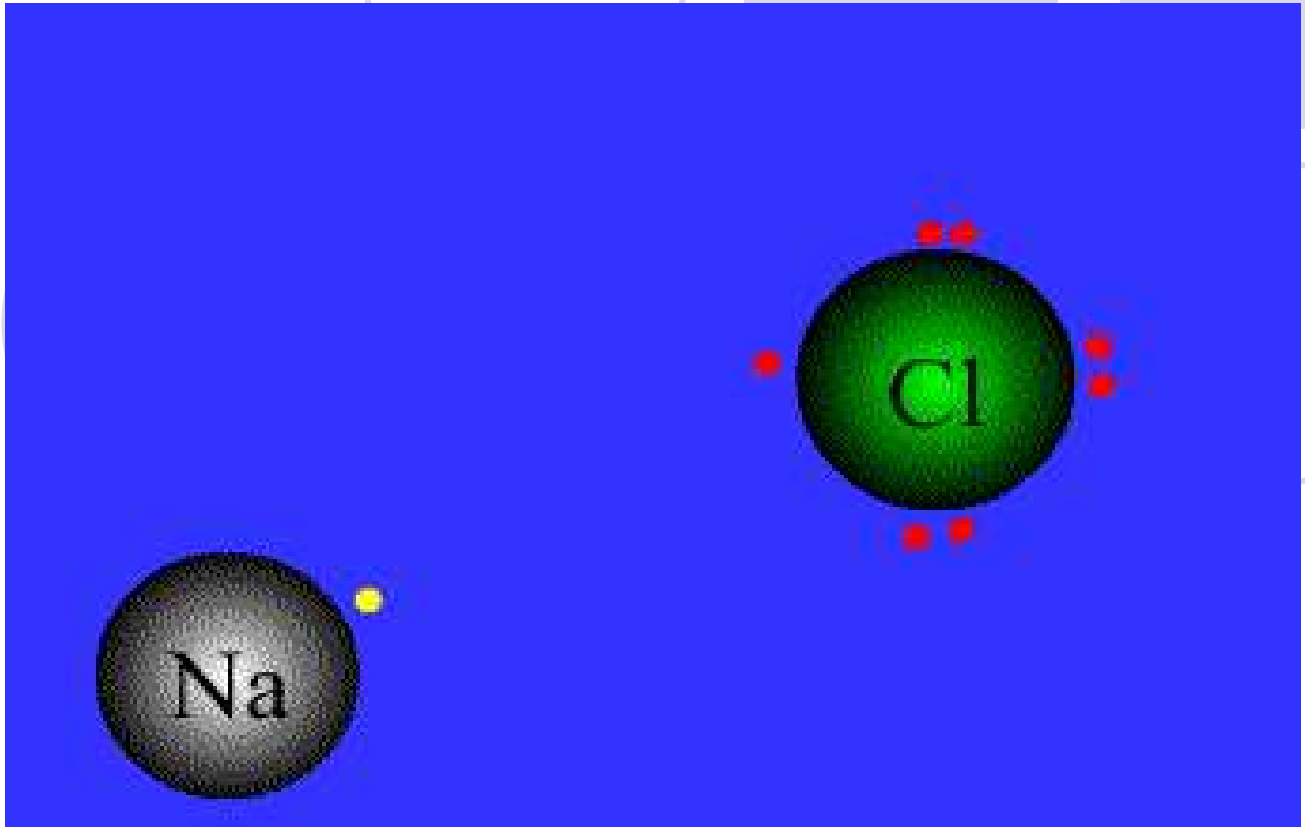
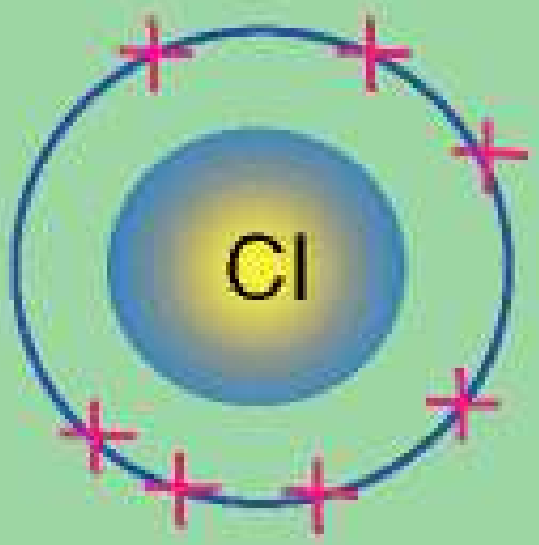
NOTES: 7.1 – Ions / Ionic Compounds



Valence Electrons:

- the number of **valence electrons** determines the chemical properties of an element.

- **Valence Electrons:** The e- in the highest occupied energy level of an element's atoms.


Cl


Cl

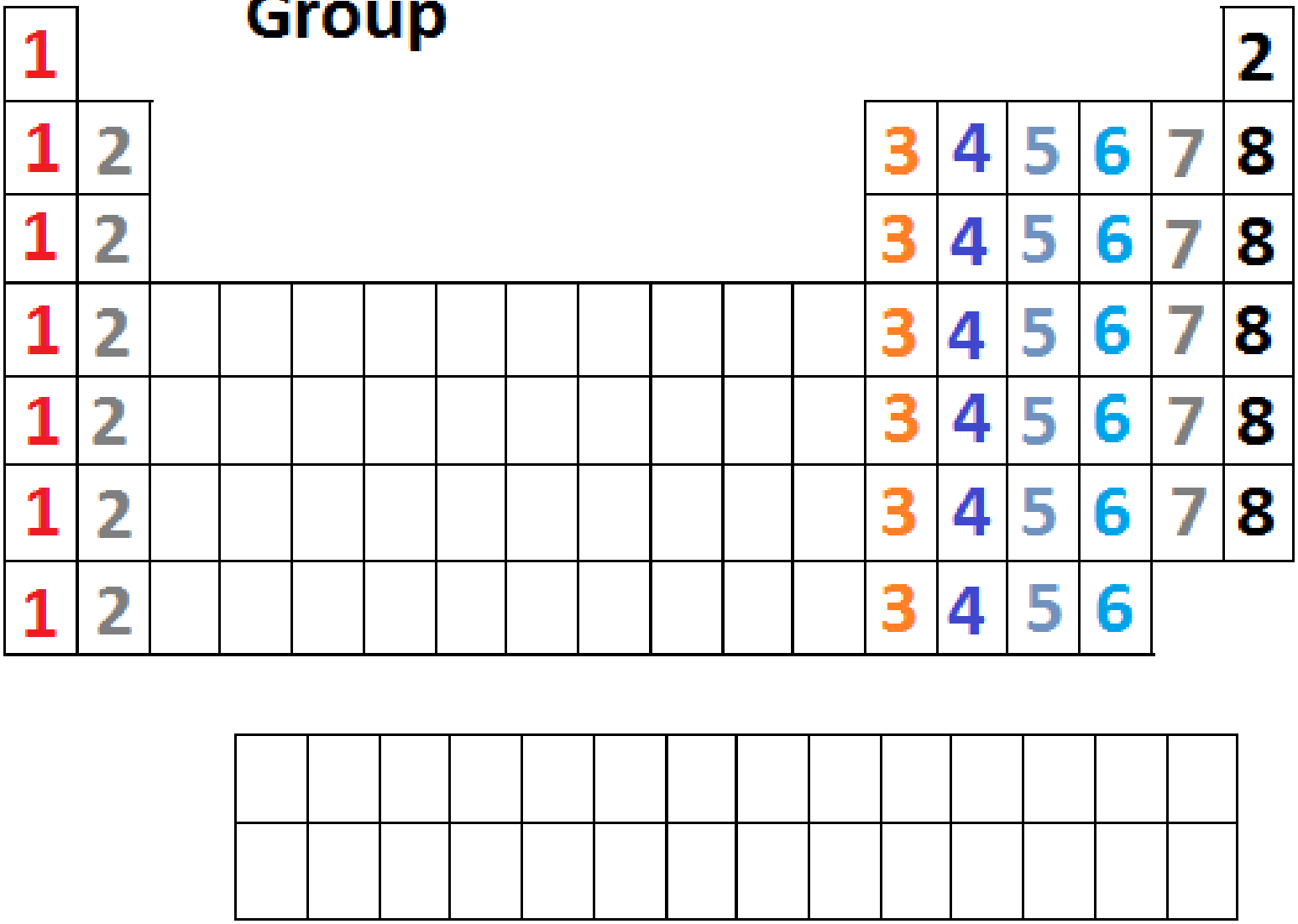
Valence Electrons:

- All elements in a particular group or family have the same number of valence electrons (and this number is equal to the group number of that element)

Examples:

- Group **1** elements (Na, K, Li, H): **1 valence e-**.
- Group **2** elements (Mg, Ca, Be): **2 valence e-**.
- Group **17 (7A)** elements (Cl, F, Br): **7 valence e-**.

Valence Electrons in Each Group

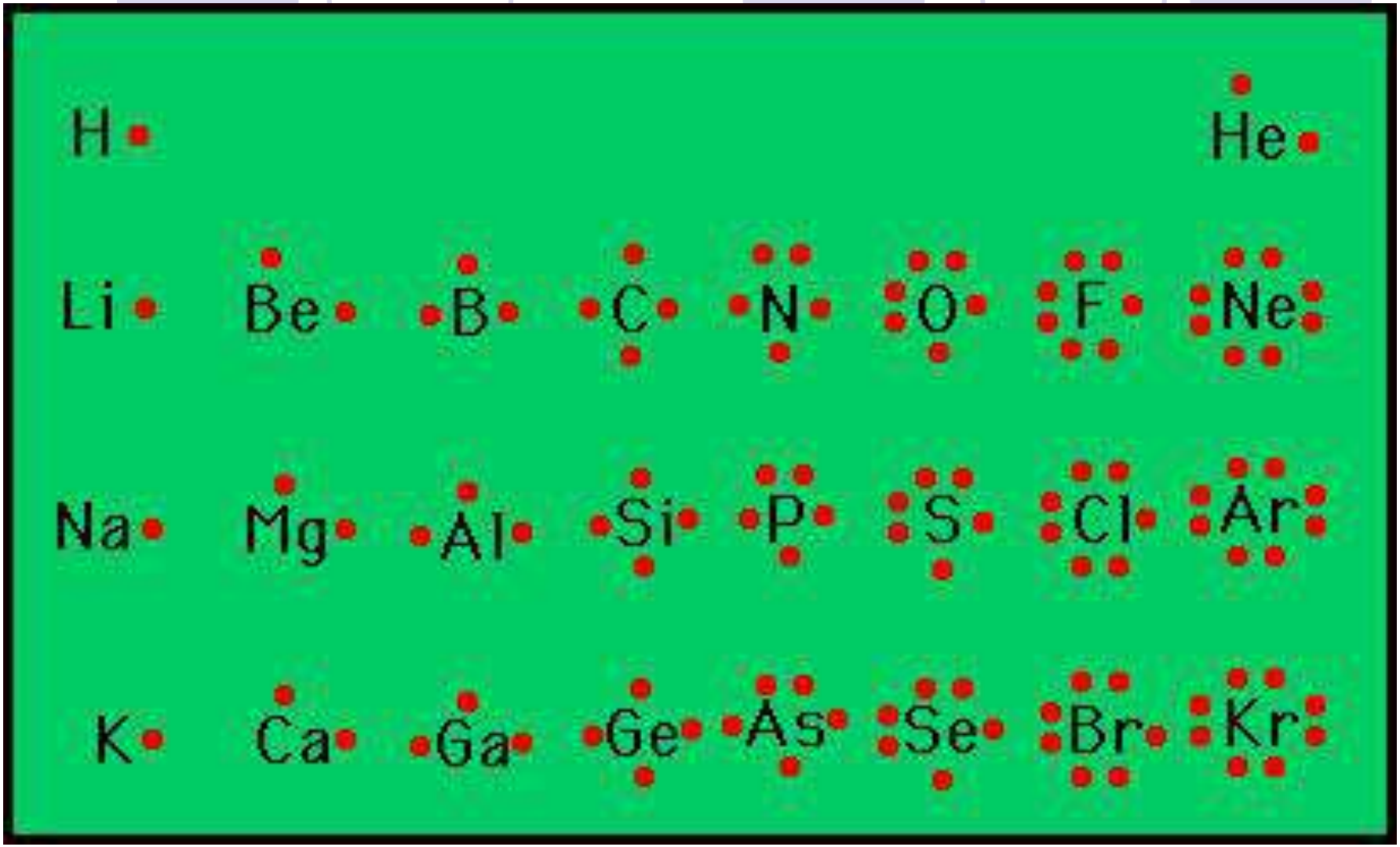


ELECTRON DOT STRUCTURES:

- **Electron dot structures** show the valence electrons as dots around the element's symbol:
- Li
- B
- Si
- N
- O
- F
- Ne

LEWIS STRUCTURES:

- **Electron dot structures** show the valence electrons as dots around the element's symbol:
- Li
- B
- Si
- N
- O
- F
- Ne


H
He
Li
Be
B
C
N
O
F
Ne
Na
Mg
Al
Si
P
S
Cl
Ar
K
Ca
Ga
Ge
As
Se
Br
Kr

OCTET RULE:

- ***Noble gas*** *atoms are very stable & therefore don't react or combine with other elements;* ***they have 8 valence electrons (a "full" outer shell!)***
- **Octet rule:** all representative elements will gain or lose (or share!) electrons to **form an octet (8) of valence e^-.**

Formation of CATIONS:

- Atoms of **METALS** form **CATIONS (positive ions)** by losing electrons.

  Na:

  Na^+:

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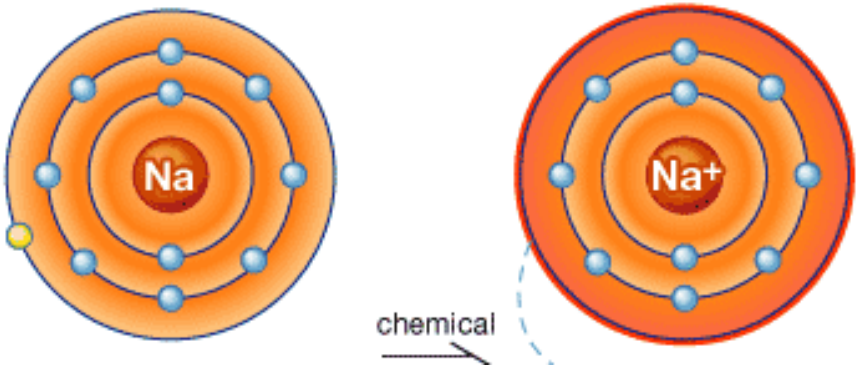
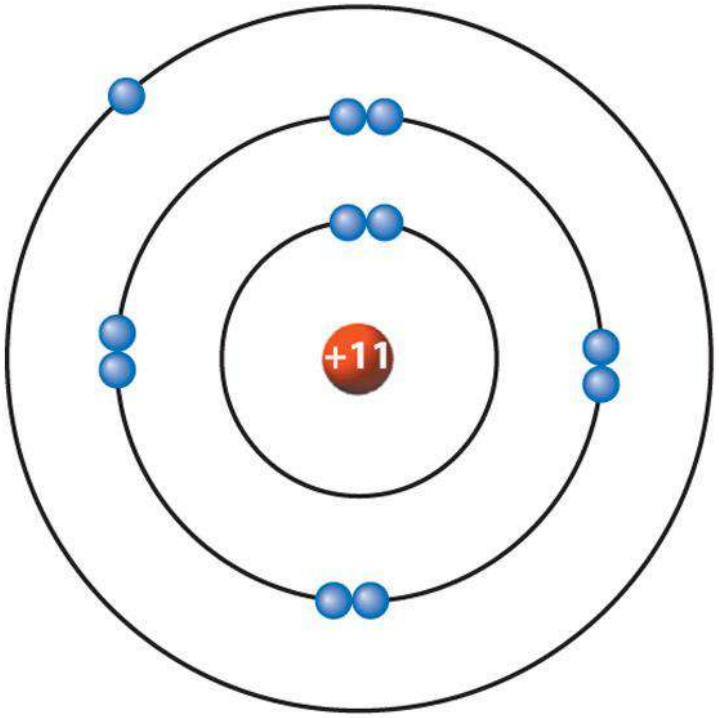
Na:

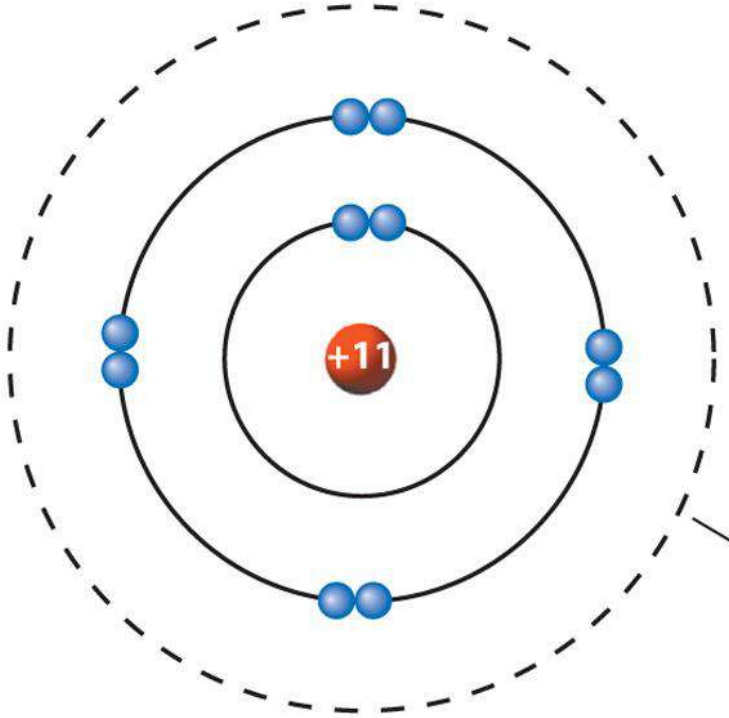
Na^+:





Na

11 protons
11 electrons
0 net charge



Vacant valence shell

Na^{1+} (positive ion)

11 protons
10 electrons
+1 net charge

Formation of CATIONS:

- Atoms of **METALS** form **CATIONS (positive ions)** by losing electrons.

Mg:

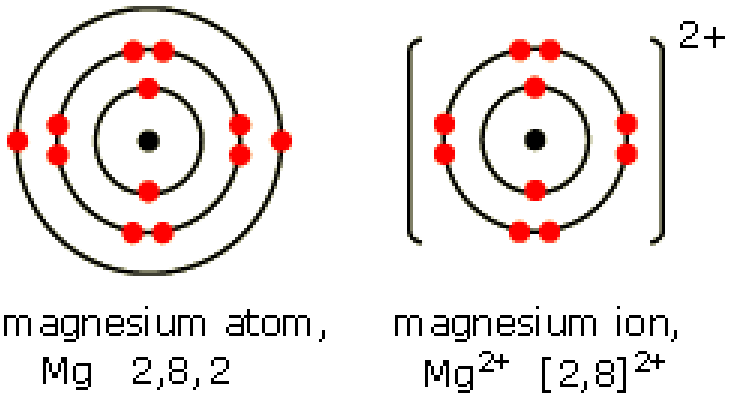
Mg^{2+}:

Formation of CATIONS:

- Atoms of **METALS** form **CATIONS (positive ions)** by losing electrons.

Mg: **2 valence e^-**

Mg^{2+}: **8 valence e^-**



magnesium atom, Mg 2,8,2

magnesium ion, Mg^{2+} $[2,8]^{2+}$

Formation of ANIONS:

- Atoms of **NONMETALS** form **ANIONS (negative ions)** by gaining electrons.

Cl:

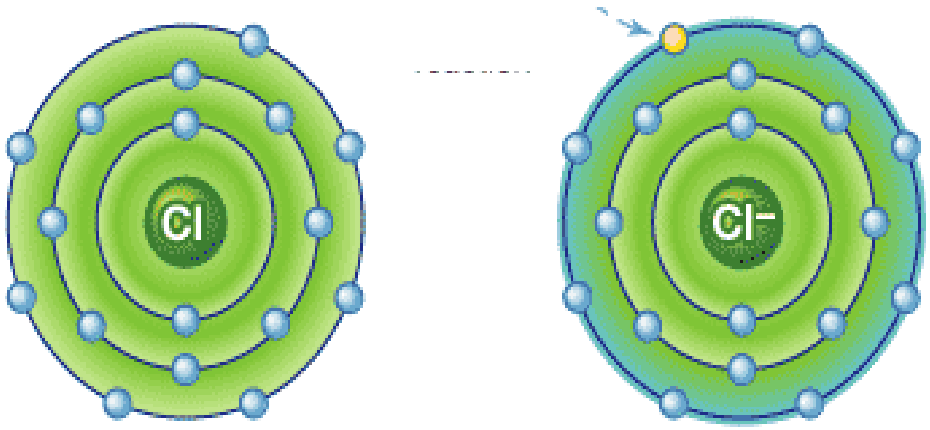
Cl^-:

Formation of ANIONS:

- Atoms of **NONMETALS** form **ANIONS (negative ions)** by gaining electrons.

Cl:

Cl^-:



Formation of ANIONS:

- Atoms of **NONMETALS** form **ANIONS (negative ions)** by gaining electrons.

O:

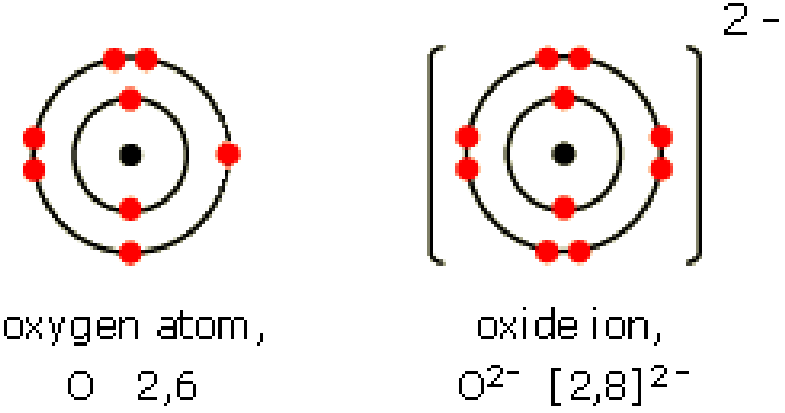
O^{2-}:

Formation of ANIONS:

- Atoms of **NONMETALS** form **ANIONS (negative ions)** by gaining electrons.

O: **6 valence e^-**

O^{2-}: **8 valence e^-**

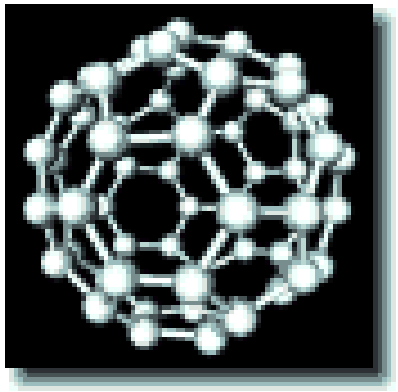


oxygen atom,
O 2,6

oxide ion,
O^{2-} $[2,8]^{2-}$

Which elements form ionic compounds and which elements form covalent (molecular) compounds??

General Rule of Thumb:



metal + nonmetal = **IONIC**

metal + polyatomic anion = **IONIC**

polyatomic cation + anion = **IONIC**

nonmetal + nonmetal = **COVALENT / MOLECULAR**

Why are ionic compounds so stable?

- **IONIC BONDS:**

  -metal plus a nonmetal

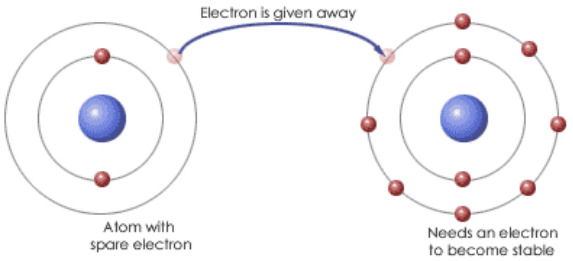
  -cations (+) plus anions (-)

  -**opposite charges attract**

- **Examples**:

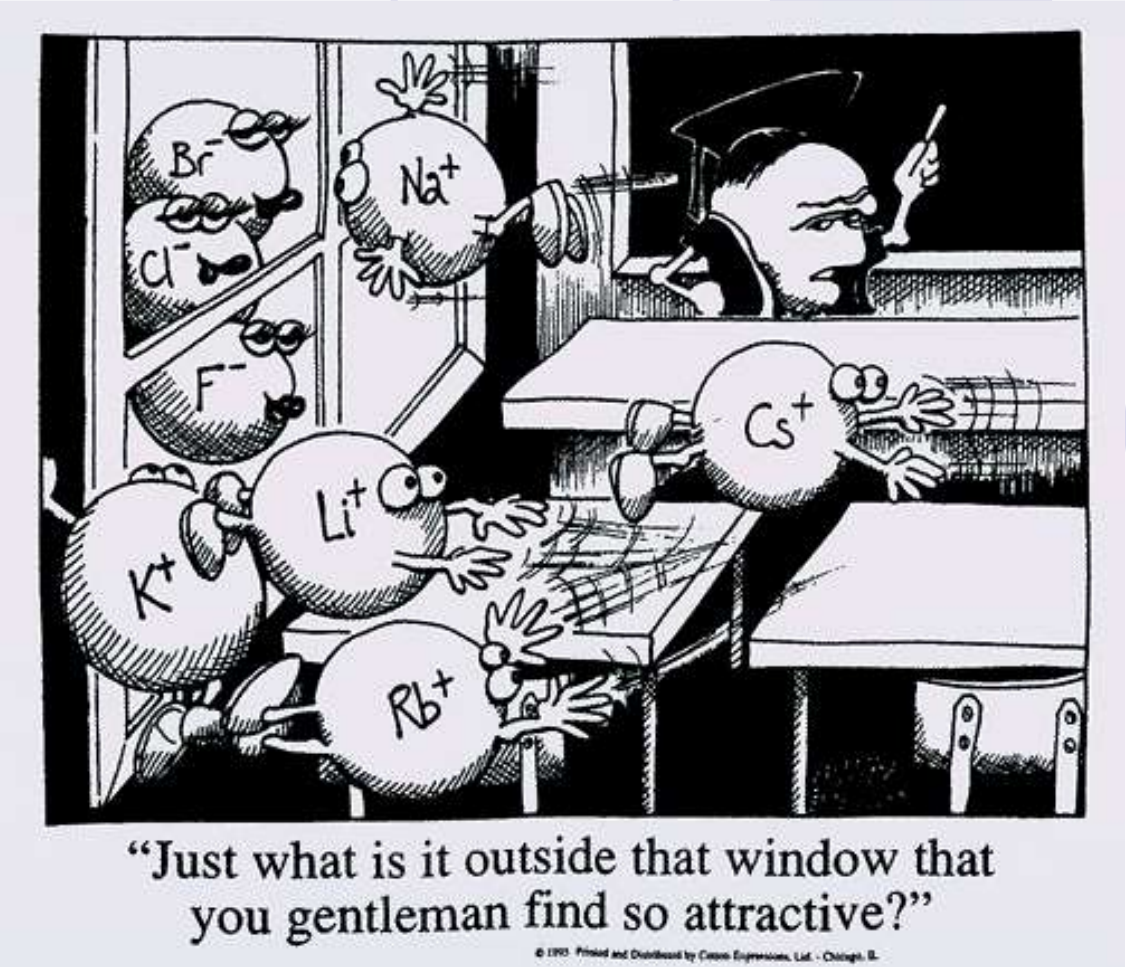
  ➔ Na^{+} and Cl^{-} form NaCl

  ➔ Al^{3+} and Br^{-} form $AlBr_3$



Ionic Bonds:

Isn't it *ionic* that opposites attract?

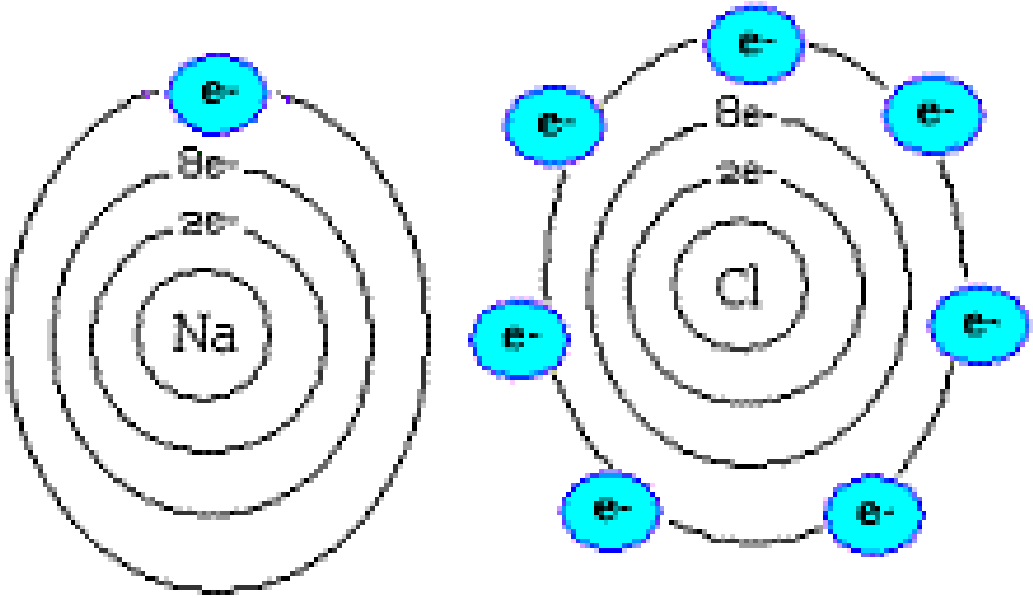


IONIC BONDS:

- Cations and anions have **opposite charges**
- Ionic compounds are **electrically neutral groups of ions** joined together by electrostatic forces.

  ➔ the **positive charges** of the cations must **EQUAL** the **negative charges** of the anions.

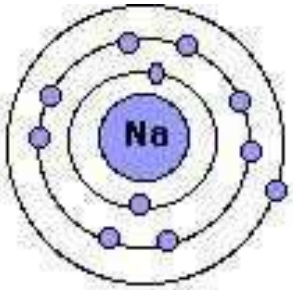
Ionic Boud

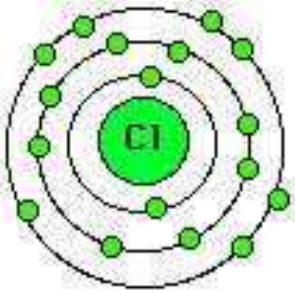


e- Negative Electrons

Na- Sodium

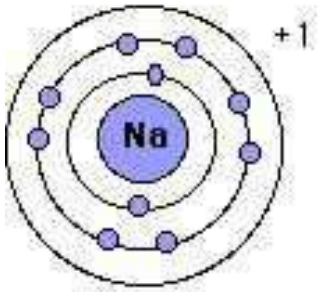
Cl-Cholerine

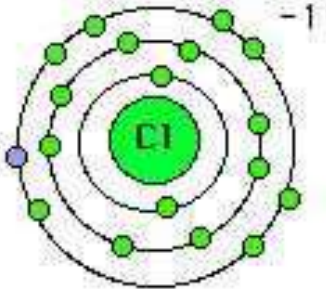




atoms

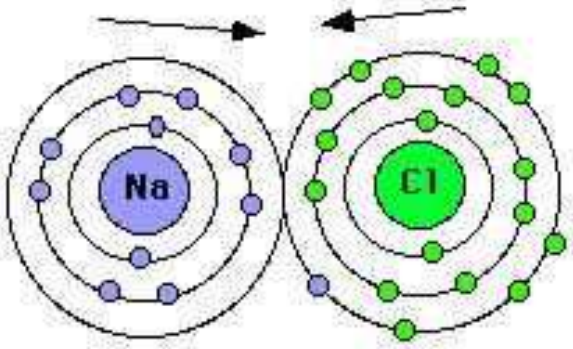
electron transfer





ions

electrostatic
attraction



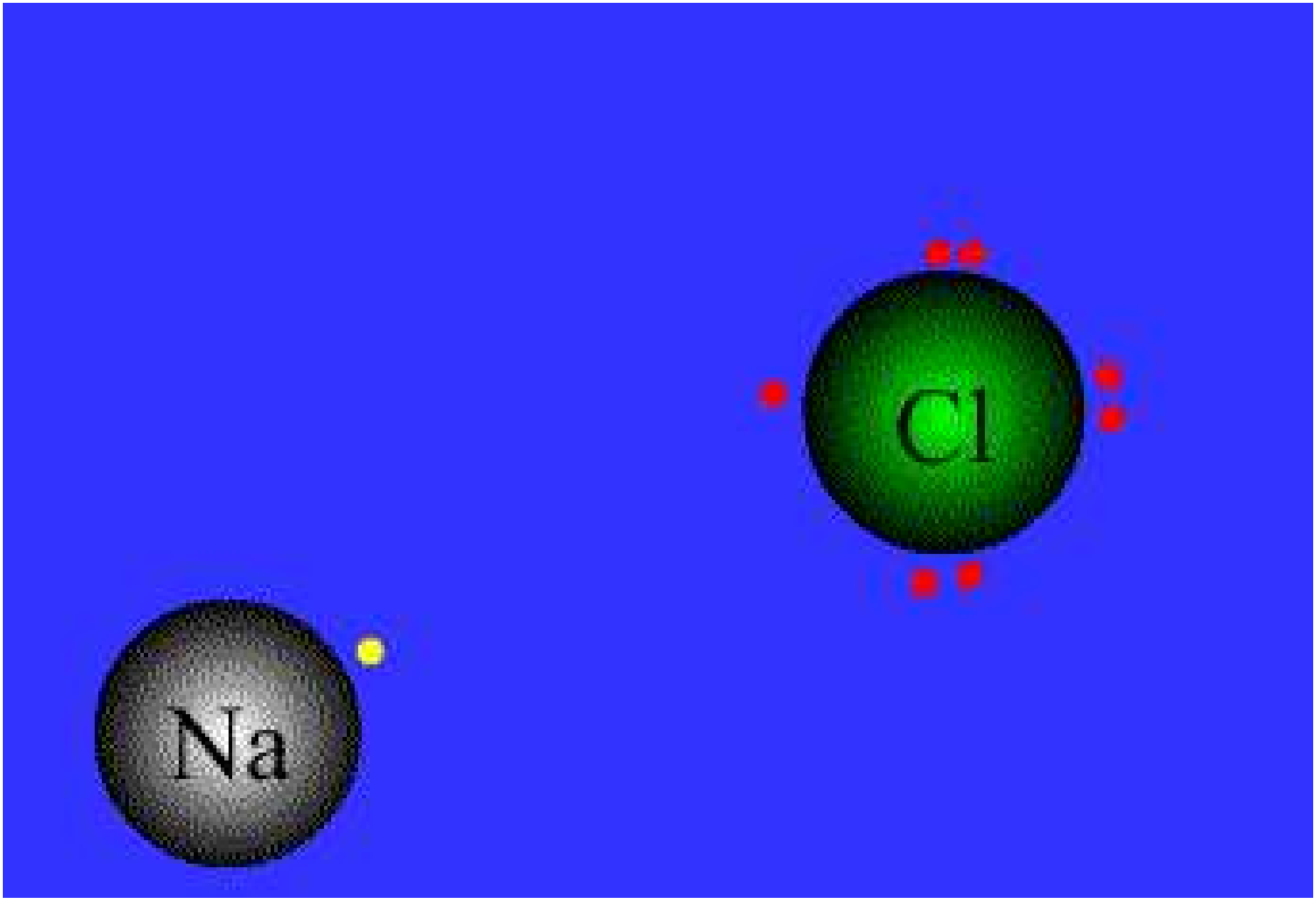
NaCl

ionic bond

This is a non-directional bond; a polygamous bond

Examples of Ionic Compounds:

Na	Cl	$Na^{+}Cl^{-} = NaCl$
Al	Br	$Al^{3+}Br^{-} = AlBr_3$
K	O	$K^{+}O^{2-} = K_2O$
Mg	N	$Mg^{2+}N^{3-} = Mg_3N_2$
K	P	$K^{+}P^{3-} = K_3P$


Cl
Na