英汉双语化学入门

申洋文　编著

清华大学出版社

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内容简介

本书由作者在南开大学为化学系本科生讲授“双语化学入门”课程所用讲义加工改编而成。书中介绍了外国语言的快速有效的学习方法，引导学生自学成才。本书包括12章，内容涉及化学元素、无机化合物命名法、简单有机化合物命名法、化学中的度量、有效数字、气体分子运动论、金属的晶体结构、周期律与电子结构、元素的电子结构、离子键、电子对互斥与分子几何结构、化学热力学。书中还提供了化学英语常用资料和英汉对照词汇供读者学习使用。

本书适合作为高等院校化学英语的入门教材，也可供自学者参考。

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作者序

Entrance to Bilingual Chemistry

为了适应我国加入世界贸易组织后高等学校教育改革的需要和落实教育部关于提高教学质量文件的要求，实行双语教学的问题已经提上教学议事日程。在双语教学工作中，首要的问题是应该先解决相应适用的教材。这里存在着若干困难。一方面，我们需要有我们自己的既能引入国际前沿的科技知识、又能反映我国发展实际水平的母语特色教材。另一方面，双语教学也需要有可用的课件。如果引入国外原版教科书，无论是购买原版书，或是购买版权影印，都将会是所费不锱的。比较方便的解决办法，是组织有能力的教师编写外文教材，利用我们自己的教材成本相对较低，不给师生增加过高的经济负担。

笔者在20世纪80年代，曾经有过讲授专业英语的经验，积累了一套快速高效入门双语化学的经验，称为“以朗读为中心的外语速效学习法”。2003年秋季开学，利用双休日，给240名大学一年级本科生开设了一门1个学分(18学时)的“双语化学入门”课，教给学生自学方法，引导他们“自学成才”掌握化学双语知识，收到了轰动性的效果。下面介绍学习方法和教学经验，供与兄弟学校交流。

以朗读为中心的外语速效学习法　学习一门外语的有效方法，就是中国古人学习古文章的三步走办法：朗读——熟记——背诵。小孩子咿呀学语，就是天天跟大人学说话，天天记，时时反馈。小孩子学说话也没有先抠语法的，语法是自然而然形成的语言习惯，没有什么理论规律性。就这一点浅显道理，在已有高中外语学习的基础上，强化一种语言的学习，最有效的方法，就是养成快速朗读外语文章的习惯，持之以恒，百炼成钢。

以朗读为中心的外语学习方法，是一种全面的方法训练，可达到以下的多方面效果：

（1）训练读文字的目力　经常锻炼快速朗读，日久可以达到，口里读着一行文字，眼睛已经望到下一行去了，这样才能快读下去。训练快速目力，非常有用。

（2）训练口语　中国人的语言是慢速度的，而外国语言是快速度的，在语音速度上有一个差距，快速朗读养成习惯，可以弥补这个差距。在朗读中注意读音正确，形成好习惯。

（3）训练耳朵听力　如上所述，中国语言是慢速的，养成我们的耳朵听力也是慢速的，不能适应与外国人对话。养成快速朗读文件的习惯，练习越读越快，给自己听，就训练了自己的耳朵听力，由慢速进入快速。这是惟一的最有效的自我锻炼。

（4）训练外语思维　在快速朗读当中，大脑中有一部分主管看和读出声，另一部分主管听和输入脑干理解。这两部分达到共鸣，就得到了全面训练：也看了，也读了，也听了，也理解了。更重要的是，养成熟练快速朗读习惯，在大脑储存器中输入和存储越来越多的文字信息，就会熟能生巧，发生质变，产生人工智能。原来外文信息输入，先通过大脑翻译功能翻译成汉语，再加以理解识别，这样构成一个慢速行为。需要反馈时，又是先有汉语思维，再由大脑翻译成外文，再通过语言反馈出去，又慢了一步。所以中国人跟外国人初次对话，往往磕磕巴巴，语言流利不起来。快速朗读经验多了，大脑发生了变化，把汉语思维自动地转变为外语思维，外语思维输入，外语思维反馈。看、读、听、理解、输入，反馈全面速度加快，不就是已经精通了外语吗！这就是外语的自学成才。

（5）快速朗读学习外语，不需要再专抠语法　外语语法，只是语言习惯，没有什么理论章法。例如说，讲时间，要讲 in the year，on the day，at the time，为什么要用不同的前置词？没有什么道理可讲。学一种语言去抠语法，是一种最愚蠢的学习方法。快速朗读学习，自然而然就把语法与文字在大脑中熟练结合，随时呼之即出，不需死记硬背。这也是朗读法的优越之处。

笔者传授给学生的具体学习方法是，首先选定一篇文章，例如一篇化学课文，或是外文报章如“China Daily”上找一篇报道文章，清晨早起，在室外找一个安静处，朗读那篇文章，逐步加快速度地反复朗读，边朗读边思考理解，一直到熟练为止，争取达到每天朗读 1 小时，坚持不懈。在初读时，遇到新单词不会，可以不理会它，继续读下去，领会了全篇意义，也就可以猜出来那个单词的含义了。读几遍以后，再查查随手带的字典，就可以把新单词牢牢地输入脑中记住了，不

需单独去背单词。专门单独背单词，也是愚蠢的学习办法。

坚持这种朗读学习3个月，自己想各种方法检查学习效果，就会发现你的外语水平大大进步了。如果坚持一个学期，坚持一年，大概你参加英语六级考试，不会有什么困难了。事在人为，全靠自己的自觉努力。正是“天下无难事，只怕有心人”，笔者祝愿进入化学学科的学者，人人都能学好英语。

本教材包括12章，内容涉及化学元素、无机化合物命名法、简单有机化合物命名法、化学中的度量、有效数字、气体分子运动论、金属的晶体结构、周期律与电子结构、元素的电子结构、离子键、电子对互斥与分子几何结构、化学热力学。在附录中提供了化学英语中的一些常识性资料，并特别编写了基础的化学英语词汇，适合为大学一年级化学概论课的化学英语查索之用。相信这本小书能够为学生的双语化学启蒙学习提供较大的便利。

申泮文

2004年2月于南开大学

Contents

Entrance to Bilingual Chemistry

Chapter 1

The Chemical Elements and Their Relative Atomic Masses

Key Words 关键词

chemical element 化学元素
relative atomic mass 相对原子质量
atomic weight 原子量
invarient 不变量
radioactive element 放射性元素
isotope 同位素
half-life 半衰期
uncertainty 未确定值
source 来源
IUPAC 国际纯粹与应用化学委员会缩写词
Commission on Atomic Weights and Isotopic Aboundences 原子量与同位素丰度委员会
under review 在评议中
Pure and Applied Chemistry 《纯粹与应用化学》期刊

The masses of many elements are not invarient but depend on the origin and treatment of the material. The values given on the table apply to elements as they exist naturally on earth. Values in brackets are used for radioactive elements whose atomic masses cannot be quoted precisely without knowledge of the origin of the elements; the value given is the relative atomic masses of the isotope of the element having the longest half-life. A number in parentheses indicates the uncertainty in the last digit of the atomic weight.

Source International Union of Pure and Applied Chemistry (IUPAC) Commission on Atomic Weights and Isotopic Aboundances. The names and symbols for elements 110 and 111 are under review. The temporary system recommended by J. Chatt (see *Pure and Applied Chemistry*, 51: 381 - 384, 1979.) is used in the table. The names of elements 101 to 109 were agreed in 1997. (See *Pure and Applied Chemistry*, 69: 2471 - 2473, 1997.)

Name		Symbol	Atomic Number	Relative Atomic Mass
锕	Actinium	Ac	89	[227]
铝	Aluminum	Al	13	26.981 538(2)
镅	Americium	Am	95	[243]
锑	Antimony	Sb	51	121.760(1)
氩	Argon	Ar	18	39.948(1)
砷	Arsenic	As	33	74.921 60(2)
砹	Astatine	At	85	[210]
钡	Barium	Ba	56	137.327(7)
锫	Berkelium	Bk	97	[247]
铍	Beryllium	Be	4	9.012 182(3)
铋	Bismuth	Bi	83	208.980 38(2)
𨨏	Bohrium	Bh	107	[262]
硼	Boron	B	5	10.811(7)
溴	Bromine	Br	35	79.904(1)
镉	Cadmium	Cd	48	112.411(8)
钙	Calcium	Ca	20	40.078(4)
锎	Californium	Cf	98	[251]
碳	Carbon	C	6	12.010 7(8)
铈	Cerium	Ce	58	140.116(1)
铯	Cesium	Cs	55	132.905 45(2)
氯	Chlorine	Cl	17	35.452 7(9)
铬	Chromium	Cr	24	51.996 1(6)
钴	Cobalt	Co	27	58.933 200(9)
铜	Copper	Cu	29	63.546(3)
锔	Curium	Cm	96	[247]
𨧀	Dubnium	Db	105	[262]
镝	Dysprosium	Dy	66	162.50(3)
锿	Einsteinium	Es	99	[252]
铒	Erbium	Er	68	167.26(3)
铕	Europium	Eu	63	151.964(1)
镄	Fermium	Fm	100	[257]
氟	Fluorine	F	9	18.998 403 2(5)
钫	Francium	Fr	87	[223]
钆	Gadolinium	Gd	64	157.25(3)
镓	Gallium	Ga	31	69.723(1)
锗	Germanium	Ge	32	72.61(2)
金	Gold	Au	79	196.966 55(2)
铪	Hafnium	Hf	72	178.49(2)
𨭆	Hassium	Hs	108	[265]

(Continued)

	Name	Symbol	Atomic Number	Relative Atomic Mass
氦	Helium	He	2	4.002 602(2)
钬	Holmium	Ho	67	164.930 32(2)
氢	Hydrogen	H	1	1.007 94(7)
铟	Indium	In	49	114.818(3)
碘	Iodine	I	53	126.904 47(3)
铱	Iridium	Ir	77	192.217(3)
铁	Iron	Fe	26	55.845(2)
氪	Krypton	Kr	36	83.80(1)
镧	Lanthanum	La	57	138.905 5(2)
铹	Lawrencium	Lr	103	[262]
铅	Lead	Pb	82	207.2(1)
锂	Lithium	Li	3	6.941(2)
镥	Lutetium	Lu	71	174.967(1)
镁	Magnesium	Mg	12	24.305 0(6)
锰	Manganese	Mn	25	54.938 049(9)
鿏	Meitnerium	Mt	109	[266]
钔	Mendelevium	Md	101	[258]
汞	Mercury	Hg	80	200.59(2)
钼	Molybdenum	Mo	42	95.94(1)
钕	Neodymium	Nd	60	144.24(3)
氖	Neon	Ne	10	20.179 7(6)
镎	Neptunium	Np	93	[237]
镍	Nickel	Ni	28	58.693 4(2)
铌	Niobium	Nb	41	92.906 38(2)
氮	Nitrogen	N	7	14.006 74(7)
锘	Nobelium	No	102	[259]
锇	Osmium	Os	76	190.23(3)
氧	Oxygen	O	8	15.999 4(3)
钯	Palladium	Pd	46	106.42(1)
磷	Phosphorus	P	15	30.973 761(2)
铂	Platinum	Pt	78	195.078(2)
钚	Plutonium	Pu	94	[244]
钋	Polonium	Po	84	[209]
钾	Potassium	K	19	39.098 3(1)
镨	Praseodymium	Pr	59	140.907 65(2)
钷	Promethium	Pm	61	[145]
镤	Protactinium	Pa	91	231.035 88(2)

(Continued)

Name		Symbol	Atomic Number	Relative Atomic Mass
镭	Radium	Ra	88	[226]
氡	Radon	Rn	86	[222]
铼	Rhenium	Re	75	186. 207(1)
铑	Rhodium	Rh	45	102. 905 50(2)
铷	Rubidium	Rb	37	85. 467 8(3)
钌	Ruthenium	Ru	44	101. 07(2)
铲	Rutherfordium	Rf	104	[261]
钐	Samarium	Sm	62	150. 36(3)
钪	Scandium	Sc	21	44. 955 910(8)
镇	Seaborgium	Sg	106	[263]
硒	Selenium	Se	34	78. 96(3)
硅	Silicon	Si	14	28. 085 5(3)
银	Silver	Ag	47	107. 868 2(2)
钠	Sodium	Na	11	22. 989 770(2)
锶	Strontium	Sr	38	87. 62(1)
硫	Sulfur	S	16	32. 066(6)
钽	Tantalum	Ta	73	180. 947 9(1)
锝	Technetium	Tc	43	[98]
碲	Tellurium	Te	52	127. 60(3)
铽	Terbium	Tb	65	158. 925 34(2)
铊	Thallium	Tl	81	204. 383 3(2)
钍	Thorium	Th	90	232. 038 1(1)
铥	Thulium	Tm	69	168. 934 21(2)
锡	Tin	Sn	50	118. 710(7)
钛	Titanium	Ti	22	47. 867(1)
钨	Tungsten	W	74	183. 84(1)
110	Ununnilium	Uun	110	[269]
111	Unununium	Uuu	111	[272]
铀	Uranium	U	92	238. 028 9(1)
钒	Vanadium	V	23	50. 941 5(1)
氙	Xenon	Xe	54	131. 29(2)
镱	Ytterbium	Yb	70	173. 04(3)
钇	Yttrium	Y	39	88. 905 85(2)
锌	Zinc	Zn	30	65. 39(2)
锆	Zirconium	Zr	40	91. 224(2)

Chapter 2

Nomenclature of Inorganic Compounds

Key Words 关键词

acid-base reaction 酸碱反应
acid 酸
alkali metal 碱金属
alkaline earth metal 碱土金属
allotrope 同素异形体
alpha(α) particle α 粒子
alpha ray α 射线
anion 阴离子
atom 原子
atomic number 原子序数
atomic weight 原子量
base 碱
beta(β) particle β 粒子
beta ray β 射线
cation 阳离子
binary compound 二元化合物
chemical formula 化学式
diatomic molecule 双原子分子
electron 电子
empirical formula 实验式
families 族
gamma(γ) ray γ 射线
group 元素族
halogen 卤素
hydrate 水合物
ion 离子
ionic compound 离子型化合物
isotope 同位素
law of conservation of mass 质量守恒定律
law of definite proportion 定比定律
law of multiple proportion 倍比定律
mass number 质量数
metal 金属
metalloid 准金属,非金属
molecular formula 分子式
molecule 分子
monoatomic ion 单原子离子
neutron 中子
noble gas 惰性气体
nonmetal 非金属
nucleus 原子核
oxyacid 含氧酸
oxyanion 含氧阴离子

oxide 氧化物
period 周期
periodic table 周期表
polyatomic ion 多原子离子
polyatomic molecule 多原子分子
proton 质子
radiation 辐射
radioactivity 放射性
structural formula 结构式
ternary compound 三元化合物

The composition of a compound may be specified by giving either its formula or its name. Here, we consider a problem that of developing a system of nomenclature for the chemical compounds. In the interest of clarity and simplicity, we shall restrict our discussion to a relatively small number of rules which will suffice to name the great majority of inorganic compounds encountered in an introductory course in chemistry.

2.1 Ionic Compounds

The names of ionic compounds are derived from those of the ions of which they are composed. We shall first consider the nomenclature of individual ions and then the names of the compounds they form.

2.1.1 Positive Ions

Monoatomic positive ion takes the name of the metal from which they are derived.

Na^+　　Ca^{2+}　　Al^{3+}

When a metal forms more than one ion, it is necessary to distinguish between these ions. The accepted practice today is to indicate the oxidation number of the ion by a Roman numeral in parentheses immediately following the name of the metal.

Fe^{2+}	iron(Ⅱ)	Cu^+	Copper(Ⅰ)	Sn^{2+}	tin(Ⅱ)
Fe^{3+}	iron(Ⅲ)	Cu^{2+}	Copper(Ⅱ)	Sn^{4+}	tin(Ⅳ)

An earlier method, still widely used, adds to the stem of the Latin name of the metal the suffixes *-ous* or *-ic*, representing the lower and higher oxidation states respectively:

Fe^{2+}	ferrous	Cu^+	Cuprous	Sn^{2+}	stannous
Fe^{3+}	ferric	Cu^{2+}	Cupric	Sn^{4+}	stannic

The only polyatomic cation to be considered here are:

NH_4^+ ammonium Hg_2^{2+} mercury(I) or mercurous

2.1.2 Negative Ions

Monoatomic negative ions named by adding the suffix *-ide* to the stem of the name of the nonmetal which they are derived.

N^{3-}	nitride	O^{2-}	oxide	F^-	fluoride	H^-	hydride
		S^{2-}	sulfide	Cl^-	chloride		
		Se^{2-}	selenide	Br^-	bromide		
		Te^{2-}	telluride	I^-	iodide		

The nomenclature of polyatomic anions is more complex. The names of some of the more common oxyanions are:

OH^-	hydroxide	NO_2^-	nitrite	ClO_2^-	chlorite
O_2^{2-}	peroxide	SO_4^{2-}	sulfate	ClO^-	hypochlorite
CO_3^{2-}	carbonate	SO_3^{2-}	sulfite	MnO_4^-	permanganate
PO_4^{3-}	phosphate	ClO_4^-	perchlorate	CrO_4^{2-}	chromate
NO_3^-	nitrate	ClO_3^-	chlorate	$Cr_2O_7^{2-}$	dichromate

It will be noted when the nonmetal such as nitrogen or sulfur forms two oxyanions in different oxidation states, the suffixes *-ate* and *-ite* are used to distinguish between the higher and lower states respectively. With elements such as chlorine which form more than two oxyanions, the prefixes *-per* (the highest oxidation state) and *-hypo* (the lowest oxidation state) are used as well.

Oxyanions that contain hydrogen as well as nonmetal and oxygen atoms are properly named as illustrated in the following examples:

HCO_3^-	hydrogen carbonate	HPO_4^{2-}	hydrogen phosphate
HSO_4^-	hydrogen sulfate	$H_2PO_4^-$	dihydrogen phosphate

2.1.3 Compounds

The name of the positive ion is given first, followed by the name of the negative ion. Examples are:

$CaCl_2$	calcium chloride
$FeBr_2$	iron(II) bromide

$(NH_4)_2SO_4$	ammonium sulfate
$Fe(ClO_4)_2$	iron(Ⅱ) perchlorate
$NaHCO_3$	sodium hydrogen carbonate

In practice, compounds containing metal atoms, regardless of the type of bonding involved, are ordinarily named as if they were ionic. For example, the compound $AlCl_3$ and $SnCl_4$, in both of which the bonding is primarily covalent, are named as follows:

$AlCl_3$ aluminum chloride $SnCl_4$ tin(Ⅳ) chloride

2.2 Binary Compounds of the Nonmetals

When a pair of nonmetals form only one compound, that compound may be named quite simply. The name of the element whose symbol appears first in the formula is written first. The second portion of the name is formed by addition the suffix *-ide* to the stem of the name of the second nonmetal. Examples include

HCl	hydrogen chloride
H_2S	hydrogen sulfide
NF_3	nitrogen fluoride

If more than one binary compound is formed by a pair of nonmetals, as is most often the case, the Greek prefixes *di* = two, *tri* = three, *tetra* = four, *penta* = five, *hexa* = six, and so on, are used to disignate the number of atoms of each element. Thus, the oxides of nitrogen are named:

N_2O_5	dinitrogen pentoxide
N_2O_4	dinitrogen tetroxide
NO_2	nitrogen dioxide
N_2O_3	dinitrogen trioxide
NO	nitrogen oxide
N_2O	dinitrogen oxide

A great many of the best known binary compounds of the nonmetals have acquired common names which are widely and, in some cases, exclusively used. These include

H_2O	water	PH_3	phosphine
H_2O_2	hydrogen peroxide	AsH_3	arsine
NH_3	ammonia	NO	nitric oxide
N_2H_4	hydrazine	N_2O	nitrous oxide

2.3 Oxyacids

The names of some of the more common oxygen acids are listed as follows:

H_2CO_3	carbonic acid	H_2SO_3	sulfurous acid
H_3BO_3	boric acid	$HClO_4$	perchloric acid
HNO_3	nitric acid	$HClO_3$	chloric acid
HNO_2	nitrous acid	$HClO_2$	chlorous acid
H_2SO_4	sulfuric acid	$HClO$	hypochlorous acid

It is of interest to compare the names of these oxyacids to those of the corresponding oxyanions listed previously. Note that oxyanions whose names end in *-ate* are derived from acid whose names end in *-ic*. Compare, for example, CO_3^{2-} (carbonate) and H_2CO_3 (carbonic acid), NO_3^- (nitrate) and HNO_3 (nitric acid), ClO_4^- (perchlorate) and $HClO_4$ (perchloric acid). Oxyanions whose names end in *-ite* are derived from acids whose names end in *-ous*. Thus, NO_2^- (nitrite) and HNO_2 (nitrous acid); ClO^- (hypochlorite) and $HClO$ (hypochlorous acid).

2.4 Coordination Compounds

The nomenclature of compounds containing complex ions in which a metal atom is held by coodinate covalent bond to two or more ligands is perhaps more involved than that of any other type of inorganic compound. Several rules are required, the more pertinent of which are as follows.

(1) As in simple ionic compounds, the cation is named first, followed by the anion.

(2) If there is more than one ligand of a particular type attached to the central atom, Greek prefixes are used to indicate the number of these ligands. Where the name of the ligand itself is complex (e. g. ethylenediammine), the number of such