

## NOTES ON THE LANGUAGE OF CHEMISTRY. 12

### ON THE LANGUAGE OF CHEMISTRY - LOCAL AND REGIONAL PROBLEMS

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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 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<sup>1,2,3,4,5,6,7,8,9,10,11</sup> devoted to problems related to the language of chemistry. Since these papers are in Macedonian, we decided to use the

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<sup>1</sup> Б. Шоптрајанов, Белешки за јазикот на хемијата. 1. Молекула или молекул, *Глас. Хем. Технол. Македонија*, **18**, 75–88 (1999).

<sup>2</sup> Б. Шоптрајанов, Белешки за јазикот на хемијата. 2. Правоговорот и правописот во наставата по хемија (I), *Глас. Хем. Технол. Македонија*, **19**, 91–98 (2000).

<sup>3</sup> Б. Шоптрајанов, Белешки за јазикот на хемијата. 3. Правоговорот и правописот во наставата по хемија (II), *Глас. Хем. Технол. Македонија*, **19**, 191–196 (2000).

<sup>4</sup> 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).

<sup>5</sup> Б. Шоптрајанов, Белешки за јазикот на хемијата. 5. За оксидите, пероксидите, супероксидите и хидроксидите, *Глас. Хем. Технол. Македонија*, **20**, 183–187 (2001).

<sup>6</sup> Б. Шоптрајанов, Белешки за јазикот на хемијата. 6. За металонидите и за металите и семиметалите, *Глас. Хем. Технол. Македонија*, **20**, 189–193 (2001).

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 groups 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 or two 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  $^2\text{H}$  and  $^3\text{H}$  are used for 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.

Symbols consisting of two characters (only the first one is capitalized) have *all* other chemical elements including those of the very heavy elements nihonium, moscovium, tennessine and oganesson which were confirmed (in 2016) to be Nh, Mc, Ts and Og respectively. In order to be consistent with the form “tennessine” which is in line with the English names fluorine, chlorine, bromine, iodine and astatine (the present Macedonian equivalents are флуор, хлор, бром, јод and астат), it is proposed to change the presently established name of the radioactive element астат into астатин, having the same form as, at least, тенесин.

The atomic symbols may be combined, giving rise to *formulas* such as NaCl or H<sub>2</sub>O 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<sub>r</sub>*(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 allowed<sup>12</sup>.

<sup>7</sup> 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).

<sup>8</sup> 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).

<sup>9</sup> 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).

<sup>10</sup> Б. Шоптрајанов, Белешки за јазикот на хемијата. 10. За тетраамминбакар(II)пентацијанонитрозилферат(II)додекахидратот, *Глас. Хем. Технол. Македонија*, **23**, 185–191 (2004).

<sup>11</sup> Б. Шоптрајанов, Белешки за јазикот на хемијата. 11. За периодичната таблица и за агрегатната сос-тојба на атомот од цинкот, *Maced. J. Chem. Chem. Eng.* **34**, 221–230 (2015).

<sup>12</sup> 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.

The same is true for the symbols for the *units* of quantities such as “m” for meter, the unit for *distance*; “m<sup>2</sup>” 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<sup>13</sup> 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 and packaging) one finds “m” or “m<sup>2</sup>” or “kg” 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 “r” for gram (and other symbols for units) in Cyrillic in some rather old Russian<sup>14</sup> and Ukrainian<sup>15</sup> sources with educational content.

An interesting case is the content of a Ukrainian textbook of physics<sup>16</sup>. In the list of basic units for physical properties, one can find “с, м, км, м<sup>2</sup>, 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”.

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<sup>17</sup> to speak about “**сантиметар**” or “**десиметар**”, with **both Latin** prefixes with a *French* pronunciation<sup>18</sup>. 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<sup>19</sup> 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<sup>20</sup>. Only “сантиметр” is present in a Macedonian–Russian dictionary<sup>21</sup> and in a Russian–Macedonian one<sup>22</sup>. In official sources in Bulgarian<sup>23</sup> and Russian<sup>24</sup> again “сантиметър” and “сантиметър” are given, but

<sup>14</sup> А. П. Кошель, *Химия, Энциклопедический словарь школьника*, Олма-пресс, Москва, 2000.

<sup>15</sup> М. Слободяник, Н. В. Улько, К. М. Бойко, В. М. Самойленко, *Загальна та неорганічна хімія*, Либідь, Київ, 2004.

<sup>16</sup> Є. В. Коршак, О. І. Ляшенко, В.Ф. Савченко, *Фізика, 7 клас*, Ірпінь, Київ, 2002.

<sup>17</sup> С. Велковска, К. Конески, Ж. Цветковски, *Толковен речник на македонскиот јазик*, Том I, Институт за македонски јазик „Крсте Мисирков“, Скопје, 2003.

<sup>18</sup> A criticism of this practice is given in the paper dealt with in footnote 8.

<sup>19</sup> See footnote 17.

<sup>20</sup> З. Мургоски, *Толковен речник на современиот македонски јазик*, Зоце Мургоски, Скопје, 2011.

<sup>21</sup> Р. Усикова (редактор), *Македонско-руски речник; Македонско-рускиот словарь*, Том III, Детска радост, МАНУ, Скопје, 1997.

<sup>22</sup> Н. Чундева, М. Најческа-Сидоровска, С. Накев, *Руско-македонски речник, Руско-македонскиот словарь*, Филолошки факултет „Блаже Конески“ – Скопје, Скопје, 1997.

<sup>23</sup> Л. Андрейчик, Вл. Георгиев, Ив. Леков, Ст. Стойков, *Правописен речник на българския книжовен език*, Наука и изкуство, София, 1976.

<sup>24</sup> *Словарь Русского языка*, Русский язык, Том I, Издание третье, Москва 1985; Том IV, Издание второе, Москва, 1984.

“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<sup>25</sup> published in Serbia, whereas “десиметар = деци-метар” and “сантиметар = центиметар” are given in another publication published by Matica Srpska<sup>26</sup>.

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<sup>2</sup>” 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 “helium” although this is a noble **gas** and is neither metal nor semimetal.

The internationally accepted names for metals, starting with beryllium are *almost always* 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<sup>27</sup>, but with a different position of the stress), it is **водоник** in Serbian<sup>28</sup>, **vodik** in Croatian<sup>29</sup> and Slovenian<sup>30</sup>, **гідроген** in Ukrainian<sup>31</sup>, **hydrogen** in English and a number of other languages, **hydrogène** in French<sup>32</sup>.

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 Bulgarian), is **dušik** in Croatian and Slovenian, **nitrogen** in English, **azote** (or **nitrogène**) in French, **нітроген** in Ukrainian and so on.

<sup>25</sup> Правописна комисија, *Правопис српско-хрватскога књижевног језика са правописним речником*, Матица српска, Нови Сад, 1960.

<sup>26</sup> М. Ранков (уредник), *Речник српскохрватскога књижевног језика*, Књига VI, Матица српска, Нови Сад, 1982.

<sup>27</sup> Г. Близнаков, Л. Боянова, А. Соколова, П. Рибарска, *Химия и опазване на околната среда* за 9 клас, Анупис, София, 2002.

<sup>28</sup> М. Ракочевић, Р. Хорват, *Опита хемија за I разред средње школе*, Завод за уџбенике и наставна средства, Београд, 2000.

<sup>29</sup> В. Sever, D. Nöthig-Hus, I. Weygand-Đurašević, *Kemija I*, Školska knjiga, Zagreb, 1986.

<sup>30</sup> A. Kornhauser, F. Lazarini, T. Pretnar, Lj. Golič, *Kemija I*, Državna založba Slovenije, 1987.

<sup>31</sup> М. Слободяник, Н.В. Улько, К.М. Бойко, В.М. Самойленко, *Загальна та неорганічна хімія*, Либідь, Київ, 2004

<sup>32</sup> А. Попоски, П. Атанасов, *Македонско-француски речник*, Скопје, 2007.

**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 the ones in the languages discussed. 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 pointed out 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 our paper which was 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 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<sup>33,34</sup> but is absent in the Interpretative dictionary<sup>35</sup> 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”. Thus it appears, **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 **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*

<sup>33</sup> Б. Шоптрајанов, *Хемија за прва година на реформираното гимназиско образование*, IV издание, Просветно дело, Скопје, 2009.

<sup>34</sup> *Правпис на Македонскиот јазик*, Институт за македонски јазик „Крсте Мисирков“, Скопје, 2016.

<sup>35</sup> К. Конески, Ж. Цветковски, С. Велковска, *Толковен речник на македонскиот јазик*, Том VI, Институт за македонски јазик „Крсте Мисирков“, Скопје, 2003.

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<sub>2</sub>O 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 official Macedonian source on orthography<sup>36</sup>, 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<sup>37</sup> and in the official interpretative dictionary<sup>38</sup>. Fortunately, the example of “оксидрат” (a “compound” that **does not exist at all**) is not repeated, but “цијанкалиум” is still there in the orthographic dictionary<sup>36</sup> and in volume VI of the Interpretative dictionary<sup>39</sup>.

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<sub>2</sub> and an English name **carbon dioxide** is discussed. In agreement with the above-mentioned system of names, the Macedonian name is **јаглерод диоксид**<sup>40</sup> and *not* **јаглероден диоксид** or **јаглерод двооксид**<sup>41</sup>. It is even worse to call it **јаглен диоксид** since **јаглен** is the Macedonian equivalent of **coal**. Nevertheless, in a recently

<sup>36</sup> Б. Видоески, Т. Димитровски, К. Конески, К. Тошев, Р. Угринова-Скаловска, *Правопис на маке-донскиот литературен јазик*, Петто издание, Просветно дело, Скопје 1977.

<sup>37</sup> К. Конески, *Правописен речник на македонскиот литературен јазик*, Просветно дело, Скопје, 1999.

<sup>38</sup> С. Велковска, К. Конески, Ж. Цветковски, *Толковен речник на македонскиот јазик*, Том III, Институт за македонски јазик „Крсте Мисирков“, Скопје, 2006.

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

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

<sup>41</sup> For the oxide with a formula CO, nobody would even dream to call it **јаглеродеднооксид**, or **јагеглерод едноксид** or **јаглен едноксид** instead of **јаглерод монооксид**.

published Serbian textbook<sup>42</sup> 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<sup>43</sup> by Zoze Murgoski for the, otherwise correct, term јаглехидрат for which the interpretation is јагленов хидрат. Fortunately, in the interpretative dictionary<sup>44</sup> 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.

Table II

*The terms corresponding to “substance” in several languages*

Language	Term	Language	Term
English	substance	Russian	вещество <sup>45</sup>
Macedonian	супстанца	Ukrainian	речовина <sup>46</sup>
Bulgarian	вещество <sup>47</sup>	Croatian	tvar <sup>48</sup>
Serbian	супстанција <sup>41</sup>	Slovenian	snov <sup>49</sup>

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<sup>50,51</sup> and this is the form the Macedonian chemists have decided to accept. However, in the

<sup>42</sup> 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.

<sup>43</sup> З. Муркоски, *Речник на македонскиот јазик*, Зоце Муркоски, Скопје, 2005.

<sup>44</sup> С. Велковска, К. Конески, Ж. Цветковски, *Толковен речник на македонскиот јазик*, Том II, Институт за македонски јазик „Крсте Мисирков“, Скопје, 2005.

<sup>45</sup> Н. Чундева, М. Најческа-Сидоровска, С. Накев, *Руско-македонски речник, Русско-македонскиот речник*, Филолошки факултет „Блаже Конески“ – Скопје, Скопје, 1997

<sup>46</sup> М. Слободяник, Н. В. Улько, К. М. Бойко, В. М. Самойленко, *Загальна та неорганічна хімія*, Либідь, Київ, 2004

<sup>47</sup> Л. Андрейчин, Вл. Георгиев, Ив. Леков, Ст. Стойков, *Правотисен речник на българския книжовен език*, Наука и изкуство, София, 1976.

<sup>48</sup> B. Sever, D. Nöthig-Hus, I. Weygand-Đurašević, *Kemija 1, Školska knjiga*, Zagreb, 1986.

<sup>49</sup> A. Kornhauser, F. Lazarini, T. Pretnar, Lj. Golič, *Kemija I, Državna založba Slovenije*, 1987.

<sup>50</sup> З. Муркоски, *Речник на македонскиот јазик*, Зоце Муркоски, Скопје, 2005.

<sup>51</sup> З. Муркоски, *Толковен речник на современиот македонски јазик*, Зоце Муркоски, Скопје, 2011.

dictionary by Dimitrovski, Korubin and Stamatovski<sup>52</sup> 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<sup>53</sup> only the entry “супстанција” is given with an explanation which has no relation to the meaning the chemists assume for the 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<sup>54</sup> 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<sup>55</sup> both “супстанца” and “супстанција” are present whereas in the encyclopedia<sup>56</sup> 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<sup>57</sup>. 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<sup>58</sup> but was kept since in the official linguistic sources (such as<sup>59</sup>) it was assumed that this is to be the only acceptable one. Only recently, this was changed and the former “молекул” officially became “молекула”<sup>60</sup> 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*<sup>61</sup>), so that “molecula” would be something like *small quantity* again in feminine gender.

<sup>52</sup> Т. Димитровски, Б. Корубин, Т. Стаматоски, *Речник на македонскиот јазик*, (трето издание), Детска радост, Скопје 1994.

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

<sup>54</sup> К. Kovač, D. Šereš, *Srpskohrvatski–mađarski rečnik*, Knjiga treća, Pokrajinski zavod za izdavanje udžbenika, Novi Sad, 1975.

<sup>55</sup> 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.

<sup>56</sup> S. Ravlić (glavni urednik), *Hrvatska enciklopedija*, Том 10, Leksikografski zavod Miroslav Krleža, Zagreb, 2008.

<sup>57</sup> Правописна комисија, *Правопис српскохрватскога књижевног језика са правописним речником*, Матица српска \* Матица хрватска, Нови Сад, Загреб, 1960.

<sup>58</sup> Б. Шоптрајанов, Белешки за јазикот на хемијата. I. Молекула или молекул, *Глас. Хем. Технол. Македонија*, **18**, 75–88 (1999) (see footnote 1).

<sup>59</sup> К. Конески, *Правописен речник на македонскиот литературен јазик*, Просветно дело, Скопје, 1999.

<sup>60</sup> С. Велковска, К. Конески, Ж. Цветковски, *Толковен речник на македонскиот јазик*, Том III, Институт за македонски јазик „Крсте Мисирков“, Скопје, 2006.

<sup>61</sup> М. Войнов, А. Милев, *Латинско българи речник*, Второ преработено и дополнено издание, Наука и изкуство, 1971.



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<sup>62</sup> (cf. Fig. 1), including the renowned dictionary by Vujaklija<sup>63</sup>.



Fig. 1. Probable origin of "молекул"

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 cited 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<sup>64</sup> it is defined as the “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<sup>65,66</sup> 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  $\equiv$  substance. The author and his coworkers have already discussed this question leading to the firm

<sup>62</sup> М. Стевановић, С. Марковић, С. Матић, М. Пешикан, *Речник српскохрватскога књижевног језика*, Матица српска, Нови Сад, 1969

<sup>63</sup> М. Вујаклија, *Лексикон страних речи и израза*, Просвета, Београд, 1996/97.

<sup>64</sup> *The Oxford Handy Dictionary*, Chancellor Press, London, 1987.

<sup>65</sup> *The Van Nostrand Chemist's Dictionary*, D. Van Nostrand Company, Princeton, New Jersey, 1956.

<sup>66</sup> С. Цветковић, *Хемија за VII одделение*, II издание, Просветно дело, Скопје, 1983.

conclusion that **molecules are not substances** and **substances are not molecules**<sup>67</sup> and that it is unacceptable to speak that, for example, “Nitric oxide, a key signaling molecule is ....”<sup>68</sup>.

### *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**<sup>69</sup>, 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 somewhat old Macedonian version of the periodic table

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

<sup>67</sup> M. Stojanovska, B. Šoptrajanov, V. M. Petruševski, Molecules are not substances, substances are not molecules, *ECRICE, Book of Abstracts*, p. 261, Kraków, 2010.

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

<sup>69</sup> The Macedonian equivalent would be “периоди”, the singular of the term being “периода”, something that is practically completely missing in our dictionaries.

**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<sup>70,71</sup>.

Table IV

*The terms corresponding to “periodic table” in several languages*

Language	Term	Language	Term
English	Periodic table	Russian	Периодическая система
French	Système périodique	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.

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.

## БЕЛЕШКИ ЗА ЈАЗИКОТ НА ХЕМИЈАТА. 12 ЗА ЈАЗИКОТ НА ХЕМИЈАТА – ЛОКАЛНИ И РЕГИОНАЛНИ ПРОБЛЕМИ

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Јазикот на хемијата се состои од симболи, зборови и искази. Меѓу *симболите*, во секој текст за хемијата најбројни се симболите на хемиските елементи, а повремено и симболите за физичките величини и единиците за нив. *Зборовите* ги означуваат хемиските единки или хемиските процеси. *Исказите*, пак, служат за да се објасни значењето на карактеристичните зборови.

Хемиските *симболи* се меѓународно утврдени и се пишуваат на ист начин, во секој јазик независно од тоа дали текстот во кој се наоѓаат се користи латиницата, кирилицата, арапското или какво и да е друго писмо.

Меѓу *зборовите* што се карактеристични за хемијата, најважни се оние што ги означуваат основни единки на материјата (на пр. атоми, молекули и сл.), општите или специфичните форми на материјата и, се разбира, хемиските називи на супстанците.

<sup>70</sup> Б. Шоптрајанов, Белешки за јазикот на хемијата. 11. За периодичната таблица и за агрегатната сос-тојба на атомот од цинкот, *Maced. J. Chem. Chem. Eng.*, **34**, 221 (2015).

<sup>71</sup> It would be even better to use the name “Таблица на периодниот систем на елементите”.

Како што веќе беше речено, карактеристичните *искази* се неопходни за да се придаде значење на зборовите, било тие да се карактеристични за хемијата (такви се хемиските називи) или имаат поопшт карактер.

Макар што јазикот на хемијата се стреми да има универзален карактер, во употреба се и термини карактеристични за дадена средина. Цел на овој труд е да се посочат проблемите (локални, регионални или поопшти) на ова поле и, кога тоа е можно, да се сугерираат начини за подобрување на сегашната ситуација.