内蒙古大学教材丛书

English Course of Chemistry

化学专业英语教程

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前 言

本书是编者总结十年来的化学专业英语教学经验，广泛搜集资料，不断摸索改进，潜心编写而成的一本教材。编写过程中不仅考虑了化学内容的系统性与完整性，而且考虑到文章语言的流畅性。内容包括从化学的历史到现状，从理论、微观结构到实际生产生活中所遇到的和所关心的问题，从无机、分析、物化、有机到高分子、环化、生化，从经典知识到前沿领域的发展等等。为了培养跨世纪新型人才，本课程介绍先进的科学思想，反映新科学方法论、新思维、新理论、新观点、新成就，克服了以往教材内容的陈旧，使化学专业英语课程具有与化学学科发展相适应的水平。文章的选材力求兼顾知识性与趣味性，每课的正文讲述系统的化学理论和知识，每课后的阅读材料内容则生动有趣，都是人们所关心和感到好奇的问题；借助统计数字和图表归纳总结内容，使思路更清晰；每课后都附有单词表、必要的注释、科技英语常用构词法、化学命名法，并精心插入了寓意与课文内容相关的图画，使学习具有乐趣。

通过对本书的学习，可以增加 2000 多个科技和化学专业英语词汇。学习科技英语中常用的构词法、化学命名法，熟悉科技英语语法及写作表达规律，对进一步的深入学习、科研工作及对外交流都会有很大帮助。本书不仅适用于大学化学系本科及研究生学习，而且适用于化学工作者和相关学科人员自学或作为阅读材料。

在本书的编著过程中，得到了内蒙古大学化学系教授李逢泽、新民、刘树堂、赛音先生及内蒙古师范大学化学系郭博书教授的大力支持；在编者对本书进行编辑、排版和打印的过程中，本系物化教研室牛雪平副教授、办公室王雷老师及无机化学教研室的同事们曾给予许多帮助和便利；无机化学教授胡襄先生细致认真地审阅和校对了全书，在此一并表示衷心的感谢。由于编者水平有限，不足与疏漏之处在所难免，望广大读者批评指正。

编 者 郭岚芬

1998 年 10 月 20 日

于呼和浩特

Lesson One

WHAT IS CHEMISTRY?

The world in which we live is composed of an innumerable variety of materials. In order to exist, man must take certain of these materials from the environment and utilize them in one way or another. The rate at which these materials are consumed and the way in which they are consumed reflects both the degree and the quality of our civilization.

Most of us would subscribe to the general truth of the foregoing sentences. But what do they have to do with chemistry? The answer is "everything," since chemistry by dictionary definition is the science dealing with the composition of substances and the transformations they undergo. But certainly there must be more to chemistry than this formal definition implies. Chemistry is concerned with the nature of all the substances that comprise the universe —from a simple water molecule to complex genes that influence reproduction of living matter. Chemistry deals with the composition and changes of composition that all these substances undergo. Through chemistry we seek to learn and to understand the general principles that govern the behavior of all matter.

The chemist, like other scientists, observes nature at work. He attempts to unlock the secrets of nature: What makes a rose red? Why is sugar sweet? Why is water wet? Why is carbon monoxide poisonous? Why does man wither with age? Problems such as these—some of which have been solved, some of which are still to be solved—are part of what we call chemistry.

Chemistry and the closely related science of physics are the two principal physical sciences. Despite its classification as a physical science, chemistry is fundamental to biology. This is not only because living organisms are made of material substances, but because life itself is essentially a very complicated system of interrelated chemical processes.

In his work a chemist may interpret natural phenomena, devise experiments that will reveal the composition and structure of complex substances, study methods for improving natural processes, or sometimes synthesize substances unknown in nature. Ultimately, the efforts of successful chemists advance the frontiers of knowledge and at the same time contribute to the well-being of man. Chemistry helps us to understand nature. However, one need not be a professional chemist or scientist to enjoy natural phenomena. Nature with its beauty, its simplicity within complexity, is for all to appreciate.

THE BRANCHES OF CHEMISTRY

Chemistry may be broadly classified into two main branches: organic chemistry and inorganic chemistry. Organic chemistry is concerned with compounds containing the element carbon. The name "organic" was originally derived from the chemistry of living plants and animals. Inorganic chemistry deals with all elements except carbon. Substances classified as inorganic are derived mainly from mineral sources rather than from animal or vegetable sources.

Other subdivisions of chemistry, such as analytical chemistry, physical chemistry, biochemistry, electrochemistry, geochemistry, and radiochemistry, may be considered specialized fields of, or auxiliary fields to, the two main branches.

Chemical engineering is that branch of engineering which deals with the development, design, and operation of chemical processes. A chemical engineer generally begins with a chemist's laboratory scale process and develops it into an industrial scale operation.

THE RELATIONSHIP OF CHEMISTRY TO OTHER SCIENCES AND TO INDUSTRY

Besides being a science in its own right, chemistry is the servant of other sciences and of industry. Chemical principles contribute to the study of physics, biology, agriculture, engineering, medicine, space research, oceanography, and many other sciences. Chemistry and physics are overlapping sciences, since both are based on the properties and behavior of matter. Biological processes are chemical in nature The metabolism of food to provide energy to living organisms is a chemical process. Knowledge of molecular structure of proteins, hormones, enzymes, and the nucleic acids is assisting biologists in their investigations of the composition, development, and reproduction of living cells.

Chemistry is playing an important role in attempting to alleviate the growing shortage of food in the world. Agricultural production has been increased with the use of chemical fertilizers, pesticides, and improved varieties of seeds. Chemistry is also producing synthetic nutrients, but much remains to be done as the world population multiplies with respect to the land available for cultivation. Man's expanding energy needs have brought about difficult environmental problems in the form of air and water pollution. Chemists as well as other scientists are also working diligently to alleviate these problems.

Advances in medicine and chemotherapy, through the development of new drugs, have contributed to prolonged life and the relief of human suffering. The entire plastics and polymer industry, unknown 50 years ago, has revolutionized the packaging the textile industries and is producing more durable and useful construction materials. Energy derived from chemical processes is used universally for heating, lighting, and transportation. There is virtually no industry that is not dependent on chemicals for its manufacturing and development; for example, petroleum, steel, rubber, paper, pharmaceuticals, electronics, transportation, cosmetics, garments, aircraft, television—the list could go on and on. Figure 1.1 illustrates the conversion of natural resources, by the chemical industry, into useful products for commerce, industry, and human needs.

ABUNDANT RAW MATERIALS

from Mine, Forest, Sea, Air, Farm, Oil, Brine and Gas Wells

↓

THE CHEMICAL INDUSTRY

in more than 13,500 plants in the U.S. converts
these raw materials into more than 10,000

CHEMICALS

such as acids and alkalies, salts, organic compounds,
solvents, compressed gases, pigments and dyes
which are used

↓

BY THE CHEMICAL INDUSTRY ITSELF

To Produce

Cosmetics
Detergents & Soap
Drugs and Medicines
Dyes & Inks
Explosives
Fertilizers
Paints
Pesticides
Plastic Materials
Sanitizing Chemicals
Synthetic Fibers
Synthetic Rubber
and many others

BY OTHER INDUSTRY

In the Production of

Durable Goods

Aircraft & Equipment
Building Materials
Electrical Equipment
Hardware
Machinery
Metal Products
Motor Vehicles & Equipment
and other products of
metal, glass, paper and wood

Nondurable Goods

Beverages
Food Products
Leather & Leather Products
Packaging
Paper & Paper Products
Petroleum & Coal Products
Rubber Products
Textiles

↓

THE ULTIMATE MARKET

(Fundamental human needs)

Health, Food, Clothing, Shelter, Transportation, Communication, Defense and Other Needs

Figure 1.1 Broad scope of the chemical industry today.
(Courtesy Manufacturing Chemists Association.)

NEW WORDS

innumerable	a.	无数的	hormone	n.	荷尔蒙
variety	n.	(仅用单数)种种	enzyme	n.	酶
environment	n.	环境	nucleic	a.	核的
subscribe	vi.	同意或赞成	pesticide	n.	杀虫剂;农药
composition	n.	成分	nutrient	n.	营养品
transformation	n.	变化,转变	multiply	vi.	增多;增加
comprise	vt.	组成	cultivation	n.	耕种;开垦
complex	a.	复杂的	diligently	ad.	勤勉地;努力地
	n	络合物	chemotherapy	n.	化(学)疗(法)
gene	n.	基因	ultimately	ad.	终极地;最后
alleviate	vt.	使缓和	prolong	vt.	延长;拖延
monoxide	n.	一氧化物	relief	n.	减轻;解除
wither	vi.	枯萎;凋谢	plastic	n.	塑料;(~s)用作单或复
interrelated	a.	相关的	polymer	n.	聚合物;多聚物
phenomenon	n.	现象	textile	a.	纺织的;
				n.	纺织
synthesize	vt.	合成	virtually	ad.	事实上的;实质上的
frontier	n.	前沿	rubber	n.	橡胶
broadly	ad.	粗略的	cosmetic	n.	化妆品
				a.	化妆用的
derive	vi.	源出;起源	illustrate	vt.	举例或以图画等说明
analytical	a.	分析的	commerce	n.	商业;贸易
geochemistry	n.	地球化学	durable	a.	耐久的
auxiliary	a.	辅助的;帮助的	petroleum	n.	石油
oceaogrphy	n.	海洋学	pharmaceutical	a.	制药的;医药的
overlap	vi.	部分重叠	garments	n.	服装;衣着
metabolism	n.	新陈代谢	conversion	n.	转化;转变
protein	n.	蛋白质	electronics	n.	电子学

Word Formation

许多动词都可以加—(t)**ion** 或—**ation** 构成名词. 如:

invent—invention

pollute—pollution

distill—distillation

explore—exploration

reflect—reflection

eliminate—elimination

combine—combination

crystallize—crystallization

化学名词中常用的前、后缀

化学名词中常用的数目词头：

1/2	hemi, semi*	12	dodeca
1	mono, uni*	13	trideca
2	di, bi*, bis	19	nondeca
3	tri, ter*	20	eicosa
4	tetra, quadri*	21	heneicosa
5	penta, quinqui *, quinque*	22	docosa
6	hexa, sexi*	29	nonacosa
7	hepta, septi*	30	triaconta
8	octa	31	hentriaconta
9	ennea, nona*	40	tetraconta
10	deca	50	pentaconta
11	undeca*, hendeca	90	enneaconta

注释：

其中有*号者是自拉丁文来的词头，其他都是自希腊文来的词头. 第一个列出的词头是最常用的. 西文烃的数目词头除前四个另有名称外，其他均如上表所列；其前四个的词头英文为 metha, etha, propa, buta.

READING MATERIAL

CHEMISTRY: AN ACTIVITY OF CREATIVE INDIVIDUALISTS

Today's public image of science is still heavily influenced by the reverberating impact of the World War II Manhattan Project that brought us the atomic bomb and the Apollo Project of the 1960s that let us set foot on the Moon. We are seen to be in an era of Big Science. But embedded in this glamorous, highly organized, and well publicized setting, there are a number of scientific disciplines that have somehow maintained the highly personal characteristics of classical human creativity: How many writers were needed to create Hamlet? How many artists to paint the Mona Lisa? How many scientists to propose relativity? Chemistry is one of these disciplines. Somehow it has remained an idiosyncratic and highly competitive activity that depends upon sustained individual initiative and personal creativity. Scientific publications in the field generally involve two or three authors. There are no examples to be found in chemistry to match the multiple authorship—dozens of authors on a single paper-like those announcing the occasional discovery of a new subatomic particle.

Chemistry has remained, worldwide, an innovative "cottage industry" with a modus operandi that has been remarkably productive. Tangible evidence of its success is provided by the faster-than-exponential discovery of new compounds. This gratifying record was achieved despite the fact that at any given moment, the molecules easiest to synthesize have already been made; the harder ones remain. Yet discovery is accelerating. The only plausible explanation is that chemistry in the small project mode is an extremely effective enterprise, both here and abroad.

Thus the term "cottage industry" describes a highly individualistic and personally creative activity rather than a consensual one. These characteristics impart a healthy competitiveness and a liberating freedom from bounding paradigms. They make chemistry an ideal field in which to nurture a young scientist's originality and initiative. He or she can be intimately involved and in control of every aspect of an investigation, selecting the question, deciding on the approach, assembling and personally operating the equipment, collecting and analyzing the data, and deciding on the significance of the results. Here is another reason to nourish this central and fundamental science in its present image.

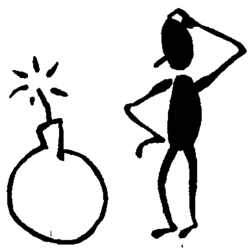
Yet we are in an era in which directors of U. S. federal science—funding agencies will candidly admit that they believe it easier to argue for an enormous increment of funding to sponsor a large machine or a massive project that for a smaller increment to stimulate many smaller projects with comparable or greater expectation for new discoveries and scientific advances that will surely respond to society's needs. Thus the Department of Energy in its 1985 budget devotes 55 percent of its Office of Energy Research budget to two "Big science" project areas: \$548M for high energy physics and \$440M for fusion research. Currently under consideration by various agencies are proposals for incremental funds to build a hard X-ray synchrotron light source (\$160M), a neutron source (\$250M), a "next-generation" multimirror telescope (\$100M), a set of "supercomputer centers," an array of "engineering centers," and an accelerator with a circumference of 80 miles (~ \$4B). Each of these new projects will require large, ongoing (and incremental) operating budgets that are irresistibly rooted in huge initial capital investments.

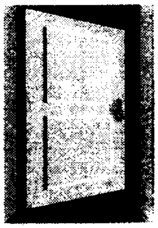
In the presence of such ambitious programs, the incremental resources needed to exploit the rich opportunities before us in chemistry are easily in scale. Because of the societal payoff to be expected from such an incremental investment, it will be readily and persuasively defensible in the individual competitive grant style already known to be effective in chemistry.

NEW WORDS

reverberate	vt.	反射(光、热等)； 〔化〕反(焰)；反响
era	n.	时代；纪元；阶段；〔地〕代
embed	vt.	栽种；埋置；〔医〕包埋
glamorous	a.	富有迷惑力；有魅力的
publicize	vt.	宣传；公布；为…做广告
propose	v.	提，推荐；计划
exponential	a. n.	指数的，幂的 指数
gratifying	a.	另人满足的；可喜的
plausible	a.	似乎有理的；嘴巧的
impart	vt.	给予；传递；透露
paradigm	n.	n. 范例；示例〔语〕 词形变化表
intimate	a.	熟悉的；本质的
analyze	v.	分析
nourish	vt.	施肥于；养育；怀抱(希望等)
candid	a.	公正的；坦率的
sponsor	vt.	发起；主办；为…做出资者
fusion	n.	熔化，熔解，熔合；(核)聚变
neutron	n.	中子
circumference	n.	圆周；周围；圆周线
ambitious	a.	有雄心的；炫耀的
persuasive	a. n.	有说服力的；劝导性的； 引诱物
grant	vt. n.	同意；授予；假定…(正确)； 准许；转让

discipline	n.	训练；惩戒；〔古〕学科
idiosyncratic	a.	(人的)特质的；特有的风格的；特异体质的
sustain	v.	承受住；维持； 证实；支持
initiative	n.	创始；积极性；主动
cottage	n.	小屋
innovative	a.	革新的；创新的
tangible	a.	可融知的；有实质的；有形的；明确的；确实的；
accelerate	v.	加速；促进
consensual	a.	经双方同意的；〔生〕交感的
bound	a. vt.	被束缚的；密切关联的 限止；形成...的边界
nurture	vt.	给…营养物；养育；培育
assemble	v.	集合；装配
data	n.	论据；资料，材料
image	n.	形象；印象；概念
increment	n.	增长；增值；〔数〕增量
budget	n.	预算
synchrotron	n.	〔原〕同步加速器
array	n.	列阵；(排列整齐的)一批；大量
irresistible	a.	不可抗拒的；不能压制的
exploit	vt.	开拓；利用
defensible	a.	能防御的；能辩护的





Lesson Two

HISTORY OF CHEMISTRY

Man from the earliest times has practiced empirical chemistry. Ancient civilizations were practicing the art of chemistry in such processes as wine making, glass making, pottery, dyeing, and elementary metallurgy. The early Egyptians, for example, had considerable knowledge of certain chemical processes. Excavations into ancient tombs dated 3000 B. C. have uncovered workings of gold, silver, copper, iron; pottery from clay; glass beads; beautiful dyes and paints; and bodies of Egyptian king in unbelievably well-preserved states. Many other cultures made significant developments in chemistry. However, all of these developments were empirical; that is, they were achieved by trial and error and did not rest upon any valid theory of matter.

Philosophical ideas relating to the properties of matter (chemistry) did not develop as early as those relating to astronomy and mathematics. The ancient Greek philosophers made great strides in philosophical speculation concerning materialistic ideas about chemistry. They led the way to placing chemistry on a highly intellectual, scientific basis. They first introduced the concepts of elements, atoms, shapes of atoms, chemical combinations, etc. The Greeks believed that there were four elements—earth, air, fire, and water—and that all matter was derived from these elements. The Greek philosophers had very keen minds and perhaps came very close to establishing chemistry on a sound basis similar to the one that was to develop about two thousand years later. The main shortcoming of the Greek approach to scientific work, however, was a failure to carry out systematic experimentation.

The Greek civilization declined and was succeeded by the Roman civilization. The Romans were outstanding in military, political, and economic affairs. They continued to practice empirical chemical artssuch as metallurgy, enameling, glass, and pottery making, but they did very little to advance new and theoretical knowledge. Eventually the Roman civilization declined and was succeeded in Europe by the Dark Ages. During this period European civilization and learning was at a very low ebb.

In the Middle East and in North Africa knowledge did not decline during the Dark Ages as it did in Western Europe. During this period Arabic cultures made contributions that were of great value to the later development of modern chemistry. In particular the Arabic number system, including the use of zero, gained acceptance; the branch of mathematics known as algebra was developed; and alchemy, a sort of pseudo-chemistry, was practiced extensively.

One of the more interesting periods in the history of chemistry was that of the alchemists (500 to 1600 A. D.). Man has long had the lust for gold, and in those days gold was considered the ultimate, most perfect metal formed in nature. The principal goals of the alchemists were to find a method of prolonging human life indefinitely and to change the base metals—such as iron, zinc, and copper—into gold. They searched for a universal solvent to transmute base metals into gold and for the "philosopher's stone" to rid the body of all diseases and to renew life. In the course of their labors, they learned a great deal of chemistry. Unfortunately, much of their work was done secretly because of the mysticism that shrouded their activities, and very few records remain.

Although the alchemists were not guided by sound theoretical reasoning and were clearly not in the intellectual class of the Greek philosophers, they did something that the philosophers had not considered worthwhile. They subjected various materials to prescribed treatments under what might be loosely described as laboratory methods. These manipulations, carried out in alchemical laboratories, not only uncovered many facts of nature but paved the way for the systematic experimentation that is characteristic of modern science.

Alchemy began to decline in the 16th century when Paracelsus (1493—1541), a Swiss physician and outspoken revolutionary leader in chemistry, strongly advocated that the objectives of chemistry be directed toward the needs of medicine and the curing of man's ailments. He openly condemned the mercenary efforts of alchemists to convert cheaper metals to gold.

The real beginning of modern science can be traced to astronomy during the Renaissance. Nicolaus Copernicus (1473—1543), a Polish astronomer, succeeded in upsetting the generally accepted belief in a geocentric universe. Although not all of the Greek philosophers had believed that the sun and the stars revolved about the earth, the geocentric concept had come to be accepted without question. The heliocentric (sun-centered) universe concept of Copernicus was based on direct astronomical observation and represented a radical departure from the concepts handed down from Greek and Roman times. The ideas of Copernicus and the invention of the telescope stimulated additional work in astronomy. This work, especially that of Galileo Galilei (1564—1642) and Johannes Kepler (1571—1630), led directly to a rational explanation of the general laws of motion by Sir Isaac Newton (1642—1727) from about 1665 to 1685.

Modern chemistry was slower to develop than astronomy and physics; it began in the 17th and 18th centuries when Joseph Priestley (1733—1804), who discovered oxygen in 1774, and Robert Boyle (1627—1691) began to record and publish the results of their experiments and to openly discuss their theories. Boyle, who has been called the founder of modern chemistry, was one of the first to practice chemistry as a true science. He believed in the experimental method. In his most important book, The Skyptical Chemist, he clearly distinguished between an element and a compound or mixture. Boyle is best known today for the gas law which bears his name. A French chemist, Antoine Lavoisier (1743—1794), placed the science on a firm foundation with experiments in which he used a chemical balance to make quantitative measurements of the weights of substances involved in chemical reactions.

The use of the chemical balance by Lavoisier and others late in the 18th century was almost as revolutionary in chemistry as the use of the telescope had been in astronomy. Thereafter chemistry was a highly quantitative experimental science. Lavoisier also contributed greatly to the organization of chemical data, to chemical nomenclature, and to the establishment of the Law of Conservation of Mass in chemical changes. During the period from 1803 to 1810 John Dalton (1766—1844), an English schoolteacher, advanced his atomic theory. This theory placed the atomistic concept of matter on a valid rational basis. It remains today as a tremendously important general concept of modern science.

Since the time of Dalton, knowledge of chemistry has advanced rapidly, with the most rapid advancement occurring at the end of the 19th century and during the 20th century. Especially outstanding achievements have been made in determining the structure of the atom, in understanding the biochemical fundamentals of life, in developing chemical technology, and in the mass production of chemicals and related products.

NEW WORDS

empirical	a.	经验主义的
pottery	n.	〔总称〕陶器;陶器制造
metallurgy	n.	冶金学,冶金术
excavation	n.	发掘;洞;发掘物
clay	n.	黏土;似黏土的物质
bead	n.	有孔小珠;水珠;空泡
trial	n.	试验;痛苦;尝试;麻烦事
valid	a.	有效的;正当的
stride	n.	大步;进展
speculation	n.	思索;推测;投机
derive	vt.	获得;推知;导出
	vi.	起源;衍生
keen	a.	锋利的;强烈的;渴望的;敏锐的
shortcoming	n.	缺点
decline	n.	下倾;衰退
alchemy	n.	炼金术
lust	n.	渴望,热烈追求
transmute	vi	变形;变质
	vt.	〔化〕使(元素)嬗变
rid	vt.	使摆脱;救出;迅速了结(工作)
mysticism	n.	神秘主义
manipulation	n.	(熟练的)操作;应付,处理;手法
outspoken	a.	直言的;坦率的
advocate	n.	辩护者
	vt.	拥护;提倡
ailment	n.	失调;精神不安
condemn	vt.	谴责;宣告…不适用 宣告患不治之症
mercenary	a.	惟利是图的;雇佣的
renaissance	n.	文艺复兴
	a.	文艺复兴的
geocentric	a.	以地球为中心的;地心的
heliocentric	a.	日心的;以日心测量的

	vi. 倾倒;衰落		
enamel	vt. 涂瓷釉于;使成光滑面	rational	a. 理性的;推理的;有理性的;合理的
	n. 搪瓷;珐琅质;瓷漆		
ebb	n. 落潮;衰落	algebra	n. 代数学

注释:pseudo—〔希〕(构词成分)"伪","拟","假".

Renaissance 加定冠词才是欧洲十四～十六世纪的文艺复兴.

Word Formation

几个常用名词后缀还有:—sion, —ment, —ence, —ance, 表示"性质","状 态","行动","过程". 如:

corrode—corrosion

explode—explosion

depend—dependence

assure—assurance

measure—measurement

assort—assortment

assist—assistance

attend—attendance

化学名词中常用的前、后缀

常用基团名称

methyl	甲基	hexyl	己基
ethyl	乙基	isopentyl	异戊基
propyl	丙基	allyl	烯丙基
butyl	丁基	benzyl	苄基(苯甲基)
pentyl	戊基	vinyl	乙烯基

READING MATERIAL

UNDERSTANDING CHEMICAL REACTIVITY

The strength of American science has been built on allowing creative, working scientists to decide independently where the best prospects lie for significant new knowledge. Many of the most far-reaching developments, both in concept and application, have come from unexpected directions. Thus, a listing of priority areas may tend to close it or quench some of the most adventurous new directions whose potential is not yet recognized.

Even so, it makes sense to concentrate some resources in specially promising areas. This can be done if we regard our research support as an investment portfolio designed to achieve maximum gain. A significant part of this investment should be directed toward consensually recognized priority areas but with a flexibility that encourages these favored listings to evolve as new frontiers emerge. A second substantial element in this portfolio should be directed toward creative scientists who propose to explore new directions and ideas. Then, a third element must be the essential resources to provide the needed instrumentation and the infrastructure for its cost-effective use in achieving the goals of the entire portfolio.

Where this balance will fall for each of the funding sources will vary, of course. Industrial research will weight rather heavily the currently recognized priority frontiers. At the other extreme, NSF must take as its first responsibility the encouragement of new avenues from which tomorrow's priority lists will be drawn. The other mission agencies should structure their portfolios between. This report shows decisively that this is a time of special opportunity for intellectual advances in chemistry. Furthermore, the report demonstrates that such advances will not only enrich our cultural heritage, but also will help us respond to human needs and sustain our economic competitiveness. It is in society's interest to exploit these opportunities and to do so with particular attention to those frontiers that deserve high priority because they can be confidently expected to yield high intellectual and social return from the needed additional federal investment. We identify here five areas that meet this criterion.

A. Understanding Chemical Reactivity

B. Chemical Catalysis

C. Chemistry of Life Processes

D. Chemistry Around Us

E. Chemical Behavior Under Extreme Conditions

Understanding Chemical Reactivity

This is surely a time of special opportunity to deepen our fundamental knowledge of why and how chemical changes take place. The advance of the frontiers of reaction dynamics at the molecular level has undergone a revolutionary advance during the last decade. At the same time, synthetic chemists are constantly adding to our arsenal of reaction types and classes of compounds in a way that is eliminating historical distinctions between organic and inorganic chemistry. Much of this remarkable progress is due to the development and application of powerful instrumental and analytical techniques that give us capability to probe far beyond current bounds of knowledge.

In reaction dynamics, we can now aspire to elucidate the entire course of chemical reactions, including the unstable structural arrangements intervening between reactants and products. Just as the last three decades saw rich development of our understandings of equilibrium molecular structures and equilibrium chemical thermodynamics, the next three decades will see elucidation of the temporal aspects of chemical change.[1] We will be able to ascertain the factors that determine the rates of chemical reactions because of our new abilities to watch the fastest chemical processes in real time, to conduct reliable theoretical calculations of reaction surfaces, to examine chemical changes at the most intimate level ("state-to-state"), to track energy movement within and between molecules, and to exploit hitherto inaccessible nonlinear photon excitation processes ("multi-photon" excitation). These remarkable possibilities are rooted in a powerful array of new instruments, foremost of which are lasers and computers, and including Fourier transform infrared spectrometers, ion cyclotron resonance techniques, molecular beams, and synchrotron radiation sources.

New reaction pathways in synthetic chemistry offer another rapidly advancing frontier. These pathways identify a high leverage opportunity because they *provide the foundation for future development of new products and new processes.* Selectivity, the key challenge in chemical synthesis, is the cornerstone. Control of the different intrinsic reactivity in each bond type (chemoselectivity), the connection of reactant molecules in proper orientation (regioselectivity) and in the desired three-dimensional spatial relations (stereoselectivity) is at last within reach. Our ability to produce a controlled molecular topography has far-reaching implications for catalyst design. The traditional line of demarkation between organic and inorganic chemists has virtually disappeared as the list of fascinating metal-organic compounds continues to grow. We have just begun to elaborate and understand the potentialities of chemical pathways opened using light as a reagent. Finally, chemists are learning how to prepare solids with a wide range of tailored properties that include inorganic solids with contrived cavities as designed catalysts, polymers with structural properties that challenge those of steel, and new families of "electronic chemicals" — inorganic and organic semiconductors, resists, super-lattice materials, optical fibers, nonlinear optical materials—that will accelerate development of microelectronics and information transition.

Again powerful instrumentation plays a central role. Rapid and definitive identification of reaction products, both in composition and structure, account for the speed with which synthetic chemists are able to test and develop adventurous synthetic strategies. Of prime importance are high-resolution Nuclear Magnetic Resonance, computer-controlled X-ray crystallography, and high-resolution mass spectroscopy coupled with the delicate separation capabilities provided by chromatography in its advanced forms.

NEW WORDS

quench	v.	熄灭;冷却;把…淬火	infrared	a.	红外线的;产生红外辐射的
				n.	红外线
adventurous	a.	喜欢冒险的;有危险性的	spectrometer	n.	分光仪
concentrate	v.	集中	cyclotron	n.	回旋加速器
promising	a.	有前途的;有出息的	resonance	n.	共振

portfolio	n.	公文包;业务量;代表作选
flexibility	n.	灵活性;柔顺性;韧性;
evolve	v.	发展;进化;推论
emerge	n.	浮现;暴露;形成
substantial	a.	物质的;实质的;多的;有重大价值的
	n.	实质性的东西;要领
instrumentation		检测仪表;仪器使用;
	n.	手段
infrastructure	n.	基础;基础结构
avenue	n.	林荫道;途径;手段
mission	n.	代表团;使命;任务
criterion	n.	标准;尺度
dynamics	n.	动力学
undergo	v.	经历
synthetic	a.	合成的
arsenal	n.	宝库;军火库;
eliminate	v.	消除
distinction	n.	区别;特性;盛名
probe	v.	用探针探查;查究
aspire	vi.	渴望;追求(知识,名誉等)
elucidate	v.	阐释
intervene	vi.	干涉;介入;调停
reactant	n.	反应物
equilibrium	n.	平衡
thermodynamics	n.	热力学
temporal	a.	短暂的;时态的
ascertain	v.	确定
track	v.	跟踪;根据(线索等)探索;通过
hitherto	ad.	迄今
radiation	n.	辐射
leverage	n.	杠杆作用;影响
intrinsic	a.	内在的;固有的
chemoselectivity	n.	化学选择性
orientation	n.	向东;定位;方向;倾向性
regioselectivity	n.	部位选择性
spatial	a.	空间的
stereoselectivity	n.	立体选择性
topography	n.	地形学;局部解剖学;拓扑学
virtually	ad.	实质上;事实上
elaborate	vt.	精心制作;详尽阐述;从简单成分合成(复杂有机化合物)
reagent	n.	试剂
tailored	a.	特制的;时髦的干净利索的
contrived	a.	人造的
cavity	n.	洞;腔
polymer	n.	聚合物
semiconductor	n.	半导体
lattice	n.	点阵;网络;格子
optical	a.	光的
strategy	n.	战略;策略;计谋
resolution	n.	分辨
crystallography	n.	结晶学
spectroscopy	n.	光谱学
delicate	a.	精致的;微妙的;棘手的;(感觉,仪器等)灵敏的;精密的;灵巧的
chromatography	n.	层析;色层(分离)法
inaccessible	a.	达不到的;难接近的;难得到的

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Lesson Three

ATOMIC THEORY AND STRUCTURE

3.1/ EARLY THOUGHTS

The structure of matter has long intrigued and engaged the minds of men. The seed of modern atomic theory was sown during the time of the ancient Greek philosophers. About 440 B. C. Empedocles stated that all matter was composed of four "elements"—earth, air, water, and fire. Democritus (about 470—370 B. C.), one of the early atomistic philosophers, thought that all forms of matter were finitely divisible into invisible particles, which he called aatoms. He held that atoms were in constant motion and that they combined with one another in various ways. This hypothesis was purely speculative and not based on scientific observations. Shortly thereafter, Aristotle (384—322 B. C.) opposed the theory of Democritus and endorsed and advanced the Empedoclean theory. So strong was the influence of Aristotle that his theory dominated the thinking of scientists and philosophers until the beginning of the17th century. The term "atom" is derived from the Greek word atomos, meaning "indivisible."

3.2/ DALTON'S ATOMIC THEORY

More than 2000 years after Democritus, the English schoolmaster John Dalton (1766—1844) revived the concept of atoms and proposed an atomic theory based on facts and experimental evidence. This theory, described in a series of papers published during the period 1803 through 1810, rested on the idea of a different kind of atom for each element. The essence of Dalton's atomic theory may be summed up as follows:

1. Elements are composed of minute, indivisible particles called atoms.
2. Atoms of the same element are alike in mass and size.
3. Atoms of different elements have different masses and sizes.
4. Chemical compounds are formed by the union of two or more atoms of different elements.
5. When atoms combine to form compounds, they do so in simple numercial ratios, such as one to one, two to one, two to three.
6. Atoms of two elements may combine in different ratios to form more than one compound.