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ON THE LANGUAGE OF CHEMISTRY - LOCAL AND REGIONAL PROBLEMS

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Abstract:

The language of chemistry consists of symbols, words and expressions. The symbols of the chemical elements are the most common ones in practically any text in chemistry, the words denote chemical entities and chemical properties while the expressions are used to explain the meaning of the characteristic words.

The chemical *symbols* are internationally agreed and are written in the same way in any language and independent of the script (Latin, Cyrillic, Arabic or any other).

Among the *words* characteristic for chemistry, the most important are those denoting the basic units of matter (e.g. atoms, molecules etc.), the general or specific forms of matter and, of course and the chemical names of substances.

The characteristic *expressions*, as already pointed out, are needed to give the meaning of words, either characteristic for chemistry (such as chemical names) or more general.

Although the language of chemistry tends to be universal in character, local terms are used and it is the aim of this communication to point out to problems (local, regional or wider) in this field and, when possible, to suggest the way to improve the present situation.

Keywords: symbols; words; expressions; local problems; regional problems

As pointed out in the abstract, the *language of chemistry* (i.e. the language the chemists use) consists of three main elements: **symbols**, **words** and **expressions**. Some of these are used in the everyday speech (including that used in the media) while others are specific for chemistry and related sciences (physics, in the first place). In what follows, each of these three categories will be treated separately.

It may be mentioned that the author has published a series of papers[1,2,3,4,5,6,7,8,9,10,11] devoted to problems related to the language of chemistry. Since these papers are in Macedonian, the author decided to use the present opportunity to repeat in English some of the points contained in some of them and to enrich the presentation by using examples from countries in the region.

Symbols

The main group of symbols consists of *chemical symbols*, *physical symbols* and *symbolic representations*.

Needless to say, for a chemist (or person speaking on chemical issues) the most important are the symbols for the **chemical elements**, consisting of one, two or three characters. The symbols for hydrogen, boron, carbon, nitrogen, oxygen, fluorine, potassium, yttrium and iodine are, respectively H, B, C, N, O, F, K, Y and I, derived from the Latin names of these elements. Two further one-character symbols are those of the nuclides deuterium (the symbol is D) and tritium (T) which are isotopes of hydrogen. When such names and symbols are used together with the nuclide with relative atomic mass of approximately 1, the name of the nuclide is *protium* and the symbol H is used for it. Rarely the symbols ^{2}H and ^{3}H are used for

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[1] Б. Шоптрајанов, Белешки за јазикот на хемијата. 1. Молекула или молекул, *Глас. Хем. Технол. Македонија*, **18**, 75-88 (1999).

[2] Б. Шоптрајанов, Белешки за јазикот на хемијата. 2. Правоговорот и правописот во наставата по хемија (I), *Глас. Хем. Технол. Македонија*, **19**, 91-98 (2000).

[3] Б. Шоптрајанов, Белешки за јазикот на хемијата. 3. Правоговорот и правописот во наставата по хемија (II), *Глас. Хем. Технол. Македонија*, **19**, 191-196 (2000).

[4] Б. Шоптрајанов, Белешки за јазикот на хемијата. 4. За честичките, за супстанците, за радикалите, за парата и за ограниченијата, *Глас. Хем. Технол. Македонија*, **19**, 197-203 (2000).

[5] Б. Шоптрајанов, Белешки за јазикот на хемијата. 5. За оксидите, пероксидите, супероксидите и хидроксидите, *Глас. Хем. Технол. Македонија*, **20**, 183-187 (2001).

[6] Б. Шоптрајанов, Белешки за јазикот на хемијата. 6. За металоидите и за металите и семиметалите, *Глас. Хем. Технол. Македонија*, **20**, 189-193 (2001).

[7] Б. Шоптрајанов, Белешки за јазикот на хемијата. 7. За ураниумот и за називите на некои други елементи, *Глас. Хем. Технол. Македонија*, **21**,75-80 (2002).

[8] Б. Шоптрајанов, Белешки за јазикот на хемијата. 8. За *величините* и *големините*, за францускиот изговор (во македонскиот јазик на латинските префикси и за скратените ознаки на величините и единиците, *Глас. Хем. Технол. Македонија*, **21**,81-85 (2002).

[9] Б. Шоптрајанов, Белешки за јазикот на хемијата. 9. За изговорот на некои странски презимиња во наставата по хемија на македонски јазик, *Глас. Хем. Технол. Македонија*, **22**,61-71 (2003).

[10] Б. Шоптрајанов, Белешки за јазикот на хемијата. 10. За тетрааминбакар(II)пентацијанонитрозилферат(II)додекахидратот, *Глас. Хем. Технол. Македонија*, **23**,185-191 (2004).

[11] Б. Шоптрајанов, Белешки за јазикот на хемијата. 11. За периодичната таблица и за агрегатната состојба на атомот од цинкот, *Maced. J. Chem. Chem. Eng.* **34**,221-230 (2015).

deuterium and tritium respectively, graphemes like these being used for the isotopes of other elements as well. There is hardly any local or regional problems with these one-character symbols except that the symbol "J" for iodine is still sometimes (*very rarely* nowadays) used.

The rest of the chemical elements have symbols consisting of two characters (only the first one is capitalized) except that the symbols of several very heavy elements consist of three characters (e.g. Uut, Uup, Uus and Uuo) derived from their *provisional names* denoting their atomic numbers, such as "**u**n**u**n**t**rium". Both the names and the three-character symbols are valid only until the existence of these elements is officially confirmed and the name is changed to its permanent form and the atomic symbol obtains its permanent two-character form. The above-mentioned changes are done by the implementation of IUPAC[12] recommendations. Clearly, the chemists, the chemical societies and the media should keep track of these recommendations and use them everywhere.

The atomic symbols may be combined, giving rise to *formulas* such as NaCl or H_2O to mention just these simple cases of formulas derived from the combinations of atomic symbols (the lower-case numerals are used to denote the ratios of the number of atoms in the so called *formula unit* (which may, or may not be *molecule* and may or may not exist as physical entity; the numeral "1" is not written).

The chemical symbols are internationally agreed and are **always** written with **Latin** characters, irrespective on whether the characters of the text in which the symbols are used are Cyrillic, Greek, Hebrew, Arabic, Chinese etc.

Another important group of symbols are those for ***physical quantities*** and their ***units***.

Examples are extremely numerous and only some are mentioned in this text. Thus, the symbol for the quantity *mass* is *m*, perhaps followed with the symbol of the entity or substance to which it refers written in parentheses, e.g. m(A), the symbol for the *quantity* of species A is n(A), for the relative atomic mass of A it is A_r(A); the *density* of substance A is given as ρ(A) etc. The symbols for quantities are again internationally agreed and are written with italic Latin or, less commonly, Greek characters and no other choice of script is

[12] The acronym IUPAC stands for International Union of Pure and Applied Chemistry.

allowed[13]. The same is true for the symbols for the *units* of quantities such as "m" for meter, the unit for *distance*; "m^2" for the unit of area etc. It should, perhaps, be explicitly noted that the units are written with *upright* (not italic) characters as is done in the above examples.

The multiples and submultiples of units are denoted by *prefixes* such as "kg" for the unit is 1000 times larger than that of the unit gram, or "mg" for a unit that is 1000 times less that of gram.

The units derived from names of people are written with a capital first character, while practically all other ones are written with lower-case character. The only exception is the grapheme for liter, for which "L" is permitted[14] since the lower-case letter "l" can be easily misread as the numeral "1"

When numerals and units are used together, it should be written, for example "2 m" or "20 °C" with a non-breaking **space** between the numerical value and the unit. This should apply even to "20 %", rather than "20%" since "%" denotes 1/100 which is sort of a unit for relative quantities. This is so because the above mentioned space stands for *multiplication* of the numerical value and the unit, so that 2 m is, in fact, 2 × m, and 20 % is 20 × 1/100.

Unfortunately, relatively often (especially in the Macedonian media) one finds "м" or "$м^2$" or "кг" or …. Such deviations from the internationally agreed symbols should be strongly discouraged and, when used, should be properly corrected. The author does not know for sure whether such practice exists or is common in other countries using the Cyrillic script, although he found "г" for gram (and other symbols for units) in Cyrillic in some rather old Russian[15] and Ukrainian[16] sources with educational content.

An interesting case is the content of a Ukrainian textbook of physics[17]. In the list of basic units for physical properties, one can find "с, м, км, $м^2$, кг" for second, meter, kilometer, square meter and kilogram, respectively. Even stranger to the author seem the entries in the list of multiples, where "д, с, м" stand for "деци, санти анд мілі".

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[13] E.R. Cohen, T. Cvitaš, J.G. Frey, B. Holmsröm, K. Kuchitsu, R. Marquardt, I. Mills, F. Pavese, M. Quack, Jürgen Stohner, H.L. Strauss, M. Taskami, A.J. Thor, *Quantities, Units and Symbols in Physical Chemistry*, Third Edition, IUPAC 2007.

[15] А. П. Кошель, *Химия, Энциклопедический словарь школьника*, Олма-пресс, Москва, 2000.

[16] М. Слободяник, Н.В. Улько, К.М. Бойко, В.М. Самойленко, *Загальна та неорганічна химія*, Либідь, Київ, 2004.

[17] Є.В. Коршак, О.І. Ляшенко, В.Ф. Савченко, *Физика, 7 клас*, Ірпінь, Київ, 2002.

A further problem exists with the pronunciation of some decimal units. Thus, in the textbook just discussed, one can find **деци** (pronounced as **deci** in Latin), but **санти** (the French pronunciation of **centi**). In Macedonian it is not only common, but even official[18] to speak about "**санти**метар" or "**деси**метар", with **both** *Latin* prefixes with a *French* pronunciation[19]. However, at least in some Macedonian textbooks, the form "центиметар" is found more and more often but the unit is sometime written as "цм".

Fortunately, some of the respectable Macedonian linguistic sources are fair enough to give alternatives. Thus in the monolingual dictionary issued by the Institute of Macedonian Language[20] the forms "десиметар" and "дециметар" are given in a single entry, but only "сантиметар" exists while "центиметар" is completely absent. The same is true in the monolingual dictionary by Zoze Murgoski[21]. Only "сантиметр" is present in a Macedonian–Russian dictionary[22] and in a Russian–Macedonian one[23]. In official sources in Bulgarian[24] and Russian[25] again "сантиметър" and "сантиметър" are given, but "дециметър" and "дециметър" are the terms associated with the ten times larger unit. It is difficult to find any logic or consistency in such a practice where one of the prefixes is used in the way it would be pronounced in French, while the other one keeps its Latin pronunciation. Only "центиметар" is present in a source[26] published in Serbia, whereas "десиметар = дециметар" and "сантиметар = центиметар" are given in another publication published by Matica Srpska[27].

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[18] С. Велковска, К. Конески, Ж. Цветковски, *Толковен речник на македонскиот јазик*, Том I, Институт за македонски јазик „Крсте Мисирков", Скопје, 2003.

[19] A criticism of this practice is given in the paper dealt with in footnote 8.

[20] See footnote 17.

[21] З. Мургоски, *Толковен речник на современиот македонски јазик*, Зозе Мургоски, Скопје, 2011.

[22] Р. Усикова (редактор), *Македонско-руски речник*; *Македонско-русский словарь*, Том III, Детска радост, МАНУ, Скопје, 1997.

[23] Н. Чундева, М. Најческа-Сидоровска, С. Накев, *Руско-македонски речник, Русско-македонский словарь,* Филолошки факултет „Блаже Конески" – Скопје, Скопје, 1997.

[24] Л. Андрейчик, Вл. Георгиев, Ив. Леков, Ст. Стойков, *Правописен речник на българския книжовен език*, Наука и изкуство, София, 1976.

[25] *Словарь Рускоrо языка***,** Русский язык, Том I, Издание третье, Москва 1985; Том IV, Издание второе, Москва, 1984**.**

[26] Правописна комисија, *Правопис српкох-рватскога књижевног језика са правописним речником*, Матица српска, Нови Сад, 1960.

[27] М. Ранков (уредник), *Речник српскохрватскога књижевног језика*, Књига VI, Матица српска, Нови Сад, 1982.

Obviously, the *French* pronunciation of some *Latin* prefixes is either acceptable or even preferred in *Ukrainian, Macedonian, Russian, Bulgarian,* and *Serbo-Croatian*. Unfortunately!

Another very common error related to units is to refer to "m^2" as "метар квадратен" instead of the correct form "квадратен метар" for "square meter" (other similar wrongly pronounced expressions abound, especially in the media).

Words

Speaking, in this content, about *words*, the author has in mind primarily ***the names of the elements, names of the minerals*** and ***the chemical names in general***.

Names of elements

The names of the chemical elements fall in one of the two categories: *internationally accepted names* and *language-specific names*.

The majority of elements have *internationally accepted names*, but some have *language-specific names.*

For metals and semimetals, the internationally accepted names mainly end with "-ium" or "-um". However, the internationally accepted name of the element with atomic number 2 is "hel**ium**" although this is a noble **gas** and is neither metal nor semimetal.

The internationally accepted names for metals, starting with beryllium and ending, for the time being, with copernicium, are *almost* identically pronounced with slight modifications to accommodate the given language.

The situation with *language-specific names*, as expected, is quite different and more complicated.

Thus, the lightest element (atomic number 1) is **водород** (in Macedonian, Russian and Bulgarian[28], but with a different position of the stress), it is **водоник** in Serbian[29], **vodik** in

[28] Г. Близнаков, Л. Боянова, А. Соколова, П. Рибарска, *Химия и опазване на околната среда* за 9 клас, Анубис, София, 2002.

[29] М. Ракочевић, Р. Хорват, *Општа хемија за I разред средње школе*, Завод за уџбенике и наставна средства, Београд, 2000.

Croatian[30] and Slovenian[31], **Гідроген** in Ukrainian[32], **hydrogen** in English and a number of other languages, **hydrogène** in French[33].

The element called **кислород** (in Macedonian, Russian and Bulgarian, again with a different position of the stress), bears the name of **кисеоник** in Serbian, **kisik** in Croatian and Slovenian, **oxygen** in English, **oxygène** in French, **оксиген** in Ukrainian and so on. The gas we in Macedonia call **азот** (the name is the same in Russian and Bugarian), is **dušik** in Croatian and Slovenian, **nitrogen** in English, **azote (**or **nitrogène**) in French, **нітроген** in Ukrainian and so on.

Сулфур is the Macedonian name of the element with atomic number 16, but it is **сумпор** in Serbian, **сульфур** in Ukrainian, **сера** in Russian, **сяра** in Bulgarian, **sulfur** in English **(sulphur** is considered as obsolete**)**, **soufre** in French etc.

A number of elements have names which significantly differ from one another.

Thus the element with a Latin name of **plumbum** (from which the symbol Pb is derived) is **олово** in Macedonian, Bulgarian, Serbian, **плюмбум** in Ukrainian, **свинец** in Russian, **olovo** in Croatian.

The Slovenian **žveplo** for sulfur is not at all similar to the rest of the above-mentioned names for element with a symbol "S" and the Croatian **kositar** for the English **tin** or for **калај** in Macedonian and Serbian and **калай** in Bulgarian is anything but similar to the above mentioned Macedonian, Serbian and Bulgarian names for the same element. In Ukrainian it is **станум** and in Russian, strangely enough, is **олово**. Of course, it should immediately be noticed that the latter name for the element with a symbol "Sn" in Russian is **identical** with the name of the element with a symbol "Pb" in Macedonian, Bulgarian or Serbian. Needless to say, this may cause confusion for a person that is unfamiliar with such a situation.

In the Macedonian official sources, the name **титан** is still present for the element with a symbol "Ti", although such a practice has been criticized in the paper dealt with in footnote 7. The arguments behind such a criticism are twofold. On the one side, it would be logical for a metallic element to have a name ending with "-ium" and, on the other hand the name of this

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[30] B. Sever, D. Nöthig-Hus, I. Weygand-Đurašević, *Kemija 1*, Školska knjiga, Zagreb, 1986.

[31] A. Kornhauser, F. Lazarini, T. Pretnar, Lj. Golič, *Kemija I*, Državna založba Slovenije, 1987.

[32] М. Слободяник, Н.В. Улько, К.М. Бойко, В.М. Самойленко, *Загальна та неорганічна хімія*, Либідь, Київ, 2004

[33] А. Попоски, П. Атанасов, *Македонско-француски речник*, Скопје, 2007.

metal would be different from the word pertaining to one of the mythological titans. To be honest, the form **титан** is present in Bulgarian, Serbian, Ukrainian and Russian and, as **titan** in Croatian and Slovenian. The author is convinced that the names титаниум/titanium is by far the better choice and that, at least in Macedonian, it should be called **титаниум** as has already been done[34] but is absent in the Interpretative dictionary[35] where the only relevant entry is "титан".

In conclusion, the language-specific names for the elements are here to stay, notwithstanding the problems they may sometime produce, the lack of consistency and logic in other cases. The only hope of the author that, if not regionally, the local weaknesses (centimeter, titanium and some other) may be surmounted.

Names of minerals

The names of the minerals are, in general, international but are not systemic.

Slight variations of the names (e.g. **гипс** in Macedonian, Serbian, Bulgarian, **гіпс** in Ukrainian, **gips** in Croatian, German, **gypsum** in English, **gypse** in French for example) exist in order to accommodate the pronunciation and the way of writing, but these are not important and can not lead to misunderstanding. Other examples of this sort are **корунд** in Macedonian, Bulgarian, Serbian, Russian, Ukrainian, **korund** in Croatian, **corundum** in English or **corindon** in French or **рубин** in Macedonian, Bulgarian, Serbian, Russian, **рубін** in Ukrainian, **ruby** in English, **rubis** in French.

Many names for minerals end with "ite" or "ит". Of this majority of names, **галенит** in Macedonian, Bulgarian, Serbian, Russian**, галеніт** in Ukrainian, **galena** in English, **galena** in French, **galenit** in Croatian or **хематит** in Macedonian, Serbian, Bulgarian, **гематит** in Russian and Ukrainian**, hematit** in Croatian, **hematite** in English, **hematite** in French and so on. Again, as long as the *written* forms of the names are considered, no confusion is likely to exist.

However, even when the written forms are identical, the pronunciation (the position of the stress) may be different. In general, in Macedonian the last syllable is stressed, so that the

[34] Б. Шоптрајанов, *Хемија за прва година на реформираното гимназиско образование*, IV издание, Просветно дело, Скопје, 2009.

[35] К. Конески, Ж. Цветковски, С. Велковска, *Толковен речник на македонскиот јазик*, Том VI, Институт за македонски јазик „Крсте Мисирков", Скопје, 2003.

галенит, хематит, лорандит would be heard, whereas in Serbian these same names would be pronounced as **галенит, хематит** or **лорандит**. The situation may become awkward in a situation when a teacher educated in Serbia would teach students in Macedonia or vice versa. Perhaps, the teachers may be re-educated, although this is hard.

Ending the story about the position of the stress, the author would like to point out that the official pronunciation form of graphite's name in Macedonian is **графит** although the form **графит** would be in line with that of other minerals with similar names. The author is convinced that changes in the Macedonian norm would be more than welcome.

Names of compounds

The names of the common substances, whether systemic or traditional, would remain as such in any language. Thus **вода** would be the written name of H_2O of Macedonian, Serbian, Bulgarian, Russian or Ukrainian, although the pronunciation and/or the position of the stress may be different, whilst **voda** (in Croatian), **water** (in English), **eau** (in French) have been and *would remain* as such in the future. Thus, no intervention is needed there.

We would, thus, concentrate to chemical names of the most widely encountered inorganic and organic compounds and the way they are written. Salts, oxides, peroxides would be considered, with their names as they appear in contemporary chemical text and, for the Macedonian ones, regarding the official linguistic norm. It would be easier if we start with this last point.

In the most official Macedonian source on orthography[36], it is explicitly stated (Fig. 1) that together are written "*the compounded chemical terms which denote names for compounds*" with five examples of which **none** is chemically correct. Nevertheless, the example of methyl alcohol written as "метилалкохол" is repeated in the orthographic dictionary by K. Koneski[37] and in the official interpretative dictionary[38]. Fortunately, the example of "оксихидрат" (a "compound" that **does not exists at all**) is not repeated, but "цијанкалиум"

[36] Б. Видоески, Т. Димитровски, К. Конески, К. Тошев, Р. Угринова-Скаловска, *Правопис на македонскиот литературен јазик*, Петто изцдание, Просветно дело, Скопје 1977.

[37] К. Конески, *Правописен речник на македонскиот литературен јазикик*, Просветно дело, Скопје, 1999.

[38] С. Велковска, К. Конески, Ж. Цветковски, *Толковен речник на македонскиот јазик*, Том III, Институт за македонски јазик „Крсте Мисирков", Скопје, 2006.

is still there in the orthographic dictionary[36] and in volume VI of the Interpretative dictionary[39].

Salts, oxides, peroxides have names that are, so to say, *multy-part* ones, i.e. composed of two or more parts. It is, of course, easier to start with names containing two parts: one for the positive (completely or partially) part and the other for the negative one. The two parts may be written separately or connected with a dash.

The situation for such names in Macedonian and some other languages is presented in the Table I.

Table I

The way a two-part name is written in several languages (sodium chloride is taken as an example)

Language	**First part**	**Second part**
English	sodium	chloride
Macedonian	натриум	хлорид
Serbian	натријум-	хлорид
Croatian	natrijev	klorid
Russian	хлорид	натрия
Ukrainian	натрій	хлорид

As seen, in Macedonian the first part of the name is a **noun**, whereas in Croatian it is an **adjective** (in Russian, the *second* part is an adjective). It is fair to mention that Macedonian linguists are suggesting that an adjective should be used in Macedonian language too, but the practically universal practice of chemists is presently opposite to such suggestions.

The situation is not always straight forward, not even in a given language such as Macedonian. To illustrate the point, the example of the name for the compound with a formula CO_2 and an English name **carbon dioxide** is discussed. In agreement with the above-

[39] К. Конески, Ж. Цветковски, С. Велковска, *Толковен речник на македонскиот јазик*, Том VI, Институт за македонски јазик „Крсте Мисирков“, Скопје, 2014.

mentioned system of names, the Macedonian name is **јаглерод диоксид**[40] and ***not*** **јаглероден диоксид** or **јаглерод двооксид**[41]**.** It is even worse to call it **јаглен диоксид** since **јаглен** is the Macedonian equivalent of **coal**. Nevertheless, in a recently published Serbian texbook[42] one can find "**угљен-диоксид"** as an alternative name for "**угљеник(IV)-оксид"** although the Serbian **угљен** is ordinarily (but not exclusively) used as the equivalent of charcoal**.**

As long as we are dealing with examples with "**јаглен**", another curious one is the explanation given in the dictionary[43] by Zoze Murgoski for the, otherwise correct, term **јаглехидрат** for which the interpretation is **јагленов хидрат**. Fortunately, in the interpretative dictionary[44] the corresponding entry is the correct form, **јаглехидрат** with no such "explanations"!

Obviously, the customs are difficult to break, even when they lead to illogical names.

The nomenclature of *organic* compounds is well established, but rather complicated for a text like the present one and will not be treated here.

General chemical terms

In what follows, a discussion will be given for two of the most important general chemistry terms – those for the **form of matter**, and those for the chemically important name for the **basic particles of matter**. Also discussed will be the variants of the term **periodic table**.

Substance. As for the first of those, the English term is **substance**, and the equivalents in Macedonian, Serbian, Bulgarian, Russian Ukrainian, Croatian and Slovenian are given in Table II.

[40] The particles denoting the number of atoms (as entities) or ions in the formula unit are **моно-**, **ди-, три-, тетра-**, etc.

[41] For the oxide with a formula CO, nobody would even dream to call it **јаглеродедноoксид**, or **јагеглерод едноксид** or **јаглен едноксид** instead of **јаглерод моноксид**.

[42] Г. Исаковић, Љ. Лукић, М. Исаковић, Н. Панајотовић, *Општа и неорганска хемија за I разред средње школе*, Завод за уџбенике и наставна средства, Београд, 2000.

[43] З. Мургоски, *Речник на македонскиот јазик*, Зозе Мургоски, Скопје, 2005.

[44] С. Велковска, К. Конески, Ж. Цветковски, *Толковен речник на македонскиот јазик*, Том II, Институт за македонски јазик „Крсте Мисирков", Скопје, 2005.

Table II

The terms corresponding to “substance” in several languages

Language	**Term**	**Language**	**Term**
English	substance	Russian	вещество[45]
Macedonian	супстанца	Ukrainian	речовина[46]
Bulgarian	вещество[47]	Croatian	tvar[48]
Serbian	супстанција[41]	Slovenian	snov[49]

As seen, only in Macedonian and Serbian the corresponding forms of the term are essentially identical with the English one, the Bulgarian and Russian ones are identical with each other when written but are pronounced slightly differently, whereas the terms in Ukrainian, Croatian and Slovenian do not bear any semblance to those in the other considered languages.

However, the difference in the ending of the term between Macedonian and Serbian) as found in Table II is not absolutely firm and unquestionable. Thus, only “супстанца” is found in the dictionaries by Z. Murgoski[50,51] and this is the form the Macedonian chemists have decided to accept. However, in the dictionary by Dimitrovski, Korubin and Stamatoski[52] the entries are “супстанца v. супстанција” with an explanation of the latter term in which only the philosophical use is given in any detail, while there is no mention of the use in chemistry and physics. On the other hand, in the interpretative dictionary[53] only the entry “супстанција” is given with an explanation which has no relation to the meaning the chemists assume for the

[45] Н. Чундева, М. Најческа-Сидоровска, С. Накев, *Руско-македонски речник, Русско-македонский словарь,* Филолошки факултет „Блаже Конески“ – Скопје, Скопје, 1997

[46] М. Слободяник, Н.В. Улько, К.М. Бойко, В.М. Самойленко, *Загальна та неорганічна хімія*, Либідь, Київ, 2004

[47] Л. Андрейчин, Вл. Георгиев, Ив. Леков, Ст. Стойков, *Правописен речник на българския книжовен език*, Наука и изкуство, София, 1976.

[48] B. Sever, D. Nöthig-Hus, I. Weygand-Đurašević, *Kemija 1*, Školska knjiga, Zagreb, 1986.

[49] A. Kornhauser, F. Lazarini, T. Pretnar, Lj. Golič, *Kemija I*, Državna založba Slovenije, 1987.

[50] З. Мургоски, *Речник на македонскиот јазик*, Зозе Мургоски, Скопје, 2005.

[51] З. Мургоски, *Толковен речник на современиот македонски јазик*, Зозе Мургоски, Скопје, 2011.

[52] Т. Димитровски, Б. Корубин, Т. Стаматоски, *Речник на македонскиот јазик*, Детска радост, Скопје 1994.

[53] К. Конески, Ж. Цветковски, С. Велковска, *Толковен речник на македонскиот јазик*, Том V, Институт за македонски јазик „Крсте Мисирков“, Скопје, 2011.

term “супстанца”. Clearly, the author is a firm supporter of the present form which is accepted by chemists and included in Table II.

The situation with the Serbian form “супстанција” that is apparently accepted (see the footnote 41) is still somewhat questionable if the meritorious dictionary sources are taken into account. Thus, in the Serbo-Croatian–Hungarian dictionary[54] under the entry “supstanca” the explanation “f. phys” (meaning the use of physics) is given, whereas for the term “supstancija” the corresponding explanation is “phil” (meaning philosophy). In the dictionary[55] both “супстанца” and “супстанција” are present whereas in the encyclopedia[56] only “supstancija” exists with an explanation in some 40 rows about the philosophical meaning, and a single one for that in physics (chemistry is not mentioned). The entry “супстанција” in Table II is based on its use in the most recent source (footnote 41) and in an orthographic text[57]. The differences between “супстанца” and “супстанција” notwithstanding, the author is convinced the form of the names for “substance” in the enumerated languages will remain as they are now and changes or unification efforts are neither expected nor advocated.

Molecule. Several problems exist concerning one of the basic building particles of matter, namely **molecule**. These are only partly related to the name itself in various languages, including Macedonian. As can be seen in Table III, the names corresponding to the English “molecule” in languages using both the Latin and the Cyrillic script are practically identical with small variations concerning the spelling. The only exception is the Serbian form “молекул“ which differs from the rest of the names since it is the only one that is *masculine* by gender (clearly, no gender specific form of a noun exists in English). In fact, for a very, very long time the Macedonian term was also “молекул”, a situation which was criticized by us[58] but was kept since in the official linguistic sources (such as[59]) it was assumed that this is

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[54] K Kovač, D. Šereš, *Sprskohrvatski–mađarski rečnik*, Knjiga treća, Pokrajinski zavod za izdavanje udžbenika, Novi Sad, 1975.

[55] М. Стевановић, С. Марковић, С. Матић, П. Рогић, М. Пешикан, А. Гортан-Премк, М. Вујанић, С. Ковачевић, *Речник српскохрватскога књижевног језика*, Књига шеста, Матица српска, Нови Сад, 1976.

[56] S. Ravlić (glavni urednik), *Hrvatska enciklopedija*, Tom 10, Leksikografski zavod Miroslav Krleža, Zagreb, 2008.

[57] Правописна комисија, *Правопис српскохрватскога књижевног језика са правописним речником*, Матица српска ∗ Матица хрватска, Нови Сад, Загреб, 1960.

[58] Б. Шоптрајанов, Белешки за јазикот на хемијата. 1. Молекула или молекул, *Глас. Хем. Технол. Македонија*, **18**, 75-88 (1999) (see footnote 1).

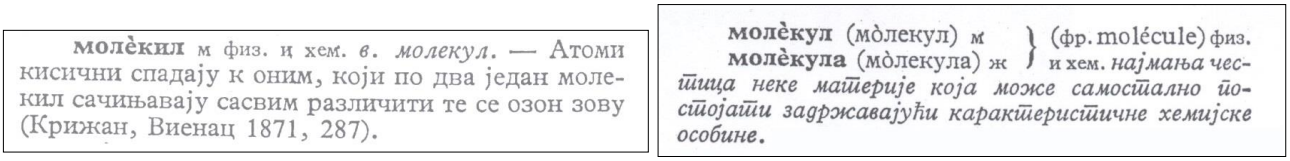
[59] К. Конески, *Правописен речник на македонскиот литературен јазикик*, Просветно дело, Скопје, 1999.

to be the only acceptable one. Only recently, this was changed and the former "молекул" officially became "молекула"[60] as should have been from the start. In fact, the origin of the term is from the Latin diminutive of "moles" (a noun in *feminine* gender meaning, for example, *quantity*[61]), so that "molecula" would be something like *small quantity* again in feminine gender.

Table III
The terms corresponding to "molecule" in several languages

Language	**Term**	**Language**	**Term**
English	molecule	Russian	молекула
French	molécule	Ukrainian	молекула
Italian	molecola	Bulgarian	молекула
Croatian	molekula	Serbian	**молекул**
Slovenian	molekula	Macedonian	молекула

It is now interesting to speculate about the reason why would in Serbian (and, for a long time, in Macedonian) the equivalent of a term which is, beyond any doubt, of *feminine* gender, be of *masculine* one. The author believes that it is a reasonable guess to assume this to be a consequence of the mechanical transfer of the French pronunciation of "molécule" (approximately, "molekil") into the Serbian equivalent of "molecule". That this is not a wild guess is evidenced by the content of some Serbian sources[62] (cf. Fig. 1), including the renowned dictionary by Vujaklija[63].


молѐкил м физ. и хем. *в. молекул.* — Атоми кисични спадају к оним, који по два један молекил сачињавају сасвим различити те се озон зову (Крижан, Виенац 1871, 287).

молѐкул (мо̀лекул) м } (фр. molécule) физ.
молѐкула (мо̀лекула) ж } и хем. *најмања честица неке материје која може самостално постојати задржавајући карактеристичне хемијске особине.*

Fig. 1. Probable origin of "молекул" [61]

[60] С. Велковска, К. Конески, Ж. Цветковски, *Толковен речник на македонскиот јазик*, Том III, Институт за македонски јазик „Крсте Мисирков", Скопје, 2006.

[61] М. Войнов, А. Милев, *Латинско български речник*, Второ преработено и допълнено издание, Наука и изкуство, 1971.

[62] М. Стевановић, С. Марковић, С. Матић, М. Пешикан, *Речник српскохрватскога књижевног језика*, Матица српска, Нови Сад, 1969

[63] М. Вујаклија, *Лексикон страних речи и израза*, Просвета, Београд, 1996/97.

Speaking about molecules, two more points should be mentioned. Both deal with *expressions* concerning these particles.

The first of these is the expression *defining* what a molecule is. The commonly found expression (the examples are too numerous to be mentioned separately) is that a molecule is a particle which is capable to exist as such and is composed of two or more identical or non identical bonded atoms. The question is whether the individual atoms of noble gasses should or should not be considered as molecules. Contrary to the usual definition, it is advisable to treat such atoms as *monoatomic molecules*. That simplifies, for example, the treatment of molecules in physical chemistry (molecular kinetic theory). Fortunately, sources can be found in which the constituent particles of monoatomic gasses *are* treated as molecules. Thus, in one of the Oxford dictionaries[64] it is stated that molecule is "smallest particle (usually a group of atoms, or in some elements one of the single atoms)". The author completely agrees.

The second point is the statement[65,66] that *molecule* is "the smallest particle of the substance that retains all the properties of the substance and is composed of one or more atoms". While the last part of this expression ("… and is composed …") is in line with the definition discussed above, the central part ("smallest particle of the substance that retains all the properties of the substance") is more than just questionable. Among the properties of the substances, namely, is their color. If the above statement is correct then some of the molecules would be white, other ones – red etc. The absurdity of such a supposition is more than obvious.

A natural consequence of the wrong basic description of molecules is the equally wrong idea that molecule ≡ substance. The author and his coworkers have already discussed this question leading to the firm conclusion that **molecules are *not* substances** and **substances are *not* molecules**[67] and that it is unacceptable to speak that, for example, "Nitric oxide, a key signaling molecule is …." [68] .

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[64] *The Oxford Handy Dictionary*, Chancellor Press, London, 1987.

[65] *The Van Nostrand Chemist's Dictionary*, D. Van Nostrand Company, Princeton, New Jersey, 1956.

[66] С. Цветковиќ, *Хемија за VII* одделение, II издание, Просветно дело, Скопје, 1983.

[67] M. Stojanovska, B. Šoptrajanov, V. M. Petruševski, Molecules are not substances, substances are not molecules, *ECRICE, Book of Abstracts*, p. 261, Kraków, 2010.

[68] D. Malan, G. J. Ji, A. Schmidt, K. Addicks, J. Hescheler, R.C. Levi, W. Bloch, B. K. Fleiscmann, Nitric oxide, a key signaling molecule in the murine early embryonic heart, *The FASEB Journal*, **18,** 1108 (2004).

Periodic law, periodic table

One of the most important laws in chemistry is **the periodic law** (or **periodic system**) which states that there is a clear and predictable relationship between the periodically occurring physical and/or chemical properties of the elements, on the one hand and some atomic property on the other.

Dmitri Mendeleev who was the first scientist to seriously explore the consequences of the periodic law, used *atomic weight* as the atomic property and arranged the then known elements in horizontal and vertical groups. His basic idea was later somewhat changed: the atomic weight was changed into *atomic mass* (more precisely, *relative atomic mass*) and then into *atomic number* (the number of protons in the atomic nucleus).

When arranged in a tabular manner, the **periodic table of elements** results. The horizontal rows are called **periods**[69], and the columns – **groups**. The periodic tables are depicted in dozens different ways, some quite ingenious. One of the classical ones is shown below (Fig. 2)

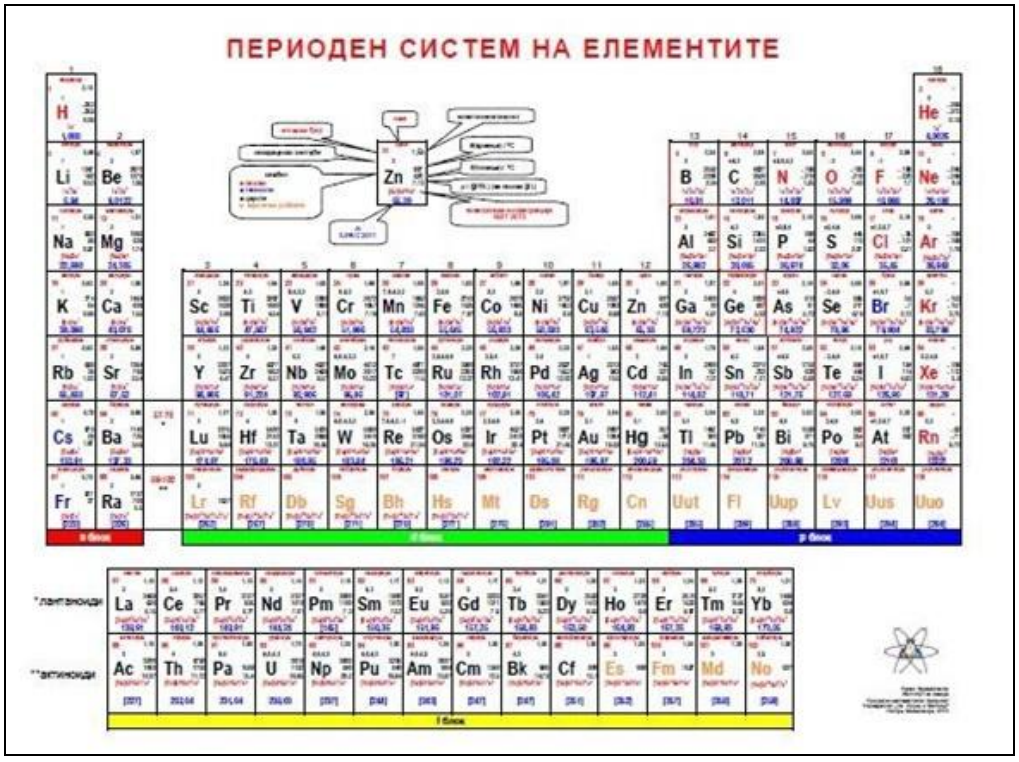

Fig. 2. A Macedonian version of the periodic table

[69] The Macedonian equivalent would be "периоди", the singular of the term being "периода", something that is practically completely missing in our dictionaries.

As can be seen, the title of the table is “Периоден систем на елементите” and the same title, perhaps with missing “...на елементите”, is used in practically all such tables in Macedonia and, with variations on the language and scripts, in most other languages (see Table IV).

It should be mentioned that there have been suggestions that the term should be “периодичен систем” but the suggestion has been rejected by Macedonian chemists on the basis of the fact that the *system* itself is **not** *periodical* (“appearing in regular intervals”). In fact, the name is based on “периода, *f*”, not on “периодичен, *adj*”!

One further point concerns the name: should it be “Периоден систем” or “Таблица на периодниот систем”? The author strongly supports the notion that the second of the mentioned doublet is to be accepted and used since it reflects the true nature of the object[70,71].

Table IV

The terms corresponding to “periodic table” in several languages

Language	**Term**	**Language**	**Term**
English	Periodic table	Russian	Периодическая система
French	Systéme pèriodique	Ukrainian	Періодична система елементів
Italian	Tavola periodica	Bulgarian	Периодична система
Croatian	Periodni sistem	Serbian	Периодни систем
Slovenian	Periodni sistem	Macedonian	Периоден систем

Conclusions

The author is convinced that, in order to solve a **problem**, one must first, *detect it* and then try to find a **solution**, being aware that **many** factors influence the attempted search for solution of the problem.

[70] Б. Шоптрајанов, Белешки за јазикот на хемијата. 11. За периодичната таблица и за агрегатната состојба на атомот од цинкот, *Maced. J. Chem. Chem. Eng.*, **34**, 221 (2015).

[71] It would be even better to use the name “*Таблица на периодниот систем на елементите*”.

It is the belief of the author that the presented text shows that *there are* problems concerning the language of chemistry, both local (Macedonian) and regional and that solutions can, hopefully, be found.

In some cases, the local inconsistencies are so deeply rooted that it would be futile to suggest changes, whereas in other cases the change to the better (in author's opinion) could be achieved relatively easily.

As for the regional inconsistencies, the ultimate hope of the author is to demonstrate their presence, whereas the actions to ameliorate the situation are exclusively the task which is left to the local authorities – chemists and linguists.