Mendelev to Oganesson
A Multidisciplinary Perspective on the Periodic Table

Edited by ERIC SCERRI AND GUILLERMO RESTREPO
The Chemist as Philosopher

D. I. Mendeleev’s “The Unit” and “Worldview”

MICHAEL D. GORDIN
Department of History, Princeton University, USA

The periodic system of chemical elements is almost certainly the most widely recognized scientific object in the world today, even though extensive debates persist about what it exactly is. Is it a theory, a collection of empirical data, a tabular arrangement of that data, a particular (best) tabular arrangement, a “paper tool,” or something else besides? Precisely because the periodic system has over close to 150 years remained so significant to the training and practice of scientists, the broader field of science studies has devoted considerable attention to it, most prominently in the philosophy of science.¹

Among the many different approaches to articulating a philosophical foundation for the periodic system, one central strand is historicist, which places great emphasis on the individual (or individuals) to whom one attributes its discovery (Gordin 2012). Almost universally, credit for the formulation of the periodic system is assigned to St. Petersburg chemist Dmitrii Ivanovich Mendeleev (1834–1907) for his 1869 table of elements, which he later used to predict the properties of three yet undiscovered elements.² Although the philosophical justification of the periodic system by no means requires engagement with Mendeleev’s own views about the periodic system—or, as argued in Gordin (2004, 182–189), how those views changed over the course of his lifetime as periodicity became more central to chemical practice—nonetheless it remains of interest to understand precisely what Mendeleev thought he was about in constructing his system, as well as his post hoc justifications of it.

There is, however, an obstacle to the full development of this line of inquiry: the Russian language itself. There is a substantial body of Imperial Russian, Soviet, and post-Soviet scholarship that would be of interest to the international community of philosophers and historians of chemistry, but it remains locked in a language not widely read by Western scholars. Even more problematic, only a very slender selection of primary sources are accessible in Western European languages (most widely cited are those available in English, although the corpus is larger if one includes French and German). The most significant of these are a Dover edition of translations into English of Mendeleev’s chemical publications about the periodic law (Mendeleev 2002); translations of the later editions of his textbook, The Principles of Chemistry (Osnovy khimii); and Mendeleev’s pamphlet (1904) on the chemical conception of the luminiferous ether (although this last is only rarely referenced). Despite some limitations,³ these sources have doubtless been helpful in deepening scholars’ awareness of Mendeleev’s own thought process, although the chemical emphasis of these pieces has obscured the fact that Mendeleev did produce philosophical writings. My goal here is to make editions of two such texts available to the English-reading public.

I selected these two pieces—“The Unit,” from 1877, and “Worldview,” from 1905—because in them Mendeleev most explicitly attempted a philosophical point of view, along the lines of the style of philosophy common in Russia at the time. (They will surely fail short in terms of rigor for an analytic philosopher today.) Neither text is, however, straightforward: the first was printed under a pseudonym, and the second he declined to publish. They are, therefore, reflections Mendeleev felt uncomfortable sharing openly. They also come from different contexts, both later than his earliest writings on the periodic system, but contemporaneous with some of his mature publications on it. Much of the scholarly literature tends to flatten the timeline, with pieces from different periods cited side-by-side without regard to Mendeleev’s temporal development. Neither piece translated here directly addresses the periodic system, although in each Mendeleev presents a nuanced and sophisticated philosophy of nature, with significant implications for his thoughts on epistemology and ontology.

“The Unit” (Popov 1877) was published in under the pseudonym “D. Popov” in Sveto (which means either “light” or “world” in Russian), a hybrid science-art-philosophy journal edited by his zoologist colleague at St. Petersburg University, Nikolai Petrovich Vagner (1829–1907).⁴ It appeared a year after Mendeleev’s public debunking of spiritualist séances (Gordin 2004, chapter 4).

---

¹ For an introduction to the field, see Scerri 2007, as well as almost any issue of the journal Foundations of Chemistry.

² For a biographical account of Mendeleev’s many activities beyond the periodic system, see Gordin 2004.

³ Principal among these is the reliance on the later editions of the Principles. The periodic system was produced in the process of writing this textbook in 1868–1869, as has been widely recognized (Gordin 2004, chapter 2, and references therein), but the versions that are translated are only the substantially revised later editions (all editions after the fifth edition of 1889), which include substantial revisions about the nature and significance of the periodic system, responding to scientific developments. These are therefore unreliable sources in elucidating the context of discovery.

⁴ On Vagner, see Gordin 2012.
in direct opposition to Wagner, who was a major participant in those debates on the spiritualist side. In Mendeleev's annotated bibliography of his writings, produced in his final decade, he commented on "The Unit" and its byline thus: "It was written by me and signed with a pseudonym (which I did only once in my life)—D. Popov—from the name of my wife, A. I. Popova" (Mendeleev in Shchukarev and Valk 1951, 83). (Actually, Anna Popova was not yet his wife; Mendeleev's divorce was not finalized—or even proposed—at that date, and he married Popova only in 1882.) Mendeleev added:

This was a transitional time for me: much was changing in me; at that time I read a great deal about religions, about sects, about philosophy, economic articles. Something is expressed [in this piece]. I took a pseudonym—for the reason that then the certainty in the veracity of the path chosen by me was still weak in me. And now I would write exactly the same directly with my last name; everything that was said, reading it anew, I would sign.

(Mendeleev in Shchukarev and Valk 1951, 82–83)

There are several features of this article that prove interesting, such as his engagement with units of measurement (in Mendeleev's career-long involvement in metrology, see Gordin 2004, 164–171) and hints of his abstract conception of chemical elements (Scerr 2007; Gordin 2009). "The Unit" is also Mendeleev's most extended discussion of the "naturalistic fallacy," although he did not use that term.

"Worldview" (Mendeleev 1948) is a much more difficult text in almost every respect: its convoluted prose style, its provenance, and its interpretation. The translation published here is based on the autograph manuscript from the Mendeleev Archives at St. Petersburg State University, edited by E. Kh. Fritsman. I have modified this version slightly in accordance with a more recent edition in Mendeleev (1995, 408–443). "Worldview" was intended to be an afterword for his collection of political and social essays, Cherished Thoughts (Zavednye mysl'yi), published while Russia was in the midst of the Revolution of 1905, which resulted in Tsar Nicholas II issuing the "October Manifesto" that provided for a constitutional monarchy with an elected parliament (Duma). On the original manuscript, Mendeleev wrote "Decided not to publish," with the date 28 September 1905 (Mendeleev 1948, 157). He eventually produced an afterword for Cherished Thoughts, composed on 4 October 1905, in which he mentioned the existence of a drafted statement of his worldview that he had refrained from publishing "because the exposition seemed to me insufficiently full" (Mendeleev 1995, 406). The afterword replicated in abbreviated form some of the thoughts about his tripartite metaphysics—also present in later editions of the Principles and in his ether pamphlet, as discussed in Gordin (2004, chapter 8)—as well as his ruminations about Don Quixote. It is clear from the picture presented in this document that earlier scholars claims that

Mendeleev was some variant of anti-metaphysical positivist (as in Vucinich 1967, Stackenwalt 1976, and Benshaude-Vincent 1986) are impossible to sustain.

One final point: As readers of Mendeleev have long been aware, the chemist adored footnotes, often presenting some of his most intriguing revisions and second thoughts in this manner (as seen in Principles of Chemistry). Most of the footnotes to these texts, however, are my own, always marked by my initials. There are two original Mendeleevian footnotes in "Worldview," one in "The Unit."

"The Unit"

In the 6th issue of Svet Mr. Alenitsin proves that in nature there is no zero, that it is a fiction. One can consider such a point helpful for certain gentlemen; but if one can ascribe existence to ideas, if a word corresponds to what exists, and if every word is already an abstraction, then the word and idea (or abstraction of this sort) which is called zero exists in consciousness. That is why to speak about zero means to speak not about nature, but about an idea, an abstraction, a generalization.

The unit is another matter. It appears to be not only an idea, but also a reality. And people definitely consider it to be such: they compose from it, it is the alpha and omega of the philosopher who seeks "I" in capital letters, it is the foundation of creation, subdivisions end with it, all the sense of individualism is in it, in a word, it without a doubt exists. Isn't it true that its existence is entirely true, unquestionable? And meanwhile, think and you will come to the conviction that the unit is simply even unthinkable in nature. The units of length, weight, time, all kinds of strengths of forces—in a word, all units used in the sciences—are known to be conventional. They do not exist, they are thought up by us, i.e. they are fictional. Let us take, for example, our Earth—even that is not a unit, because there are other worlds: planets. There are just as many suns, because the stars are all exactly the same kind of thing as our sun, and if the sun does not have plural declinations in general use, then this depends only from the fact that language was formed at a time when one believed in unitarity more than one should. Give it a try, and you can say: suns, of suns, with suns, etc. It is true that these words don't sound pretty, but that is only because we did not grow up with the idea of the plurality of worlds and suns, we learned it, we were not born with it, it was imbibed only through the long path of study—and, chiefly, because we grew up with the concept of unit, we learn to count from units, we even think in units. Because of this, most likely, people affirm to us, at one time (occasionally, not more) a single unit for

6 "Positive and Negative." p. 129. (Alenitsin 1877–1878—MG)  
7 The Russian first-person pronoun is not ordinarily capitalized.—MG  
8 In the original: "cónica, conicus, comune." Russian is a case language, and certain forms conventionally exist only in the singular, as is the case for "sun." The words Mendeleev uses here strike native speakers as extremely awkward.—MG
success, although they are prepared to give high marks for diligence and behavior. The whole misfortune is that we are already very confident in the autonomy of the unit and we forget or do not know that in nature a unit is impossible and, moreover, a unit in nature is even unthinkable. We think up the zero, but not the unit. Look and consider. Let’s imagine a single, say, ram. He doesn’t exist at all. He will die and will not remain a ram and will become a zero and will forever remain a zero. And remember that one person or one ram is very close to zero. Two—a man and a woman—are thinkable in nature as the beginning of a genus, as the embryo of a collective, development, a consciousness, self-consciousness, isolation; but one male or one female or a unit—that won’t even lead to a conception of anything. Behind each of us, around every one, beside every one, together with every one, in every word, sound, concept—in everything, in everything one feels the aggregate, the complexity, the mass of units, the collective. Individualism, or the entire essence of our education, is a ripe and even rotting fruit of the concept of the unit which exists autonomously in nature. But from this fruit, when it rots, a seed will certainly remain, and this seed will give a new, splendid development.

“I am the king of nature, it is mine, I recognize myself, I will live, I will begin to create, I will be in a state of bliss, I found…” These are all concepts, words, and thoughts, supported by the firm confidence in the unit—not thought through entirely—and it will reconstruct itself, it will change with the ages, it will fade away into thoughts. Thus a great deal has already changed since the time when Homer, or even Virgil, wrote.

“And you are not the king of nature,” they will say to us, “and if you rule that is only because you received and use the legacy of your predecessors, because you were formed in a family, in a society, in a state. Alone, you are simply nature’s slave. Your individual is only zoological, animal, and all your humanity and all that you revere, all of this is from others, with others, and not for you alone, not personal but general. Understand this and you will cease boasting about yourself. Yes! This is not yours, but was given to you by someone. Thus the right hand is not the property of the right arm, but of the entire person. Wool from a sheep, thread from a spinner, cloth from a weaver, a seam from a tailor—this is the matter and the property not of one, but of many people and rather a lot of people at that. You are conscious of yourself, they will also tell us, “only because your thought developed from your father and mother, sisters and brothers, teachers, and colleagues, in a word, from the fact that you are not a unit in nature but a part of a whole, a cell in a large organism. And your laudatory I is just as senseless as would be your arm’s boast that it draws or writes, that the hand belongs to it.”

People will speak thus when they come to realize that there is no unit in nature. And then a new phase will begin, then individualism will fall, then the Slavic communal idea will replace the idea of the unit, and the matter will go much further than at present. New epochs, we propose, will begin both in thoughts and deeds, and in beliefs and popular fates, but—never fear—there will be less nonsense, and neither the ancient idea of the state, nor the newer, free unit, will disappear: things will be better for them because there will be more truth and sense. For centuries the affairs of life will grow more complex because people will know more, and better—they will preserve, they will adapt to life consciously and unconsciously. Buddhist self-abnegation and contemporary self-aggrandizement are both bad extremes. The good is more complicated than them, possibly more desirable.

There is no zero in nature, and the unit is unthinkable in nature, although it appears to exist. Both the zero and the unit are words, ideas. Taking the word—for in the beginning everything was and will be a word—apart from the rest, we at first understand it as corresponding to something real, singular. But meanwhile it never has this character. The word is already a generalization. The “horse” is not this one and not that other horse, but the general, abstract concept. The word “unit” is also an abstraction, but furthermore an abstraction of a higher order than that which is connected with the word “horse.” We cannot say anything, not a single word, without falling into abstraction and this abstraction about the unit as something which exists in nature is precisely the same kind of abstraction, the same kind of fiction, as the concept of zero. There is no difference. Both abstractions are inevitable, lawful, helpful; the thought becomes tangible, living, fruitful in the word. We usually think in words. But say that in the beginning there will be just a word, as something real, in the end there ought to be a true idea which corresponds to it as something general; in the contrary case the word is nothing more than empty noise. The idea of the unit will only be true when people understand that in nature it is the same kind of meaningless thing as the zero, that the unit is nothing in and of itself, that it is only a creation of our minds similar to the ones resorted to in geometry when one imagines that a curve is composed of a large number of straight lines. People have understood the unit poorly up to the present, they have become enamored of it, and because of the parts they did not see the whole; but it has become high time to recognize that we all separately consider ourselves significant units, but in essence each of us is in and of himself a zero. We go a degree higher and then the unit will be of a higher order—the family, society, state, humanity. And on these degrees our life will become better and we will begin to seek bliss not personally, seek delight not as units, we will not mistake the good with delight but will begin to understand ourselves as nothing more than microscopic cells in the entire organism. Thus we will go ever higher, beginning from the conventional zero and unit into the non-conventional infinite. This path of thought is also perfectly clear and simple, inevitable and helpful, as that path of thought according to which everything

---

9 This is a pun. Russian grading runs on a scale of 5 to 1, with the lowest number (“unity”) being a failing grade.—MG

10 The “Slavic communal idea” is a reference to the commune (obshchina) which dominated Slavophile thought. On the full political and philosophical implications of Slavophilism, the heyday of which was in the 1840s and 1850s, see Walicki (1975).—MG
visible is formed from indivisible atoms, everything living from cells, as the first and simplest units to which our contemporary gaze has reached. Only the lowest organism is a single cell. And just as how for the cell all its functions are mixed up, so will ours all remain mixed up until we come to terms with the concept of the social organism, until we cease being individualists, until we recognize that we are units of the lowest order. And so we dreamed that everything is conditional and relative, only our philosophical I is unconditional, original, and existing. Speaking truthfully: in its idea our proper, personal unit is rarely different from zero and in no form is it identical, in its actual nature, to thought free from conditional forms and worlds—this I of the individualists is no more, no less, than a zero.

The idea of zero, in my opinion, was harmless, but the concept of the unit has caused a lot of misfortune. People’s sense in nature will be clear only when they come into consciousness together with the idea of infinity. If one recognizes in nature a unit, it is impossible to deny either the zero or infinity. In life only the finite is possible and desirable. It is constrained by the concepts of the greatest good and the smallest evil.

D. Popov

“Worldview”

I cannot—I even simply don’t have enough of such audacity—to close the exposition of my *Cherished Thoughts* without having tried to communicate my own fundamental principles, which were worked out through the entire totality of what I have experienced and learned in life, since my entire exposition was essentially determined by these principles, albeit not directly. I consider this all the more necessary in our time, which is openly occupied by “reevaluation” and the concentrated striving to find anew the supposedly lost “origin of all origins,” setting forth at times from a subjective autonomous point of view, at times from some kind of abstract unity, whether it be energy in general, or electricity in particular, or something other—only not the ancient origin point, which we name God. They are now trying to establish the reciprocal distance from physics to metaphysics as vanishingly small, so that in physics (especially after the discovery of radioactivity) they directly transition into metaphysics, and in the latter they are trying to achieve the clarity and objectivity of physics. The old gods are overturned and they seek new ones, but they have not arrived at anything at all permissible or integral; and so skepticism is legitimized, remaining content with aphorisms and denying the possibility of an integral general system. This is very sadly expressed in philosophy, setting out from Schopenhauer and Nietzsche; in the natural sciences we are trying “grasp the ungraspable” following the example of [Wilhelm] Ostwald or even [Johann Heinrich] Ziegler [in Switzerland, viz., in his “Die wahre Einheit von Religion und Wissenschaft” by J. H. Ziegler, Dr. philos., Zürich, 1904, and still better in his: “Die wahre Ursache der heller Lichtstrahlung des Radiums”, 1905])

13 Ziegler 1904, 1905.—MG
14 An idiom attributed to Russian fabulist Ivan Krylov.—MG
15 The Duma, Russia’s first parliament, was formed as a consequence of the Russian Revolution of 1905, taking place precisely as Mendeleev composed this document.—MG
16 The Babi faith was a religious movement that flourished from 1844 to 1852 in Iran.—MG
for very little, because the eternal, the general, and the unified in any event is logically higher than the real, which is understood only in the temporary, the partial, and the heterogeneous, only graspable by reason in abstraction, which indeed comprises the domain of the sciences, including philosophy (if it does not become—on stilts—the science of sciences). The sciences essentially abstract from direct realism, and if they are either real in subject or real in utility (because they give useful predictions), then this only underscores the necessity of abstractions, their significance and utility. It must be a great confusion of thought when one wants with scientific examples to find a realization of higher unity, to express using only the real the multiplicity of realities or abstractions. This ends up running around in circles. And when one sees this they throw it out immediately, they immediately fall into skepticism relating to any and all generalizations—of course except for words, which are in themselves nothing more than the original generalizations. The realization, in whatever form it might be, of a generalization so abstract as a general "unit" or "unity" just simply contradicts the entire spirit of the sciences and cannot lead to anything other than the doubts of skepticism. The flaw here is not at all in the very idea of unity but only in the striving to realize it in images, forms, and particular conceptions. This will never achieve anything by the very logic of the matter, and one must not attempt to imagine the general "unit" either in such materialities as matter or energy, or in such realities as reason, will, the individual, or all humanity, because both the one and the other must be contained by this general "unit" and both the one and the other comprise only a topic of the generalizing sciences.

And thus I explain skepticism by the unreasonableness of forcing science, which generalizes realism and in the form of predictions conquers it for human use and by this means returns to reality, forcing science to relate these very same topics to its extreme generalizations. And one must not do this because scientific generalizations are not an already-changing limitlessness or reality, but are limited by the fact that one can only study (and only "pebbles on the banks of the ocean of the unknown" are studied, as Newton said) up to the point that it became possible to predict something and these scientific generalizations ought to remain unchanging until the very study of reality compels changing, expanding, and perfecting them. From this all of metaphysics, upon which rests all of skepticism, has not given anything sensible and useful.

But enough about that. In any event it is absolutely necessary to admit the enormity of the mass of the completely unknown. Whether there is or there isn't, in this or that given area of knowledge, a certain limit which is impossible to transgress, I am not going to explore because it is entirely inappropriate to resolve this for the communication of what comprises the subject of my original thoughts. The issue at the present time is only about what a reasonable generalization may now achieve, about what one must or is able to agree (although one must be personally satisfied only temporarily, entirely besides the "origin of all ors," for which the ground will be created not through study but through what is called faith and is determined by instinct, will, feeling, and heart. After all, where indeed will the generalizations of reason cease? Won't all of the work of centuries gathered in science reduce to a single formulation of particulars? Where is the limit of contemporary reasonable generalizations if not in a general "unit"? Precisely there is the question of worldview, the task of that array of thoughts by which from long ago such directly applied sciences—such as the medical, engineering-technical, and juridical sciences—differ from the philosophical sciences, to which relate not only philosophy, philology, and history but also all the mathematical and natural sciences. The first are bound with the second so tightly that many minds have been confused by this tightness, but simple common sense easily recognizes that the applied sciences are moved by the philosophical sciences and, at the same time, that the philosophical sciences are worked out only because they (albeit only with a dim light) illuminate all the same the path of life—i.e. they serve utility both directly and essentially—by means of the applied sciences. Already one primary and clearly never-ending search for new parts of truth, which distinguishes science, directly points to science's striving to perfection and to the recognition of the bottomlessness of the unknown; more briefly; serving science teaches modesty united with persistence, and means one from premature arrogance and slavery to prejudices. And since science, setting out from actuality or reality, gradually all the same reaches certain propositions or affirmations, doubtlessly justified by observations and experiments, one has a right to consider these partial truth or "laws." No one, it seems, will take this away from science. But since in the republic of science "freedom" of opinions is guaranteed to that degree that there are no attempts (either secretly or openly) to ask the majority, so everyone is free to speak in the name of science—not only everyone who has studied a little, and any author, scribbler, or humorist, but even a simple passerby, and therefore it is extraordinarily or extremely easy to get lost concerning "the last words of science." And one will not seek here, perhaps, any sort of signs—except rather negative ones—for differentiating all forms of usurpation from the actual voice of science, since the sense capable of leading here is not innate but is gained only through long and bitter experience. It shows, however, that the truly scientific is usually accompanied by a calm modesty, and there is no true science where people try sharply and with judgmental reception to shut the mouth of any contradiction, although there sometimes appears an artistic virtuosity and many footnotes to "the last word of science." Read a bit of how Copernicus and Newton introduced the truths they found and you will be convinced. It's as if true science speaks or advises "please don't believe my words, and try only to verify them," from which on the one hand I cannot but express this advice: consider as authentic science only that which is affirmed after doubts and every type of trial (observations and experiments, numbers and logic), and you will not trust very much "the last
With these thoughts I conclude the book, knowing or, better said, understanding, that now is not the kind of time for gradualist thoughts like mine, capable only somewhat of influencing the disturbed minds of today’s youth, for whom this book was principally written. It is possible to be effective in this matter only through images, as Cervantes did with his Don Quixote. One is viciously sorry for him, and it is impossible not to recognize the purity of his convictions, and yet people have stopped imitating him because they already very clearly saw how people like him produce only nonsense and ridiculousness. One must know how to write about how, in searching for freedom, one acts against freedom. Alas, I do not have these talents; I did not summon and nurture them. However, regardless of my attitude to this current book, I won’t repent of writing it, but delight in the fact that I finished it, because, no matter what, all the same I hope it will be clear from my book what kinds of thoughts saturated the professors of the times of the late Count D. A. Tolstoi—who, I will admit, I consider the first cause of many contemporary Russian misfortunes and an exemplary and skillful mischief-maker and confounder.

27 September 1905

D. Mendelev[j]

References


