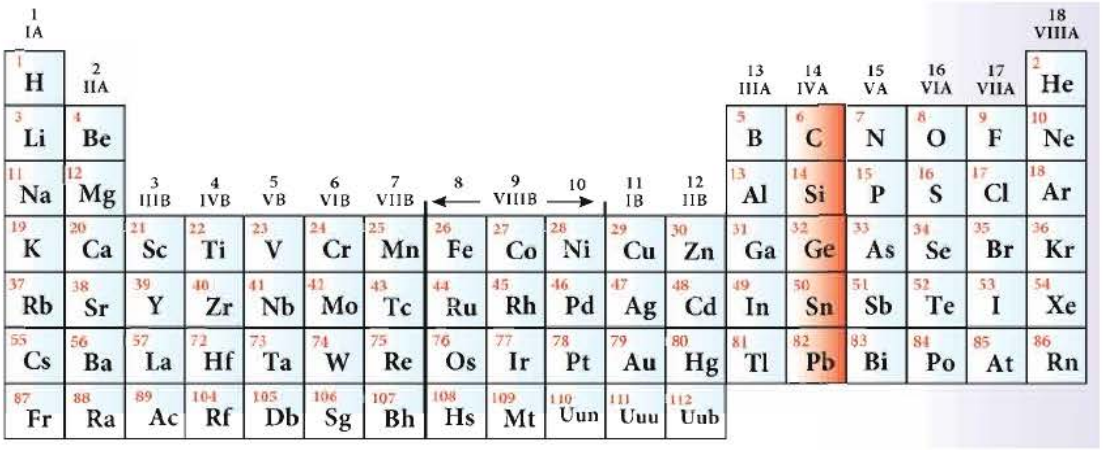
Fourth group IVA

1. The elements of this group are characterized present four electrons in the outer shell include: Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn), Lead (Pb).
2. The metallic properties of these elements including non-metallic for carbon properties but in silicon and germanium semi-metals, while tin and lead are considered as real metallic.
3. Decreased the boiling point and melting point from top to bottom of the group.
4. This group needs to gain or lose or contribute four electrons to reach a stable electronic arrangement and for the difficulty of losing or gain four electrons, they tend to share four electrons by forming a covalent bond.
5. Oxidative state of elements of this group +4.



Carbon: reactions of elements

1.Reaction of carbon with air

Carbon and also burns in air when heated to 600-800°C - an expensive way to make carbon dioxide!

$$C(s) + O_2(g) \rightarrow CO_2(g)$$

When the air or oxygen supply is restricted, incomplete combustion to carbon monoxide, CO, occurs.

$$2C(s) + O_2(g) \rightarrow 2CO(g)$$

2.Reaction of carbon with water

Carbon, either as graphite or diamond does not react with water under normal conditions. Under more forsing conditions, the reaction becomes important. In industry, water is blown through hot coke. The resulting gas is called water gas and is a mixture of hydrogen (H_2, 50%), carbon monoxide (CO, 40%), carbon dioxide (CO_2, 5%), nitrogen and methane ($N_2 + CH_4$, 5%).

$$C + H_2O \rightarrow CO + H_2$$

3.Reaction of carbon with the halogens

Graphite reacts with fluorine, F_2, at high temperatures to make a mixture of carbon tetrafluoride, CF_4, together with some C_2F_6 and C_5F_{12}.

$$C(s) + \text{excess } F_2(g) \rightarrow CF_4(g) + C_2F_6 + C_5F_{12}$$

The other halogens appear to not react with graphite.

4.Reaction of carbon with acids

Graphite reacts with the oxidizing acid hot concentrated nitric acid to form mellitic acid, $C_6(CO_2H)_6$.

Silicon: reactions of elements

1.Reaction of silicon with air

The surface of silicon is protected by a very thin layer of silicon dioxide, SiO_2. At temperatures above about 1400°C, silicon reacts with nitrogen, N_2, in the air as well as oxygen, to form the Si_3N_4.

$$Si(s) + O_2(g) \rightarrow SiO_2(s)$$
$$3Si(s) + 2N_2(g) \rightarrow Si_3N_4(s)$$

2.Reaction of silicon with water

The surface of lumps of silicon is protected by a very thin layer of silicon dioxide, SiO_2.

$$Si + 2H_2O \rightarrow SiO_2 + 2H_2$$

3.Reaction of silicon with the halogens

Silicon reacts with all the halogens to form silicon tetrahalides. So, it reacts with fluorine, F_2, chlorine, Cl_2, bromine, Br_2, and iodine, I_2, to form respectively silicon(IV) fluoride, SiF_4, silicon(IV) chloride, $SiCl_4$, silicon(IV) bromide, $SiBr_4$, and silicon(IV) iodide, SiI_4. The reaction with fluorine takes palce at room temperature but the others requiring warming over 300°C.

$$Si(s) + 2F_2(l) \rightarrow SiF_4(g)$$
$$Si(s) + 2Cl_2(l) \rightarrow SiCl_4(g)$$
$$Si(s) + 2Br_2(l) \rightarrow SiBr_4(l)$$
$$Si(s) + 2I_2(l) \rightarrow SiI_4(s)$$

4. Reaction of silicon with acids

Silicon does not react with most acids under normal conditions but is dissolved by hydrofluoric acid (HF)

$$Si(s) + 4HF(aq) \rightarrow [SiF_4] (aq) + 2H_2(g)$$

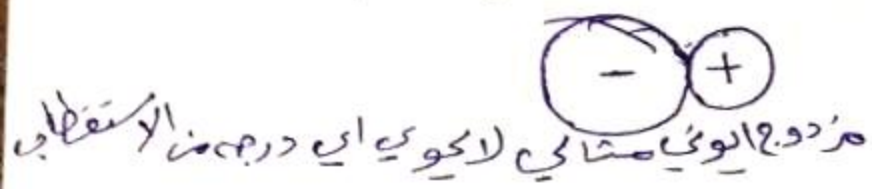
5.Reaction of silicon with bases

Silicon is attacked by bases such as aqueous sodium hydroxide to give silicates, highly complex species containing the anion $[SiO_4]^{4-}$.

$$Si(s) + 2NaOH(aq) + H_2O \rightarrow Na_2SiO_3 + 2H_2(g)$$

Ionic Compound Polarization

The electrostatic force excreted by a cation on an anion distorts its electron cloud, which has a tendency to move towards the cation. The degree of polarization is directly proportional to the charge of the cation and to its size . Due to polarization the ionic compound gains a certain degree of covalence.



الاستقطاب : هو التشوه المتبادل الذي يحدث لايوني المزدوج (A^+B^-)

Factors affecting the increase or decrease of polarization

1 - positive ion size: the smaller the size of the positive ion increased polarization because of the concentration of positive charge within the small size compared to scattering when the positive ion is large.

Melting point	Compounds
678	$BeCl_2$
985	$MgCl_2$
1009	$CaCl_2$
1145	$SrCl_2$
1233	$BaCl_2$

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The inverse ratio between polarization, radius and linearity between melting point and radius نصف القطر.

2 - When the positive ion charge increases, the polarization increases because the concentration of more than positive charge on the negative ion electrons generates a greater polarization force. Therefore, the increase in polarization increases the covalent

properties within the ionic compounds and decreases the melting points.

Melting point	Compounds
1073	$NaCl$
985	$MgCl_2$
453	$AlCl_3$

3 - The size of negative ion: the larger the size of the negative ion increased the polarization process because the large volume of negative ion leads to the alienation of its external electrons from its nucleus and thus easy to polarize by the positive ion.

Melting point	Compounds
1661	CaF_2
1009	$CaCl_2$
1003	$CaBr_2$
848	CaI_2

So the increase the size of the negative ion and the decrease the size of the positive ion increased the polarization and decreased the degrees of melting. The covalent bond increase and ionic properties decrease.

Hydrogen

Hydrogen, symbol H, is a reactive, colorless, odorless, and tasteless gaseous element. The atomic mass of hydrogen is 1.00797. The atomic number of hydrogen is 1. The element is usually classed in group 1 (or IA) of the periodic table. Electronic configuration is $1s^1$.

Preparation Methods of Hydrogen

Hydrogen is prepared in the laboratory:

1. by the action of a dilute strong acid on metals, such as zinc:

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$$

2. by reaction amphoteryc metals with dilute base, such as sodium hydroxide:

$$Zn + 2NaOH + 2H_2O \rightarrow Na_2[Zn(OH)_4] + H_2$$

3. by electrolysis of water:

$$2H_2O \xrightarrow{\text{electroles is}} 2H_2 + O_2$$

4. Industrially, hydrogen is prepared from water and hydrocarbons. Until recently the water-gas reaction was an important way of hydrogen preparing. The **water-gas reaction** is *an industrial process in which steam is passed over red-hot coke giving a gaseous mixture of carbon monoxide and hydrogen:*

$$C + H_2O(g) \rightarrow CO + H_2$$

Reactions of Hydrogen

1. Hydrogen reacts with many nonmetals. In these reactions it derives hydrogen-cation, H^+. Hydrogen combines with nitrogen in the presence of a catalyst forming ammonia:

$$3H_2 + N_2 \rightarrow 2NH_3$$

with sulfur forming hydrogen sulfide:

$$H_2 + S \rightarrow H_2S$$

with chlorine forming hydrogen chloride:

$$H_2 + Cl_2 \rightarrow 2HCl$$

and with oxygen forming water:

$$2H_2 + O_2 \rightarrow 2H_2O$$

The reaction of oxygen and hydrogen takes place at room temperature in the presence of a catalyst such as finely divided platinum only. When hydrogen is mixed with the air or oxygen and ignited, the mixture explodes.

2. Hydrogen also combines with some metals. Because of the small electron affinity of the hydrogen atom .Thus, sodium and calcium react with hydrogen gas at moderate temperatures giving the hydrides:

$$2Na + H_2 \rightarrow 2NaH$$

$$Ca + H_2 \rightarrow CaH_2$$

3. It acts as a reducing agent on metallic oxides, such as copper oxide, removing the oxygen and leaving the metal in a free state:

$$CuO + H_2 \rightarrow Cu + H_2O$$

4. Hydrogen reacts with unsaturated organic compounds forming corresponding saturated compounds:

$$CH_2{=}CH_2 + H_2 \rightarrow CH_3{-}CH_3$$

5.Reaction of hydrogen with water

Hydrogen does not react with water.

6.Reaction of hydrogen with the halogens

Hydrogen gas, H_2, reacts with fluorine, F_2, in the dark to form hydrogen(I) fluoride.

$$H_2(g) + F_2(g) \rightarrow 2HF(g)$$