Chemistry

I. Chemical elements and their pronunciation in English

II. Chemical nomenclature

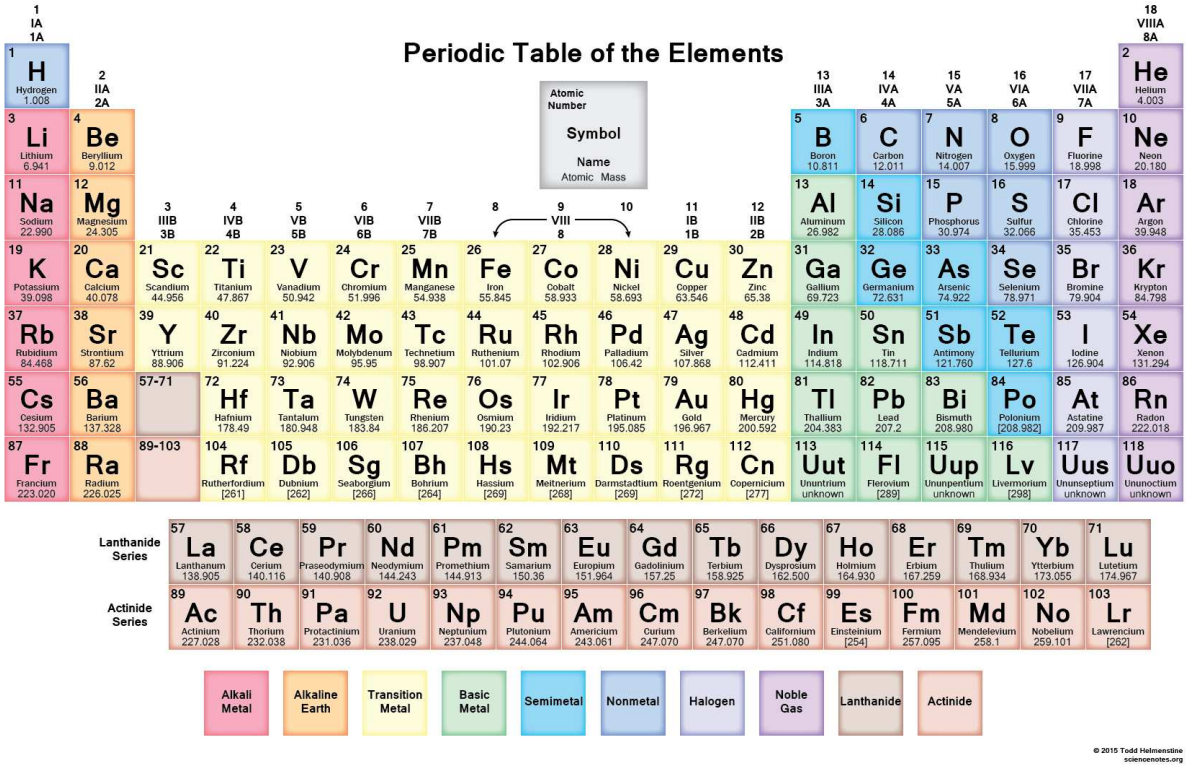
1. **Inorganic chemistry – naming inorganic compounds**
2. **Organic chemistry – naming organic compounds**

III. How to read chemical formulas in inorganic chemistry – examples

IV. How to read chemical formulas in organic chemistry – examples

V. Notes on reading chemical formulas

VI. Some abbreviations in common use in chemistry



Source: http://sciencenotes.org/wp-content/uploads/2015/01/PeriodicTableMuted.png

Symbol	Atomic number	English	Pronunciation	Czech
Ac	89	actinium	*æk'tiniəm*	aktinium
Ag	47	silver	*silvə*	stříbro
Al	13	aluminium	*ælə'miniəm*	hliník
Am	95	americium	*əme'risiəm*	americium
Ar	18	argon	*'a:gən*	argon
As	33	arsenic	*'a:sənik*	arsen
At	85	astatium	*əs'teitiəm*	astat
Au	79	gold, aurum	*'gəuld; 'o:rəm*	zlato
B	5	boron	*'bo:ron*	bór
Ba	56	barium	*'beəriəm*	baryum
Be	4	beryllium	*bə'riliəm*	beryllium
Bh	107	bohrium	*'bo:riəm*	bohrium
Bi	83	bismuth	*'bizməə*	bizmut

Bk	97	berkelium	*bəːˈkeiliəm*	berkelium
Br	35	bromine	*ˈbrəumiːn*	bróm
C	6	carbon	*ˈkɑːbən*	uhlík
Ca	20	calcium	*ˈkælsiəm*	vápník
Cd	48	cadmium	*ˈkædmiəm*	kadmium
Ce	58	cerium	*ˈsiəriəm*	cer
Cf	98	californium	*ˌkæliˈfoːniəm*	kalifornium
Cl	17	chlorine	*ˈkloːriːn*	chlór
Cm	96	curium	*ˈkjuəriəm*	curium
Cn	112	copernicium	*kopənˈiːšiəm*	kopernicium
Co	27	cobalt	*ˈkəuˌboːlt*	kobalt
Cr	24	chromium, chrome	*ˈkrəumiəm, ˈkrəum*	chróm
Cs	55	caesium	*ˈsiːziəm*	cesium
Cu	29	copper, cuprum	*ˈkopə, ˈkjuːprəm*	měď
Db	105	dubnium	*ˈdubniəm*	dubnium
Ds	110	darmstadtium	*ˌdɑːmˈstætiəm*	darmstadtium
Dy	66	dysprosium	*ˌdisˈprəuziəm*	dysprosium
Es	99	einsteinium	*ˌainˈstainiəm*	einsteinium
Er	68	erbium	*ˈəːbiəm*	erbium
Eu	63	europium	*ˌjuəˈrəupiəm*	europium
F	9	fluorine	*ˈfluəriːn*	fluor
Fe	26	iron, ferrum	*ˈaiən, ˈferəm*	železo
Fl	114	flerovium	*fleˈrəuviəm*	flerovium
Fm	100	fermium	*ˈfəːmiəm*	fermium
Fr	87	francium	*ˈfrænsiəm*	francium
Ga	31	gallium	*ˈgæliəm*	gallium
Gd	64	gadolinium	*ˌgædəˈliniəm*	gadolinium
Ge	23	germanium	*ˌdžəːˈmeiniəm*	germanium
H	1	hydrogen	*ˈhaidrədžən*	vodík
He	2	helium	*ˈhiːliəm*	helium
Hf	72	hafnium	*ˈhɑːfniəm*	hafnium
Hg	80	mercury	*ˈməːkjuri*	rtuť
Ho	67	holmium	*ˈhəulmiəm*	holmium
Hs	108	hassium	*ˈhæsiəm*	hassium
I	53	iodine	*ˈaiədiːn*	jód
In	49	indium	*ˈindiəm*	indium
Ir	77	iridium	*aiˈridiəm*	iridium
K	19	potassium	*pəˈtæsiəm*	draslík
Kr	36	krypton	*ˈkriptən*	krypton
La	57	lanthanum	*ˈlænθənəm*	lanthan
Li	3	lithium	*ˈliθiəm*	lithium
Lu	71	lutecium	*luˈtiːšiəm*	lutecium
Lv	116	livermorium	*ˌlivəˈmoːriəm*	livermorium
Lw	103	lawrentium	*ˌloːˈrentiəm*	lawrencium
Md	101	mendelevium	*ˌmendəˈliːviəm*	mendelevium
Mg	12	magnesium	*mægˈniːziəm*	hořčík
Mn	25	manganese	*ˈmængəniːz*	mangan
Mo	42	molybdenum	*məˈlibdinəm*	molybden
Mt	109	meitnerium	*maitˈneːriəm*	meitnerium

N	7	nitrogen	*ˈnaitrədžən*	dusík
Na	11	sodium	*ˈsəudiəm*	sodík
Nb	41	niobium	*naiˈəubiəm*	niob
Nd	60	neodymium	*niəˈdimiəm*	neodym
Ne	10	neon	*ˈni:on*	neon
Ni	28	nickel	*ˈnikl*	nikl
No	102	nobelium	*ˌnəuˈbi:liəm*	nobelium
Np	93	neptunium	*ˌnepˈtju:niəm*	neptunium
O	8	oxygen	*ˈoksidž(ə)n*	kyslík
Os	76	osmium	*ˈozmiəm*	osmium
P	15	phosphorus	*ˈfosfərəs*	fosfor
Pa	91	protactinium	*ˌproutækˈtiniəm*	protaktinium
Pb	82	lead, plumbum	*ˈled, ˈplʌmbəm*	olovo
Pd	46	palladium	*pəˈleidiəm*	palladium
Pm	61	prometheum	*prəˈmi:ɵiəm*	promethium
Po	84	polonium	*pəˈləuniəm*	polonium
Pr	59	praseodymium	*ˌpræziəˈdimiəm*	praseodym
Pt	78	platinum	*ˈplætinəm*	platina
Pu	94	plutonium	*ˌplu:ˈtəouniəm*	plutonium
Ra	88	radium	*ˈreidiəm*	radium
Rb	37	rubidium	*ruˈbidiəm*	rubidium
Re	75	rhenium	*ˈri:niəm*	rhenium
Rf	104	rutherfordium	*rʌðəˈfo:diəm*	rutherfordium
Rg	111	roentgenium	*ˌrənˈdži:niəm*	roentgenium
Rh	45	rhodium	*ˈrəudiəm*	rhodium
Rn	86	radon	*ˈreidən*	radon
Ru	44	ruthenium	*ˌru:ˈɵiniəm*	ruthenium
S	16	sulphur	*ˈsʌlfə*	síra
Sb	51	antimony	*ˈæntiməni*	antimon
Sc	21	scandium	*ˈskændiəm*	skandium
Se	34	selenium	*siˈliniəm*	selen
Sg	106	seaborgium	*si:ˈbogiəm*	seaborgium
Si	14	silicon	*ˈsilikən*	křemík
Sm	62	samarium	*səˈmɑ:riəm*	samarium
Sn	50	tin, stannum	*ˈtin, ˈstænəm*	cín
Sr	38	strontium	*ˈstrontiəm*	stroncium
Ta	73	tantalum	*ˈtæntələm*	tantal
Tb	65	terbium	*ˈtə:biəm*	terbium
Tc	43	technecium	*tekˈnišiəm*	technecium
Te	52	tellurium	*teˈljuəriəm*	tellur
Th	90	thorium	*ˈɵo:riəm*	thorium
Ti	22	titanium	*taiˈteiniəm*	titan
Tl	81	thallium	*ˈɵæliəm*	thalium
Tm	69	thullium	*ˈɵju:liəm*	thulium
U	92	uranium	*juˈreiniəm*	uran
Uuo	118	ununoctium	*ə,nanˈoktiəm*	ununoctium
Uup	115	ununpentium	*ə,nanˈpentiəm*	ununpentium
Uus	117	ununseptium	*ə,nanˈseptiəm*	ununseptium
Uut	113	ununtrium	*əˈnantriəm*	ununtrium
V	23	vanadium	*vəˈneidiəm*	vanad

W	74	tungsten	*'taŋstən*	wolfram
Xe	54	xenon	*'zi:nən*	xenon
Y	39	yttrium	*'itriəm*	yttrium
Yb	70	ytterbium	*i'tə:biəm*	ytterbium
Zn	30	zinc	*'zink*	zinek
Zr	40	zirconium	*zə'kəuniəm*	zirkonium

Notes:

- Before a newly found element is assigned its final name confirmed by IUPAC (International Union of Pure and Applied Chemistry), its name is based on a **system of temporary names**. They use prefixes based on Latin and Greek numerals indicating the atomic number followed by the ending – (i)um. Thus, e.g., livermorium (atomic number 116), the heaviest element yet and one of the latest products of nuclear fusion, called after the research centre in Livermore, USA, was first referred to as ununhexium.

System of prefixes (and their symbols):

0 - nil (n)	1 - un (u)	2 - bi (b)	3 - tri (t)
4 - quad (q)	5 - pent (p)	6 - hex (h)	7 - sept (s)
8 - oct (o)	9 - enn (e)		

For example:
the yet unnamed element with atomic number 113 can be theoretically called ununtrium (= un+un+tri+um)
the yet unnamed element with atomic number 115 can be theoretically called ununpentium (= un+un+pent+ium)

- From the point of **history**, the names of elements can be divided into several groups, reflecting, for example:

- the **mineral** in which they were found, e.g.
  calcium – vápník - from the Latin word *calx* (= vápno)
  silicon – křemík - from the Latin word *silex* (= křemen)
- the **colour** properties, e.g.
  chlorine - chlór – from the Greek word *chloros* (= yellowgreen)
  iodine – jód – from the Greek word *ioeidés* (= violet); its vapours are violet
- the names of **planets and stars,** e.g.
  helium – helium – from the Greek word *helios* (= Sun)
  mercury – rtuť – from the French word *mercure* (= rtuť) and the Greek hero
  neptunium – neptunium – after the name of the planet *Neptun* and the god
- figures from **mythology or history**, e.g.
  tantalum – tantal – after the Greek king *Tantalos*
  prometheum – promethium – after the Greek hero *Prometheus*
- names of **famous scientists**, e.g.
  fermium – fermium – after E. *Fermi*, the Italian physicist
  mendelevium – mendelevium – after D. I. *Mendeleev*, the Russian chemist
  bohrium – bohrium – after N. *Bohr*, the Danish scientist
- **geohraphical** terms, e.g.

polonium – polonium – after *Poland,* the country of M. Curie-Sklodowska
dubnium – dubnium – after *Dubna*, the Russian centre of nuclear research
livermorium – livermorium – after *Livermore,* the US centre of nuclear research
gallium – gallium – after *Gallia*, the Latin word for France

- Symbols of chemical elements are **pronounced** as letters of the alphabet, e.g.
U [ju:] H [eič] S [es]

- There are **differences in the spelling** of some names between British (BE) and American English (AE), for example:

in **BE** aluminium	in **AE** aluminum
sulphur, sulphate, sulphite	sulfur, sulfate, sulfite

- In compounds, some elements use also the **Latin version** of their name:
Gold – Aurum Iron – Ferrum (e.g. Ferrum oxide)
Lead – Plumbum Tin – Stannum

II. Chemical nomenclature

Chemical nomenclature /nəu´menkleičə/ is a system of rules for naming chemical compounds which is to ensure that the name of every compound, whether spoken or written, matches a single substance, and, if possible, that the substance has a single name.
The **first attempt** to provide a system of naming compounds goes back to the late 18th century (A. Lavoisier) and has been constantly refined. The present nomenclature of inorganic and organic compounds as recommended by IUPAC can be found in its Red Book and Blue Book, respectively. However, there exist even other forms of naming depending on the user and addressee. Therefore, there is **no single correct form of nomenclature,** but there are various forms appropriate to the circumstances. The traditional system for naming inorganic compounds used below is intended for both non-specialist and specialist users among engineering students.

Beginnings of the **Czech inorganic nomenclature** go back to the first half of the 19th century (J. S. Presl, J. Jungmann). However, fundamental for the system is the contribution of B. Batěk and E. Votoček of 1914 and 1941, expressing the oxidation state/number of elements, namely the system of affixes (-ný, -natý, -itý, -ičitý, -ičný/-ečný, -ový, -istý, -ičelý).

1. Inorganic chemistry – naming inorganic compounds

A) Oxides

The nomenclature of oxides depends mainly on the number of oxides which the given element can form.

1) If the element forms **only one** oxide, the name of the element (cation) comes first, without any change (irrespective of the valence state of the element), followed by the word “oxide” [*´oksaid*], i.e.

element + oxide

e.g. Al_2O_3 – aluminium oxide (oxid hlinitý)

2) If the given element can form **more than one** oxide, the valence state is taken into consideration. It is expressed by:

a) **prefixes** **mono-** [*´monə-, ´mono-, ´monəu*]
di- [*dai-*]
tri- [*trai-*]
tetr(a)- [*´tetrə-*]
pent(a)- [*´pentə-/ pen´tæ-*]
hex(a)- [*´heksə-/ hek´sæ-*]
hept(a)- [*´heptə/, hep´tæ-*]
oct(a)- [*´oktə-/ ok´tæ-*]

The prefix becomes part of the word "oxide"

element + mono/di…oxide

e.g. NO_2 – nitrogen dioxide (oxid dusičitý)
N_2O_3 – nitrogen trioxide (oxid dusitý)
N_2O_5 – nitrogen pentoxide (oxid dusičný)

b**) affixes** **-ous** [*-əs*] (for the lower valence state)
-ic [*-ik*] (for the higher valence state)

The affix is added to the name of the cation to distinguish between the R_2O and RO types of oxides. They are used only with Latin names of elements:

cation of the element …ous + oxide
cation of the element …ic + oxide

e.g. N_2O – nitrous oxide (oxid dusný)
NO – nitric oxide (oxid dusnatý)

c) **prefix** **sesqui-** [*´seskwi-*]
The prefix becomes part of the word "oxide" of the R_2O_3 type

element + sesquioxide

e.g. Mn_2O_3 – manganese sesquioxide (oxid manganitý)

d) **prefix** **sub-** [*sab-*] or **hemi-** [*´hemi-*]
The prefix denotes an oxide in a valence state lower than the common valence state of the element:

element + sub/hemi…oxide

e.g. Pb_2O – lead suboxide, lead hemioxide (suboxid železa)

e) **prefix** **per-** [*pə-*] or
super- [*ˊsju(:)pə-*]
The prefix denotes a peroxide**.**

e.g. H_2O_2 – hydrogen peroxide (peroxide vodíku)

3) Oxides with **two different valence states** of the element are denoted by combining the names of both oxides:

Fe_3O_4 – ferriferous oxide, ferrosoferric oxide (oxid železnato-železitý)

B) Acids

1) **Acids not containing oxygen atoms** are denoted by:

a) **affix –ic** [*-ik*] and the word "acid" [*ˊæsid*]:

e.g. HCl – hydrochloric acid (kyselina chlorovodíková)
HI – hydroiodic acid (kyselina jodovodíková)

b) or the acidic molecules can be considered compounds with hydrogen and the **names are formed as with oxides**:

e.g HCl – hydrogen chloride (chlorovodík, plyn)
HI – hydrogen iodide (jodovodík, plyn)

2) **Acids containing oxygen atoms**:
To name the acid, the number of possible acids is decisive:

a) If **only one** acid can be formed, its name is formed by adding **–ic** [*-ik*] to the element

e.g. H_2CO_3 – carbonic acid (kyselina uhličitá)

b) If **only two** acids can be formed, as with oxides, the affix **–ous** [*-əs*] denotes the lower valence acid and **–ic** [*-ik*] the higher valence acid:

e.g. HNO_2 – nitrous acid (kyselina dusitá)
HNO_3 – nitric acid (kyselina dusičná)

c) If the given element forms **more than two** acids, the acid in the lowest valence state combines the prefix **hypo-** [*´haipəu-*] with the affix **–ous** [*-əs*]; for the highest valence the affix **–ic** [*-ik*] and the prefix **per-** [*pə-*] are combined:

e.g. HClO – hypochlorous acid (kyselina chlorná)
$HClO_2$ – chlorous acid (kyselina chloritá)
$HClO_3$ – chloric acid (kyselina chlorečná)
$HClO_4$ – perchloric acid (kyselina chloristá)

d) Similar to the Czech nomenclature, the English system uses the following prefixes
meta- [*´metə-*]
ortho- [*´oθə-, o´θo-*]
pyro- [*´pairəu-*]
thio- [*´θaiəu-*]
hypo- [*´haipə-*]:

e.g. HPO_3 – metaphosphoric acid (kyselina metafosforečná)
H_3PO_4 – orthophosphoric acid (kyselina trihydrogenfosforečná)
$H_4P_2O_7$ – pyrophosphoric acid (kyselina difosforečná)
H_3PO_3S – thiophosphoric acid (kyselina thiofosforečná)

C) Hydroxides

Similar to oxides, the word **hydroxide** [*hai´droksaid*], is combined

1) with the unchanged name of the cation if **only one** hydroxide can be formed:

e.g. NaOH – sodium hydroxide (hydroxid sodný)

2) with the name of the element with affixed **–ous** [*-əs*] or **–ic** [*-ik*] to distinguish between the lower and higher valence states, respectively:

e.g. $Fe(OH)_2$ – ferrous hydroxide (hydroxid železnatý)
$Fe(OH)_3$ – ferric hydroxide (hydroxid železitý)

D) Salts

1. Salts of acids not containing oxygen atoms:
To name the salt, the number of possible salts is decisive:

a) If the cations form a salt in a **single valence state**, the name is formed as with oxides, i.e. the cation remains unchanged and the name is given by the anion with the affix **–ide** [*-aid*]:

element + anion…ide

e.g. NaCl – sodium chloride (chlorid sodný)

2) If the cation forms salts in **various valence states**, then, similar to oxides, the valence state is taken into consideration. It is expressed by**:**

a) **prefixes mono-** [*´monə-, ´mono-, ´monəu-*]
di- [*dai-*]
tri- [*trai-*], etc.:

e.g. FeS – iron monosulphide (sulfid železnatý)
FeS_2 – iron disulphide (disulfid železa)

b) or a**ffixes –ous** [*-əs*] and
- ic [*-ik*]

The affix becomes part of the cation name.

e.g. $FeCl_2$ – ferrous chloride (chlorid železnatý)
$FeCl_3$ – ferric chloride (chlorid železitý)

c) The valence state of the metal can also be denoted by the **Roman numeral**:

e.g. $FeCl_3$ – iron(III)-chloride (chlorid železitý)

2. Salts of acids containing oxygen

The name is formed by starting from the name of the respective acid, and
- the affix **–ous** [*-əs*] is replaced by the affix **–ite** [*-ait*] or
- the affix **–ic** [*-ik*] by the affix **–ate** [*-eit*],

preserving also the respective prefixes **hypo-** and p**er-**:

e.g. hypochlorous acid – hypochlorite (chlornan)
chlorous acid – chlorite (chloritan)

e.g. chloric acid – chlorate (chlorečnan)
perchloric acid – perchlorate (chloristan)

2. Organic chemistry - naming organic compounds

There are **trivial** and **systematic** names of organic compounds. Trivial names (such as acetone, toluene) have their origin in history or in nature. IUPAC takes care of a systematic nomenclature system in chemistry. The system of naming organic compounds according to IUPAC is illustrated below.

Systematic names are built up by joining syllables according to the following rules:

a) **A syllable** is used to denote the number of carbon atoms in the longest straight unbranched carbon chain in the compound. The number of carbon atoms thus formulates a saturated hydrocarbon (having only single bonds between carbon atoms) and the specific compound is regarded as a substituted hydrocarbon (using prefixes of functional groups, double bonds etc.). The longest straight carbon chain can be found by following the occurrences of carbon in the formula.

The systematic syllables are:

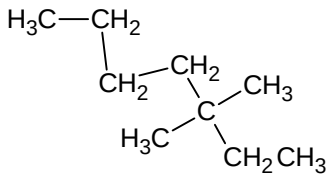
Number of Carbon Atoms	1	2	3	4	5	6	7	8	9	10
Syllable (Saturated Hydrocarbon)	meth(ane)	eth(ane)	prop(ane)	but(ane)	pent(ane)	hex(ane)	hept(ane)	oct(ane)	non(ane)	dec(ane)

An ending is used to indicate the type of bond between the carbon atoms:

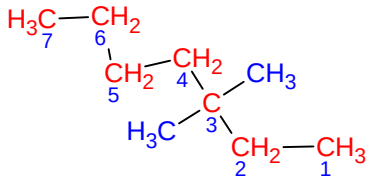
Type of Bonds	**Ending**
Single bonds	–ane (for example ethane)
Double bond	–ene (for example ethene)
Triple bond	–yne (for example ethyne)

In one compound there can be more double or triple bonds.

Example 1: Find the longest straight unbranched carbon chain in the following compound and name it:



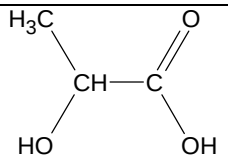
What do we already know?
We have found the longest unbranched carbon chain (highlighted by red colour and marked by numbers 1 – 7). The number of carbon atoms is seven; therefore, the name of the compound will be derived from *heptane*. All bonds in our compound are single bonds; therefore, the ending "-ane" in *heptane* is correct.



The carbon atoms in the longest unbranched carbon chain are numbered by Arabic numerals. The numbers are placed so as to have the smallest number where the chain is

branched (blue groups in our compound, carbon atom number 3). These two $–CH_3$ groups are called functional groups.

b) **A syllable (prefix or ending)** is used to indicate **a functional group**:

Formula of a Functional Group	Functional Group Name	Prefix	Ending	Example	
$–C_nH_{2n+1}$	alkyl group	-	-yl	$–C_2H_5$	-ethyl
–OH	alcohol		-ol	C_2H_5OH	ethanol
		hydroxy-			2-hydroxy-propanoic acid
–CHO	aldehyde	aldehyde-	-al	HCHO	methanal
=CO	ketone		-one	CH_3COCH_3	propanone
–Cl	chloride	chloro-	-	C_2H_5Cl	chloroethane
$–NH_2$	amino	amino-	-	CH_3NH_2	aminomethane
$–NO_2$	nitro	nitro-	-	$C_6H_5NO_2$	nitrobenzene
–COOH	carboxylic acid	-	-oic acid / carboxylic acid	CH_3COOH	ethanoic acid

What do we already know?
There are two methyl groups (functional groups) in position 3. Compounds with the same molecular formula but different structure (e.g. different position of functional groups) are called isomers. Therefore, it is important to mark the position of the functional group. Isomers usually have different chemical or physical properties.

c) **Greek prefixes** are used to indicate the number of the same functional group(s), except for the monosubstituted compound.

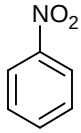
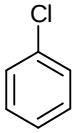
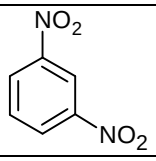
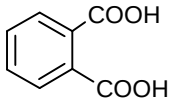
Number of Groups	Prefix	Number of Groups	Prefix
1	mono-	6	hexa-
2	di-	7	hepta-
3	tri-	8	octa-
4	tetra-	9	nona-
5	penta-	10	deca-

What do we already know?
There are two methyl groups in the compound; therefore, the prefix is “di-” - dimethylheptane. As has already been shown, Arabic numerals are used to denote the carbon atoms in the carbon chain to which functional groups are bonded. We know that two functional groups are in position 3; therefore, the name of the compound is 3,3-dimethylheptane.

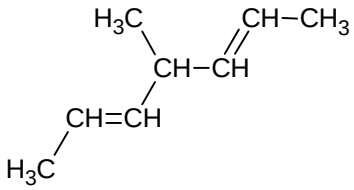
What does 3,3-dimethylheptane mean? How do we understand the name of this compound?
The main (longest) carbon chain is "heptane". It refers to a carbon chain with 7 atoms.
The ending "-ane" indicates that all bonds between carbon atoms are single bonds. Then we know from "dimethyl" that two methyl groups are in the structure and that both are in position 3; therefore, twice 3 ("3,3").

d) **Aromatic compounds**

Aromatic compounds without side chains have benzene as the root with the already mentioned prefixes and suffixes to indicate functional groups. The selected examples are in the following table:

Structure	Name	Structure	Name
	nitrobenzene		chlorobenzene
	1,3-dinitrobenzene		benzene-1,2-dicarboxylic acid

Example 2: Can you now name the following compound?

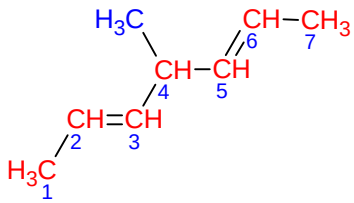


Rules:

1) Find the longest unbranched carbon chain.
2) Number carbon atoms in the longest unbranched carbon chain and name the chain.
3) Determine bonds between carbon atoms.
4) Indicate a functional group/functional groups in the main chain.
5) Indicate the number and position of functional group(s).
6) Finally, name the compound.

Solution:

1) The longest unbranched carbon chain is highlighted by red colour.

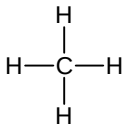
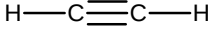


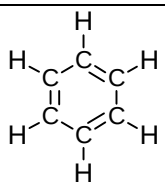
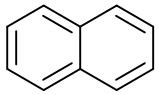
2) The numbered carbon atoms are shown above. The main syllable of hydrocarbon is "hept", because it has 7 atoms.

3) Between C_2 and C_3, and C_5 and C_6 there are two double bonds – thus there is "di-" before "-ene", i.e. "diene". Moreover, numbers of the first atoms from where the double bond starts are used before the ending "diene", i.e. "2,5-diene".
4) The functional group in the main chain is a methyl group $–CH_3$.
5) There is only one methyl group in position 4.
6) The name of the compound thus is 4-methylhepta-2,5-diene.

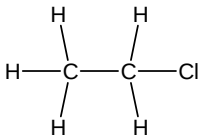
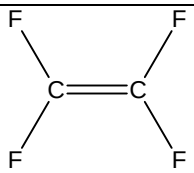
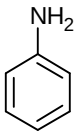
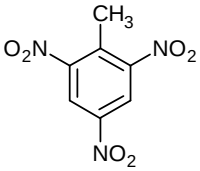
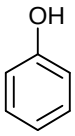
Note: When the terminal ending (i.e. "diene" in our case) starts with a consonant, there is "-a" at the end of the hydrocarbon name (hepta).
If there is just one double bond in position 2, the name of the compound would be 4-methylhept-2-ene. Because the terminal ending ("-ene") starts with a vowel, we do not have to add "-a" at the end of the hydrocarbon name.

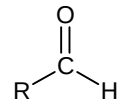
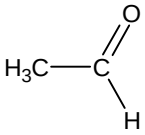
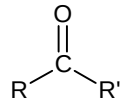
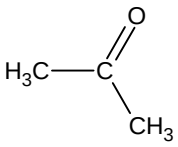
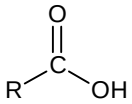
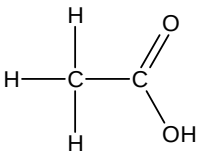
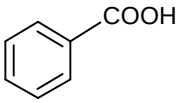
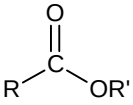
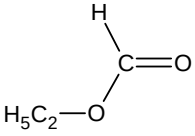
OVERVIEW OF HYDROCARBONS AND DERIVATIVES OF HYDROCARBONS
Part A: Hydrocarbons

Group Name	Group Characteristics	Selected Representatives		
		Name	Formula	Properties
Alkanes	Only single bonds between carbon atoms *(General formula C_nH_{2n+2})*	methane		the simplest alkane; main component of natural gas
		octane	C_8H_{18}	very flammable; a component of gasoline (petrol)
Cycloalkanes	Cyclic alkanes *(General formula C_nH_{2n})*	cyclohexane		can have different conformations – chair or boat ones
Alkenes	At least one double bond between carbon atoms *(General formula C_nH_{2n})*	ethene (ethylene)	C_2H_4	the simplest alkene; a plant hormone (causes ripening of fruits)
Alkynes	At least one triple bond between carbon atoms *(General formula C_nH_{2n-2})*	ethyne (acelylene)		a linear symmetrical molecule; colourless gas; the simplest alkyne

Arenes (aromatic hydrocarbons)	Hydrocarbons with alternating double and single bonds between carbon atoms forming ring(s)	benzene		planar structure; carcinogenic; liquid with a sweet smell
		naphthalene		polycyclic aromatic hydrocarbon; white crystalline solid

Part B: Derivatives of Hydrocarbons

Group Name	Group Characteristics	Selected Representatives		
		Name	Formula	Properties
Haloalkanes (halogenoalkanes, alkyl halides)	Containing one or more halogens (F, Cl, Br, I)	chloroethane (ethyl chloride)		used as a local anesthetic in sports
		tetrafluoroethylene		polytetrafluoroethylene (PTFE) - produced by its polymerization; also known as Teflon or Gore-Tex
Amines	Containing an amino functional group $-NH_2$	aniline		toxic organic compound with formula $C_6H_5NH_2$, used in dye industry
Nitro compounds	Containing a nitro functional group $-NO_2$	TNT (trinitrotoluene)		yellow-coloured solid; explosive material
Alcohols	Containing a hydroxyl functional group -OH	methanol	CH_3OH	also known as wood alcohol; used to be produced as a byproduct of distillation of wood
		ethanol	C_2H_5OH	alcohol found in alcoholic beverages, produced by fermentation of sugars
Phenols (phenolics)	Containing a hydroxyl group bonded directly to an arene	phenol		crystalline volatile solid; an important industrial precursor to many materials

Ethers	Containing an oxygen atom connected to two alkyl or aryl groups R-O-R	dimethyl ether	CH_3-O-CH_3	the isomer of ethanol; colourless gas
Aldehydes	Containing an aldehyde functional group –CHO 	acetaldehyde (ethanal)		occurs naturally in coffee, bread, and ripe fruit
Ketones	Containing a carbonyl functional group R-CO-R’ 	acetone (propanone)		important solvent; used also for cleaning purposes in laboratories
Carboxylic acids	Containing a carboxyl functional group -COOH 	methanoic acid (formic)	HCOOH	contained in insect stings and nettles
		ethanoic acid (acetic)		part of vinegar
		butanoic acid (butyric)	$CH_3(CH_2)_2COOH$	unpleasant smell and acrid taste; present in rotten butter
		benzoic acid		an aromatic carboxylic acid
Esters	Containing a functional group RCOOR’ 	ethyl formate		rum odour (odorant)

Notes: R and R’ represent a hydrogen atom (–H) or alkyl group (e.g. methyl –CH_3, ethyl –C_2H_5 etc.)

III. How to read chemical formulas in inorganic chemistry – examples

Symbol	English	Pronunciation	Czech
$AlBr_3$	aluminium bromide	*‚ælju'miniəm 'brəumaid*	bromid hlinitý
$AlCl_3$	aluminium chloride	*‚ælju'miniəm 'klo:raid*	chlorid hlinitý
ND_3	deutero ammonia	*‚dju:tərə ə'məuniə*	deuteroamoniak, amoniak -3d-
$NH_4CO_2NH_2$	ammonium carbamate	*ə'məuniəm ‚ka:bəməit*	karbaminan amonný
NH_4OH	ammonium hydroxide	*ə'məuniəm hai'droksaid*	hydroxid amonný (vodný roztok amoniaku)
$SbBr_3$	antimony tribromide	*'æntiməni trai'brəumaid*	bromid antimonitý
$SbCl_5$	antimony pentachloride	*'æntiməni ‚pentə'klo:raid*	chlorid antimoničný
SbI_3	antimony triiodide	*'æntiməni trai'aiədaid*	jodid antimonitý
Sb_2O_3	antimony trioxide	*'æntiməni trai'oksaid*	oxid antimonitý
$AsBr_3$	arsenic tribromide	*ɑ:'s(ə)nik trai'brəumaid*	bromid arsenitý
AsH_3	arsine	*'ɑ:si:n*	arzenovodík/arzan
BeI_2	beryllium iodide	*bə'riliəm 'aiədaid*	jodid berylnatý
$BiBr_3$	bismuth tribromide	*'bizməθ trai'brəumaid*	bromid bizmutitý
BBr_3	boron tribromide	*'bo:ron trai'brəumaid*	bromid boritý
CdO	cadmium oxide	*'kædmiəm 'oksaid*	oxid kademnatý
$Ca(OH)_2$	calcium hydroxide	*'kælsiəm hai'droksaid*	hydroxid vápenatý
$CaCO_3$	calcium carbonate	*'kælsiəm 'ka:bənit*	uhličitan vápenatý
$Ca(HCO_3)_2$	calcium hydrogen carbonate	*'kælsiəm 'haidrədžən 'ka:bənit*	hydrogenuhličitan vápenatý
CO_2	carbon dioxide	*'ka:bən dai'oksaid*	oxid uhličitý
CO	carbon monoxide	*'ka:bən mo'noksaid*	oxid uhelnatý
C_3O_2	carbon suboxide	*'ka:bən sab'oksaid*	suboxid uhlíku
CS_2	carbon disulphide	*'ka:bən dai'salfaid*	sirouhlík
$COCl_2$	phosgene	*'fosdži:n*	fosgen
Cl_2O	chlorine monoxide	*'klo:ri:n mo'noksaid*	oxid chlorný
ClO_2	chlorine dioxide	*'klo:ri:n dai'oksaid*	oxid chloričitý
Cl_2O_6	dichlorine hexoxide	*dai'klo:ri:n heks'oksaid*	dimer oxidu chlorového
Cl_2O_7	chlorine heptoxide	*'klo:ri:n hept'oksaid*	oxid chloristý
$Cr(CO)_6$	chromium hexacarbonyl	*'krəumiəm ‚heksə'ka:bənil*	hexakarbonyl chromu

CrO_2Cl_2	chromyl chloride	*‘krəumil ‘klo:raid*	chromylchlorid
$CoCl_2$	cobaltous chloride	*kəu’bo:ltəs ‘klo:raid*	chlorid kobaltnatý
Cu_2Br_2	cuprus bromide	*‘kju:prəs ‘brəumaid*	dimer bromidu měďného
$FeCl_3$	ferric chloride	*‘ferik ‘klo:raid*	chlorid železitý
$FeCl_2$	ferrous chloride	*‘ferəs ‘klo:raid*	chlorid železnatý
HCl (g)	hydrogen chloride	*‘haidrədžən ‘klo:raid*	chlorovodík
HCl (aq)	hydrochloric acid	*‘haidrəu’klo:rik ‘æsid*	kyselina chlorovodíková
HF (g)	hydrogen fluoride	*‘haidrədžən ‘fluəraid*	fluorovodík
HF (aq)	hydrofluoric acid	*‘haidrəu’fluorik ‘æsid*	kyselina fluorovodíková
H_2O_2	hydrogen peroxide	*‘haidrədžən pə’roksaid*	peroxid vodíku
H_2S	hydrogen sulphide	*‘haidrədžən ‘salfaid*	sulfan (dříve sirovodík)
PbS	lead sulphide	*‘led ‘salfaid*	sulfid olovnatý
LiOH	lithium hydroxide	*‘liəiəm hai’droksaid*	hydroxid lithný
$MnCl_2$	manganous chloride	*‘mængenəs ‘klo:raid*	chlorid manganatý
$HgCl_2$	mercuric chloride	*mə:’kjuərik ‘klo:raid*	chlorid rtuťnatý
NO	nitric oxide	*‘naitrik ‘oksaid*	oxid dusnatý
N_2O	nitrous oxide	*‘naitrəs ‘oksaid*	oxid dusný
N_2O_4	dinitrogen tetroxide	*dai’naitrədžən tet‘roksaid*	dimer oxidu dusičitého
NOCl	nitrosyl chloride	*‘naitrəsil ‘klo:raid*	nitrosylchlorid
PH_3	phosphine	*‘fosfi:n*	fosfan
PH_4Cl	phosphonium chloride	*fos’fəuniəm ‘klo:raid*	fosfonium chlorid
SiH_4	silane	*‘sailein*	silan
SiO_2	silicon dioxide	*‘silikən dai‘oksaid*	oxid křemičitý
AgCl	silver chloride	*‘silvə ‘klo:raid*	chlorid stříbrný
NaBr	sodium bromide	*‘səudiəm ‘brəumaid*	bromid sodný
$NaHCO_3$	bicarbonate	*bai’ka:bənit*	hydrogenuhličitan sodný
Na_2CO_3	sodium carbonate	*‘səudiəm ’ka:bənit*	uhličitan sodný
NaCl	sodium chloride	*‘səudiəm ‘klo:raid*	chlorid sodný
NaOH	sodium hydroxide	*‘soudiəm hai’droksaid*	hydroxid sodný
SO_2	sulphur dioxide	*‘salfə dai‘oksaid*	oxid siřičitý
SO_3	sulphur trioxide	*‘salfə trai‘oksaid*	oxid sírový
H_2SO_4	sulphuric acid	*sal’fjuərik ‘æsid*	kyselina sírová
H_2O	water	*‘wo:tə*	voda

IV. How to read chemical formulas in organic chemistry – examples

English	Pronunciation	Czech
dichlormethane	*dai'klo:rəu'mi:θein*	dichlormethan
formaldehyde	*fo:'mældəhaid*	formaldehyd
formic acid	*'fo:mik 'æsid*	kyselina mravenčí
methane	*'mi:θein*	metan
methanol	*'meθənol*	metanol
methylamine	*'mi:θail'æmi:n*	metylamin
acetylene	*ə'setili:n*	acetylen
acetonitrile	*'æsitəu'naitrail*	acetonitril
ethylene	*'eθili:n*	ethylen
acetaldehyde	*'æsət'ældihaid*	acetaldehyd
acetic acid	*ə'si:tik 'æsid*	kyselina octová
ethylamine	*i:θail 'əmi:n*	ethylamin
acetone	*'æsitəun*	aceton
propane	*'prəupein*	propan
propene	*'prəupi:n*	propen
propylene	*'prəupili:n*	propylen
propyne	*'prəupain*	propyn
propyl acetate	*'prəupil 'æsitit*	propylacetát
ethylacetate	*'eθail 'æsitit*	octan ethylnatý
butane	*'bju:tein*	butan
butyl alcohol	*'bju:til 'ælkəhol*	butylalkohol
diethylene glycol	*dai'eθili:n 'glaikəul*	diethylenglykol
diethyl sulphate	*dai'i:θail 'salfeit*	diethylsulfát
diethyl sulphite	*dai'i:θail 'salfait*	diethylsulfit
diethyl sulphide	*dai'i:θail 'salfaid*	diethylsulfid
isobutylamine	*,aisəu'bju:til,əmi:n*	isobutylamin
amyl alcohol	*'æmil 'ælkəhol*	amylalkohol
hexachlorobenzene	*,heksə'klo:rəu'benzi:n*	hexachlorbenzen
pentachlorobenzene	*,pentə'klo:rəu'benzi:n*	pentachlorbenzen
benzene	*'benzi:n*	benzen
chloroaniline	*'klo:rəu'ænilain*	chloranilin
nitroaniline	*'naitrəu'ænilain*	nitroanilin
phenol	*'fi:nol*	fenol
aniline	*'ænilain*	anilin
hexene	*'heksi:n*	hexen
hexane	*'heksein*	hexan
hexanol	*'heksənəul*	hexanol
benzonitrile	*'benzəu'naitrail (-ril)*	benzonitril
benzaldehyde	*'benz'ældəhaid*	benzaldehyd
benzoic acid	*ben'zoik'æsid*	kyselina benzoová
toulene	*'toljui:n*	toulen
benzyl alcohol	*'benzil 'ælkəhol*	benzylalkohol

heptane	*'heptein*	heptan
styrene	*'stairi:n*	styren
ethylbenzene	*'i:θail'benzi:n*	ethylbenzen
caprilic acid	*kæp'rilik 'æsid*	kyselina kaprylová
octane	*'oktein*	oktan
propylbenzene	*'prəupail 'benzi:n*	propylbenzen
isopropylbenzene	*,aisəu'prəupail 'benzi:n*	isopropylbenzen
benzyl acetate	*'benzil 'æsitit (-eit)*	benzylacetát
nonane	*'nəunein*	nonan
naphtalene	*næftəli:n*	naftalen
butylbenzene	*'bju:tail'benzi:n*	butylbenzen
tert. butylbenzene	*'tə:šəri 'bju:tail'benzi:n*	terc. butylbenzen
ethyl benzoylacetate	*'i:θail 'benzoil'æsitit*	benzoylacetát ethylnatý
biphenyl	*bai'fi:nail*	difenyl
fluorene	*'fluəri:n*	fluoren
benzophenone	*'benzəu'fi:nəun*	benzofenon
anthracene	*'ænərəsi:n*	anthracen
benzil	*'benzil*	benzyl

V. Notes on reading chemical formulas

1) If the symbol of the element is preceded by a number, the number may indicate **molecules or moles**, e.g.

2 H_2O - two molecules /´molekjulz/ of H_2O or
- two moles /´məulz/ of H_2O

2) **Signs** $^{+}$ **and** $^{-}$ express the positive or negative valence of the ion, e.g.

H^+ - univalent positive hydrogen ion [juni´veiənt ´pozitiv ´aiən]
jednomocný kladný iont (kation) vodíku

Cu^{2+} - divalent positive copper ion [dai´veiənt …..]
dvoumocný kladný iont mědi /měďnatý kation

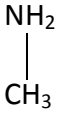
Al^{3+} - trivalent positive aluminium ion [trai´veiənt …..]
trojmocný kladný iont hliníku

Cl^- - univalent negative chlorine ion [juni´veiənt ´negətiv ´klo:ri:n …..]
jednomocný záporný iont chlóru / chloridový anion

3) Higher **valence** is expressed by the following **prefix** + the word "valent". The prefix is always stressed:

tetra -	tetravalent [,tetrə´veiənt]	čtyřmocný
penta -	pentavalent [,pentə ´veiənt]	pětimocný
hexa -	hexavalent [,heksə ´veiənt]	šestimocný
hepta -	heptavalent [,heptə ´veiənt]	sedmimocný
octa -	octavalent [,oktə´veiənt]	osmimocný

4) Sign ——— expresses a bond between atoms and is not read:



bond between nitrogen and carbon atoms

5) Sign	+	stands for	plus	plus
			together with	spolu, s
Sign	=	stands for	give(s)	dávají, dá
			form(s)	tvoří
Sign	I	stands for	give(s)	dávají, dá
			pass(es) over to	přecházejí do, přechází do
			lead(s) to	vedou k, vede k
Sign	⇄	stands for	form(s)	tvoří
			is/are formed	tvoří se, vznikne, vzniknou
			equilibrium	je v rovnováze

6) Among chemists, there is no general agreement on how to pronounce some of the frequent suffixes in chemical compounds, although some dictionaries will offer good guidance. Also, pronunciation in AE and BE can differ and may even vary from laboratory to laboratory. The **most frequent pronunciation** of suffixes is as follows:

Suffix

- ene [**- i:n]**
e.g. ethene [ˊi:əi:n], acetylene [ˊæsətili:n], fluorine [ˊfluəri:n], toluene [ˊtolui:n], napthalene [ˊnefəəli:n], benzene [ˊbenzi:n], ethylene [ˊeəili:n]

- ane **[- ein]**
e.g. ethane [ˊi:əein], butane [ˊbju:tein], propane [ˊprəupein], methane [ˊmi:əein]

- ite **[- ait]**
e.g. fluorite [ˊfluərait], chloride [ˊklo:raid], sulphite [ˊsalfait]

- yl **[- il]** and often **[- ail]**
e.g. amyl [ˊaemil/ ˊæmail], benzyl [ˊbenzil/ ˊbenzail]; methyl [ˊmeəil/ ˊmeəail], ethyl [ˊeəil/ ˊeəail]

-ine **[- i:n]** and often **[- ain]**
e.g. pyridine [ˊpiridi:n], fluorine [ˊfluəri:n], phosphine [ˊfosfi:n], iodine [ˊaiədi:n]
ethylamine [ˊi:əilˊəmi:n], bromine[ˊbrəumi:n], chlorine [ˊklo:ri:n], benzine [ˊbenzi:n]
aniline [ˊænilain], methylamine [ˊmi:əailˊəmi:n]
Note that with some names identical pronunciation may be confusing:
benzine x benzene [ˊbenzi:n] fluorine x fluorene [ˊfluəri:n]

-ide **[- aid]** and also **[- i:d]**

e.g**.** hydride [ˊhaidraid], chloride [ˊklo:raid], iodide [ˊaiədaid], peroxide [pərˊoksaid], sulphide [ˊsalfaid], oxide [ˊoksaid], bromide [ˊbrəumaid], hydroxide[,haidrˊoksaid], sachar**i**de [ˊsækəraid], fluoride [ˊfluəri:d], nitramide [ˊnaitrəmi:d], trifluoride[/,traiˊfluəri:d]

-ate **[- eit]** and also **[- it]**
acetate [ˊæsəteit], perchlorate [,perˊklo:reit], dichromate [daiˊkrəumeit], carbonate [ˊka:boneit], sulphate [ˊsalfeit]

7) The **first syllable is stressed** if there is no prefix:
e.g: cadmium [ˊcædmiəm], acetate [ˊæsəteit]

8) **Unstressed syllables** are often pronounced in **full**, i.e. they are not reduced:
e.g. phenol [ˊfi:nol], boron [ˊbo:ron]

9**) The vowel** preceding the following prefixes – acic, - alic, - anic, - aric, - elic, - enic, -eric, - etic, -idic, -ilic, -inic, -isic, -onic, - opic, - oric is **usually short,** and **stress** is on the syllable **preceding – ic.**
e.g. chloric [ˊklorik]
but: acetic [ˊəsi:tik], ceric [ˊsi:rik]

VI. Some abbreviations in common use in chemistry

Symbol	English	Pronunciation	Czech
a.	acid	*ˈæsid*	kyselina
acet. a.	acetic acid	*əˈsi:tik ˈæsid*	kyselina octová
al.	alcohol	*ˈælkəhol*	alkohol
amor. , amorph.	amorphous	*əˈmo:fəs*	amorfní
anh.	anhydrous	*ænˈhaidrəs*	bezvodý
aq. 	aqua aqueous water	*ˈækwə* *ˈeikwiəs* *ˈwo:tə*	vodný voda
at. no.	atomic number	*əˈtomik ˈnambə*	atomové číslo
at. wt.	atomic weight	*əˈtomik ˈweit*	atomová váha
b. p.	boiling point	*ˈboiliŋ ˈpoint*	bod varu
conc.	concentrated	*ˈkonsen,treitid*	koncentrovaný
d., dec.	decompose	*,di:kəmˈpəuz*	rozložit
dil.	dilute	*daiˈlju:t*	ředit
dist.	distilled	*disˈtild*	destilovaný
evap.	evaporation	*i,væpəˈreišən*	vypařování
i., insol.	insoluble	*inˈsoljubl*	nerozpustný
liq.	liquid	*ˈlikwid*	tekutý, kapalný
p. sol.	partly soluble	*ˈpa:tli ˈsoljubl*	částečně rozpustný
r.m.m.	relative molecular mass	*,relətiv məˈlekjulə ,mæs*	relativní molekulová hmotnost
sol.	soluble	*ˈsoljubl*	rozpustný

sp. wt.	specific weight	*spə‘sifik ‘weit*	specifická váha
subl.	sublime	*sə‘blaim*	sublimovat
m.p.	melting point	*‘meltiŋ ‘point*	bod tání
vac.	vacuum	*‘vækjuəm*	vakuum
20°C	twenty degrees Celsius	*‘twenti di’gri:z ‘selziəs*	20°C
▷	above	*ə‘bav*	výše
◁	below	*bi‘ləu*	níže
∞	soluble in all proportions	*‘soljubl in ‘o:l prə‘po:šənz*	rozpustný v jakémkoli poměru