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# 化学用語の命名法の傾向について On Chemical Nomenclature

日本の化学歴史を振り返って  
History Surrounding the Japanese Language Barrier



# Introduction

化学は古来から何か国で勉強されたのに、よく理解されたのは過去数世紀以内です。

Chemistry has been pondered and studied for ages, but has only been well understood within the last few centuries.

Chemical terminology is *very* complex!

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Driving question: how were chemistry's concepts and conventions introduced to Japanese through the language barrier?

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## **Antoine Lavoisier - the father of modern chemistry**

Lavoisier, born in Paris in 1743, revolutionized chemistry with his findings. Discouraged from science by his father, he initially studied for and obtained a law degree.



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## Lavoisier's work

- Published the law of conservation of mass
- Discovered that diamond, charcoal, and carbon dioxide all were composed of the same substance; called it “carbon”
- Determined that sulfur was indivisible into smaller substances, therefore an element
- Coined names for oxygen and hydrogen

舍密開宗





# 鎖国

日本は1633年ごろから1853年まで「鎖国」をしました。

その時、他の国とあまり貿易をしませんでした。

From 1633 until 1853, Japan underwent its *sakoku* or *closed-country* period.

During this time, it did not trade with other nations, and people were largely not allowed in or out.



しかし、オランダとだけ貿易をしました！

However, they did trade with the Dutch!

During this time, Japanese who studied the Western technology and science brought by the Dutch were called 蘭学者 (*rangakusha*), or Dutch scholars

One particular *rangakusha* of note was Udagawa Youan

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# 宇田川榕菴

宇田川榕菴は1830年ごろオランダ語に翻訳された「The Elements of Experimental Chemistry」という本を手に入れました。

宇田川さんは読んで、自分の実験をして、自分の本を書きました。

Udagawa obtained a Dutch translation of William Henry's book, "the Elements of Experimental Chemistry," in about 1830.

After reading it and conducting his own experiments, Udagawa wrote his own book.

植物或其體種子等ヲ謂ノ分離スレバ自ラ精酵  
酵ハ此酵ニシテ其見象光景ハ另

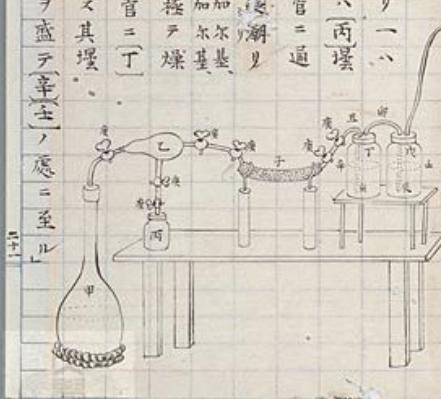
精酵按二  
酸酵二  
醇酵二

植物分離  
自發精酵第二百九十六章

○舍密原本云、蔗糖百北ヲ水四百北  
ニ和シ酵母十北ヲ和シ通計五百  
之ヲ水十二彬篤ヲ容ベキ大格  
爾弗(甲)ニ納レ酵管ヲ續ク



受器ヲ螺旋ス  
此受器三口アリ一ハ  
管管ニ通シ一ハ丙管ニ通  
ニ通シ一ハ子管ニ通  
ス子管ハ内ニ通  
易キ鹽類消散加爾基  
里醋酸加ノ粗碎極干燥  
各物性如里油ヲ盛テ其壇ニ至ル



舍密開宗 (せいみかいそう) - seimi kaisou



Udagawa created many terms in Japanese which are still used today; among them, 酸素 (*oxygen*), 炭素 (*carbon*), and 水素 (*hydrogen*).

In addition, he named processes like 酸化 (*oxidation*), 還元 (*reduction*), and 溶解 (*dissolution*).

This was the first introduction of the findings of Lavoisier to Japan!

# 化学の命名法



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# Japanese syllabaries

ひらがな - Hiragana - purely phonetic

カタカナ - Katakana - also purely phonetic, used mainly for foreign words

漢字 - Kanji - borrowed from Chinese, each character has its own meaning

n	w-	r-	y-	m-	h-	n-	t-	s-	k-	
シ N	ワ WA	ラ RA	ヤ YA	マ MA	ハ HA	ナ NA	タ TA	サ SA	カ KA	-a
	ヰ WI	リ RI		ミ MI	ヒ HI	ニ NI	チ CHI	シ SHI	キ KI	-i
		ル RU	ユ YU	ム MU	フ FU	ヌ NU	ツ TSU	ス SU	ク KU	-u
	ヱ WE	レ RE		メ ME	ヘ HE	ネ NE	テ TE	セ SE	ケ KE	-e
	ヲ WO	ロ RO	ヨ YO	モ MO	ホ HO	ノ NO	ト TO	ソ SO	コ KO	-o

# 周期表

1 H																		2 He
3 Li	4 Be																	
11 Na	12 Mg																	
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og	
			58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu		
			90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr		

The elements of the periodic table can be organized by which syllabary their names use.

In this figure, red elements use katakana transliterations of their english names, blue use katakana transliterations of their latin names, yellow use kanji to denote uniquely Japanese names, and orange use a mix of both syllabaries.

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# Elements with unique *kanji* names

Hydrogen	H	水素
Carbon	C	炭素
Nitrogen	N	窒素
Oxygen	O	酸素
Phosphorus	P	磷
Sulfur	S	硫黃
Chlorine	Cl	塩素
Bromine	Br	臭素

Iron	Fe	鐵
Copper	Cu	銅
Zinc	Zn	亜鉛
Silver	Ag	銀
Platinum	Pt	白金
Gold	Au	金
Mercury	Hg	水銀
Lead	Pb	鉛

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## Elements with *katakana* names

The majority of the metals, as well as the noble gases, use *katakana* transliterations of their english or latin names—for example:

- リチウム *richiumu* - lithium
- タングステン *tangusuten* - tungsten
- イリジウム *irijiumu* - iridium
- ナトリウム *natoriumu* - sodium (from “natrium”)

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## Elements whose names use both *katakana* and *kanji*

Boron	B	ホウ素
Fluorine	F	フッ素
Silicon	Si	ケイ素
Arsenic	As	ヒ素
Iodine	I	ヨウ素

# Naming chemical compounds in Japanese

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## Acids and salts - 酸や塩など

“Acid” and “salt” use the same *kanji* as do “oxygen” and “chlorine,” respectively.

This is a bit of a misnomer; Lavoisier had incorrectly postulated that oxygen was crucial to the formation of acids!



# Salts

日本語で、陰イオン名は最初に来ます。

英語 - sodium chloride —> 日本語 - 塩化ナトリウム

「化」- “change;” used in this case to link the two ions

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# Acids

Simple acids are just denoted with 酸; eg, hydrochloric acid (HCl) simply becomes 塩酸.

Polyatomic ions are named with similar conventions as in english; below are some examples aligned with their english counterparts.

酸	英語名	日本語名	陰イオン	英語名	日本語名
$\text{HClO}_4$	Perchloric acid	過塩素酸	$\text{ClO}_4^-$	Perchlorate	過塩素酸塩
$\text{HClO}_3$	Chloric acid	塩素酸	$\text{ClO}_3^-$	Chlorate	塩素酸塩
$\text{HClO}_2$	Chlorous acid	亜塩素酸	$\text{ClO}_2^-$	Chlorite	亜塩素酸塩
$\text{HClO}$	Hypochlorous acid	次亜塩素酸	$\text{ClO}^-$	Hypochlorite	次亜塩素酸塩



# IUPAC - 国際純正・応用化学連合

20世紀初頭、国際純正・応用化学連合は生まれました。

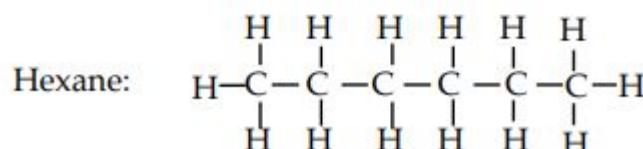
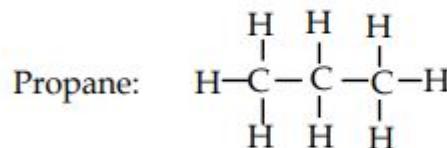
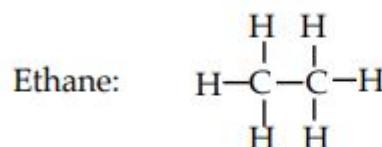
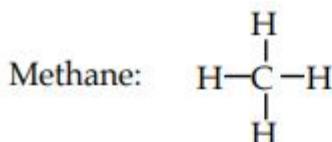
そして、有機化合物の規定的な名前を作るシステムが初めて生まれました。

In the early 20th century, the International Union of Pure and Applied Chemistry was formed.

The IUPAC created a standardized system for naming organic compounds. This translates directly into Japanese via *katakana*.



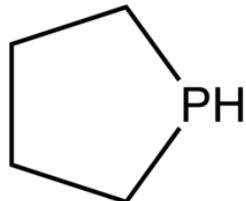
These rules would be very complicated to summarize completely; shown are some basic organic molecules and their standardized names.



## Problems with *katakana* transliteration

カタカナに翻訳するのはあいまいになる場合があります。

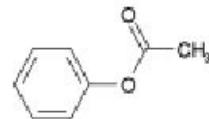
When converting words to *katakana*, English's sounds are inherently more specific, so ambiguity may arise.



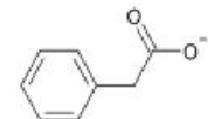
Phospholane  
1H ホスホラン



Phosphorane  
ホスホラン

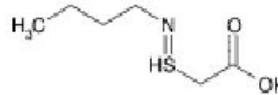


Phenyl acetate

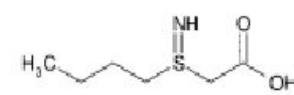


Phenylacetate

Figure 1. The impact of whitespace on name interpretation.



N-butylsulfiminimidoylactic acid



n-butylsulfiminimidoylactic acid

Figure 2. The impact of capitalization on name interpretation.

# 外来語

The adoption of foreign words into Japanese via katakana is referred to as 外來語 (*gairaigo*). While extremely common in modern Japanese, this was not the case until well after *sakoku* ended.

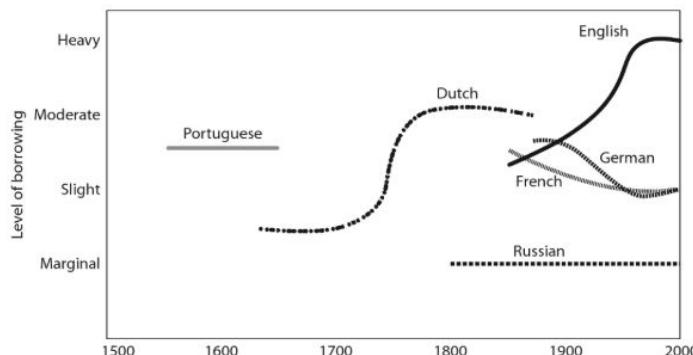


Figure 2.1. *Gairaigo timeline: 1500-present*

For Udagawa, it likely made more sense and was easier to devise Japanese names for chemical elements at the time.

Likewise, as chemistry grew more comprehensive, the use of katakana and adherence to international nomenclature became the more convenient choice.

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# Conclusions

The modernization of the Japanese language itself is reflected in chemical terminology!

## References

- Johanning, J. (Nov. 2003) *Problems in translating Japanese chemical texts to English.*  
<http://hugepatheticforce.org/chem-for-translators.pdf>
- Ichige, M; Sugita, K. (31 Mar. 2014) *A guidebook for etymology of chemical elements.*  
<https://opac.ll.chiba-u.jp/da/curator/100517/B9784903328164.pdf>
- Sayle, R. (21 Jul 2008) *Foreign Language Translation of Chemical Nomenclature by Computer.*  
<https://pubs.acs.org/doi/pdf/10.1021/ci800243w>
- Helmenstine, T. (3 Dec 2017) *List of Elements in Japanese.*  
<https://sciencenotes.org/list-elements-japanese/>
- Waseda University Library. n.d. *Seimi Kaisou.*  
[https://www.wul.waseda.ac.jp/koshobunko08/b08\\_b0027/](https://www.wul.waseda.ac.jp/koshobunko08/b08_b0027/)  
<https://kotobank.jp/word/%E8%88%8E%E5%AF%86%E9%96%8B%E5%AE%97-86508>  
<https://web.lemoyne.edu/~giunta/EA/LAVPREFann.HTML>  
<https://www.famousscientists.org/antoine-lavoisier/>
- Irwin, M. (2011) *Loanwords in Japanese.*  
[https://books.google.com/books?id=lb1xAAAAQBAJ&pg=PA25&lpg=PA25&dq=gairaigo+timeline&source=bl&ots=o-qSG\\_kucJ&sig=ACfU3U27Tb49GMY4qy0X14N8\\_m69DorDxA&hl=en&sa=X&ved=2ahUKEwiP5pq6ro7pAhXoXIEHeyeCXkQ6AEwAXoECAkQAQ#v=onepage&q=gairaigo%20timeline&f=false](https://books.google.com/books?id=lb1xAAAAQBAJ&pg=PA25&lpg=PA25&dq=gairaigo+timeline&source=bl&ots=o-qSG_kucJ&sig=ACfU3U27Tb49GMY4qy0X14N8_m69DorDxA&hl=en&sa=X&ved=2ahUKEwiP5pq6ro7pAhXoXIEHeyeCXkQ6AEwAXoECAkQAQ#v=onepage&q=gairaigo%20timeline&f=false)