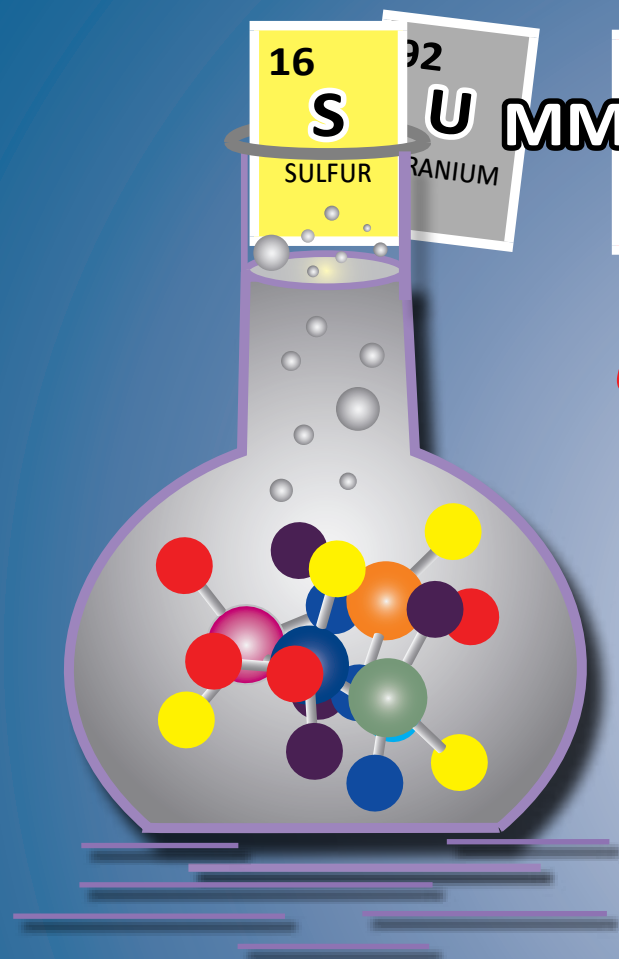
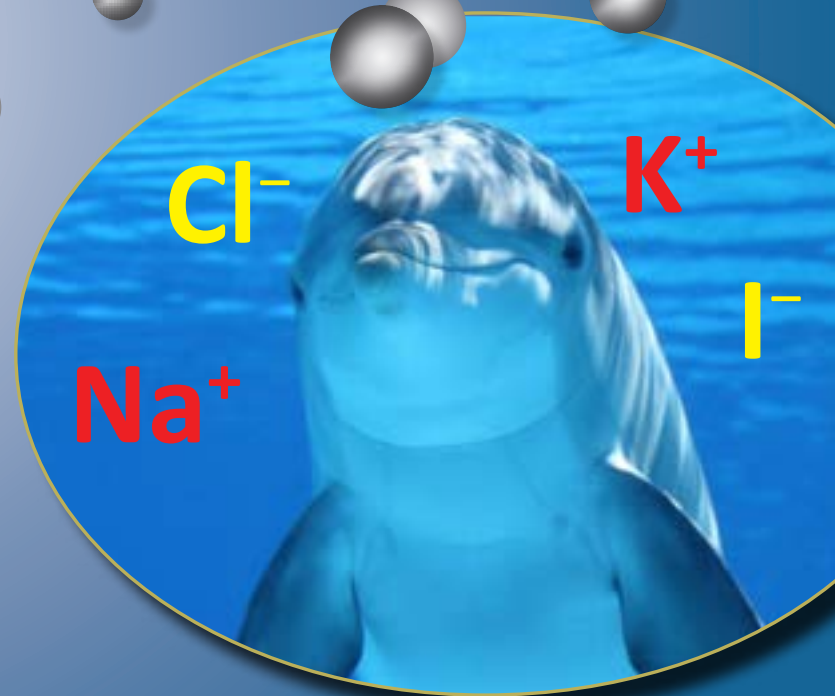
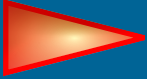




and REVISION

*Alkali metals
Sodium base
Halogens
Hydrochloric acid
Periodic law
Periodic table*



- **ALKALI METALS. SODIUM** **Na** **3**
- **HALOGENS. CHLORINE** **Cl₂** **12**
- **PERIODIC LAW. PERIODIC TABLE** **23**
-  **PROJECTS** **23**

Click on a topic to jump to the page

● Alkali metals. Sodium Na

KEY TOPICS

1. Which metals are alkali metals?
2. What are the physical properties of alkali metals?
3. Are alkali metals reactive substances?
4. Why is NaOH a base?
5. Are alkali bases dangerous substances?

KEY WORDS

- Alkali metals
- Sodium base
- Neutralization
- Carbonization
- Safety precautions



Na⁺

K⁺

WHAT ARE ALKALI METALS?

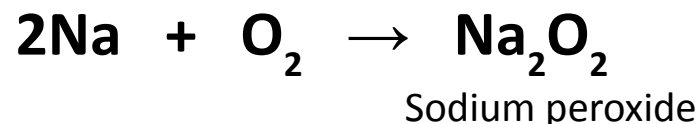
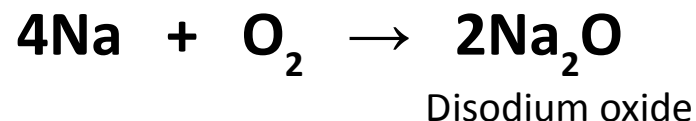
Lithium Li, sodium Na, potassium K, rubidium Rb and caesium Cs are commonly known as **alkali metals**. As suggests their name, they are metals. They have similar physical and chemical properties. Sodium is a well known element even in the everyday life – table salt is a compound made up of sodium and chlorine – NaCl.

SODIUM Na

Sodium is a crystalline substance but it is soft and can be cut with a knife. It is silvery white with a metallic lustre. It is a good conductor of heat and electricity. It is plastic and odourless. Sodium is lighter than water.

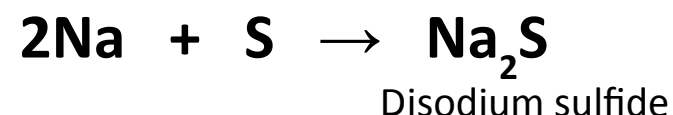
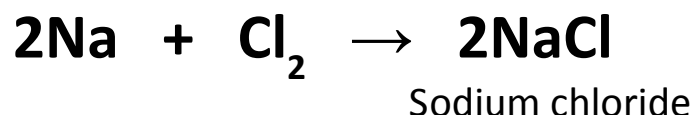
Typical for sodium are the reactions with oxygen O₂, nonmetals (for example chlorine Cl₂, sulfur S), water H₂O and acids (for example hydrochloric acid HCl):

REACTION WITH OXYGEN O₂. Depending on the amount of oxygen reacting with sodium the product is disodium oxide Na₂O or sodium peroxide Na₂O₂:



The reaction is vigorous and the surface of a freshly cut piece of sodium rapidly loses its lustre – a thin layer of oxide forms. For this reason sodium is always kept under petrol.

REACTION WITH CHLORINE Cl_2 AND SULFUR S. Sodium combines with chlorine and sulfur and forms compounds salts – sodium chloride NaCl and disodium sulfide Na_2S :



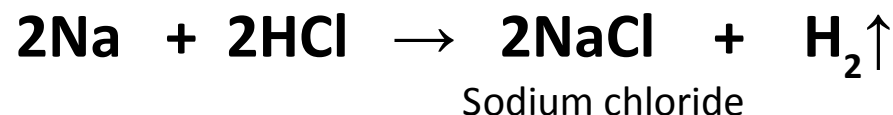
Both interactions are reactions of synthesis – two simple substances react to produce a chemical compound.

REACTION WITH WATER H_2O . This reaction is vigorous and a significant amount of heat is liberated:



The temperature rises rapidly and the evolved hydrogen gas (H_2) may ignite. The produced sodium base NaOH dissociates into positive sodium ions Na^+ and negative hydroxide ions OH^- .

REACTION WITH HYDROCHLORIC ACID HCl. Sodium displaces hydrogen of HCl producing the salt NaCl:



! Sodium is a highly hygroscopic substance and can cause severe injuries. Should not be touched with hands.

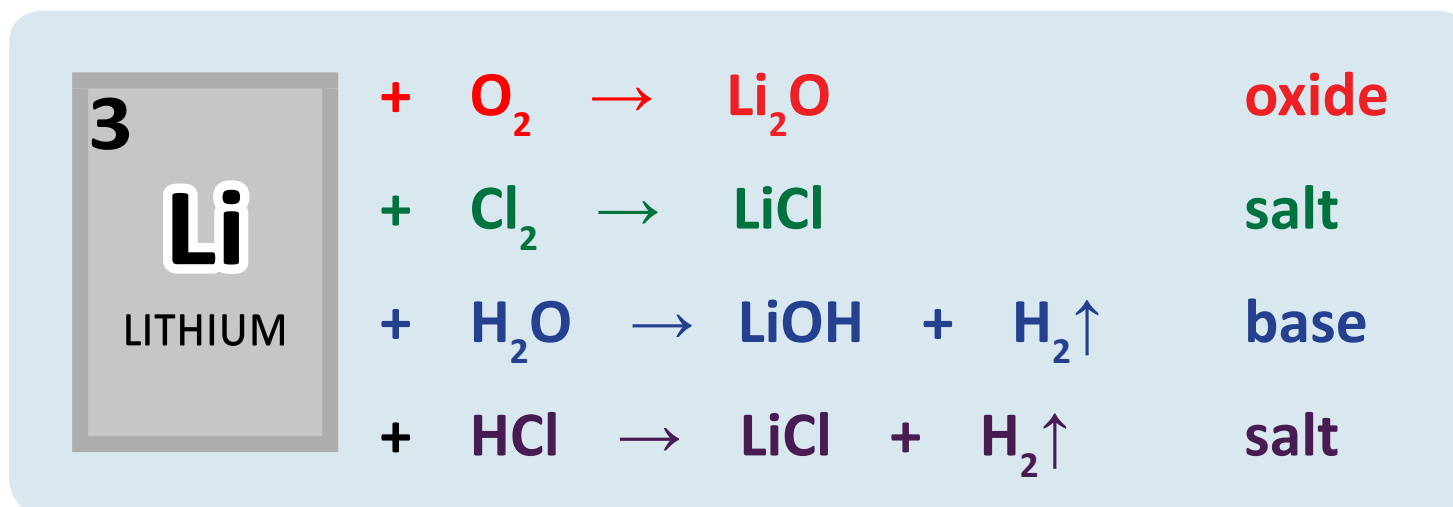
*The symbol „ $\uparrow$ “ is used to indicate that a gas is evolved in the atmosphere.

The other alkali metals (lithium Li, potassium K, rubidium Rb, and caesium Cs) are also typical metals. Their density, melting and boiling points change gradually with the increase of their relative atomic masses:

ALKALI METAL	Chemical symbol	Relative atomic mass	Density kg/m ³	Melting point °C	Boiling point °C
Lithium	Li	6,94	535	180,5	1341,8
Sodium	Na	22,99	971	98,8	883
Potassium	K	39,1	862	63,4	759
Rubidium	Rb	85,47	1532	39,3	688
Caesium	Cs	132,91	1879	28,4	670

Lithium is the lightest metal. Only rubidium and caesium are heavier than water. All alkali metals are soft but caesium is the softest metal.

The chemical properties of lithium, potassium, rubidium and caesium are similar to the chemical properties of sodium – typical are interactions with oxygen, chlorine, water and hydrochloric acid. For example the typical reaction for lithium are as follows (try to balance the equations):



The reaction of potassium with water is vigorous and as for sodium the evolved hydrogen gas may ignite. Rubidium and caesium react violently with water and the reaction proceeds with an explosion.

This set of chemical interactions determine the **metallic character** of the alkali metals.

The bases of alkali metals are well known compounds. NaOH is one of the most widely used.

Sodium base NaOH

Sodium base is a white crystalline compound. It is built up of positive sodium ions Na^+ and negative hydroxide ions OH^- . It is heavier than water (its density is $2\,139\text{ kg/m}^3$) Its melting and boiling points are high as compared to pure sodium ($322\text{ }^\circ\text{C}$ and $1\,380\text{ }^\circ\text{C}$).

NaOH is soluble in water and dissociates into Na^+ and OH^- ions:



Chemical compounds dissociating in water into positive metallic ions (Na^+ , K^+ , Ca^{2+} , etc.) and negative hydroxide ions OH^- are BASES.

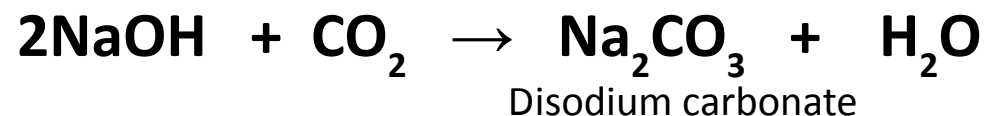
In aqueous solutions of bases red litmus paper turns blue. Phenolphthalein is pink-red.

For all basic aqueous solutions **pH > 7**.

***pH** is a measure of the basicity or the acidity of the solutions – its value is related to the amount of H^+ ions in the solution.

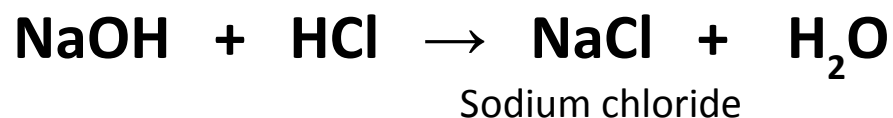
Typical chemical reactions of NaOH are its interactions with carbon dioxide CO₂ and hydrochloric acid HCl:

REACTION WITH CARBON DIOXIDE CO₂. NaOH transforms into a salt – Na₂CO₃:



Usually NaOH is a granular substance. If exposed to air the granules carbonize – a thin layer of Na₂CO₃ forms on their surface as sodium base reacts with carbon dioxide in the air.

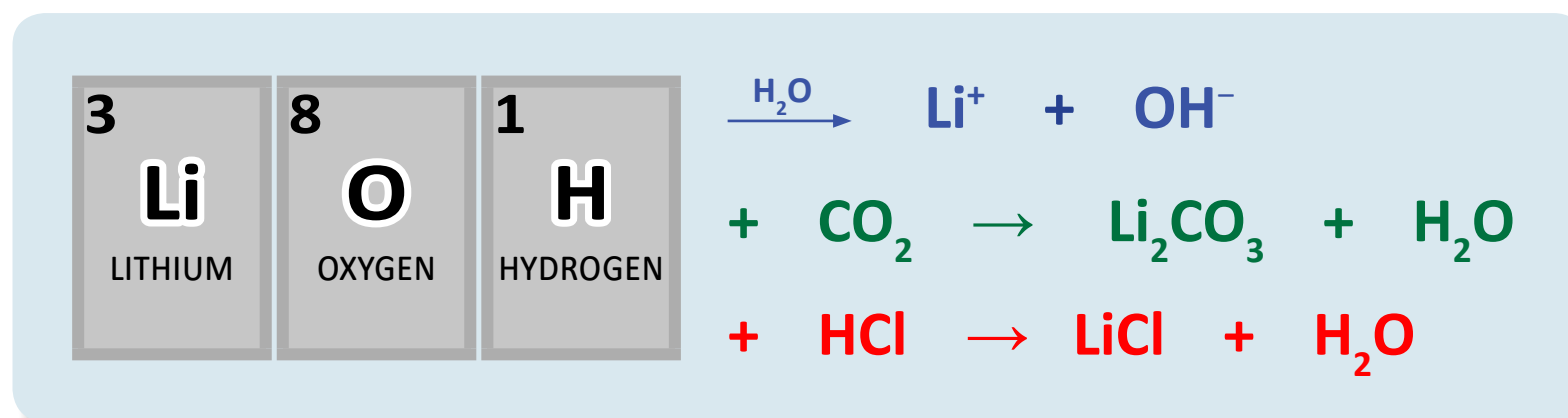
REACTION WITH HYDROCHLORIC ACID HCl. The reaction of sodium base with hydrochloric acid results in the production of a salt (sodium chloride NaCl) and the formation of water. This is a reaction of neutralization:



**The reaction of a base with an acid is called NEUTRALIZATION.
The products are a salt and water.**

Sodium base is a highly corrosive compound and safety precautions should be respected strictly when using it – goggles, protective gloves and an apron are obligatory.

The properties of the other alkali bases (LiOH, KOH, RbOH and CsOH) are similar to the properties of NaOH. For example lithium dissociates in water into positive lithium ions Li^+ and negative hydroxide ions OH^- , with carbon dioxide CO_2 it forms dilithium carbonate Li_2CO_3 and water and it neutralizes hydrochloric acid HCl to produce lithium chloride LiCl and water (try to balance the equations):



Rubidium base RbOH and caesium base CsOH are more aggressive compounds than sodium base NaOH and potassium base KOH. Caesium base corrodes even glass.

CAN YOU ANSWER THESE QUESTIONS ?

1. What are alkali metals?
2. Why are alkali metals kept under petrol?
3. How to produce table salt?
4. What products are made in the reaction of potassium with water?
5. What happens to granules of NaOH if exposed to air?
6. Why does red litmus paper turn blue in aqueous solutions of alkali bases?
7. What are the products of a neutralization reaction?
8. Why should safety precautions always be respected when using alkali bases?

● Halogens. Chlorine Cl

KEY TOPICS

1. Which nonmetals are halogens?
2. What are the physical properties of halogens?
3. Are halogens reactive substances?
4. Why is the dissolved in water HCl an acid?
5. Is chlorine harmful for man?

KEY WORDS

- Halogens
- Chlorination
- Hydrogen halides
- Hydrochloric acid
- Chlorides

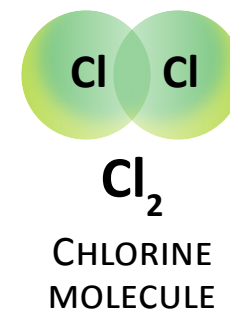


WHAT ARE HALOGENS?

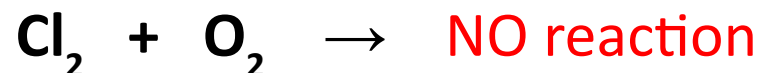
Fluorine F, chlorine Cl, bromine Br and iodine I are commonly known as **halogens**. They are typical nonmetals. They have similar physical and chemical properties. Chlorine is a well known element even in the everyday life – as we already mentioned table salt is a compound made up of sodium and chlorine – NaCl.

Chlorine Cl

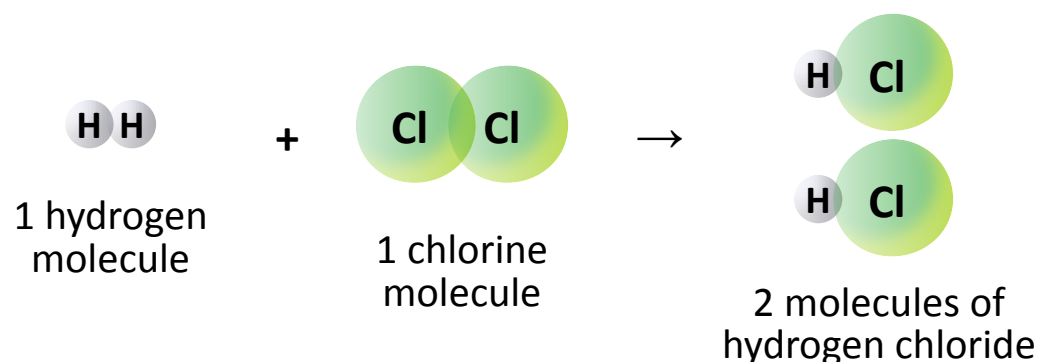
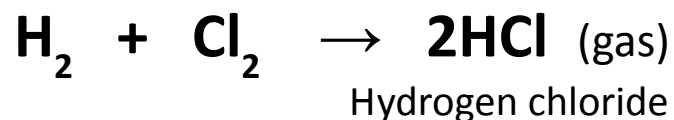
Chlorine is a suffocating pale yellow-green gas with a sharp odour. It is a molecular substance – two chlorine atoms bond to form diatomic molecules Cl_2 . It is an insulator – it does not conduct electricity and heat. Chlorine Cl_2 dissolves very well in water. Chlorine Cl_2 is a poison and can harm the respiratory system.



Chlorine is very reactive. Typical are the interactions with hydrogen H_2 , metals (for example potassium K, calcium Ca) water H_2O . **Chlorine does NOT react directly with oxygen!**

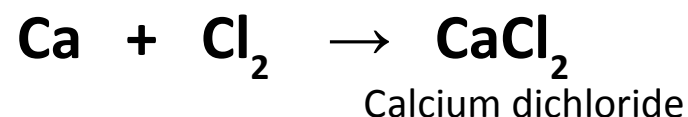


REACTION WITH HYDROGEN H_2 . Chlorine combines with hydrogen to produce a gas – HCl (hydrogen chloride):

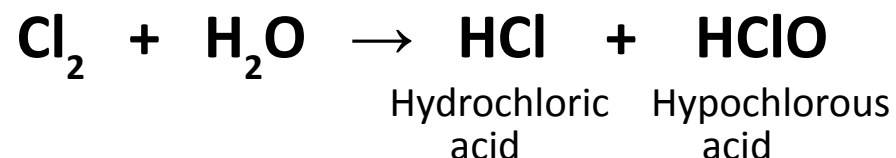


The mixture of hydrogen and chlorine can explode (it is an explosive hazard).

REACTION WITH METALS. In these reactions of chemical synthesis the products are salts called chlorides (sodium chloride NaCl, potassium chloride KCl, calcium dichloride $CaCl_2$). Chlorine is monovalent (as in the HCl molecules):



REACTION WITH WATER. Chlorine reacts with water. The process is known as chlorination of water. Hydrochloric acid (dissolved in water hydrogen chloride) and hypochlorous (HClO) acid are formed. The process is used to disinfect water:



Chlorine can be added to a solution of sodium base instead of pure water. Chlorine molecules react with sodium base and produce sodium chloride and sodium hypochlorite:



A dilute solution of NaClO is used as a bleaching agent in household. It is a whitener and a disinfectant.

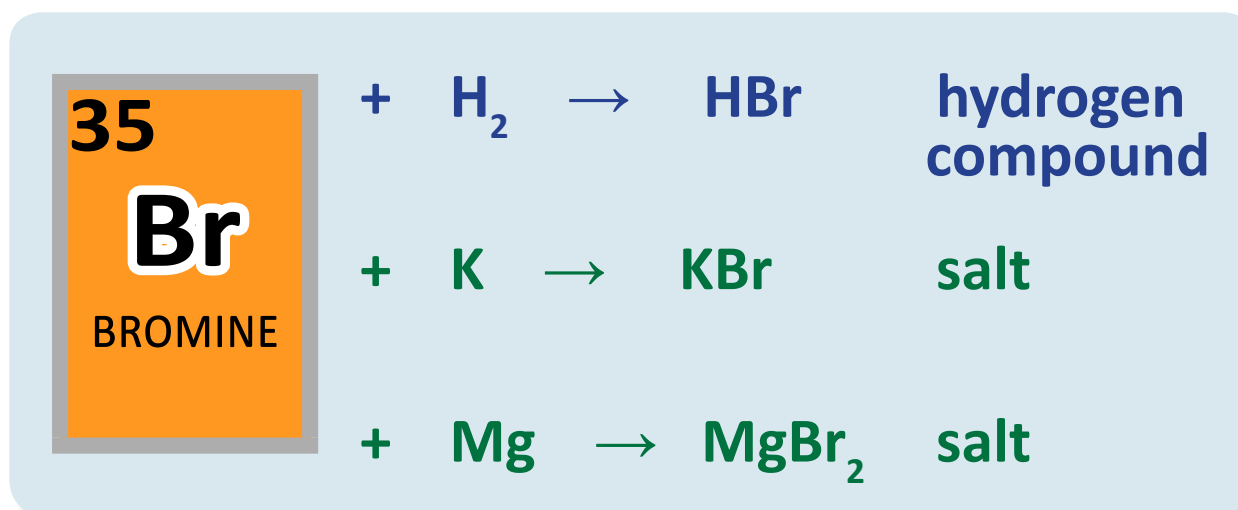
The other halogens (fluorine F, bromine Br, iodine I) are also typical nonmetals. Fluorine is a pale yellow gas, bromine is a dark red liquid and iodine is a red-violet fragile crystalline molecular solid:

HALOGENS	Chemical symbol	Physical state	Melting point °C	Boiling point °C
Fluorine	F	gas	– 219,6	– 188,1
Chlorine	Cl	gas	– 101,5	– 34,4
Bromine	Br	liquid	– 7,2	58,8
Iodine	I	solid	113,7	184,3

Fluorine (as chlorine) is toxic and with a sharp suffocating odour. Bromine and iodine are slightly soluble in water. Halogens are insulators. They do not conduct electricity and heat.

Halogens are reactive compounds. Fluorine F_2 is the most reactive nonmetal. It forms compounds with almost all chemical elements. The chemical activity of halogens decreases with the increase of their relative atomic masses. Iodine I_2 is the least reactive.

The chemical properties of fluorine, bromine and iodine are similar to the chemical properties of chlorine – typical are interactions with hydrogen and metals. For example the typical reactions for bromine are as follows (try to balance the equations):



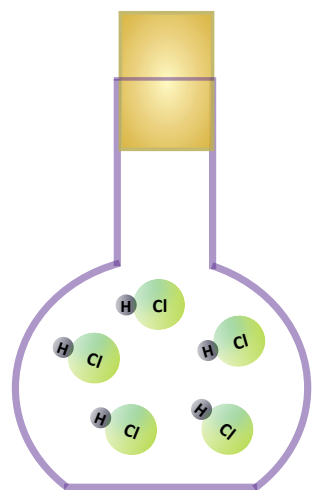
The reaction of fluorine with hydrogen is very fast. The reaction of chlorine is rapid only under the action of direct sunlight and heating. Bromine and iodine react with hydrogen only under heating. Hydrogen compounds of halogens are known as **hydrogen halides**. They are gases.

This set of chemical interactions determines the **nonmetallic character** of the halogens.

Hydrogen halides dissolve in water and decompose into positive hydrogen ions H^+ and negative ions of halogens (F^- , Cl^- , Br^- , I^-). They are acids. The most widely used is the hydrochloric acids HCl .

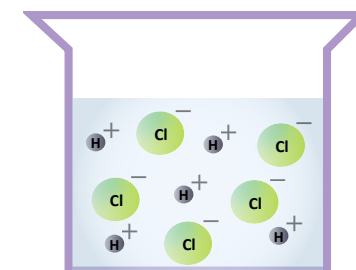
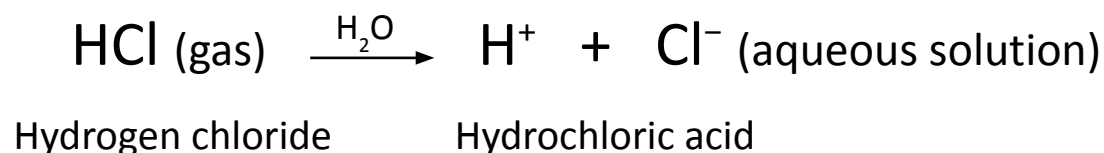
Chemical compounds dissociating in water into positive hydrogen ions H^+ and negative acidic ions (for example F^- , Cl^- , Br^- , I^-) are ACIDS.

Hydrochloric acid HCl



Hydrogen chloride HCl

The dissociation of hydrogen chloride (gas) in water is expressed as follows:



Hydrochloric acid HCl

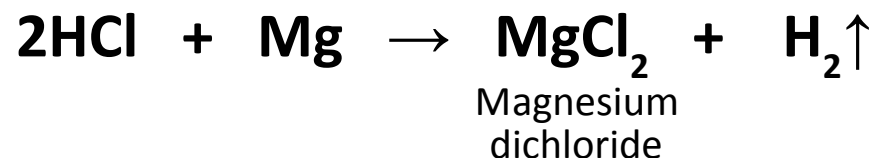
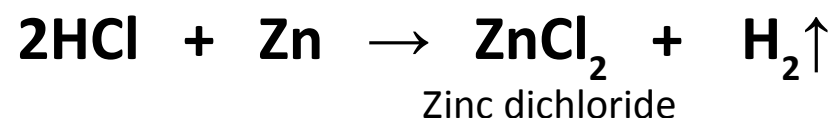
In aqueous solutions of acids blue litmus paper turns red.
Phenolphthalein is colourless.

For all acidic aqueous solutions **$\text{pH} < 7$** .

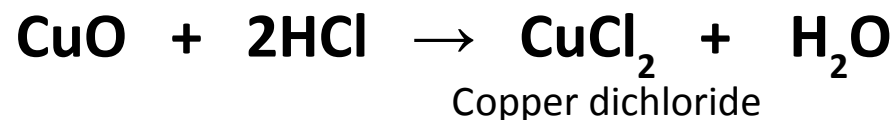
***pH** is a measure of the acidity or the basicity of the solutions – its value is related to the amount of H^+ ions in the solution.

Typical chemical reactions of hydrochloric acid HCl are its interactions with metals (for example zinc Zn, magnesium Mg), oxides of metals (for example copper oxide CuO) and with bases (for example LiOH, NaOH, KOH):

REACTION WITH METALS (Zn, Mg). Hydrochloric acid reacts with active metals and the products are a salt (chloride) and hydrogen H₂:

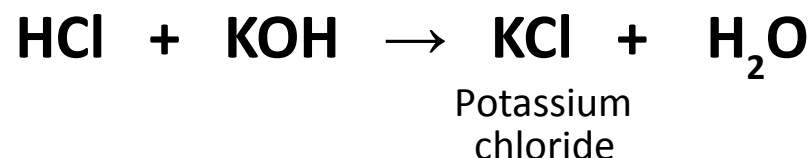


REACTION WITH OXIDES OF METALS. The products are always a salt (chloride) and water. For example with copper oxide:



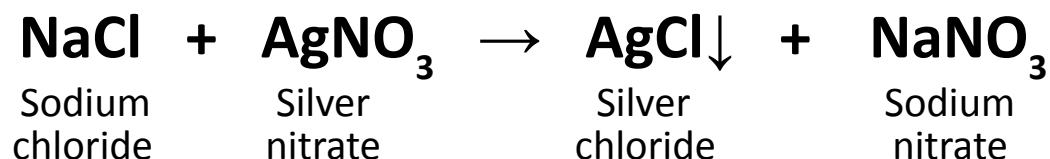
This is a double displacement reaction. The insoluble dark brown CuO transforms into CuCl₂ and the solution turns green-blue.

REACTION WITH BASES. This is a process of neutralization and the products are a salt (chloride) and water. For example with potassium base:



Chlorine is monovalent in all chlorides.

Most of chlorides are soluble in water and their aqueous solutions contain negative chloride ions Cl^- . Their presence is detected with a specific reagent – silver nitrate AgNO_3 . It is soluble in water and decomposes into Ag^+ and a 4-atomic negative ion NO_3^- . A reaction of double displacement occurs resulting in the formation of a white precipitate of the insoluble in water silver chloride AgCl :

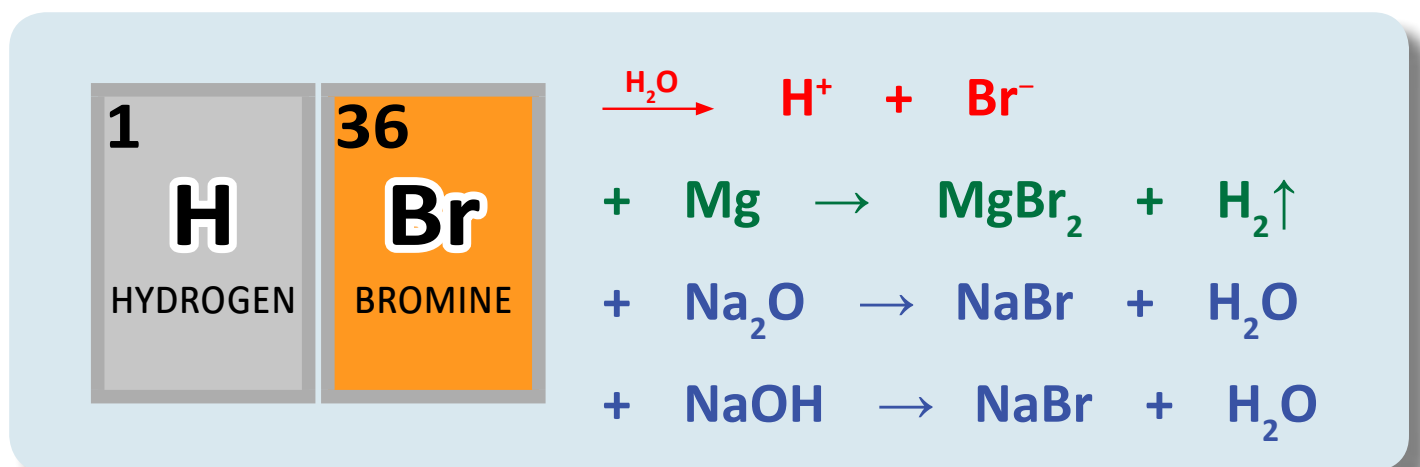


**THE INTERACTION WITH AgNO_3
IS A TEST REACTION FOR SOLUBLE CHLORIDES.**

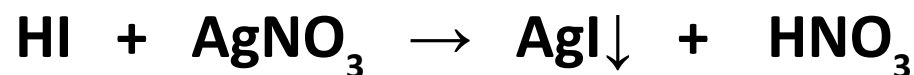
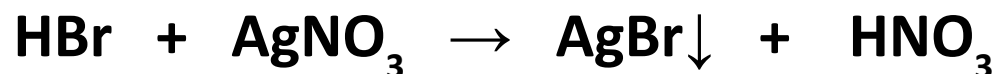
*The symbol „↓“ is used to indicate that a precipitate of an insoluble compound is formed.

The properties of the aqueous solutions of the other hydrogen halides (HF, HBr, HI) are similar to the properties of hydrochloric acid HCl. For example hydrogen bromide HBr dissociates in water into positive

hydrogen ions H^+ and negative bromide ions Br^- . With magnesium Mg it produces magnesium dibromide and water and with an oxide of metal (for example Na_2O) – a salt (bromide) and water. It neutralizes bases (for example sodium base NaOH) (try to balance the equations).



Test reagent for Br^- and I^- ions is also AgNO_3 (as for chloride ions Cl^-). Silver bromide AgBr and silver iodide AgI are insoluble in water salts. AgBr is a pale yellow compound while AgI is yellow:



white precipitate	AgCl Silver chloride
pale yellow precipitate	AgBr Silver bromide
yellow precipitate	AgI Silver iodide

CAN YOU ANSWER THESE QUESTIONS ?

1. Which of the known up today 118 elements are halogens?
2. Is chlorine harmful for man?
3. Is it possible to synthesize an oxide of chlorine in a direct reaction with oxygen?
4. How are hydrogen compounds of halogens called?
5. Why does HCl dissolved in water react as an acid?
6. What happens if a blue litmus paper is dipped in hydrochloric acid?
7. What is a neutralization reaction? What type of reaction is it?
8. What are salts? Give examples of reaction of HCl resulting in the formation of chlorides.

● Periodic law. Periodic table

KEY TOPICS

1. What does the periodic law state?
2. How is the periodic table organized?
3. What are periods?
4. What are groups (main and secondary)?
5. What is the periodic table used for?

KEY WORDS

- Periodic table
- Periodic law
- Atomic number
- Period
- Group

Periodic table showing elements and their atomic weights (A_r).

Elements highlighted with pink circles and arrows:

- Scandium, Sc $A_r = 45,0$
- Calcium, Ca $= 40$
- Zirconium, Zr $= 90$
- Hafnium, Hf $A_r = 178,5$

Other elements visible include: Gallium, Ga $A_r = 69,7$; Germanium, Ge $A_r = 72,6$; Niobium, Nb $= 94$; Vanadium, V $= 51$; Chromium, Cr $= 52$; Manganese, Mn $= 55$; Iron, Fe $= 56$; Cobalt, Co $= 59$; Nickel, Ni $= 58,7$; Copper, Cu $= 63,5$; Zinc, Zn $= 65,4$; Silver, Ag $= 108$; Cadmium, Cd $= 112$; Uranium, U $= 238$; Barium, Ba $= 137$; Lead, Pb $= 207$; Bismuth, Bi $= 210$; Thallium, Tl $= 204$; Tin, Sn $= 118$; Antimony, Sb $= 122$; Tellurium, Te $= 128$; Iodine, I $= 127$; Cesium, Cs $= 133$; Francium, Fr $= 223$; Radium, Ra $= 226$; Actinium, Ac $= 227$; Thorium, Th $= 232$; Protactinium, Pa $= 231$; Uranium, U $= 238$; Neptunium, Np $= 237$; Plutonium, Pu $= 244$; Americium, Am $= 243$; Curium, Cm $= 247$; Berkelium, Bk $= 247$; Californium, Cf $= 251$; Einsteinium, Es $= 252$; Fermium, Fm $= 257$; Mendelevium, Md $= 258$; Nobelium, No $= 259$; Lawrencium, Lr $= 262$.

ARE CHEMICAL ELEMENTS COMPLETELY DIFFERENT FROM EACH OTHER?

The answer is „yes“ and „no“ – each element is unique but there are elements displaying similar properties. For example alkali metals, halogens and others. Many attempts have been made to classify the known chemical elements but the first worldly recognized „summary“ of the human knowledge of the chemical elements was proposed by Dimitrii Mendeleev in 1869 – this was the first **PERIODIC TABLE** of the chemical elements (it is shown on the previous page). Today we know much more about the structure of atoms and molecules but the periodic table is used worldwide as a classification of the chemical elements.

1

IA

1

H

HYDROGEN

1,0079

2

IIA

3

Li

LITHIUM

6,94

4

Be

BERYLLIUM

9,01

11

Na

SODIUM

22,99

12

Mg

MAGNESIUM

24,31

19

K

POTASSIUM

39,10

20

Ca

CALCIUM

40,08

21

Sc

SCANDIUM

44,96

22

Ti

TITANIUM

47,87

23

V

Vanadium

50,94

24

Cr

Chromium

52,00

25

Mn

MANGANESE

54,94

26

Fe

IRON

55,85

27

Co

COBALT

58,93

28

Ni

NICKEL

58,69

29

Cu

COPPER

63,55

30

Zn

ZINC

65,38

37

Rb

RUBIDIUM

85,47

38

Sr

STRONTIUM

87,62

39

Y

Yttrium

88,91

40

Zr

ZIRCONIUM

91,22

41

Nb

NIObium

92,91

42

Mo

MOlybdenum

95,96

43

Tc

TECHNETIUM

(98)

44

Ru

RUTHENIUM

101,1

45

Rh

RHODIUM

102,9

46

Pd

PALLADIUM

106,4

47

Ag

SILVER

107,9

48

Cd

CADMIUM

112,4

55

Cs

CAesium

132,9

56

Ba

BARium

137,3

57

La

LANTHANUM

138,9

72

Hf

HAFNIUM

178,5

73

Ta

TANTALUM

180,9

74

W

TUNGSTEN

183,8

75

Re

RHENIUM

186,2

76

Os

OSMIUM

190,2

77

Ir

IRIDIUM

192,2

78

Pt

PLATINUM

195,1

79

Au

GOLD

197,0

80

Hg

MERCURY

200,6

87

Fr

FRANCIUM

(223)

88

Ra

RADIUM

(226)

89

Ac

ACTINIUM

(227)

104

Rf

RUTHERFORDIUM

(261)

105

Db

DUBNIUM

(262)

106

Sg

SEABORGIUM

(266)

107

Bh

BOHRNIUM

(264)

108

Hs

HASSIUM

(277)

109

Mt

MEITNERIUM

(268)

110

Ds

DARMSHTADTIUM

(281)

111

Rg

ROENTGENIUM

(272)

112

Cn

COPERNICIUM

(285)

113

Nh

NIHONIUM

(286)

114

Fl

FLEROVIUM

(289)

115

Mc

MOSCOWIUM

(290)

116

Lv

LIVERMORIUM

(293)

117

Ts

TENNESSINE

(294)

118

Og

OGANESSON

(294)

18

VIIIA

2

He

HELIUM

4,00

10

Ne

NEON

20,18

18

Ar

ARGON

39,95

36

Kr

KRYPTON

83,80

54

Xe

XENON

131,3

86

Rn

RADON

(222)

13

IIIA

5

B

BORON

10,81

14

IVA

6

C

CARBON

12,01

15

VA

7

N

NITROGEN

14,01

16

VIA

8

O

OXYGEN

16,00

17

VIIA

9

F

FLUORINE

19,00

13

Al

ALUMINUM

26,98

14

Si

SILICON

28,09

15

P

PHOSPHORUS

30,97

16

S

SULFUR

(32,06)

17

Cl

CHLORINE

35,45

13

Ga

GALLIUM

69,72

14

Ge

GERMANIUM

72,63

15

As

ARSENIC

74,92

16

Se

SELENIUM

(78,96)

17

Br

BROMINE

(79,90)

13

In

INDIUM

114,8

14

Sn

TIN

118,7

15

Sb

ANTIMONY

121,8

16

Te

TELLURIUM

127,6

17

I

IODINE

126,9

13

Tl

THALLIUM

204,3

14

Pb

LEAD

207,2

15

Bi

BISMUTH

(209,0)

16

Po

POLONIUM

(209)

17

At

ASTATINE

(210)

13

Nh

NIHONIUM

(286)

14

Fl

FLEROVIUM

(289)

15

Mc

MOSCOWIUM

(290)

16

Lv

LIVERMORIUM

(293)

17

Ts

TENNESSINE

(294)

18

Og

OGANESSON

(294)

3

IIIB

4

IVB

5

VB

6

VIB

7

VIIB

8

VIIIB

9

VIIIB

10

VIIIB

11

IB

12

IIB

Atomic Number

1

H

Symbol

HYDROGEN

Name

1s¹

Electronic Configuration

Relative Atomic Mass (atomic weight)

1,0079

alkali metals

alkaline earth metals

transition metals

lanthanides (lanthanoids)

actinides (actinoids)

other metals

inert elements (noble gases)

halogens

other nonmetals

6

58

Ce

CERIUM

140,1

59

Pr

PRASEODYMIUM

140,9

60

Nd

NEODYMIUM

144,2

61

Pm

PROMETHIUM

(145)

62

Sm

SAMARIUM

150,4

63

Eu

EUROPIUM

152,0

64

Gd

GADOLINIUM

157,3

65

Tb

TERBIUM

158,9

66

Dy

DYSPROSIUM

162,5

67

Ho

HOLMIUM

164,9

68

Er

ERBIUM

167,3

69

Tm

THULIUM

168,9

70

Yb

YTERBIUM

173,1

71

Lu

LUTETIUM

175,0

7

90

Th

THORIUM

232,0

91

Pa

PROTACTINIUM

231,0

92

U

URANIUM

238,0

93

Np

NEPTUNIUM

(237)

94

Pu

PLUTONIUM

(244)

95

Am

AMERICIUM

(243)

96

Cm

CURIUM

(247)

97

Bk

BERKELIUM

(247)

98

Cf

CALIFORNIUM

(251)

99

Es

EINSTEINIUM

(252)

100

Fm

FERMIUM

(257)

101

Md

MENDELEVIUM

(258)

102

No

NOBELIUM

(259)

103

Lr

LAWRENCIUM

(262)

f-elements

The periodic table illustrates the **PERIODIC LAW** also first formulated by Dimitrii Mendeleev. According to the modern knowledge it states that:

The properties of the elements recur periodically as their atomic numbers increase.

To each element is associated an atomic number and elements are arranged in order of increasing atomic numbers – the atomic number of an element is one less than the atomic number of the next element and one more than the atomic number of the previous element.

The elements in the periodic table are organized in **PERIODS** (horizontal rows) and **GROUPS** (vertical columns). The periodic table comprises **7 periods** and **18 groups** (8 main and 8 secondary groups as groups 8, 9 and 10 are considered as one secondary group). The main groups are known as A groups (IA to VIIIA), while the secondary groups are known as B groups (IB to VIIIB). In two rows below the 7th period are located two families of elements: *Lanthanides* – similar in properties with ^{57}La and *Actinides* – resembling ^{89}Ac .

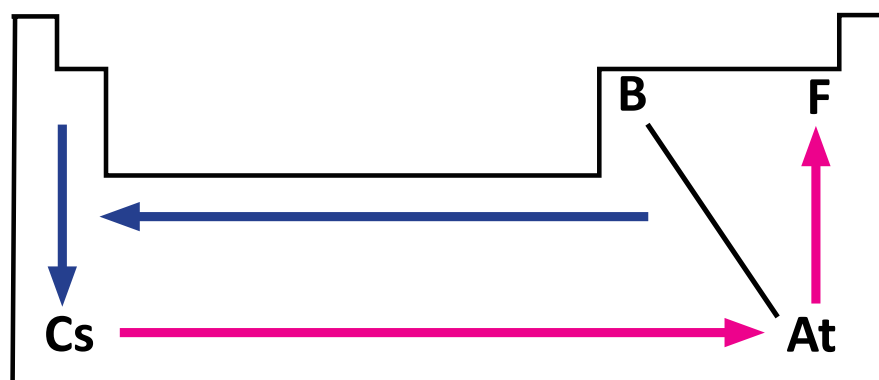
Each period starts with an alkali metal and ends with a noble gas:

2	3	4	5	6	7	8	9	10
	Li	Be	B	C	N	O	F	Ne
	LITHIUM	BERYLLIUM	BORON	CARBON	NITROGEN	OXYGEN	FLUORINE	NEON
	6,9	9	11	12	14	16	19	20
alkali metal	← More metallic elements						noble gas	

The elements in a vertical column (a group) have similar properties. For example the IA group elements are the alkali metals and the VIIA group elements are the halogens.

The properties of the elements change gradually along the periods and in the groups:

- Across a period with the increase of the atomic numbers elements become more nonmetallic;
- In a main group with the increase of the atomic numbers the elements become more metallic.



→ more nonmetallic elements

→ more metallic elements

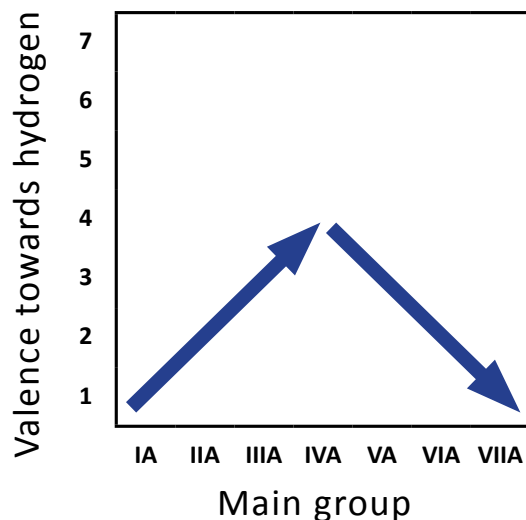
The most metallic chemical elements are situated in the left-hand lower corner. The most nonmetallic elements are to be found in the right-hand upper corner of the periodic table. The virtual line between B (Boron) and At (Astatine) is considered as a boundary between metallic and nonmetallic elements.

14 I(VA)

6	C CARBON 12
14	Si SILICON 28
32	Ge GERMANIUM 73
50	Sn TIN 119
82	Pb LEAD 207
114	Fr FLEROVIUM (289)

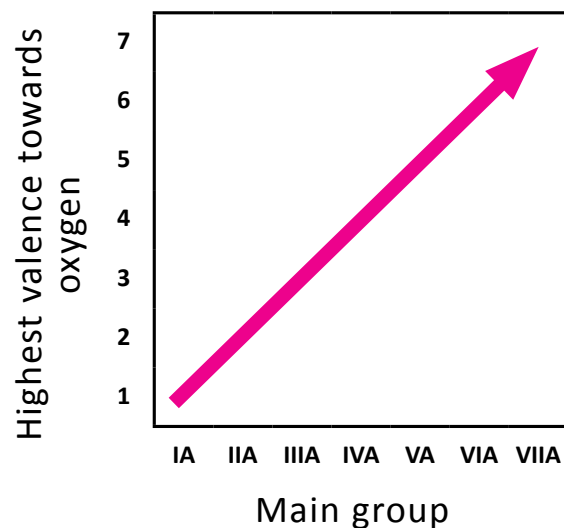
More nonmetallic elements

Generally, metallic elements combine with both hydrogen and oxygen to form compounds that are bases, while nonmetallic elements form acids. For example sodium is a typical metal and the compound NaOH is a base. Sulfur is a nonmetallic element and the compound H₂SO₄ is an acid.



Most of the elements form compounds with hydrogen H and with oxygen O. Their valence towards hydrogen is constant but many elements display a variable valence towards oxygen. **AS A RULE:**

- For the IA, IIA, IIIA and IVA groups elements the valence **towards hydrogen** is identical with the number of the main group – 1th, 2nd, 3th and 4th valence. For example NaH (IA), CaH_2 (IIA), BH_3 (IIIA) and CH_4 (IVA). For the VA, VIA and VIIA groups elements it is equal to $8 - \text{the number of the main group}$. For example NH_3 ($8 - 5 (\text{VA}) = 3$), H_2O ($8 - 6 (\text{VIA}) = 2$) and HCl ($8 - 7 (\text{VIIA}) = 1$);



IA and IIA group elements display a constant valence **towards oxygen** and it is identical with the group number. For example Li_2O (lithium is monovalent (IA group)) and CaO (calcium is divalent (IIA group)). Most of the other elements form two or more oxides (for example CO and CO_2). Their highest valence **towards oxygen** coincide with the main group number. For example CO_2 (carbon is a IVA group element and is tetravalent). N_2O_5 (nitrogen is a VA group element and its highest valence is the 5th), SO_3 (sulfur is a VIA group element and its highest valence is the 6th). Cl_2O_7 (chlorine is a VIIA group element and its highest valence is the 7th).

CAN YOU ANSWER THESE QUESTIONS ?

1. Why is the periodic law a fundamental law of the material world?
2. Why is the periodic table a „classification“ of all chemical elements?
3. What are periods and what are groups?
4. How does the character of chemical elements change across a period and down a main group?
5. Which element is more metallic – lithium Li or caesium Cs?
6. Which element is more nonmetallic – fluorine F or iodine I?
7. How to determine the valence towards hydrogen and oxygen of the main groups elements?



PROJECTS

1. THE PERIODIC TABLE – HISTORY

Learn more about the invention of the periodic table and the Mendeleev's predictions about some of the undiscovered at this time chemical elements.

2. ALKALI METALS

Learn more about the structure and properties of alkali metals. Search information about some interesting uses of these metals. Are they recycled?

3. CHLORINE AND HYDROGEN CHLORIDE

How to produce chlorine and hydrogen chloride (on an industrial scale and in the laboratory)? Describe the chemical processes and pay special attention to the environmental issues.

4. FREONS

What are freons? How do they affect environment? Why is their use restricted?