THE CHINESE PERIODIC TABLE: A ROSSETTA STONE FOR UNDERSTANDING THE LANGUAGE OF CHEMISTRY IN THE CONTEXT OF THE INTRODUCTION OF MODERN CHEMISTRY INTO CHINA

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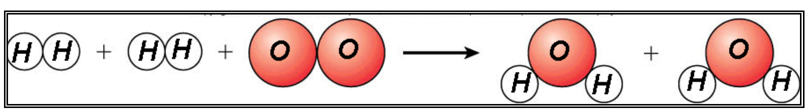
(**Part 1**: Presentation given at the national ACS meeting in Anaheim, CA, March 29, 2004)

Most of us tell our beginning students that learning chemistry is like learning a new language. However, the student soon learns that in many ways this language is quite unique.

Some of the differences can be summarized:

1. **Conceptual Content**: Most of the words can only be understood in terms of the underlying concept that may not be in the learner's experience.
2. **Structural Content**: Many words of chemical substances express structural features. (For example, the chemist who talks about "hexane" or "2-hexene" can immediately visualize a 6-carbon chain with or without a double bond starting at the 2nd carbon.
3. **Forms of Expression**: And finally, the chemist has devised at least three ways of expressing the chemical language:
   a. In words and sentences: "Hydrogen combines with oxygen to yield water."
   b. Symbolically: "$2\ H_2 + O_2 \rightarrow 2\ H_2O$"
   c. With pictures as atom spheres or with electron clouds:



Students are faced with understanding the new language on three levels:

1. The language of chemistry
2. The language of science
3. The language of their world-view of the physical world about them.

Thus both familiar and new words are linked to new concepts and structures that require special kinds of visualization. I am reminded of Lavoisier's observation about the new chemical he introduced:

- *"The impossibility of separating the nomenclature of the science from the science itself, is owing to this, that every branch of physical science must consist of three things: the series of **facts** which are the objects of science; the **ideas** which represent these facts; and the **words** by which these ideas are expressed."*

  A.L. Lavoisier, *Elements of Chemistry in a New-Systematic Order,* 1790, Robert Kerr Translation.

We might place Lavoisier's view in a concept diagram.

Figure 1a: Concept Diagram of Lavoisier's Language of Science

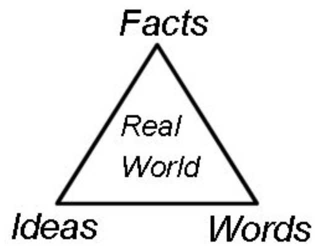
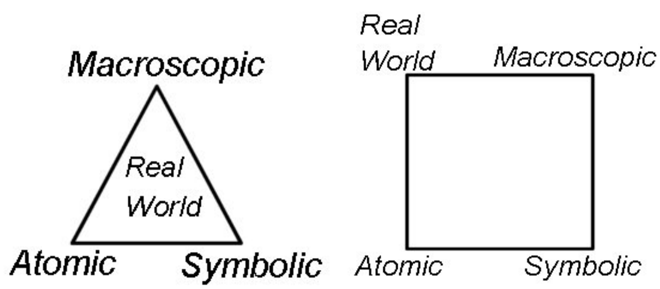


Figure 1b-c: Traditional and Non-traditional Concept Diagrams of Viewing the Real World



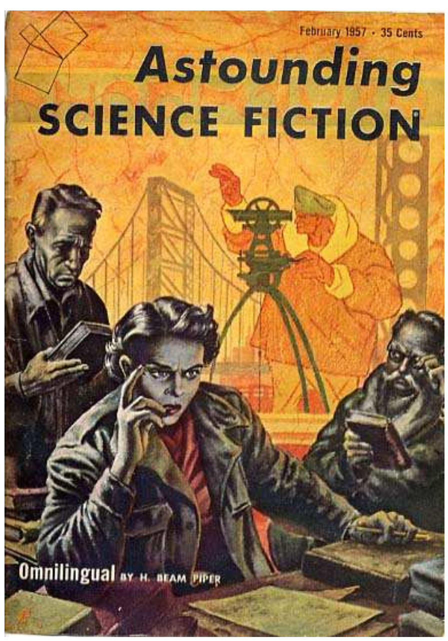
The three terms used by Lavoisier now appear in more modern concept diagrams as the Macroscopic-, Symbolic- and Microscopic (or atomic) way of viewing the real world. But for many students there between their real world is disconnected.. (Figure 1c) In short many students have difficulty in translating the language of the chemical world into their own world view. Perhaps what is needed is a bilingual dictionary that could help them to decipher the meanings of this new world of chemistry.

Now suppose we are trying to understand a completely new language that for all practical purposes has vanished leaving no trace in our conscious memory. Westerners found the key to deciphering hieroglyphics when they uncovered the Rosetta Stone (Fig. 2) that provided 3 lines of parallel meanings in hieroglyphics, demotic script and Greek.

Figure 2: The Rosetta Stone

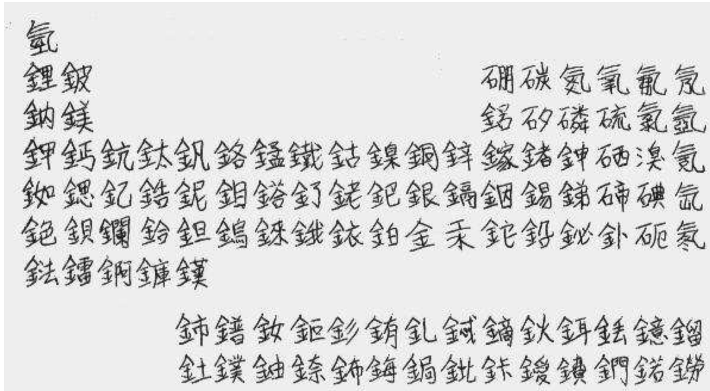
As teachers, we like to think the modern periodic table of the elements is the chemistry students' Rosetta stone. However, for many students this stone remains un-deciphered. Despite our entreaties, our students often appear as novice archeologists touring a forbidding planet in some science fiction story (Figure 3).

Figure 3. Cover of February, 1957 issue of *Astounding Science Fiction*, and figure from H. B. Piper's story, "Omnilingual" (p. 17)



Here is how the Periodic Table might appear to them (Figure 4):

Figure 4: Chinese Periodic Table (from the Web – of unknown origin)



Even if you don't read Chinese, some interesting relationships are found in this periodic table. (I do not know why helium was left out.) See Figure ___ for pictures of the four radicals used to identify the substances as elements.

Several groups of elements have a common picture (radical or character) associated with them:

1. Eleven elements (hydrogen, the noble gases [helium missing], fluorine and chlorine, nitrogen and oxygen) - all could be characterized as existing as gases in their natural state – share a common character: the "gas" radical.
2. There are 7 non-metals (B, P, S, Se, Te, I, As) that contain the "stone" radical.
3. Bromine and mercury contain the "liquid" character.
4. Overwhelming majority of the remaining elements at the left side of the table are metals and share the character found in the element, gold.

The shape of the periodic table allows one to identify the location of elements. In modern times the direct translation of the Chinese elements to chemical formulas and then to formula weight can be accomplished with my Chinese Periodic table calculator. (See: http://people.emich.edu/bramsay1) Any chemist who knows the position of the elements in the table may easily accomplish the translation of the Chinese characters of the elements to Western symbols. The writing and stoichiometric analysis of aluminum sulfate is illustrated below.

Figure 5a. A Chinese Periodic Table Calculator (View before formula entry.)

化学元素表 Calculator

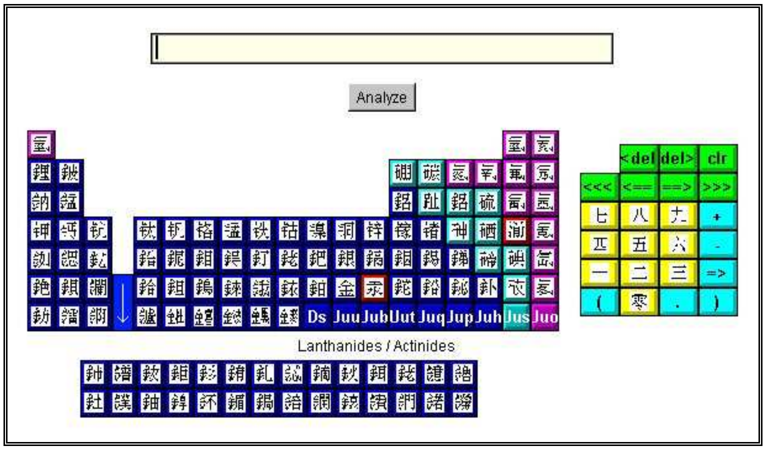


Figure 5b. A Chinese Periodic Table Calculator (View after formula entry.)

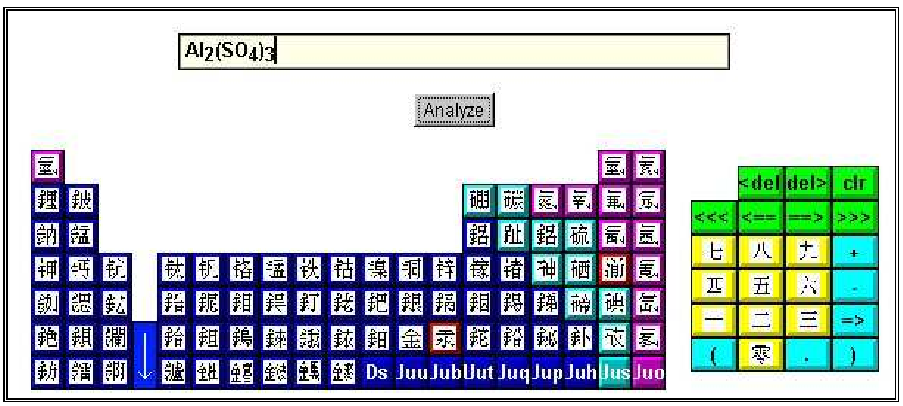
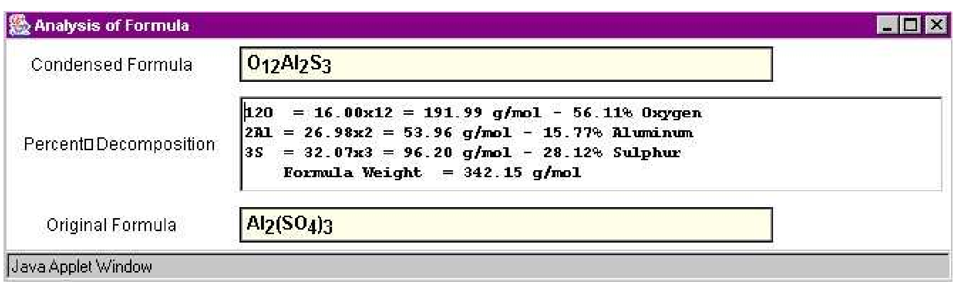


Figure 5c. A Chinese Periodic Table Calculator (View after formula analysis.)



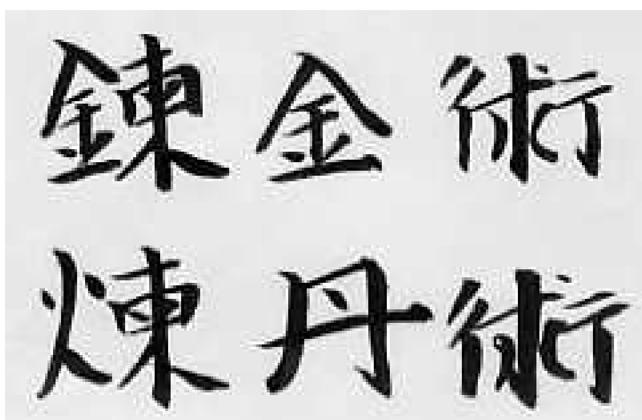
The translation of the Chinese Periodic Table to the "Western" Periodic Table is relatively easy. That is to say, the student would learn in the writing of chemical formulas and equations that the periodic table – whatever language – is the "chemist's computer keyboard."

But has the translation and understanding been as simple in the other direction? This question was prompted a few years ago when I was taking a beginning course in conversational Chinese. Toward the end of the course, we were exposed to the "writing" of a few words in Chinese. I was curious as to how the Chinese pictograph for "Chemistry" came about.

Figure 6: The word for "Chemistry" written in Simplified- and Traditional Chinese Characters

This word for chemistry comes from the use of two characters which mean, "the study of change". This seemed to have a curious derivation when we think of the origin of the word chemistry in the West may have come from the Arabic word for "alchemy". However, these two characters are not found in the Chinese characters for the two types of alchemy known in China for many centuries.

Figure 7: Chinese Characters for Two Types of Alchemy: top row = Gold-making, bottom row = Elixir Preparation



The three major alchemical traditions known in ancient China were: *aurifaction*, *aurifiction*, and *macrobiotics*. The first dealt with the efforts to make gold from "baser" metals. *Aurifiction* was the conscious attempt to imitate gold. The focus of *macrobiotics*, developed in China, was in the preparation of elixirs that when taken would allow the practitioner to become immortal. You will note in the first and middle character in the top row in Figure 8 the use of the Chinese character for gold.. You will find the metal character (4th character in Figure 9) was one of the five elements that may have provided some theoretical basis for Chinese alchemical practice and knowledge of materials.

Figure 8: The Five Chinese Elements (Phases): Fire, Water, Wood, Metal, Earth

火 水 木 金 土

It is not my purpose to discuss the early development of Chinese science except to say it seems to have had little impact upon the subsequent introduction of modern chemistry into China. The 5 "elements" did not have the same meaning to the Chinese as in the West.

> "The modern concept of a chemical element as a 'substance that cannot be resolved by chemical means into simpler substances' did not exist in traditional Chinese. The notion of irreducible, elemental substances actually runs against the mainstream of Chinese thought about the material world, which tended to regard all substances as merely stages in the transformations of *qi*, differing only in purity and congelation."

As pointed out by Joseph Needham, modern Western science was alien to the traditional Chinese.

> "The mechanical view of the world simply did not develop in Chinese thought, and the organicist view in which every phenomenon was connected with every other according to hierarchical order was universal among Chinese thinkers."

The practical working with chemicals was not widespread in China except for those who were working with metal refining. In fact Western chemistry was essentially unknown in China until introduced by rather unconventional means in the late 19th century, although Jesuit missionaries introduced some Western science into China in the 17th and early 18th century.

Western technology was introduced in the middle of that century as part of China's "self-strengthening" polices to protect the Qing dynasty from internal and external attacks. Although the Chinese were primarily interested in importing Western technology and expertise to improve their military preparedness, the influx from the West included many protestant missionaries who had different objectives in mind. Most of the missionaries concentrated on translating religious tracts into Chinese – but a few had a broader view of what was necessary for the education of the Chinese. This took the form of translating many scientific works, especially textbooks, into Chinese. This was particularly troublesome for several reasons:

1. Since none of the early translators has a background in science, and chemistry in particular, they were not in position to fully understand the conceptual basis of the work they translated.
2. The Chinese to whom the translations were addressed had no background in any kind of experimental type of science – and for that matter – little practical "hands-on" experience that made it virtually impossible for them to relate to descriptions of chemical properties and changes.
3. And finally, it was difficult to pierce the barrier between the ideographic and the alphabetic civilizations. As one of the chemists in China noted,

   "We do not usually appreciate the extent to which western science has grown hand in hand with the language medium."

We might remind ourselves of the pictogram origins of many of the more abstract pictographs that evolved from them. For example let us look at the ancient origins of the 5 elements (taken from some examples provided by Needham).

Figure 9. Pictogram origins of the 5 Elements: metal, wood, water, fire, earth

The **metal** pictogram, for example, was perhaps a drawing of a mine shaft with a cover or a hill above, the dots indicating lumps of ore. The **wood**, **water** and **fire** characters suggest pictograms of a tree, running water and flames. **Earth**'s pictogram may be a drawing of the phallic-shaped altar of the god of the soil.

To overcome these barriers, the missionaries had to "invent" much of the new language of chemistry as well as change the Chinese scientific view of world about them. One of the missionaries, Alexander Wylie, was faced with the task of describing this new world. Since what was known to some about the chemical world was that these substances could undergo changes in properties, Wylie combined the Chinese characters for "change" and "study" to describe chemistry as "the study of change". (See figure 7 above.)

The first task was to decide on what characters should be used for the 60 some elements known at that time. The use of the English symbols was briefly considered, but rejected for nationalistic reasons. Transliteration, while not completely rejected, was not very practical since the "written" Chinese pictographs do not provide any guidance, as Western languages do, as to the pronunciation of the "word". By the end of the 19th century several guidelines of chemical nomenclature had been agreed upon; though by the early 20th century the use of both Western symbols and Chinese characters were used. The Chinese characters of well-known substances would be used as much as possible. Some eleven "element" substances were known by the middle of the 19th century. The names of most of these were retained but often shortened in the spoken language.

Carbon	Copper	Gold

Iron Lead Mercury	Phosphorus Silver Sulfur	Tin Zinc

To identify the substance as an element, the first character of the element name would include a "radical" that would reflect the element's physical state in which it was normally found (See figure 10):

- The metal radical for metals
- The stone radical for solid non-metals.
- The water radical for elements occurring as liquids.
- The gas radical for elements occurring as gases.

William Aldolf (Ph.D., Univ. Pennsylvania, 1915) who taught chemistry at Yanching University in China in the early 20th century described the early nomenclature in an article in the *Journal of Chemistry Education* in 1927.

Figure 10. Some Chinese Characters of the Elements used in China in the early 20th Century

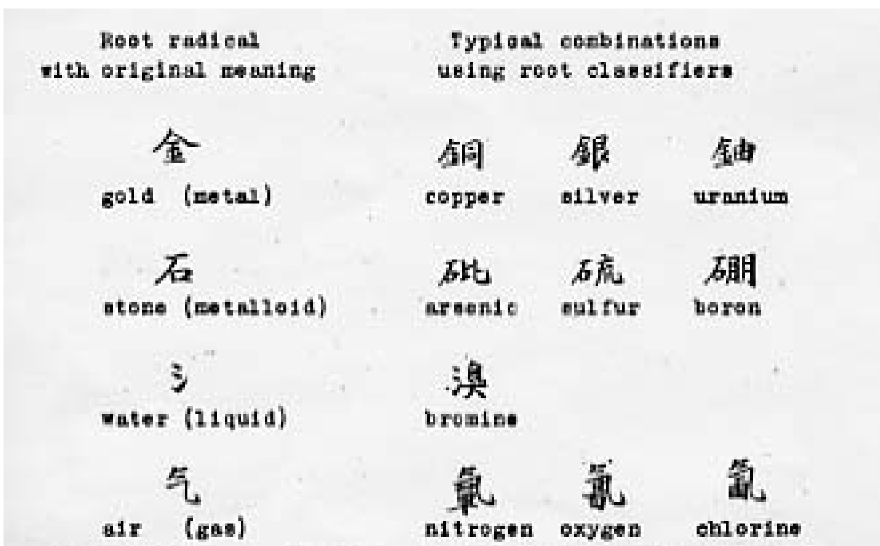


FIG. 1.—Chinese characters for some of the chemical elements. Many of these names are prehistoric; the same principle illustrated above has likewise been followed in manufacturing new ideograms for the newer elements.

The writing of chemical formulas and equations using these characters became (at least to me) problematic. Here is a vertical rendering (Figure 11) of the reaction (written in the older dualistic style) of calcium carbonate with sulfuric acid (sulfur trioxide). (The plus [+] sign was replaced by an inverted "T" in Chinese.)

$$CaO \cdot CO_3 + SO_3 = CaO \cdot SO_3 + CO_2$$

Figure 11. Vertical Rendering of a chemical reaction in Chinese

鈣養炭養二上硫養三‖鈣養硫養三上炭養二.

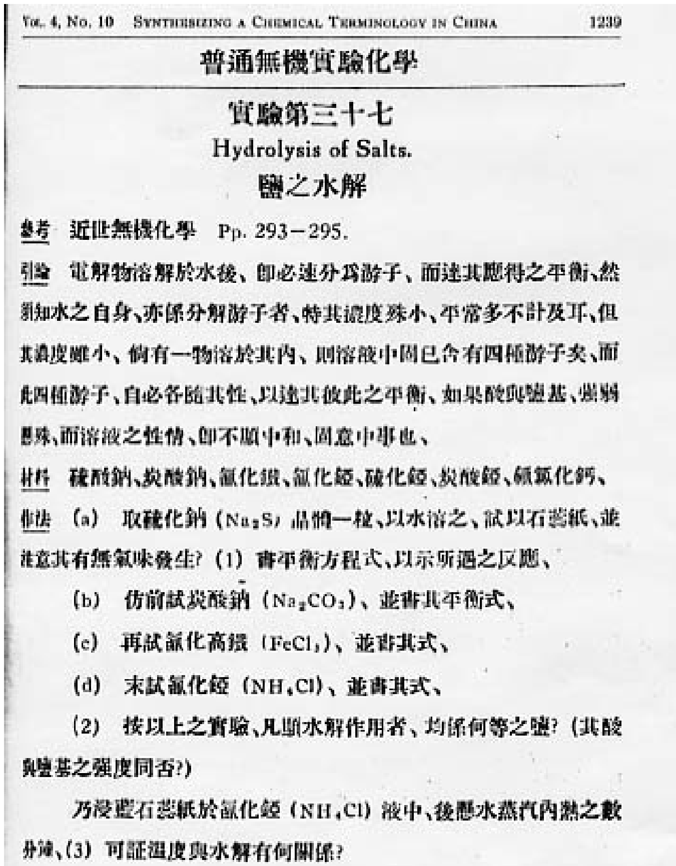
Later subscripts were introduced. Here is an example of the formula of $FeSO \cdot SO_3$ (in dualistic notation):

Figure 12

[The system] may be extended by putting the primary substance first and then the secondary substance, for example [iron(II) sulphate] 鐵養硫養三 [$FeO.SO_3$ in dualistic or $FeSO_4$ in modern notation]. [45]

How much longer this mode of writing chemical formulas has not been explored. By the early part of the 20th century, Western symbols were used. William Adolph included in his 1927 article an excerpt form a translation of a chemistry laboratory manual (Chapin, *Second Year Chemistry*).

Figure 13



Vol. 4, No. 10 SYNTHESIZING A CHEMICAL TERMINOLOGY IN CHINA 1239

普通無機實驗化學

實驗第三十七

Hydrolysis of Salts.

鹽之水解

參考 近世無機化學 Pp. 293−295.

引論 電解物溶解於水後、卽必速分爲游子、而達其應得之平衡、然須知水之自身、亦係分解游子者、特其濃度殊小、平常多不計及耳、但其濃度雖小、倘有一物溶於其內、則溶液中固已含有四種游子矣、而此四種游子、自必各隨其性、以達其彼此之平衡、如果酸與鹽基、强弱懸殊、而溶液之性情、卽不顯中和、固意中事也、

材料 硫酸鈉、炭酸鈉、氯化鐵、氯化錏、硫化錏、炭酸錏、氰氨化鈣、

作法 (a) 取硫化鈉(Na_2S)晶體一粒、以水溶之、試以石蕊紙、並注意其有無氣味發生? (1) 書平衡方程式、以示所遇之反應、

(b) 仿前試炭酸鈉(Na_2CO_3)、並書其平衡式、

(c) 再試氯化高鐵($FeCl_3$)、並書其式、

(d) 末試氯化錏(NH_4Cl)、並書其式、

(2) 按以上之實驗、凡顯水解作用者、均係何等之鹽? (其酸與鹽基之强度同否?)

乃浸藍石蕊紙於氯化錏(NH_4Cl)液中、後懸水蒸汽內熱之數分鐘、(3) 可証溫度與水解有何關係?

Adolph provided many examples of the benefits of the use of Chinese characters in chemical nomenclature. For organic compounds he felt that the “characters were suggestive of the molecular constitution. Look, for example, at the names of methane, butane and ethene whose names tell us the number of carbon atoms and the degree of unsaturation. (Figure 14)

Figure 14

FIG. 3.—Additional examples of Chinese chemical nomenclature.

It should be pointed out that the introduction and naming of the chemical elements in the latter part of the 19th century was accomplished without the availability of a periodic table of the elements. The concept of periodicity (and a presumably a picture of the table) first appeared in a short-lived journal, *Yaquan Zazhi* (*Yaquan Journal*) in early 1901. This first chemistry journal was only published for two years (1900-1901) and consisted largely of translations from Japanese chemistry articles. (Is the Chinese Periodic Table shown in figure 2 from this journal?)

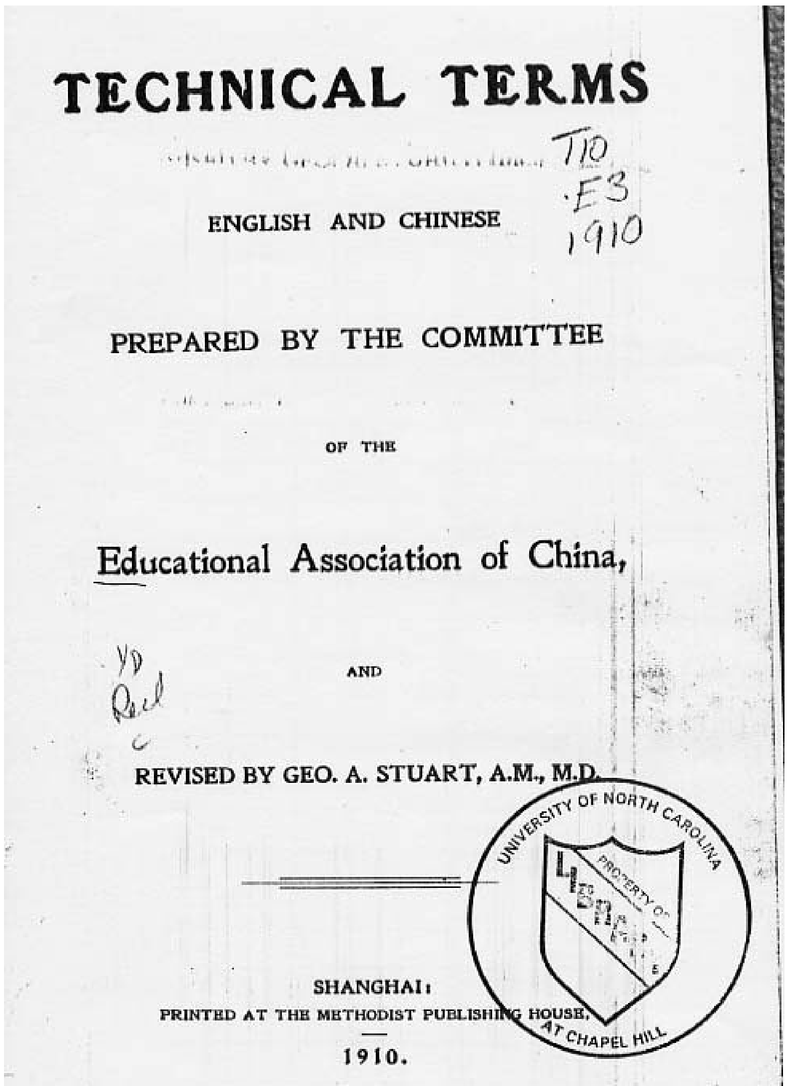
"*Early Chemical Education in China: The University of Pennsylvania Connection*."

Part 2: This research has continued and an update was presented at the national ACS meeting in Philadelphia on August 25, 2004.

William Henry Adolph, who taught chemistry in China in the early part of the 20th century, received his Ph.D. in Chemistry from the University of Pennsylvania in 1915, represented the new wave of scientifically trained professionals that came on the scene later. I will have more to say about him later.

Most of the problems of formulating a chemistry nomenclature had been overcome by the earlier group of missionaries before Adolph. This resulted in the publication of a list of technical terms in the first decade of the 20th century. The list, prepared by the Educational Association of China, appeared in two editions published in 1904 and an expanded version in 1910. The main list – in the 1910 edition (Figure 15) – included about 10,000 entries in 484 pages. Only about 250 terms seemed related to chemistry. A 64 page appendix, however, listed some 1600 chemical substances, mostly inorganic chemicals (Figure 17). The 72 elements were listed in 1910 included the Noble gases helium, argon and xenon. The 61 elements listed in the 1904 edition did not include several of the rare earths and Noble gases.

Figure 15


TECHNICAL TERMS

ENGLISH AND CHINESE

PREPARED BY THE COMMITTEE

OF THE

Educational Association of China,

AND

REVISED BY GEO. A. STUART, A.M., M.D.

SHANGHAI:
PRINTED AT THE METHODIST PUBLISHING HOUSE.

1910.

This was not your typical technical dictionary, however, as you can see from some excerpts in Figure 16)

<u>Figure 16: Excerpt from *Technical Terms*</u>

Carat, ...	加拉
Carbolic acid, ...	酥醋，架波匿酸，加播沥酸
Carbon, ...	碳，炭，炭質，炭精
,, dioxide, CO^2, ...	碳氧强浛，碳氧雙浛，炭養$_{二}$
,, monoxide, CO, ...	碳氧弱浛，碳氧單浛，炭養
,, disulphide, CS^2, ...	碳硫强浛，碳硫雙浛，碳硫$_{二}$
,, cored, ...	[illegible]炭條
,, filament, ...	炭絲
,, for electric lamps, ..	電燈炭條
,, gas, ...	煤氣炭
,, holder, ...	炭條揷
Carboniferous, ...	產煤，煤礦[illegible]

Under the entry for carbon and some of it compounds, for example, there are several points of interest:

1. The "western" chemical formulas are used along with the English name. (There is some inconsistency as to whether to use superscripts or subscripts.)
2. To the right are given the Chinese names. Where alternative names have been used – the preferred name is placed first.
3. Sometimes the Chinese chemical name would include a subscript. (The use of Chinese chemical formulas like this was short-lived, however.)

Below is shown the first page from the List of Chemical Substances (Figure 17).

Figure 17: Excerpt from the Appendix in *Technical Terms*

List of Chemical Substances.

INORGANIC.

Aluminum. III.

Acetate	$Al\bar{A}_3$	釷醋礬	$\bar{A}=C_2H_3O_2$
Chloride	$AlCl_3$	釷綠鹽	
Fluoride	AlF_3	釷氟鹽	
Hydrate	$Al(HO)_3$	釷沎	
Nitrate	$Al(NO_3)_3$	釷氮強礬	
Oxide	Al_2O_3	釷銹	
Phosphate	$AlPO_4$	釷磷強礬	
Silicate		釷砂強礬	
Silicide	Al_2Si_3	釷砂洽	
Sulphate	$Al_2(SO_4)_3$	釷硫強礬	
Sulphide	Al_2S_3	釷硫洽	
and Potassium Silicate	$AlKSi_3O_8$	釷鉀砂強礬	These are numerous, and comprise both metas and orthos.
" Sodium "	$AlNaSi_3O_8$	釷鈉砂強礬	
" Ammonium Sulphate	$Al_2Am_2(SO_4)_4$	釷錏硫強礬	錏白礬
" Potassium Sulphate	$Al_2K_2(SO_4)_4$	釷鉀硫強礬	鉀白礬
" Sodium Sulphate	$Al_2Na_2(SO_4)_4$	釷鈉硫強礬	鈉白礬

What you can see from the entries below is the diversity in what might be considered a technical term.

Figure 18: Excerpt from *Technical Terms*

Benediction, ...	祝禱，祝文
Benefactor, ...	恩人
Benevolence, ...	仁，仁愛
Benzine, ...	苯辛，徧西尼
Benzoic acid, ...	安息香酸，辨佐匿酸
Berberidaceæ, ...	小櫱科
Beryl, ...	綠玉，球
Beryllium,..	鋍
[illegible]	[illegible]

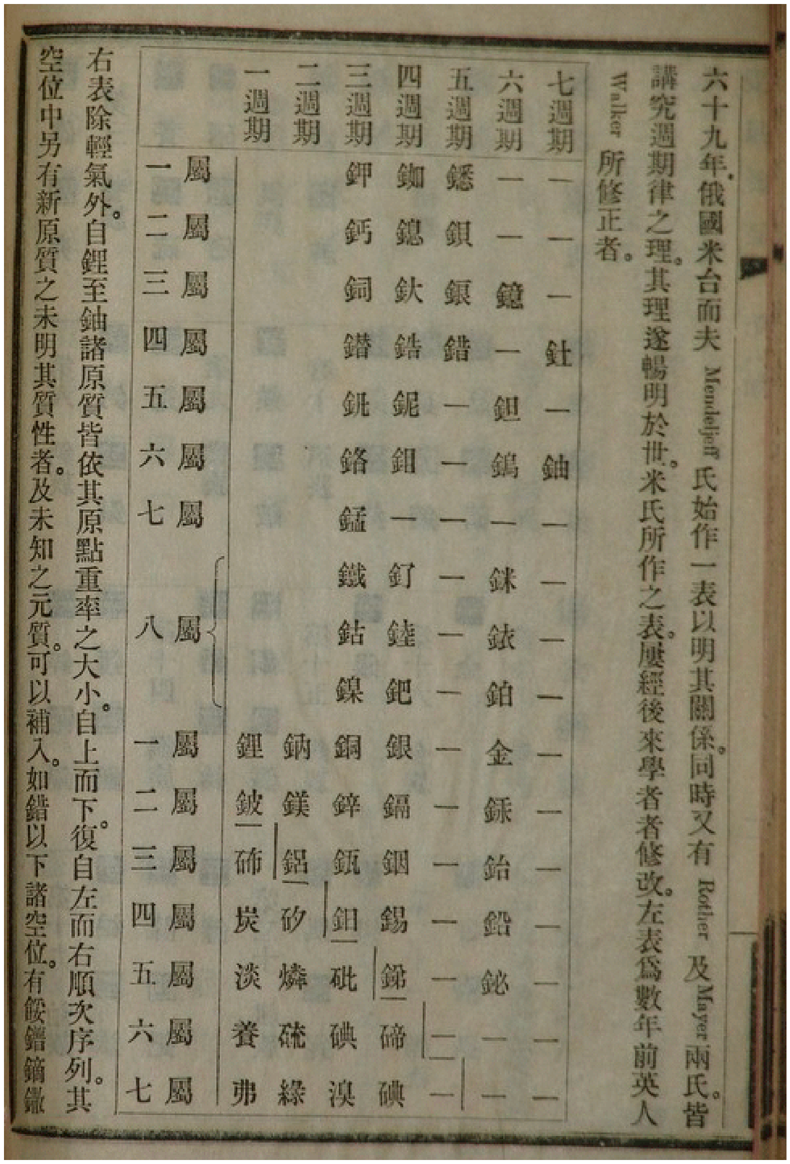
Figure 19: Another Excerpt from *Technical Terms*

Church (the building), ...	會堂，堂屋
,, (body), ...	教會
,, Anglican, ...	安立甘會
,, Baptist, ...	浸理會
,, Congregational, ...	公理會
,, Dutch Reformed, ..	荷蘭改革會
,, Episcopalian, ...	監督會
,, Established, ...	國立教會，國教
,, Greek, ...	希臘教會
,, Independent, ...	獨立會
,, Lutheran, ...	路得會
,, Methodist Episcopal, ..	美以美會，監理會
,, national, ...	國家教會
,, organization, ...	公會
,, Presbyterian, ...	長老會
,, Roman Catholic, ..	天主教，羅馬教
,, Unitarian, ...	惟一神會
,, Universalist, ...	普救會

The interesting thing about the list of elements settled upon by the end of the 19th century, is that it was developed in the absence of the use of the periodic table of elements (Figure 20) which was not known in China until 1901 – which only appeared in 1901 in *Yaquan zazhi*, the first chemical journal published in China. The editor, Du Yaquan, was largely self-taught and represented the new generation of scientifically-trained Chinese who contributed to

Figure 20: The First Chinese Periodic Table

Yaquan zazhi 亞泉雜誌*: the first chemical journal in China*



六十九年，俄國米台而夫 Mendeljeff 氏始作一表以明其關係。同時又有 Rother 及 Mayer 兩氏。皆講究週期律之理。其理遂暢明於世。米氏所作之表。屢經後來學者者修改。左表爲數年前英人 Walker 所修正者。

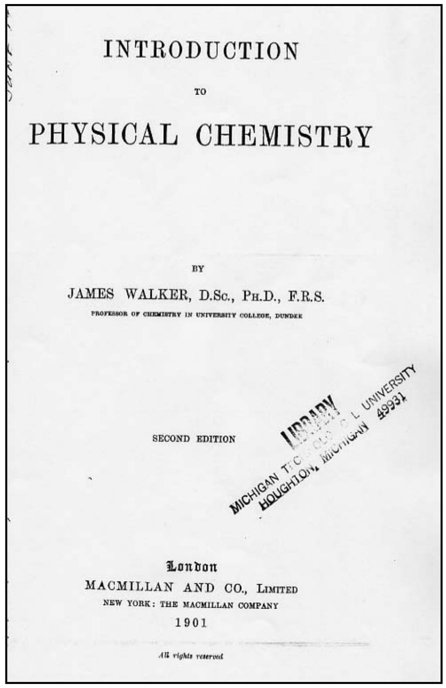
	一週期	二週期	三週期	四週期	五週期	六週期	七週期
一屬			鉀	銣	鏭	—	—
二屬			鈣	鎴	鋇	—	—
三屬			鈳	釱	鑭	鐿	—
四屬			鐟	鋯	錯	—	釷
五屬			銚	鈮	—	鉭	—
六屬			鉻	鉬	—	鎢	鈾
七屬			錳	—	—	—	—
八屬			鐵	釕	—	銤	—
			鈷	鏈	—	銥	—
			鎳	鈀	—	鉑	—
一屬	鋰	鈉	銅	銀	—	金	—
二屬	鈹	鎂	鋅	鎘	—	錰	—
三屬	硼	鋁	鎵	銦	—	鉈	—
四屬	炭	矽	鍺	錫	—	鉛	—
五屬	淡	燐	砒	銻	—	鉍	—
六屬	養	硫	碘	碲	—	—	—
七屬	弗	綠	溴	碘	—	—	—

右表除輕氣外。自鋰至鈾諸原質皆依其原點重率之大小。自上而下。復自左而右順次序列。其空位中另有新原質之未明其質性者。及未知之元質。可以補入。如鍇以下諸空位。有鈸鐠鏑鐽

The periodic table you see here may look a bit strange – by rotating some 90^0 , it may look a bit more familiar: with the families as columns, the periods as rows.

The periodic table was taken from a Japanese source based on the periodic table prepared by James Walker at the turn of the century. (His name is shown on the upper right hand corner of the page.)

Figure 21: Title page of the 1901 edition of James Walker's *Introduction to Physical Chemistry*


INTRODUCTION

TO

PHYSICAL CHEMISTRY

BY

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SECOND EDITION

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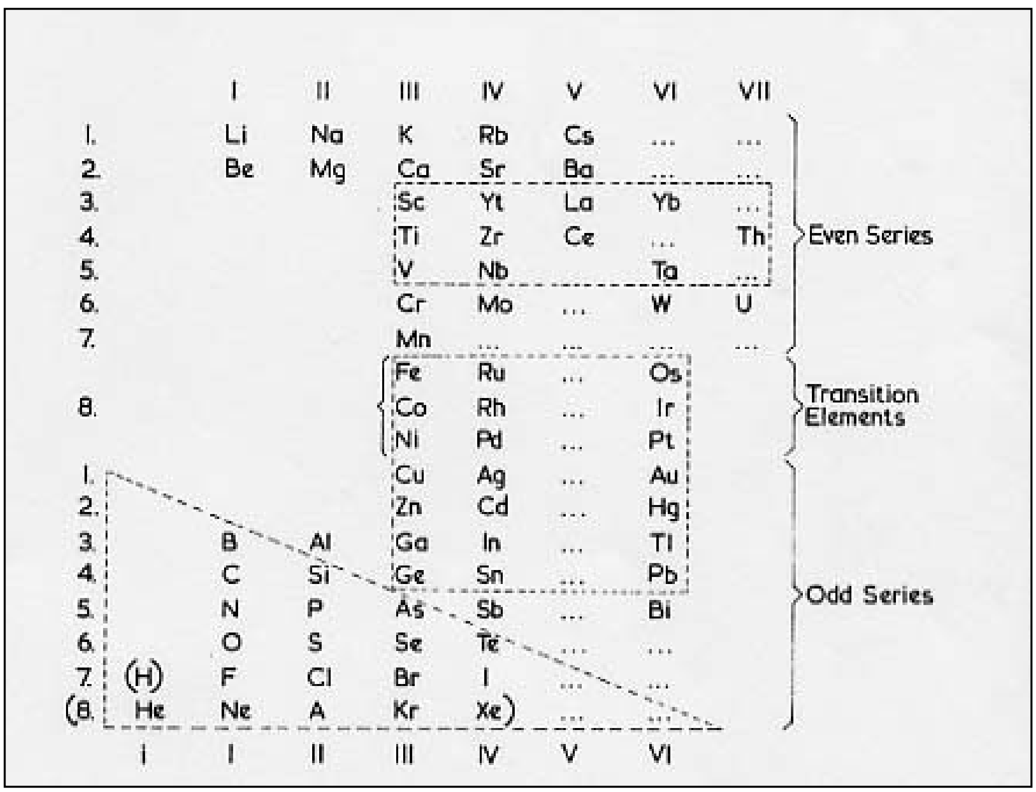
Figure 22: Walker's Periodic Table of 1901



		I	II	III	IV	V	VI	VII	
1.		Li	Na	K	Rb	Cs	...	...	Even Series
2.		Be	Mg	Ca	Sr	Ba	...	...	
3.				Sc	Yt	La	Yb	...	
4.				Ti	Zr	Ce	...	Th	
5.				V	Nb		Ta	...	
6.				Cr	Mo	...	W	U	
7.				Mn	...	...	...	...	
8.				Fe	Ru	...	Os		Transition Elements
				Co	Rh	...	Ir		
				Ni	Pd	...	Pt		
1.				Cu	Ag	...	Au		Odd Series
2.				Zn	Cd	...	Hg		
3.		B	Al	Ga	In	...	Tl		
4.		C	Si	Ge	Sn	...	Pb		
5.		N	P	As	Sb	...	Bi		
6.		O	S	Se	Te	...	...		
7.	(H)	F	Cl	Br	I	...	...		
(8.	He	Ne	A	Kr	Xe)	...	...		
	i	I	II	III	IV	V	VI		

Walker's periodic table arrangement attempted to find a place for the rare earth elements. But this table still does not quite fit the Chinese version since it includes the Noble gases. Apparently then the Chinese version was based on Walker's periodic table published in the first edition of his textbook of 1899 – which does not include any mention of the place of the Noble gases.

Figure 23: Walker's Periodic Table of 1899

TABLE I

	I.	II.	III.	IV.	V.	VI.	VII.	
1.	Li	Na	K	Rb	Cs	...	...	Even Series.
2.	Be	Mg	Ca	Sr	Ba	...	...	
3.			Sc	Yt	La	Yb	...	
4.			Ti	Zr	Ce	...	Th	
5.			V	Nb	?	Ta	...	
6.			Cr	Mo	...	W	U	
7.			Mn	...	...	...	...	
8.			Fe	Ru	...	Os		Transition Elements.
			Co	Rh	...	Ir		
			Ni	Pd	...	Pt		
1.			Cu	Ag	...	Au		Odd Series.
2.			Zn	Cd	...	Hg		
3.	B	Al	Ga	In	...	Tl		
4.	C	Si	Ge	Sn	...	Pb		
5.	N	P	As	Sb	...	Bi		
6.	O	S	Se	Te ?	...	...		
7.	F	Cl	Br	I	...	...		
	I.	II.	III.	IV.	V.	VI.		

It is interesting that Walker does not have a place for hydrogen. Note also in the Chinese periodic table that 4 elements [Li, Na, Be, and Mg] in rows (columns) 1 and 2 of the "even series" of Walker's table have been moved down to rows (columns) 1 and 2 of the "odd series".

Thus by the early 20th century, the basic structure of modern chemistry had established a foothold in China. The long-term survival of chemistry was achieved with the establishment of a number of missionary universities which provided an increasingly more specialized education of Chinese students – especially in the sciences.

I'd like to return and conclude with a few words about William Adolph. He caught my attention when I ran across two articles that appeared in the *Journal of Chemical Education* in 1927. The second paper was based on a presentation he gave before the Division of Chemical Education at the national ACS meeting in Detroit on September 7, 1927.

- "Synthesizing a Chemical Terminology in China", *Journal of Chemical Education*, **4** (10), pp. 1233-1240 (1927);
- "Some Aspects of Chemical Education in China", *Journal of Chemical Education*, **4** (12), pp. 1488-1492 (1927)

I do not have as yet a complete run-down on the chronology of his life. His papers are available in the Archives of the United Board for Christian Higher Education in Asia at the Yale University Library. I have not as yet had time to examine his reports..

- 1890, Shantung Christian University (Chee-loo University), Tsinan, China
- University of Pennsylvania

  1912, A.B.

  1915, PhD.

  "The Quantitative Methods for Fluorine" under the direction of Edgar Fahs Smith.
- 1920-21, Instructor at University of Illinois
- 1915-1926, Shantung Christian University
- 1927-28, Assoc. Prof., University of Nebraska
- 1929 -48, Professor of Nutrition, Yenching University.
  - Acting President, 1946-48
- 1948-58, Yale University.

I am assuming that he started out as a Missionary in China teaching, it would seem at Shantung Christian University (Chee-loo), and soon realized that he needed more scientific training. He returned to America and completed his AB and PhD degrees at the University of Pennsylvania. He worked under Edgar Fahs Smith. [Smith, you may recall was responsible for the founding of the ACS Division of the History of Chemistry.]

After another 5 years in China, he returned for a brief stay at the University of Illinois to learn more about methods of laboratory instruction. At that time he worked with Professor S.W. Parr on "coal" since he was much interested in industrial chemistry. In a letter to Adolph, Edgar Fahs Smith wrote, "I have no doubt that that great country, someday in the near future, will be demanding men of your training in the development of the mineral resources."

Adolph then returned to Shantung University where he encountered some ferment from the Chinese Students. He wrote to Smith from Shantung about the educational changes taking place in China. There was perhaps an over enthusiastic interest in the study of science, and the pursuit of democratic freedom..

To Smith (printed newsletter):

> *"The New Thought Movement with its radical tinge and a Bolshevist flavor is waking all of us from out Far Eastern lethargy. Student independence have already reached excesses. All China has gone mad, educationally speaking, over science… Such an*

opportunity of interpreting the west to the east comes only once, I think, in a nation's history."

Smith's reply reflected perhaps a turn to a more conservative and spiritual view of the value of science.

> *"I hope, however, that the Bolshevistic ideas will not take possession of the Chinese. Your account of how a group of students determined to expel a Dean in one of the colleges is disturbing. You could not do better than to acquaint them with the Constitution of the United States, or Mr. Washington's Farewell Address."*
>
> *"I find studying these documents ... that I become more and more conservative. They are a steadying influence, and if young China is going to become company, somebody needs to put on gentle brakes."*
>
> *"Yes they will probably run wild over science, but while science does wonderful things, it doesn't do all things. We should get these people to study the spiritual side of things. It seems odd for me here in America to say that, because I think we need a great deal of the same thing."*

During a one-year visit to the University of Nebraska, he presented a paper at the Detroit ACS meeting in which he discussed the problems of chemical education in China. Adolph thought the main problem was that most students seemed to want to memorize everything – the textbook and lecture material instead of thinking about the subject.

> "The deep-rooted character of the original disorder is partly explained by the fact that the common word 'to study' in China literally translated means to **repeat the book**."

Adolph thought that the essence of chemistry could be to stress the inductive way of learning that could be achieved via laboratory work.

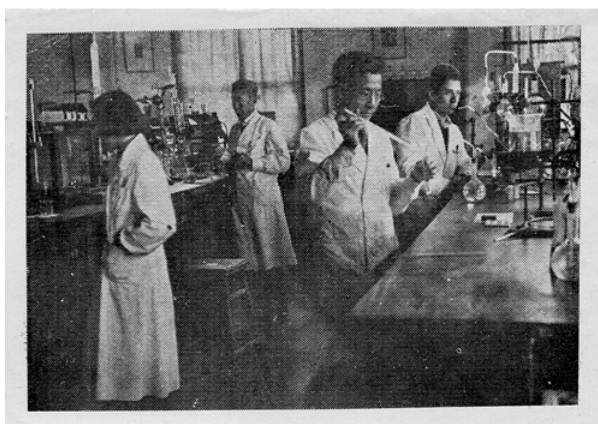
Adolph's research interests shifted from quantitative analysis to the study of nutrition. He later taught at Yenching [now Peking] University and served for a few years as President until the Communists took control of the Universities in the 1940s.

Here are a few photographs of William Adolph and his students at Yenching University in the 1930s. Note the public chemistry demonstration put on by the Chemistry Club.

Figure 24a: Faculty in the 1930s.

Figure 24b: Student Chemistry Laboratory in the 1930s;

Figure 24c: Student Chemistry Demonstration



Follow-up Research Questions

1. Check Adolph's letters, diary, and chemistry textbook (published in China in the 1930s) at Yale University library.
2. Locate later Chinese chemical nomenclature (1920s) publications.
3. More information about Japanese chemistry publications from the late 19^{th} and early 20^{th} century. And first Japanese Periodic Table?
4. What is an appropriate publication outlet?

Selective Bibliography

- Adolph, William H., "Some Aspects of Chemical Education in China", *Journal of Chemical Education*, **4**, (12), pp. 1488-1492, 1927.
- Adolph, William H., "Synthesizing a Chemical Terminology in China", *Journal of Chemical Education*, **4**, (10), pp. 1233-1240, 1927.
- Benfey, Otto Theodor, "Chemistry and the Word 'Chemistry'- Some Oriental Links", in *the pHilter* (American Chemical Society, Student Affiliates Newsletter), **18**, (4), pp. 1-4, 1986.
- Fryer, John, "Science in China", *Nature*, May 5, 19, pp. 9-11, 54-57, 1881.
- Lerner, Fred, "Rosetta Stone", in *Year's Best SF5*, Harper-Collins, 2000, pp. 238-270.
- Mahdihassan, S., "The Chinese Origins of the Word Chemistry", *Current Science*, **15**, p. 136, p234, 1946.
- Needham, Joseph, *Science and Civilization in China*, vol. 1 (1965); Vol 2 (1969); vol. 5, pt. 2 (1974); vol. 5, pt. 4 (1980).
- Needham, Joseph, *The Grand Titration: Science and Society in East and West*, University of Toronto Press, 1969.
- Piper, H.Beam, "Omnilingual" in *Astounding Science Fiction*, February 1957, pp. 8-46.
- Reardon-Anderson, James, *The Study of Change: Chemistry in China, 1840 -1949*, Cambridge University Press, Cambridge, 1991.
- Shen, Guo-Wei, "The Creation of Technical Terms in English-Chinese Dictionaries from the Nineteenth Century", in *New Terms for New Ideas. Western Knowledge and Lexical Change in Late Imperial China*, Leiden, 2001, pp. 287-304.
- Wright, David, "The Great Desideratum: Chinese Chemical Nomenclature and the Transmission of Western Chemical Concepts", in *Chinese Science*, **14**, pp. 35-70, 1997.
- Wright, David, *Translating Science: The Transmission of Western Chemistry into Late Imperial China, 1840 – 1900*, Brill, Leiden, 2000.