# Alkaline Earth Metals Group II (IIA)

| Element | | Electronic structure |
|---|---|---|
| Beryllium | $^{4}Be$ | [He] $2s^2$ |
| Magnesium | $^{12}Mg$ | [Ne] $3s^2$ |
| Calcium | $^{20}Ca$ | [Ar] $4s^2$ |
| Strontium | $^{38}Sr$ | [Kr] $5s^2$ |
| Barium | $^{56}Ba$ | [Xe] $6s^2$ |
| Radium | $^{88}Ra$ | [Rn] $7s^2$ |

The second group of metals was called alkaline earth metals because it enters the structure of the earth's crust.

## General properties

1- All (G2) elements have two S-electron in their outer shell therefore they are divalent ثنائية التكافؤ

2- Forming colorless ionic compound.

3- Less basic than group 1.

4- The diagonal relationship with Be (IIA) and Al (IIIA).

5-The divalent cation possess the electronic structure of the noble gas.

The following table illustrate the main important difference between G1 and G2.

1.Group I elements always monovalent ($M^{+}$) while group II element are divalent ($M^{++}$).

2. Atomic radius of G2 < G1 due to decrease of atomic size.

3.The density of G2> G1 due to decrease in atomic size حجم الذري.

4. Ionization energy G2 > G1 .

5. The compounds of G2 are more heavily hydrated than G1 .

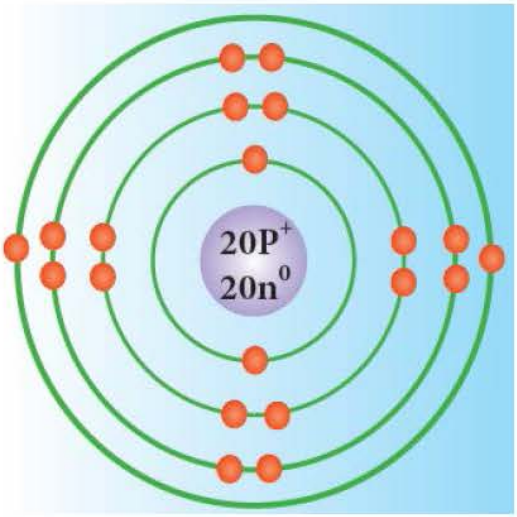
6.Na and K are the most abundant element in G1 while Mg and Ca are the most abundant element of G2.

## Calcium

Atomic number = 20

Mass number = 40

| رمز الغلاف | رقم الغلاف(n) | عدد الالكترونات |
|---|---|---|
| K | 1 | 2 |
| L | 2 | 8 |
| M | 3 | 8 |
| N | 4 | 2 |




## Chemical properties

There is no calcium free in nature because of its effectiveness and present united with other elements, consisting of fixed compounds Including carbonates and others.

## Calcium: reactions of elements

**1.Reaction of calcium with air**

Calcium metal burns in air to give a mixture of white calcium oxide, CaO, and calcium nitride, $Ca_3N_2$.

$$2Ca(s) + O_2(g) \rightarrow 2CaO(s)$$

$$3Ca(s) + N_2(g) \rightarrow Ca_3N_2(s)$$

**2.Reaction of calcium with water**

Calcium reacts slowly with water. The reaction forms calcium hydroxide, $Ca(OH)_2$ and hydrogen gas ($H_2$).

$$Ca(s) + 2H_2O(g) \rightarrow Ca(OH)_2(aq) + H_2(g)$$

**3.Reaction of calcium with the halogens**

Calcium is very reactive towards the halogens fluorine, $F_2$, chlorine, $Cl_2$ bromine, $Br_2$, or iodine, $I_2$, and burns to form the dihalides calcium(II) fluoride, $CaF_2$ , calcium(II) chloride, $CaCl_2$, calcium(II) bromide, $CaBr_2$, and calcium(II) iodide, $CaI_2$ respectively.

$$Ca(s) + F_2(g) \rightarrow CaF_2(s)$$

$$Ca(s) + Cl_2(g) \rightarrow CaCl_2(s)$$

$$Ca(s) + Br_2(g) \rightarrow CaBr_2(s)$$

$$Ca(s) + I_2(g) \rightarrow CaI_2(s)$$

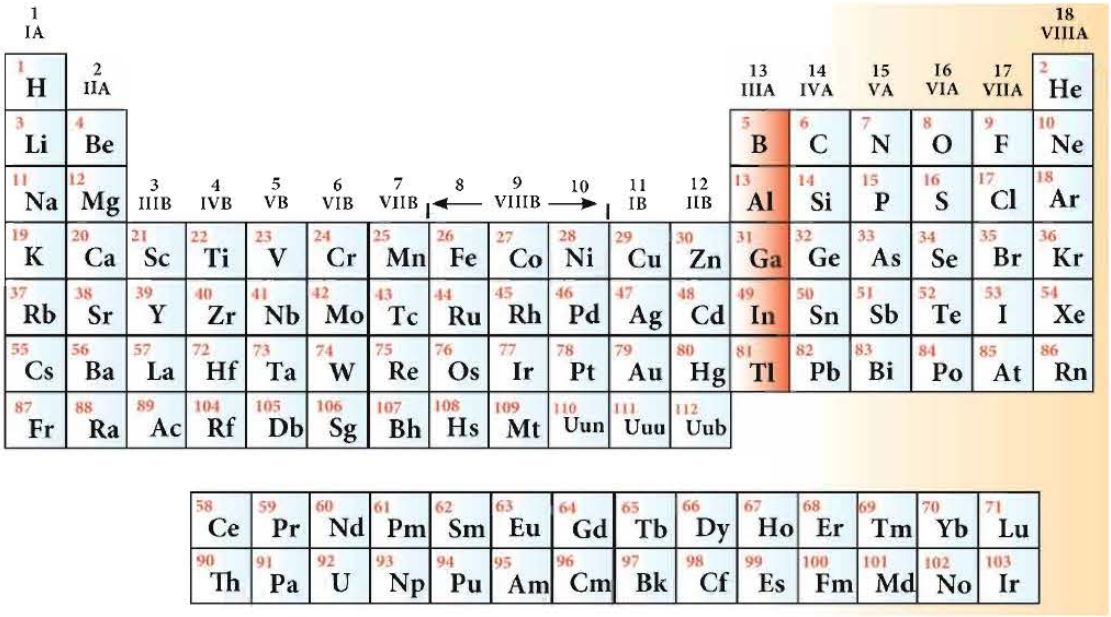
**4.Reaction of calcium with acids**

Calcium metal dissolves readily in dilute or concentrated hydrochloric acid to form solutions containing the aquated Ca(II) ion together with hydrogen gas, $H_2$.

$$Ca(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2(g)$$

# Elements of Group IIIA

The elements of this group are Boron (B), Aluminum (Al), Gallium (Ga), Indium (In) and Thallium (Ti).




## General properties

1. The present of three electrons in the outer shell of their atoms so that the equivalent is three (+3).
2. Elements of this group are metals except boron, which is a semi-metal.
3. Ionizing energy this elements are less energy than the ionization energy of the second group because the elements of this group contain one electron in the secondary shell P after a saturated secondary shell. The second group elements are ns2, their outer shell.

   As the atomic number increases, the energy of ionizing its atoms decreases due to its large atomic volume.
4. The basic properties of the elements of this group increase and the acidity decreases as the atomic number increases. The boron oxide is acidic, aluminum oxide is amphotery, and the other elements of this group are alkaline.

## Boron: reactions of element

**1.Reaction of boron with air**

Boron does not react with air at room temperature. At higher temperatures, boron does burn to form boron (III) oxide, $B_2O_3$.

$$4B + 3O_2(g) \xrightarrow{\text{(At higher temperatures)}} 2B_2O_3(s)$$

**2.Reaction of boron with water**

Boron does not react with water under normal conditions.

**3.Reaction of boron with the halogens**

Boron reacts with the halogens fluorine, $F_2$, chlorine, $Cl_2$, bromine, $Br_2$ to to form the trihalides boron(III) fluoride, $BF_3$, boron(III) chloride, $BCl_3$, and boron(III) bromide, $BBr_3$ respectively.

$$2B(s) + 3F_2(g) \rightarrow 2BF_3(g)$$
$$2B(s) + 3Cl_2(g) \rightarrow 2BCl_3(g)$$
$$2B(s) + 3Br_2(g) \rightarrow 2BBr_3(l)$$

**4.Reaction of boron with acids**

Crystalline boron does not react with boiling hydrochloric acid, HCl, or boiling hydrofluoric acid, HF. Powdered boron oxidizes slowly when treated with nitric acid, $HNO_3$.

$$B + HNO_3 + H_2O \rightarrow H_3BO_3 + NO$$

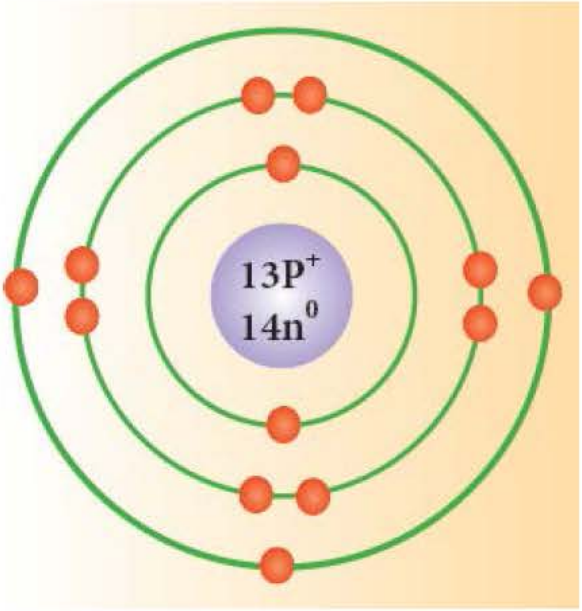
**5.Reaction of boron with strong base**

Boron react with strong base like sodium hydroxide ( NaOH) produce sodium borate:

$$2B + 6NaOH \rightarrow 2Na_3BO_3 + 3H_2$$

## Aluminum

| عدد الالكترونات | رقم الغلاف(n) | رمز الغلاف |
|---|---|---|
| 2 | 1 | K |
| 8 | 2 | L |
| 3 | 3 | M |




## Aluminum: reactions of elements

**1.Reaction of Aluminum with air**

Aluminum is a silvery white metal. Aluminum will burn in oxygen with a brilliant white flame to form the trioxide alumnium(III) oxide, $Al_2O_3$.

$$4Al(s) + 3O_2(l) \rightarrow 2Al_2O_3(s)$$

**2.Reaction of Aluminum with water**

Aluminum is a silvery white metal. Aulumium metal does not react with the water.

$$Al + H_2O \rightarrow \text{No reaction}$$

**3.Reaction of Aluminum with the halogens**

Aluminum metal reacts vigorously with all the halogens to form Aluminum halides. So, it reacts with chlorine, $Cl_2$, bromine, $I_2$, and iodine, $I_2$, to form respectively Aluminum(III) chloride, $AlCl_3$, Aluminum(III) bromide, $AlBr_3$, and Aluminum(III) iodide, $AlI_3$.

$$2Al(s) + 3Cl_2(l) \rightarrow 2AlCl_3(s)$$

$$2Al(s) + 3Br_2(l) \rightarrow 2AlBr_3(s)$$

$$2Al(s) + 3I_2(l) \rightarrow 2AlI_3(s)$$

**4.Reaction of Aluminum with acids**

Aluminum metal dissolves readily in dilute sulphuric acid to form solutions containing the aquated Al(III) ion together with hydrogen gas, $H_2$. The corresponding reactions with dilute hydrochloric acid also give the aquated Al(III) ion.

$$2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$$

$$2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g)$$

**5.Reaction of Aluminum with bases**

Aluminum dissolves in sodium hydroxide with the evolution of hydrogen gas, $H_2$, and the formation of aluminates of the type $[Al(OH)_4]^-$.

$$2Al(s) + 2NaOH(aq) + 6H_2O \rightarrow 2Na^+(aq) + 2[Al(OH)_4]^- + 3H_2(g)$$