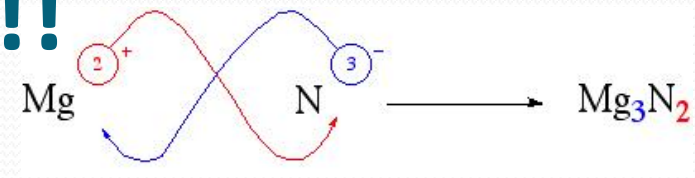


- Compound formed: NaCl

Now you try!! (only draw lewis dot diagrams)

- Ca and F 
- Al and P 
- K and N 

There has GOT to be an EASIER WAY!!!!



Criss Cross Rule

1) Figure out the **charge** the atom will have when it becomes an **ion**

IT'S EASIER TO SEE on the PERIODIC TABLE

REMEMBER THE PATTERN????

Pattern on the PT

Charge:	+1	+2	+3	-3	-2	-1	0
	H						He
	Li	Be	B	N	O	F	Ne
	Na	Mg	Al	P	S	Cl	Ar
	K	Ca					
Group:	1	2	13	15	16	17	

Notice: Metals tend to be Cations (+ ve)
Non-metals are anions (- ve)

The Criss Cross Rule

- Recall: An **Ionic Compound** is composed of a **metal** (cation) and a **non-metal** (anion)

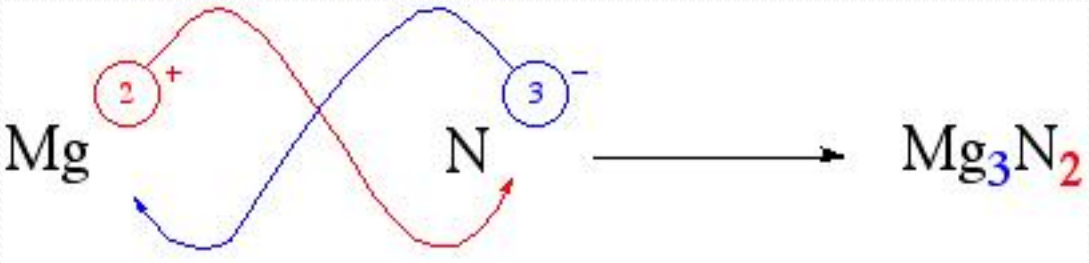
2) Write the **charge** as a **superscript**

Example: Mg^{2+} N^{3-}

The Criss Cross Rule

3) **The Criss Cross Rule**:

The value of the **charge** on <u>one</u> ion is the **subscript** of the **<u>other</u>**



The subscript shows that there are 2 N's for 3 Mg's.

** Check with a lewis-dot diagram*

More Examples

Ex. 1) Mg and Cl $\quad Mg^{2+}\ Cl^{-} \longrightarrow MgCl_2$

Ex. 2 Cu(II) and S $\quad Cu^{2+}$ **and** $S^{2-} \longrightarrow CuS$

Since the **2 ions** have the **same charge**. Each Cu will **only** attract 1 S

*There are **never** any charges on the final product - they **balance out***

DOES THIS RULE REPLACE BOHR DIAGRAMS?

NOPE! You MUST know BOTH ways for tests and exams!! ☺

Now you try

- Na and I
- Li and Cl
- Al and I
- Ba and F
- Ca and N

Naming of Ionic compounds

- **Ionic compounds** have **2-word** names

- **First Name** the **metal**.
- **Second Name** the **non-metal** with **–ide** suffix.

- Example: NaCl sodium chloride

Examples

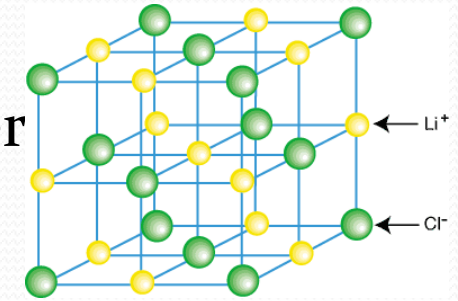
- Name the following

a) Ag_2O b) Sr_3N_2 c) KBr

d) ZnO e) CaF_2 f) Cs_2S

g) Al_2O_3 h) $AlCl_3$ i) ZrO_2

Properties of Ionic Compounds



- **Crystal lattice** – every ion is attracted to all other ions with the opposite charge

- **High melting point** – the **attraction** in the crystal pattern leads to very **strong bonds**, making it hard to break apart ionic compounds melt at **high T**.

- **Conductivity** – when **dissolved in water** they conduct electricity

- in water the bonds **dissociate**, leaving lots of **ions** to carry the charge

Covalent Bonding

- Formed between two or more **non-metals** that **share** e^- (s) between them

- The **sharing** forms a link between the atoms
  - called a **covalent bond**

- Rule: an atom will **share** however many e- it **needs** to become **stable**

Hydrogen gas: H_2

Chlorine gas: Cl_2

Methane (CH_4)

Oxygen (O_2)

Water

Nitrogen gas

Naming Covalent Compounds

1. Write the correct **prefix** (see below) for the first non-metal and it's **name**
2. Write the **prefix** and **name** for the second non-metal

NOTE: mono- is not required for the first non-metal, but is needed for the second.

Prefix	# of atoms	Prefix	# of atoms
Mono-	1	Penta-	5
Di-	2	Hexa	6
Tri	3	Hepta	7
Tetra	4	Octa	8

Special Names

- Some molecular compounds can also go by specific names. You should recognize:

- **Water** (H_2O)
- Methane (CH_4)
- **Ammonia** (NH_3)
- **Ozone** (O_3)
- **Diatomic molecules:** Hydrogen (H_2), Oxygen (O_2), Fluorine (F_2), Bromine (Br_2), Iodine (I_2) , Nitrogen, (N_2), Chlorine (Cl_2)

Examples

- Name the following: (on a separate paper)

a) PCl_5 b) NO_2 c) SiO_2

d) CH_4 e) CCl_4 f) $AsBr_3$

g) SCl_2 h) Cl_2O i) $ClBr_5$

Write the correct formula for the following:

a) phosphorous trihydride b) nitrogen tribromide

c) diphosphorous tetrachloride d) silicon disulfide

e) chlorine trifluoride f) arsenic pentafluoride

g) dihydrogen monoxide h) silicon dichloride

Exit Questions

1. What is the difference between an atom and an ion?
2. Anion and cation
3. What's the difference between Ionic and covalent bonding
4. Explain why the sodium ion carries a positive charge and chlorine a negative in NaCl
5. Do you know how to name Ionic and covalent and write formulas? (using lewis dot diagrams and criss-cross rule)

Remember to Practice for quiz next class (ionic and covalent, naming)