

# CHEMISTRY

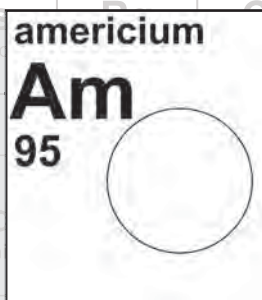
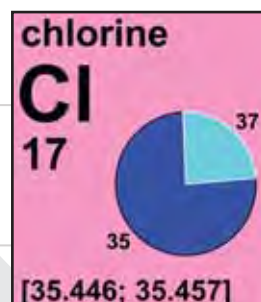
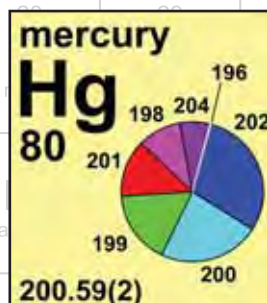
## International

March-April 2011  
Volume 33 No. 2



## Atomic Weights

### No Longer Constants of Nature



Where Would We Be  
without Chemistry?

The International Year of  
Chemistry Begins!



# From the Editor

## CHEMISTRY International

The News Magazine of the  
International Union of Pure and  
Applied Chemistry (IUPAC)

[www.iupac.org/publications/ci](http://www.iupac.org/publications/ci)

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### Printed by:

Cadmus Communications, Easton, PA, USA

### Subscriptions

Six issues of *Chemistry International* (ISSN 0193-6484) will be published bimonthly in 2011 (one volume per annum) in January, March, May, July, September, and November. The 2011 subscription rate is USD 110.00 for organizations and USD 50.00 for individuals. Subscription orders may be placed directly with the IUPAC Secretariat. Affiliate Members receive *CI* as part of their Membership subscription, and Members of IUPAC bodies receive *CI* free of charge.

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Periodicals postage paid at Durham, NC 27709-9990 and additional mailing offices. POSTMASTER: Send address changes to *Chemistry International*, IUPAC Secretariat, PO Box 13757, Research Triangle Park, NC 27709-3757, USA.

ISSN 0193-6484

**T**he idea of changing something we take for granted can be a bit jarring, especially something as enduring and long-standing as the atomic weights on the periodic table. As the guardian of the internationally accepted values of atomic weights, the IUPAC Commission on Isotopic Abundances and Atomic Weights must continually assess these values and provide guidance on their usage.

At this time, the Commission's assessment and review of published data, combined with the continuous improvement of analytical techniques available to the scientific community, are forcing a shift in the basic perception about atomic weights. Nowadays, measurement precision is such that in many cases the isotopic variation of certain elements, and not the uncertainties of the measurement, is what causes differences in atomic weight values. So, instead of hiding the concept of isotopes with an abstract number, the Commission now recommends



providing the interval values for elements whose standard atomic weight is not constant.

It took about a century for the chemistry community to reach this point. There is no surprise in what the commission reveals; it is just the result of a process that has now reached a tipping point. Some might say "Why complicate things and render a basic concept more complex?" I think that a better way to view the situation is to consider this new development as an opportunity to explore or review concepts such as isotopes, or uncertainties, and to ask "What is 'in' these numbers?" Aside from presenting long tabulations, the Commission reports published in the February 2011 *Pure and Applied Chemistry* are full of details, footnotes, and annotations that together are quite enlightening. The feature on page 10 authored by Ty Coplen and Norman Holden is an easier-to-read introduction to the formal reports.

In response to the Commission's recommendations, a brand new updated periodic table has been compiled, which is provided here on the back cover. Yet another version with graphics similar to what is shown on the cover will be released very soon. An IUPAC task group chaired by Norman Holden is to provide the educational community with the tools and resources necessary to understand and adopt these recent changes.

The other feature in this issue, on page 4, offers a contrasting record of what concerns and interests chemists. Peter Atkins gives us a snapshot of the countless contributions of chemistry to the modern world in "Where Would We Be without Chemistry?" Perhaps this is too bold a question to fully answer, but chemists must not lose sight of the big picture. The International Year of Chemistry has given us an opportunity to talk to the world at large and Atkins reminds us to rightly celebrate the impact of chemistry and the ways in which it has transformed the world.

Happy IYC!

Fabienne Meyers

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## Mounting a Positive Offensive

by Nicole Moreau

**O**ur two-year wait is over: the International Year of Chemistry is upon us! Now that the official Launch

Ceremony has occurred—that was on 27–28 January at the UNESCO Headquarters in Paris—it is certainly time to start celebrating our beautiful science. One of the best ways I can think of to start observing IYC is by contemplating what chemistry means to you personally and how best to explain this to others.

As more of your friends, family, and acquaintances hear about IYC, you may be responding to more questions (or opinions) about chemistry. So, why not be prepared to countenance a false impression about chemistry. But be assured, I am not advocating that we, as chemists, be defensive. Instead, let's make a collective New Year's resolution to mount a "positive offensive" on behalf of chemistry.

As I see it, there are two main types of misperceptions about chemistry. One occurs because chemistry is seen as a "central science," ubiquitous in all other fields of science. While this is certainly a wonderful thing, the danger is that chemistry becomes so diffuse across many different areas of science that it loses some of its identity in its own right. The other type of misperception exists mainly among the general public. In many countries (mainly Western), a rather large percentage of the population associates chemistry with issues such as environmental degradation or cancer.

## The First IUPAC Congress and General Assembly in a Latin American Country

**O**n behalf of IUPAC, the Colegio de Químicos de Puerto Rico is delighted to host the 43rd Congress. IUPAC 2011 will provide the appropriate forum to foster the bridging of innovation in chemistry and related fields between the Americas and the world.

The Colegio de Químicos de Puerto Rico is committed to promoting development and innovation in the chemical sciences in the Americas (North, Central, South, and Caribbean regions). Through the Colegio's membership in the Federación Latinoamericana de Asociaciones Químicas (FLAQ), we have contributed to the establishment of stronger relations between IUPAC, American Chemical Society, and Latin America.

The main goals of the 43rd IUPAC Congress and the 46th General Assembly, 31 July–6 August 2011, are the following:

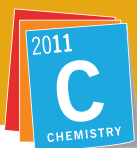
- foster the bridging of innovation in chemistry and related fields between the Americas and the world
- establish a gateway for the new interdisciplinary fields of science developed in the last decade
- promote the development of science and technology as the basis for a sustainable environment
- strengthen collaboration among young Caribbean and Latin American scientists
- present Puerto Rico as an important hub in advanced manufacturing of biopharmaceutical products

The theme for the IUPAC 2011 Congress is "Chemistry Bridging Innovation between the Americas and the World." The Congress will

include plenary lectures, symposia, oral presentations, poster presentations, workshops, group meetings, and an up-to-date scientific exhibition.

Seven Nobel Laureates in Chemistry and other distinguished scientists will be plenary speakers during the Congress. The program will include more than 30 symposia on these main topics:

- Alternative Energy Sources
- Chemistry and the Environment
- Chemistry of Life
- Chemical Education and Heritage
- Industrial and Applied Chemistry
- Materials Science
- Macromolecular Chemistry, Supramolecular Chemistry, and Nanotechnology
- Chemical Synthesis
- Chemical Analysis and Imaging
- Theoretical, Physical, and Computational Chemistry



# IYC 2011

## International Year of CHEMISTRY

Chemists must make sure that chemistry comes across loud and clear, and takes credit where credit is due. It's time to remind everyone that, for example, many of the cutting-edge forensic techniques we regularly see played out on our TV screens are built on fundamental chemical principles. And that DNA sequencing—which enables us to figure out the genomes of an ever-increasing variety of species—would be awfully difficult were it not for advances in chemistry. In addition, we must point out that chemistry will be essential to solving any of the vexing problems facing humankind, including energy, sustainable development, health, materials, and food production.

If you need some inspiration in kicking off the celebration of chemistry, you should read the news item on page 16 about “Women Sharing a Chemical Moment in Time,” an ambitious project spearheaded by Dr. Mary Garson. On 18 January 2011, one week prior to the launch of IYC, women in chemistry gathered all around

the world for breakfast networking meetings. Each country/region arranged its own event(s) and, at pre-arranged times, breakfasts were linked together by SKYPE/video, thereby creating a global chemical handshake. In addition to networking, the

aim was to celebrate the pivotal role of Marie Curie in chemistry, and to reflect on the current landscape for women chemists.

Activities such as this, and the hundreds of others you will find on the IYC site <[www.chemistry2011.org](http://www.chemistry2011.org)>, are very encouraging. When I see how most countries are keen to make IYC a great success, how determined and inventive they are, I can't help but feel optimistic about the year ahead.

Wishing you a fruitful and happy chemical year. 🍷

**Nicole J. Moreau** <[nj.moreau@free.fr](mailto:nj.moreau@free.fr)> has been IUPAC president since January 2010. She has been an elected member of the Bureau since 2000, a member of the Executive Committee since 2006, and vice president for 2008-2009. She is also general secretary of the French National Committee for Chemistry.

The IUPAC 2011 Congress is a cornerstone event of the International Year of Chemistry and will be a major event for the development of chemistry and related scientific and technological disciplines in Puerto Rico, the Americas, and the world.

Various activities are being organized for the celebration of the International Year of Chemistry during the IUPAC 2011 Congress:

- Primary- and secondary-school teachers and students will participate in activities with the visiting Nobel Laureates to promote chemistry in association with the local Department of Education.
- The House of Representatives will approve a resolution to recognize IUPAC and the visiting Nobel Laureates.
- A special session of the Senate to recognize IUPAC and the visiting Nobel Laureates will be held on Thursday, 4 August.

- The World Chemistry Leadership Meeting will be held during the 2011 General Assembly. A full-day event is planned for 2 August. We are currently in the middle of a UNESCO-declared decade promoting sustainable development issues, and the meeting will implement an enhanced level of dialogue on sustainable development among the scientific community represented by the IUPAC family, UN agencies, and industry.


### San Juan, Puerto Rico

San Juan is the capital of Puerto Rico and one of the oldest colonial cities in the Western Hemisphere. Its Spanish influence is most visible in the historic district of Old San Juan. A leisurely walking tour of the district is the best way to experience its historic, centuries-old treasures.

A major focal point of modern San Juan is its new, state-of-the-art Puerto Rico Convention Center, an architecturally dynamic structure that recalls the shapes and colors of the Caribbean in an elegant, modern style. The brand-new Sheraton Hotel next to the Convention Center will be the headquarters of the 2011 Congress.

The Organizing Committee and the Colegio de Químicos de Puerto Rico are pleased to welcome scientists and chemists from around the world to the IUPAC 2011 Congress and to Borinquén (Arawakan name for Puerto Rico), the pearl of the Caribbean.

**Gabriel A. Infante** is president of the organizing committee for the IUPAC 2011 Congress.

 [www.iupac2011.org](http://www.iupac2011.org)  
<http://welcome.topuertorico.org/descrip.shtml>

# Where Would We Be without Chemistry?

by Peter Atkins

**T**his year the world celebrates the International Year of Chemistry. The celebrations are wholly justified because chemistry is hugely important for all of us, wherever we live. Without chemistry's contributions, the world would lack color; we would live in Stone Age conditions, underfed, dressed in skins, without the many devices that ease our lives and entertain us; and our lives would be short and painful.

I will admit from the outset that chemistry, like any great enterprise, has a downside as well as an upside. It is used to make explosives for armaments, it creates poisons, and the effluents of chemistry plants can harm the environment. In the worst cases, chemical accidents have killed and injured thousands. The explosion at the Union Carbide plant in Bhopal, India, in 1984, for example, blighted thousands of innocent lives, and its terrible consequences are still with us today. While these negative aspects of chemistry have to be acknowledged, all technological and scientific advances have disadvantages, which we must weigh carefully against their advantages. With some exceptions, the chemical industry is well aware of its obligations to humanity and the environment and does what it can to avoid the potentially damaging effects of its activities.

This article will concentrate on chemistry's positive contributions to the modern world and leave it to the reader to judge whether they outweigh its negatives.

Chemistry is the science of matter and the changes that matter can undergo. In the broadest possible terms, chemists take one form of matter and conjure from it a different form. In some cases, they take raw materials from the Earth, such as oil or ores, and produce other materials directly from them, such as petroleum fuels and iron for steel. Chemists might harvest the skies, taking nitrogen from the atmosphere and converting it to fertilizer. In many cases, they take more sophisticated forms of matter and convert them to materials suitable for use as fabrics or as substances needed for high technology.

## Communal Living Is Possible Thanks to Chemistry

Take water, for instance, the absolutely essential enabler of life. Chemistry has made communal living possible by purifying water and ridding it of pathogens. Chlorine is the principal agent in water purification: without chlorine, disease would be rampant, and urban living a gamble. Chemists have found ways of extracting this element from an abundant source: sodium chloride, or common salt. Yet is urban living possible without the environmental disadvantages of using chlorine? Can chemists (perhaps you the reader or one of your students whom you have encouraged to pursue the study of chemistry) find such a substitute for chlorine? A replacement for chlorine in this application is highly desirable because it is a dangerous and untrustworthy ally: although its potent chemical reactivity enables chlorine to purify water, that same reactivity enables chlorine to attack other compounds and enter the food chain as dioxins and related compounds. These compounds can attack the nervous system and accumulate in body fat. Chlorine and its



*Professor Tebello Nyokong in her laboratory in the Department of Chemistry at Rhodes University of South Africa. One of five L'OREAL-UNESCO laureates in 2009, she earned the award for her research on chemical compounds known as phthalocyanine dyes. These could be used to attack cancerous tissues in a procedure that would be less intrusive than chemotherapy.*



compounds also rise high in the atmosphere where they contribute to the destruction of ozone and the formation of acid rain.

Chemists are at the forefront of the battle to obtain potable water from brackish water, from poisoned water in aquifers (such as the arsenic-laden water from deep aquifers in Bangladesh), and from that most abundant source of all, the oceans, by desalination. Chemists have contributed directly to this crucial task by developing reverse osmosis, a process in which pressure is applied to brackish water to drive it through a filtering membrane, thereby rendering it potable. Chemists have also contributed indirectly by developing membranes that promote the efficiency of the process by reducing its energy demands and increasing the lifetime and effectiveness of the membrane. It goes without saying that chemists' traditional skills of analysis—discovering what is present in water, what can be tolerated, and what essential element should be removed to trigger the desired reaction—are vital to this endeavor.

## The Search for Explosives Spawns a Green Revolution

Then there is food. As the global population grows, and the productive land area on Earth is eroded, it becomes more and more important to coax crops into greater abundance. The traditional way to encourage abundance is to apply fertilizers. Here, chemists have made a huge contribution, in finding sources of nitrogen and phosphorus and ensuring that these can be assimilated by plants. Although controversial because of its possible interference with inheritable factors and the uncontrolled transfer of those factors into other species, genetic engineering is another exciting approach to increasing the food supply. Genetically modified (GM) food crops can reduce the need for chemical pesticides, resist viral infection and drought, and, like natural breeding, produce more abundant yields rich in desirable components. The introduction of golden rice, for example, which includes genes from yellow daffodils to provide a high concentration of precursors of vitamin A, might help millions of people in Africa and Southeast Asia who suffer from vitamin A deficiency, which is responsible for millions of deaths and thousands of cases of irreversible blindness.

Nitrogen is astonishingly abundant, making up nearly three-quarters of the atmosphere, but in its natural form it cannot be assimilated by most plants. One of chemistry's greatest achievements, attained at

the beginning of the 20th century under the impetus not of a humane desire to support life but of an inhumane desire to kill, was the discovery of a method for harvesting nitrogen from the air and turning it into a form that could be absorbed by crops. The original impetus of this discovery was the need to replace the natural source of nitrogen, nitrates mined in arid regions of Chile, since more abundant and reliable supplies of nitrogen were needed for the manufacture of explosives during World War I (1914–1918). The development in Germany of an effective, economical process for converting nonreactive gaseous

nitrogen into a reactive form, by chemist Fritz Haber and his compatriot, the chemical engineer Carl Bosch, initially in 1909 and on an industrial scale in 1913, was a landmark achievement for the chemical industry for several reasons. As well as depending on the discovery of appropriate catalysts, it required the development of an industrial plant that operated at temperatures and pressures never previously attained.

The discovery of a process for producing reactive nitrogen revolutionized agriculture in the 20th century by permitting more abundant yields. But the process remains energy-intensive. It would be wonderful if the processes known to occur in certain bacteria associated with the root systems of leguminous plants, such as clover, alfalfa, and peanuts, could be emulated on an industrial scale to harvest nitrogen. In the natural process, nitrogen is released in a usable form when a plant dies and so becomes available to other plants. This is the basis for crop rotation in traditional farming and for the emulation of traditional methods in organic farming. Chemists have invested decades of research in investigating this natural process, dissecting in detail the enzymes that bacteria use in their quiet and energy-efficient, low-pressure, low-temperature way to produce usable nitrogen. There are glimmers of success. If you want to go down in history as the chemist who cracked the problem of feeding the world, your opportunity may lie in continuing this important work.



*The introduction of golden rice, which includes genes from yellow daffodils, might help millions of people throughout Africa and Southeast Asia who suffer from vitamin A deficiency.*

## Where Would We Be without Chemistry?

Phosphorus—derived from the remains of prehistoric animals—is abundant, too. Calcium phosphate from the bones of these ancient animals, and molecules of adenosine triphosphate (ATP), which powered their cells, lie in great compressed heaps of phosphate rock below the world's oceans and continents. Most of the world's phosphate rock reserves (85 percent) are located in Morocco. Taken together, China and Morocco account for 91 percent of the world's reserves, according to the International Fertilizer Development Center. Phosphorus is derived from phosphate rock and is used to produce fertilizers. By turning fossilized animals into fertilizer, chemists help to recycle the dead to feed the living.



### Without Energy, Civilizations Would Collapse

After water and food, we need energy. Nothing happens in the world without energy. Civilizations would collapse if it ceased to be available. Civilizations advance by deploying energy in ever greater abundance. Chemists contribute at all levels and to all aspects of developing both new sources of energy and more efficient applications of current sources.

Petroleum is one of the legacies of the past, being the partially decomposed residue of organic matter, such as plankton and algae, that sank to the bottom of lakes and seas and was later subjected to heat and pressure. It is, of course, an extraordinarily convenient source of energy, as it can be transported easily, even in weight-sensitive aircraft. Chemists have long contributed to the refinement of this raw material, which is squeezed and pumped from the ground. They have developed processes and catalysts that have taken the molecules provided by nature, cut them into more volatile fragments, and reshaped them so that they burn more efficiently.

Of course, burning nature's underground bounty might be seen, especially by future generations, as the wanton destruction of an invaluable resource. The supply of petroleum is also finite and, although new sources of petroleum are forever being discovered, for the time being at least, they are proving hazardous and increasingly expensive to access and use. Although an "empty" Earth is decades away, one day nonrenew-

able resources such as petroleum will be depleted. Chemists are already at work on the development of new sources of energy. Young people entering the field of chemistry today will find great opportunities to make an impact on the future well-being of the world and its people through the development of new energy sources.

Where do chemists currently look for new sources of energy? The Sun is an obvious source, and the capture of its energy adopted by nature, namely photosynthesis, is an obvious model to emulate. Chemists have already developed moderately efficient photovoltaic materials and continue to improve their efficiency. Nature, with its headstart of four billion years on laboratory chemists, has already developed a highly efficient system based on chlorophyll. Although the principal features of the process are understood, a challenge for current and future chemists is to adapt nature's model to an industrial scale. One route is to use sunlight to split water ( $H_2O$ ) into its component elements and to pipe or pump the hydrogen to where it can be burned.

I say "burned," but chemists know that there are more subtle and efficient ways of using the energy that hydrogen and hydrocarbons represent than igniting them, capturing the energy released as heat, and using that heat in a mechanical, inefficient engine or electrical generator. Electrochemistry, the use of chemical reactions to generate electricity and the use of electricity to bring about chemical change, is potentially of huge importance to the world. Chemists have already helped to produce the mobile sources, the batteries, that drive our small portable appliances, such as lamps, music players, laptops, telephones, and monitoring devices of all kinds, as well as, increasingly, our cars.

In collaboration with engineers, chemists are deeply involved in the development of fuel cells on all scales, from driving laptops to powering entire homes and conceivably villages. In a fuel cell, electricity is generated by allowing chemical reactions to dump and extract electrons into and from conducting surfaces while fuel, either hydrogen or hydrocarbons, is supplied from outside. The viability of a fuel cell depends crucially on the nature of the surfaces where the reactions take place and the medium in which the cells are immersed. This is another area of chemistry in which the aspiring chemist could make a profound difference in the future of his or her country and the world.

Even nuclear power, both fission and one day fusion, the emulation on Earth of the Sun, depends



# Where Would We Be without Chemistry?

on the skills of chemists. The construction of reactors for nuclear fission depends on the availability of new materials. The extraction of nuclear fuel in the form of uranium and oxides from its ores involves chemistry. Holding back the development and public acceptance of nuclear energy, apart from political and economic concerns, is the problem of how to dispose of the spent radioactive fuel. Chemists are contributing to solutions to this problem by identifying ways to extract useful isotopes from nuclear waste and to ensure that it does not enter the environment and become a hazard for centuries to come. Chemists who collaborate with nuclear engineers to solve the problem of nuclear waste will help both to reduce the risks of nuclear power and to facilitate the development of less hazardous nuclear fusion. Nuclear fusion involves smashing isotopes of hydrogen together and capturing the energy released as they merge to form helium, as happens on the Sun. The challenge in nuclear fusion is to achieve high temperatures, because only then do the nuclei smash together with sufficient force to overcome their electrical repulsion—and to avoid melting the entire apparatus. The major nuclear fusion research effort in France, known as the International Thermonuclear Experimental Reactor (ITER) project (*iter* is Latin for “the way”), is an international project on an unprecedented scale, involving countries representing half the world’s population.

## Plastics from Oil

I have alluded to the seemingly wanton destruction of an invaluable resource when the complex organic mixture we know as oil is sucked from the ground where it has lain for millennia, then casually burned. Of course, not all the oil goes through the exhausts of our cars, trucks, trains, and aircraft. Much is extracted and used more productively in an awesome chain of reactions that chemists have developed which constitute the petrochemicals industry.

Of the many petrochemical products, plastics have probably made the greatest impact on our lives. A century ago, everyday objects were metallic, ceramic, or natural, that is, made from such materials as wood, wool, cotton, and silk. Today, many objects that we use on a daily basis are synthetics derived from oil. Our clothes and fabrics in our homes are synthetics spun from materials developed by chemists; we travel with bags and cases formed from synthetics; our electronic equipment—televisions, telephones, music players, and laptops—are molded from synthetics. Our vehicles

are increasingly fabricated from synthetics. The look and feel of the world is different today from what it was a hundred years ago: touch an object today, and its texture will typically be synthetic. For this transformation, we are indebted to chemists.

Even if you lament the passing of many natural materials, you can still thank chemists for their preservation when they *are* used. Natural matter rots, but chemists have developed materials that can slow decay. New wood preservatives, for instance, have been developed to avoid problems associated with old preservatives, which were typically based on copper and could leach into the soil, poisoning it with arsenic, copper, and chromium.

## Lighter Cars, Molecular Computers, and Intelligent Clothing

Plastics are but one face of the materials revolution that has characterized the last hundred years and continues vigorously today. Chemists are also developing ceramics that are beginning to replace the metals used in vehicles, making them lighter and thereby increasing the efficiency of our transport systems. Ceramics are already used in the exhaust manifolds of some high-performance cars, and experiments have been conducted to replace the entire engine block with ceramics. Ceramics are a factor in the simplification of the car engine’s cooling system and help today’s engines withstand high temperatures. Problems with fabrication and crack resistance still await chemists’ solutions.

Chemists are also responsible for the development of the semiconductors that form the material infrastructure of the digital world and enable communications and computation. Chemists have been involved in developing optical fibers to replace copper in the transmission of signals. Materials developed by chemists make possible the displays that act as interfaces with the human visual system.

Currently, chemists are at work on molecular computers, in which switches and memory are based on changes in the shape of molecules. The successful development of such materials will result in an



*Chemists collaborate with engineers to develop the batteries that drive laptops and mobile devices.*

## Where Would We Be without Chemistry?

unprecedented increase in computational power and an astonishing compactness of the processing unit. If you are interested in the development of such smart materials, you can expect to participate in a revolution in computation. Quantum computing is another exciting prospect, which will depend on appropriate new materials developed by chemists and represent an extraordinary revolution in communication and computation.

Modern fabrics depend crucially on chemistry. Take chemistry away from clothing and fashion, and we are left almost naked, cold, and most certainly drab. Traditional dyes, such as those used in Javanese batik and Indian block-printing, are chemicals that have been extracted from plants for application to fabric. Modern fabrics include synthetics such as polyesters, nylon, and polyamides. Chemistry also makes more subtle contributions to fabrics: it incorporates bromine compounds into fabrics to act as flame retardants, and nanomaterials to prolong resistance to chafing, create resistance to bacteria, and suppress wrinkling. Even more exciting developments to which you might contribute are on the horizon: e-textiles (so-called intelligent clothing) with embedded electronic capabilities, including the ability to change colors and patterns (and even display advertisements!) that reflect our moods. Such textiles will be able to adjust their thermal properties to the ambient conditions and, let's hope, be self-cleaning.

### Agents against Disease: Pharmaceutical Companies

I cannot neglect to mention the role of chemistry in health care. One of chemistry's greatest contributions to our well-being—and, it must be added, to the welfare of domesticated animals—has been the development of pharmaceuticals. Chemists can be justly proud of their contributions to the development of a variety of agents against pain and disease. The introduction of anesthetics in the late 19th and early 20th centuries was an especially welcome contribution. Think of undergoing an amputation 200 years ago, with only

brandy and gritted teeth to sustain you! Some of the anesthetics currently used, such as procaine, have been developed specifically to avoid adverse side effects, including addiction, which often accompa-



*This 19th-century patient has been given nitrous oxide (N<sub>2</sub>O) to numb the pain of having a tooth extracted. Also known as laughing gas, nitrous oxide was identified as an anesthetic in 1772 by the English chemist Joseph Priestley.*

nied the use of such traditional materials as cocaine, derived from Peruvian coca. Chemists have also developed a vast array of antibiotics, often by observing nature closely. A century ago, bacterial infection was a deadly prospect; now it is treatable with antibiotics. We hope that it remains that way, but we still need to prepare for the unknown or unforeseen.

Pharmaceutical companies often come under attack for what many regard as profligate profits and exploitation. Yet their underlying motive is admirable: to reduce human

suffering by developing drugs that conquer pain and combat disease. Chemists are at the heart of this endeavor. It is highly regrettable that drug development can be so expensive. Modern computational techniques have been useful in the search for new lines of approach and in the effort to reduce reliance on animal testing. Extraordinary care needs to be exercised when introducing foreign materials into living bodies, and years of costly research can suddenly be trashed if unacceptable consequences are discovered at the final stage of testing. Chemists' involvement in the pharmaceutical industry might transform it in a manner we cannot yet foresee. You or one of your colleagues may one day become one of the proud chemists who have contributed to saving millions of lives.

### How Biology Became Chemistry

Closely allied with chemists' contribution to the alleviation of disease is their involvement in research at a molecular level. Biology became chemistry just over 50 years ago when the double helix structure of DNA was discovered. Molecular biology, which sprung in large measure from that discovery, is chemistry applied to organisms. Chemists, often in the guise of molecular biologists, have opened the door to understanding life and its principal characteristic, inheritance, at a most fundamental level through the rational investigation of

## Where Would We Be without Chemistry?

vast areas of the molecular world. Their work has also transformed both forensic medicine and anthropology, helping to bring criminals to justice and to trace ethnic origins and ancestry.

Chemistry's shift of attention to the processes of life has occurred at a time when the traditional branches of chemistry—organic, inorganic, and physical—have reached a stage of considerable maturity and are ready to focus on the extremely complex network of processes going on inside organisms—inside human bodies in particular. Discoveries by chemists have helped create a rational basis for approaches to the treatment and prevention of disease. Genomics and proteomics are of crucial importance to chemists who work in this field. As its name suggests, genomics is the study of the genomes of organisms. So far, the human genome and those of several other animal species have been mapped. The term “proteomics,” which combines the words “protein” and “genomics,” refers to the study of the proteins produced by an organism. In these areas of chemistry you can truly feel confident about standing on the shoulders of the giants who have preceded you, and know that you are attacking disease at its roots.

### Magicians of Matter

I have focused on a few of the achievements of applied chemistry, for they are the tangible outcome of the labors of myriad working chemists over the ages, as well as, it must be said with some caution, the alchemists, who were, above all, motivated by the desire to turn base metals into gold.

There is, however, another aspect of chemistry that should not go unnoticed and which, for many, is the real justification for the pursuit of chemistry. Chemistry provides insight into matter and the workings of the material world. It is thus a deeply cultural pursuit. It is fitting then that, in the light of UNESCO's support of the International Year of Chemistry, chemistry should be at once educational, scientific, and cultural. Chemistry not only opens our inner eye to the properties and behavior of matter. It is also a truly transnational and transcultural activity, in which advances build on contributions from chemists in almost every country in the world.

The early chemists like Englishman John Dalton (1766–1844) brought the existence of atoms and molecules to our attention, and their successors have shown us how to relate those entities to what we observe. Although we can take pleasure from merely

looking at the vibrant color of a flower, it is through chemistry that we can perceive the molecular origin of the color and thus deepen our delight.

Muhammad ibn Zakariya ar-Razi (865–925) was a Persian alchemist, chemist, physician, and philosopher. Many “firsts” are attributed to him, including being the first to differentiate smallpox from measles and to write a book on pediatrics. He was also the first to discover sulfuric acid, after perfecting the methods of distillation and extraction. He discovered numerous other chemicals and compounds, including kerosene, alcohol, and ethanol.

The early chemists began to understand why one substance reacted with another but not with something else. Those who followed in their footsteps discovered the motive power of chemical change and thereby expanded our understanding of why things happen in the world. We understand what drives the world forward, why crops grow, why we live and die, and why anything happens at all.

Much, of course, remains to be done. Although the fundamental principles of chemistry are now well established, their application remains as challenging and vigorously pursued as ever. Chemistry lets us plumb the depths of matter, and fabricate subtle arrangements of atoms that might not exist anywhere else in the universe, and that possess properties that are exquisitely tuned for a hitherto unforeseen application. If you are, or intend to become, a chemist, you will become a magician of matter, able to conjure unexpected or intended new forms of matter from what surrounds us. Of course, you will not be an actual magician: rather, you will be a rational, understanding manipulator, an architect on the scale of molecules.

The International Year of Chemistry is rightly a celebration of the transformation of the world and the lives of its inhabitants by chemistry. It rightly celebrates current achievements of chemists, the impact of chemistry on people everywhere, and the advancement of the field by collaboration throughout the world. It also rightly anticipates chemistry's important contributions to the new world yet to be. 🏆

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# Atomic Weights

## No Longer Constants of Nature

by Tyler B. Coplen and Norman E. Holden

**M**any of us were taught that the standard atomic weights we found in the back of our chemistry textbooks or on the Periodic Table of the Chemical Elements hanging on the wall of our chemistry classroom are constants of nature. This was common knowledge for more than a century and a half, but not anymore. The following text explains how advances in chemical instrumentation and isotopic analysis have changed the way we view atomic weights and why they are no longer constants of nature.

### Atomic Weight

The concept of atomic weights goes back to the time of John Dalton at the beginning of the 19th century. Much of chemistry in the first half of that century involved the measurement and analysis of atomic weights. Many scientists, most notably Dmitri Mendeleev, analyzed and divided the atomic weights of the elements into triads, octaves, and spirals, based on similarities of the chemical and physical properties of these elements. Mendeleev provided a periodic table along with predictions of new elements to fill gaps in his table, and these elements subsequently were discovered. In 1882, Frank W. Clarke recommended atomic-weight values for use in science, industry, and trade.<sup>1</sup> The American Chemical Society appointed Clarke as a one-man committee to issue atomic-weight tables annually. Groups in other countries created committees with a similar purpose. The values of the atomic-weight tables of these committees often differed, however, leading the German Atomic Weights Commission to call for an international commission to determine atomic weights. The first report (1901) of the International Commission on Atomic Weights (ICAW) was published as a flyleaf in the first issue of the *Chemische Berichte* in January 1902.<sup>2</sup> In 1913, the Commission became part of the International Association of Chemical Societies (IACS). Although IACS was dissolved following World War I,

the Commission continued to publish updated tables of atomic weights each year until 1921–1922. In 1919, the International Union of Pure and Applied Chemistry (IUPAC) was created as the chemical section of the International Research Council. An atomic-weight report from a new Commission, under IUPAC auspices, was first prepared in 1925. Since that time, ICAW or its successors within IUPAC, hereafter termed the Commission, took over the careful evaluation and dissemination of atomic-weight values, which continued to be considered “constants of nature.”

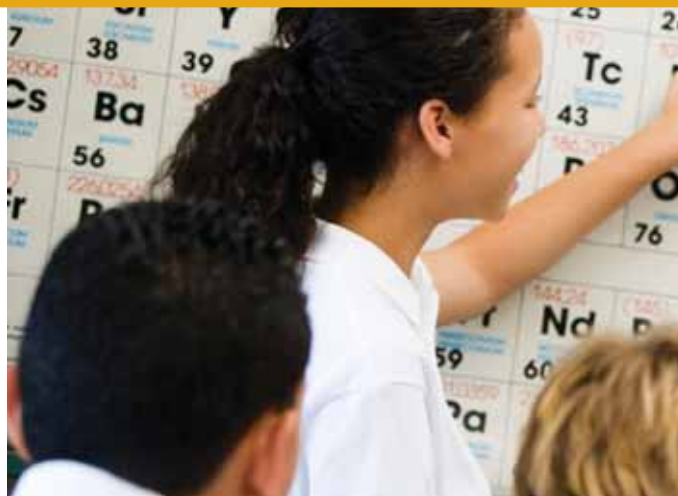
### Isotopes

A constant of nature, such as the Faraday constant [ $96\,485.3399(24)\text{ C mol}^{-1}$ ], typically is known to better than 1 part in a million parts. IUPAC's Periodic Table<sup>3</sup> lists a value of 10.811(7) for boron. If standard atomic weights are constants of nature, why are the values not published with greater accuracy? The answer, of course, is that the atomic weight of an element depends upon the source of the material and upon its number of stable isotopes, where isotopes are atoms of the same element having different mass numbers. At the start of the twentieth century, radioactive elements were discovered. Fredrick Soddy showed the chemical identity of meso-thorium ( $^{228}\text{Ra}$ ) and radium ( $^{226}\text{Ra}$ ).<sup>4</sup> He concluded that these chemical elements had different radioactive properties and different atomic weights, but the same chemical properties and so should occupy the same positions in the Periodic Table of the Elements. He coined the word “isotope” (Greek: “in the same place”) to account for radioactive species.<sup>5</sup> An event that profoundly affected atomic weights was the discovery by John (J.J.) Thomson<sup>6</sup> in 1912 that the element neon was made up of two stable isotopes,  $^{20}\text{Ne}$  and  $^{22}\text{Ne}$ . ( $^{21}\text{Ne}$  was discovered later.) With the discovery of stable isotopes and the use of mass spectrographs to measure the isotopic composition of chemical elements, it was realized that the masses of the individual stable isotopes and their isotopic-abundance values (mole fractions) could provide an alternative method for estimating an element's atomic weight. With technical improvements to mass spectrometers, the accuracy of this method began to exceed that of chemical determinations of atomic weight. Over the last half of the 20th century, almost every new recommended atomic-weight value was based on mass spectrometric measurements.

## Variations in Abundances of Isotopes and Atomic Weights

In 1908, the atomic weight of “common” lead (from a nonradioactive source material) was measured to be 207.2,<sup>7</sup> while a 1914 measurement<sup>8</sup> of lead from a thorium silicate mineral had an atomic weight of 208.4. A low value of 206.4 was measured for the atomic weight of lead in uranium samples in 1914.<sup>9</sup> Differences in lead atomic-weight values were considered to be an exceptional case that was attributed to lead isotopes being products of the natural radioactive decay chains. However, in 1936, Malcolm Dole<sup>10</sup> reported the variation of oxygen’s atomic-weight value in air and in water, because of variations in abundances of its stable isotopes. In 1939, Alfred O.C. Nier<sup>11</sup> reported on the 5 percent variation in the isotopic composition of carbon. It was becoming clear that atomic weights might not be constants of nature. At the Commission’s meeting in 1951, it was recognized that the isotopic-abundance variation of sulfur impacted the internationally accepted value of an atomic weight.<sup>12</sup> In order to indicate the span of values that may apply to sulfur from different natural sources, the value  $\pm 0.003$  was attached to the atomic weight of sulfur. Ranges were listed for six elements (H, B, C, O, Si, and S) due to the natural variation in their isotopic compositions, and experimental uncertainties were added for an additional five elements (Cl, Cr, Fe, Br, and Ag) in the 1961 report of the Commission.<sup>13</sup> In the 1969 report of the Commission,<sup>14</sup> uncertainties were added for all atomic-weight values for the first time. IUPAC had now added to its responsibilities the careful evaluation and dissemination of atomic-weight uncertainties, derived from critically assessed published information. Also in the 1969 report, the Commission acknowledged for the first time that

the discovery that most chemical elements exist in nature as isotopic mixtures, many of which are known to vary in composition, makes it necessary to modify the historical concept of atomic weights as constants of nature. Even though [stable] isotopes have not been observed in nature for some elements (currently 21 in number), it appears more logical to consider that isotopic mixtures represent the normal rather than the exceptional state of an element. The Commission considers that this attitude will promote an awareness that uncertainties in the values given in the International Table are no longer, as in earlier times, to be regarded as resulting only from errors in the measurement of



the value, but that they arise from natural variations in isotopic composition. . . . To arrive at the recommended value for the atomic weight the Commission will use weighting procedures so that the value will be optimized for materials in world science, chemical technology and trade, rather than represent an estimated geochemical average.

Not all elements, though, exhibit variations in their atomic weights; some have only one stable isotope. Determination of the standard atomic weights of the 21 elements with a single stable isotope,<sup>15</sup> such as F, Al, Na, and Au, is relatively simple because they depend only upon the atomic mass of a single stable isotope. These standard atomic weights **are** constants of nature, and their values are known to be better than one part in a million parts.

As a result of the growing importance of isotopic measurements for atomic weights, the Commission changed its name in 1979 to the Commission on Atomic Weights and Isotopic Abundances. The Commission decided that an atomic weight could be defined for any specified sample. For the IUPAC table of recommended values of atomic weights, the Commission stated:

Dated Tables of Standard Atomic Weights published by the Commission refer to our best knowledge of the elements in natural terrestrial sources.<sup>16</sup>

Atomic-weight distributions determined from published variations in isotopic compositions can span relatively large intervals. Figure 1 shows the variation in atomic weight as a function of mole fraction of <sup>2</sup>H in selected hydrogen-bearing materials. The atomic weight of hydrogen in “normal” materials spans atomic-weight values from approximately 1.00785

## Atomic Weights

to 1.00811,<sup>17-19</sup> whereas the uncertainty of the atomic weight calculated from the best measurement<sup>20</sup> of the isotopic abundance of hydrogen is about a thousand times smaller:  $A_r(\text{H}) = 1.007\,981\,75(5)$ . By a “normal” material, the Commission means a material from a terrestrial source that satisfies the following criterion:

The material is a reasonably possible source for this element or its compounds in commerce, for industry or science; the material is not itself studied for some extraordinary anomaly and its isotopic composition has not been modified significantly in a geologically brief period.<sup>21</sup>

To determine the atomic-weight value of an element having variations in the abundances of its stable isotopes in natural materials that result in a span of atomic-weight values (e.g., H, Li, B, C, N, etc.), the Commission typically has evaluated published variations in isotopic compositions, selected an atomic weight near the median value as the standard atomic weight, and assigned an uncertainty to encompass most or all of the published atomic-weight values. For example, for hydrogen (figure 1) the Commission selected at its 1981 meeting<sup>22</sup> a standard atomic-weight value of 1.00794 with an uncertainty of 0.00007. The Commission’s concern that the chemical com-

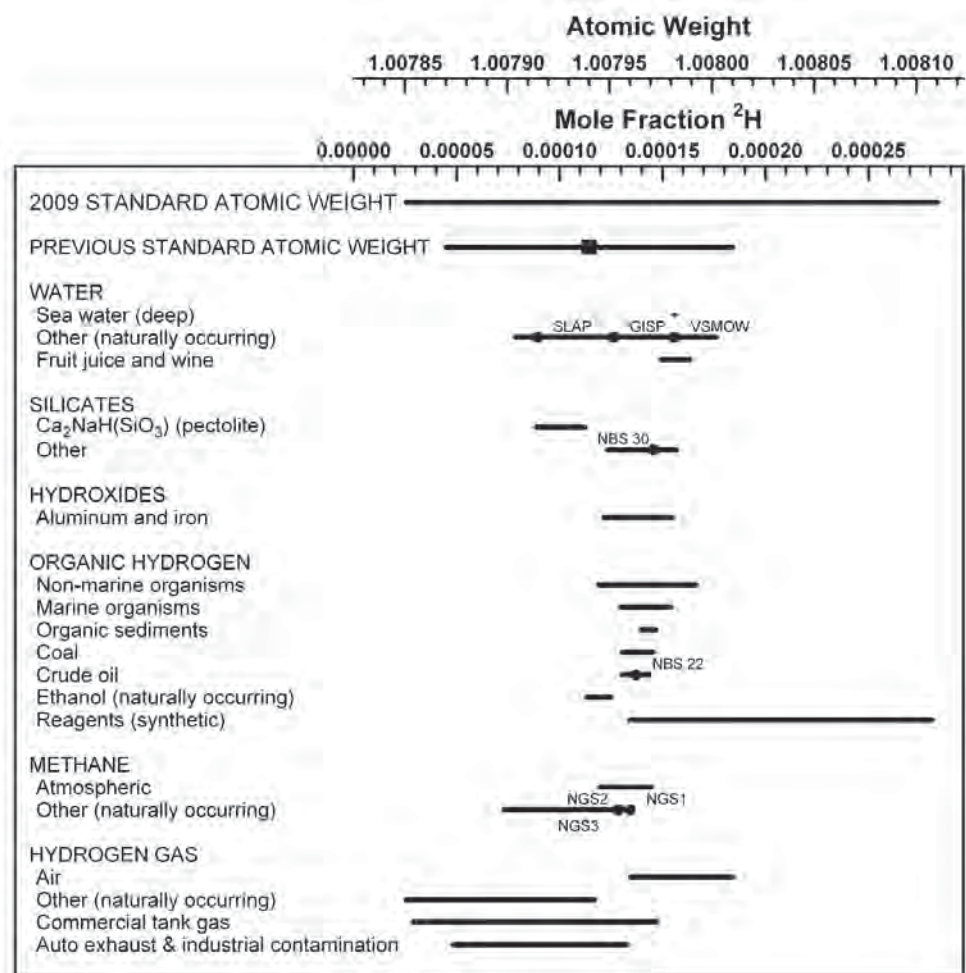


Figure 1. Variation in atomic weight with isotopic abundance of selected hydrogen-bearing materials.<sup>17-19</sup> Isotopic reference materials are designated by solid black circles. The previous (2007) standard atomic weight of hydrogen was 1.00794(7). The atomic-weight uncertainty of the “best measurement” of isotopic abundance<sup>20</sup> is approximately  $\pm 0.000\,000\,05$ , which is about 1000 times smaller than the uncertainty of the 2007 standard atomic weight.<sup>23</sup>



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munity would have difficulty handling asymmetric uncertainties and that most computer programs would not be able to treat asymmetric uncertainties properly led the Commission always to adopt symmetric uncertainties for standard atomic-weight values, even in cases where asymmetric uncertainties were called for. This presentation method is unsatisfactory for several reasons:

1. Students and others commonly misinterpret the uncertainty value of the standard atomic weight as a measurement uncertainty, and they wonder why standard atomic weights cannot be determined more accurately.
2. In years following the determination of a new standard atomic weight, newly published natural variations provide atomic-weight values that commonly exceed the bounds of the newly adopted standard atomic-weight value; thus, standard atomic weights needed to be changed regularly or they did not reflect recently published scientific literature.
3. The standard atomic-weight value is commonly expected by readers to reflect a Gaussian distribution, and it does not reflect satisfactorily the bimodal distribution of some elements—for example, that of boron and sulfur.<sup>17,18</sup>
4. It is often difficult, or even impossible, to find a material with an atomic-weight value identical to the standard atomic weight. For example, finding a hydrogen-bearing material with an atomic weight of 1.007 94 would be a challenge.

### Atomic-Weight Intervals

A new presentation method for standard atomic weights of elements such as H, Li, B, C, and N was needed. At its meeting in 2009 in Vienna, the Commission decided to express the standard atomic weight of hydrogen and nine other elements in a manner that clearly indicates that the values are not constants of nature.<sup>24</sup> The span of atomic-weight values in normal materials is termed the “interval.” The interval is used together with the symbols  $[a; b]$  to denote the set of values  $x$  for which  $a \leq x \leq b$ , where  $b > a$  and where  $a$  and  $b$  are the lower and upper bounds, respectively.<sup>25</sup> Neither the upper nor lower bounds have any uncertainty associated with them; each is a considered decision by the Commission based on professional evaluation and judgment. Writing the

### Guidelines for Atomic-Weight Intervals\*

1. The variation in atomic-weight values,  $A_r(E)$ , of an element E is termed an atomic-weight “interval” with the symbol  $[a; b]$ , where  $a$  and  $b$  are the lower and upper bounds, respectively, of the interval; thus, for element E,  $a \leq A_r(E) \leq b$ .
2. The standard atomic weight of an element, expressed as an interval,  $[a; b]$ , should not be expressed as the average of  $a$  and  $b \pm$  half of the difference between  $b$  and  $a$ .
3. The atomic-weight interval and range should not be confused. The atomic-weight range is equal to  $b - a$ , where  $a$  and  $b$  are the lower and upper bounds, respectively.
4. The lower and upper bounds commonly are determined from mass spectrometric measurements of normal materials, taking into account both the uncertainties of the measurements and the uncertainty of the “best measurement” of isotopic abundances of an element used to determine its 2007 standard atomic weight.
5. The atomic-weight interval encompasses atomic-weight values of all normal materials.
6. Both lower and upper bounds are consensus values, and neither has any uncertainty associated with it.
7. The atomic-weight interval is the standard atomic weight, which is the best knowledge of the atomic weights of natural terrestrial sources.
8. The number of significant figures in the lower and upper bounds are adjusted so that mass spectrometric measurement uncertainties do not impact the bounds.
9. The number of significant figures in the lower and upper bounds should be identical. A zero as a trailing digit in a value may be needed and is acceptable.
10. The atomic-weight interval is selected conservatively so that changes in the Table of Standard Atomic Weights are needed infrequently. Thus, IUPAC’s Commission on Isotopic Abundances and Atomic Weights may recommend additional conservatism and may reduce the number of significant figures.
11. The atomic-weight interval is given as precisely as possible and should have as many digits as possible, consistent with the previously stated rules.
12. Values of atomic-weight intervals are updated in the Table of Standard Atomic Weights by the Commission following completion of an IUPAC project reviewing the published literature for peer-reviewed isotopic-abundance data.
13. If the variation in isotopic composition in normal materials of an element is under evaluation by an IUPAC project, a footnote “r” may be retained in the Table of Standard Atomic Weights until the project completes its evaluation in order that changes to the tables are infrequent. Currently, such elements include He, Ni, Cu, Zn, Se, Sr, Ar, and Pb.

\*See reference 24 for more details.

## Atomic Weights

standard atomic weight of hydrogen as [1.00784; 1.00811] indicates that the atomic weight in any normal material will be greater than or equal to 1.00784 and will be less than or equal to 1.00811. Thus, the atomic-weight interval is said to encompass atomic-weight values of all normal materials. The range of an interval is the difference between  $b$  and  $a$ —that is,  $b - a$ .<sup>25</sup> Thus, the range of the atomic-weight interval of hydrogen is calculated as  $1.00811 - 1.00784 = 0.00027$ .

The lower bound of an atomic-weight interval is determined from the lowest atomic weight determined by the Commission's evaluations, taking into account the uncertainty of the measurement. Commonly, a mass spectrometrically determined isotope-delta measurement<sup>17,18</sup> is the basis for the determination of the bound. In addition to the uncertainty in the isotope-delta measurement, the uncertainty in the atomic weight of the material anchoring the delta scale is also taken into account.<sup>17,18</sup> If substance P is the normal terrestrial material having the lowest atomic weight of element E, then

$$\text{lower bound} = \text{lowest } A_r(E)_P - U[A_r(E)]_P$$


where  $U[A_r(E)]_P$  is the combined uncertainty that incorporates the uncertainty in the measurement of the delta value of substance P and the uncertainty in relating the delta-value scale to the atomic-weight scale. For hydrogen, the substance with the lowest published, evaluated <sup>2</sup>H abundance is hydrogen gas in a natural gas well,<sup>17,18</sup> and for it  $A_r(\text{H}) = 1.0078507$ , and  $U[A_r(\text{H})] = 0.0000046$ . Thus, the lower bound is 1.0078461. The combined uncertainty constrains the number of significant figures in the atomic-weight value of the bound. For hydrogen, the sixth digit after the decimal point is uncertain; therefore, the value is truncated to five digits after the decimal point. For the lower bound of hydrogen, 1.0078461 is truncated to 1.00784. The upper bound is determined in an equivalent manner, but for an upper bound, the trailing digit is increased to ensure the atomic-weight interval encompasses the atomic-weight values of all normal materials. The lower and upper bounds are evaluated so that the number of significant digits in each is identical. If a value ends with a zero, the zero may need to be included in the value to express the required number of digits.

Elements whose 2007 atomic weights are now presented as intervals<sup>24</sup> are shown in the following table.

Element name	2007 Atomic Weight <sup>23</sup>	2009 Atomic Weight <sup>24</sup>
hydrogen	1.007 94(7)	[1.007 84; 1.008 11]
lithium	6.941(2)	[6.938; 6.997]
boron	10.811(7)	[10.806; 10.821]
carbon	12.0107(8)	[12.0096; 12.0116]
nitrogen	14.0067(2)	[14.006 43; 14.007 28]
oxygen	15.9994(3)	[15.999 03; 15.999 77]
silicon	28.0855(3)	[28.084; 28.086]
sulfur	32.065(5)	[32.059; 32.076]
chlorine	35.453(2)	[35.446; 35.457]
thallium	204.3833(2)	[204.382; 204.385]

The most recent periodic table (based on reference 24) is reproduced as a tear-off page on the back cover of this issue.

In some cases, such as for trade and commerce, users may need a representative value for an element having an atomic-weight interval. Conventional atomic-weight values are conventional quantity values<sup>25</sup> and are provided by the Commission.<sup>24</sup> For example, the conventional atomic-weight value for hydrogen is 1.008.

Figure 2 (next page) is an example from IUPAC's periodic table of the isotopes for the educational community.<sup>26</sup> The isotopic abundances of an element are shown in a pie diagram. This figure shows four classifications of elements (from left to right): (a) those whose standard atomic weights are **not** constants of nature and that are assigned an interval, (b) those whose standard atomic weights are **not** constants of nature and that are not assigned an interval, (c) those whose atomic weight **is** a constant of nature because they have one stable isotope, and (d) those that have no standard atomic weight because they have no stable isotopes. This fundamental change in the presentation of the atomic weights represents an important advance in our knowledge of the natural world and will underscore the significance and contributions of chemistry to the well-being of humankind in the International Year of Chemistry in 2011. 

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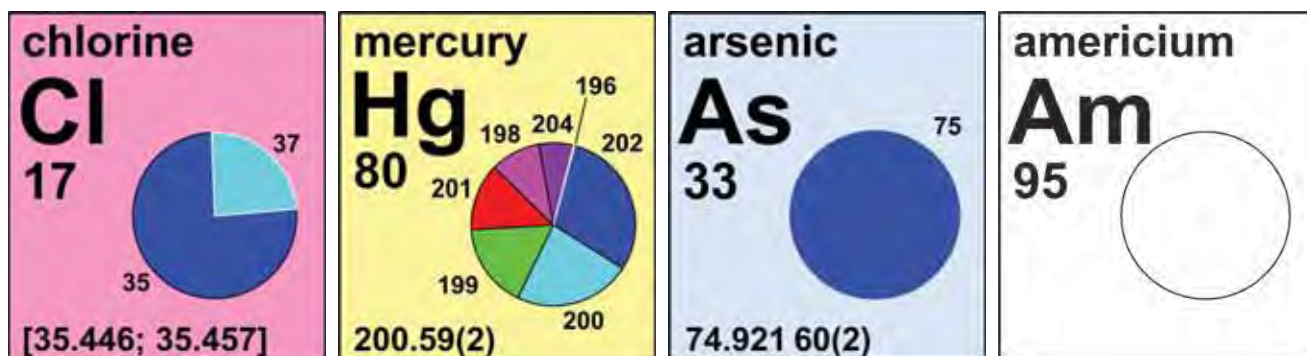


Figure 2. Potential illustrations for elements in IUPAC's new periodic table of the isotopes for the educational community<sup>26</sup> with stable isotopic abundances shown as pie diagrams (from left to right): Element (chlorine) whose standard atomic weight is not a constant of nature and is an interval. Element (mercury) whose standard atomic weight is not a constant of nature and is not an interval. Element (arsenic) whose standard atomic weight is a constant of nature because it has one stable isotope. Element (americium) that has no stable isotopes and thus no standard atomic weight.

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## Women Sharing a Chemical Moment in Time

by Mary Garson



**O**n the morning of 18 January 2011, women chemists from 44 countries leapt out of bed with purpose and shared breakfast together. They were taking part in the international networking event “Women Sharing a Chemical Moment in Time,” a “prequel” to the official launch of the International Year of Chemistry (IYC2011) in Paris on 27–28 January.

Worldwide there were close to 100 breakfasts, involving roughly 5000 women chemists, making it one of the largest gatherings of women scientists worldwide. A number of countries held multiple breakfasts; in Australia there were 9, while in both the UK and the Netherlands, there were at least 10 different functions.

Since an aim of IYC2011 is for chemists to “connect” as well as “participate,” the event organizers encouraged different breakfasts to interact with each other using video chat or Skype. In this way, participants created a chemical “handshake” around the globe, in the same way that a Mexican wave travels around a sports stadium.

Naturally, we had to cede the very first breakfast to New Zealand (Massey, Wellington; GMT +13), which then contacted several Australian breakfasts. From Australia, other international connections were then made with Singapore, Taiwan, and an event in Beijing hosted by the Chinese section of the Royal Society of Chemistry that was attended by Richard Pike, CEO of RSC. The Brisbane audience and their Chinese coun-

terparts listened by Skype to an address by Vivian Lam, a L’Oreal-UNESCO laureate fellow for Asia.

The chemical handshake “relay” was then passed across to Russia, and into Europe and Africa. In Johannesburg, the South African Chemical Institute hosted a breakfast attended by IUPAC President Nicole Moreau (France) and ACS President Nancy Jackson. The event was particularly well supported in the Netherlands and in the UK; both countries hosted at least 10 different events, and a video link between the Beijing event and the main RSC event in London nicely joined Asia to Europe. The handshake then continued into Argentina (GMT -2), Brazil, Paraguay, Peru, Venezuela, and Colombia (GMT -5). North American breakfasts made links across the Pacific to Hawaii (GMT -10), which contacted Wellington in New Zealand across the International Dateline, thus completing the 24-hour global circuit.

After the event, a Cambridge woman scientist described in an online blog how she had an online breakfast with a European colleague and a colleague in Peru (who must have got up in the middle of the night to participate!)—an exciting confirmation of a transatlantic link, as well as a connection between the Northern and Southern hemispheres. Skype sessions between Slovenia and Kenya, and between the UK and various African countries provided a North-South dialogue in Europe-Africa, while Paraguay Skyped Canada, and Colombia Skyped the USA.

Every country arranged their individual event(s) to suit the needs of their own audience, and many of them were able to attract local media attention. In the UK the BBC radio program *Womans Hour* ran an interview with two participants from the London breakfast held



*A chemical handshake in Brisbane (l) placed on Twitter is mirrored in Ascension, Paraguay (r) 20 hours later.*

at Burlington House. In Russia, a central group met for a roundtable discussion in Moscow and shared their conversation with breakfasts in other Russian locations as well as in Azerbaijan and Kazakhstan. In Strasbourg, France, a conversation between four members of the European parliament was streamed live, as were some of the meetings held in the USA. A huge dump of snow paralyzed transportation in Philadelphia, Pennsylvania, USA, but despite this, a few extremely hardy souls actually walked to the breakfast event held there by the Chemical Heritage Foundation—commitment indeed! In Brisbane, Australia, a disastrous riverside flood required that breakfast be moved to a different location at only 24 hours notice before the event; it was quite a challenge to inform all 60 participants of the new venue. Some countries held “breakfast for dinner” events that better suited the timelines of their



*A creative summary of the 44 countries that joined in Women Sharing a Chemical Moment in Time is shown in this Wordle image by Dr. Gwen Lawrie, The University of Queensland.*

working chemists, while Japan held a women chemists tea party.

Many countries took the opportunity to use the event to plan contributions to IYC, although the publicized themes of the event were first to celebrate the

## The Year Begins!

The official launch of the International Year of Chemistry 2011 took place on 27 January in Paris at the headquarters of the United Nations Educational Scientific & Cultural Organization (UNESCO). Over 1000 delegates from 60 countries—including four Nobel Prize winners, diplomats, government ministers, and dignitaries—took part in the much-anticipated opening ceremony.

UNESCO Director General Irina Bokova delivered the opening address with a challenge of sorts for the world’s chemists: “After a century of rapid advances, chemistry today stands at a crossroads . . .” According to Bokova, there are two major issues that the field must address:

1. Chemistry must become a science that is better shared and better known.
2. The chemistry of the future must be a responsible science.

IUPAC President Nicole Moreau, the second speaker, explained why and how IUPAC had come to co-sponsor the IYC with UNESCO.

She also implored chemists to do everything in their power to change chemistry’s terrible public image.

The Official Welcome and Inauguration portion of the ceremony also included these eminent speakers:

- Valérie Pécresse, minister of higher education and research, France
- Teshome Toga, ambassador of Ethiopia to France
- Senator Andrei Guriiev, on behalf of the Russian Federation
- Catherine Bréchnignac, ICSU president
- Mehdi Drissi, on behalf of the director general of FAO

Jean-Marie Lehn of France, who won the Nobel Prize for chemistry in 1987, framed the importance of the year in his talk, titled “From Matter to Life: Chemistry!”: “The essence of chemistry is not just to discover but to create novel expressions of complex matters. The book of chemistry is not just to be read, it is to be written.”

The rest of the opening ceremony was divided into three

sections: Chemistry and the Progress of Civilization, Women in Chemistry, and Global Trends and Perspectives: Chemistry and Sustainable Development.



*UNESCO Director General Irina Bokova at the IYC Opening Ceremony.*

Among the notable speakers was Marie Sklodowska Curie’s granddaughter Prof. Hélène Langevin-Joliot, director of research at CNRS. Her inspiring talk about her grandmother, “A Woman Scientist Disproving the Myth,” reinforced the central importance of Marie Curie to the year-long celebration of chemistry.

 [www.chemistry2011.org](http://www.chemistry2011.org)

100th anniversary of the awarding of the Nobel Prize in Chemistry to Marie Curie and the achievements of women chemists that have benefited society, and secondly to reflect on the current landscape for women in chemistry. Breakfast participants also reflected on why they were inspired by chemistry, and spoke to the younger chemists present about their own work experiences.

As international host of the event, I Skyped with newly found colleagues in Slovenia, Paraguay, Argentina, Colombia, and Peru. Paraguay held an evening function as this better suited their work habits; consequently, the timing of their event coincided with a very early breakfast (19 January of course) in Australia. When their Skype call came through at 6 AM, I remembered just in time to put a smart T-shirt on top of my pajamas before switching on the video camera.

From the many messages received since the event, it is clear that there was also a genuine mood of “chemistry togetherness” created on the day. A big factor in the success of the event, and the ease of communication between different events, was the interactive and user-friendly IYC2011 website managed by Fabienne Meyers of IUPAC.

Kathryn Linge (Curtin U.) helped by sending out e-mails during a 24-hour period when there were power, and consequently Internet, disruptions in Brisbane owing to the floods. Kathryn set up a Twitter site (@IYC\_Breakfast; monitored with the hashtag #chemhandshake) which was used by many contributors; it was extraordinary watching messages come in from enthusiastic Tweeters as their local events kicked off, and many older chemists appreciated better the potential of these social networking tools once encouraged to master them.

Twitter allowed the rapid sharing of photo images, or blog access; a particular favorite was one from Perth in which the “deeply philosophical” blogger lamented her porridge and soil analysis of 19 January compared to the grand breakfast of the day before! A handshake image from the Brisbane breakfast was transmitted by Twitter, and reappeared in Paraguay more than 20 hours later (see photos on page 16).

In early January, UNESCO commissioned the preparation of a short video of clips from various breakfasts and arranged for it to be shown as part of a session

on Women in Chemistry during the official IYC launch at UNESCO headquarters in Paris on 27 January. Each country sent footage and photo images directly to UNESCO, from which a captivating video was prepared. It was a privilege to introduce the video presentation at the launch ceremony, and truly memorable to meet two very special women who also spoke in the session on Women in Chemistry: Helen Langevin-Joliot, the granddaughter of Marie Curie, and Ada Yonath, Nobel Laureate in Chemistry. The day after, there was an official French-Polish celebration of Marie Curie held at the Sorbonne, attended by the first lady of Poland as well as a French government minister, various ambassadors, and senior scientific representatives. Afterwards, what better way to complete a memorable trip to Paris than by visiting the graves of Pierre and Marie Curie in the nearby Pantheon.

We hope that the enthusiasm and interest generated by the event will translate into ongoing strong support for IYC2011 within the Australian chemical community and across the world. An important outcome was the reminder to women chemists that they should step up and take a role in their own professional societies; the leadership opportunities that are created by working on professional society business are worthwhile, as they are beneficial to career development. For an overview of this event (and links to videos and related info), see the IYC website <[www.chemistry2011.org/participate/activities/show?id=37](http://www.chemistry2011.org/participate/activities/show?id=37)>.

### Acknowledgments

Thanks to both IUPAC and UNESCO for their strong support of this initiative, and to the many national chemical societies which helped to publicize the event among their local members. The grassroots appeal of the event was definitely a factor in its success. Finally, in addition to Kathryn Linge and Gwen Lawrie, mentioned earlier, Janet Bryant and Katie Hunt of the US and Barabara Moreno Murillo (Colombia) were invaluable in helping to coordinate events in the Americas. A particular “thank you” to both New Zealand and Hawaii, without whom the “chemical handshake” could not have been completed!

Mary Garson <[m.garson@uq.edu.au](mailto:m.garson@uq.edu.au)> is a professor at the University of Queensland, in Brisbane, Australia. Her scientific interests include the chemistry and natural bioactivity of secondary metabolites from both the marine and terrestrial environment. She is a member and secretary of the IUPAC Division on Organic and Biomolecular Chemistry. This year, she is also the co-chair of the Organizing Committee of the 27th International Symposium on the Chemistry of Natural Products which is to be held 10–15 July 2011 in Brisbane.

### On Your Marks, Get Wet, Ready, Go!

**T**he Global Water Experiment has now released a website to help focus and manage that IYC global activity. Please visit and bookmark [water.chemistry2011.org](http://water.chemistry2011.org).

On 22 March, which is World Water Day, the website will be completely functional, allowing participating schools to submit their data online and share their findings with others.

Water—A Chemical Solution: A Global Experiment is an IYC 2011 activity designed to unite students around the globe in participating in activities that highlight the role that chemistry plays in issues of water quality and purification.

Details on the four experiments that have been developed are available at [water.chemistry2011.org](http://water.chemistry2011.org). In addition, a poster explaining the experiment is now available at [www.chemistry2011.org/participate/activities/show?id=92](http://www.chemistry2011.org/participate/activities/show?id=92).

At this time, the team encourages everyone to gear up and get the word out to teachers in your community!

 <http://water.chemistry2011.org>

### African Journal of Chemical Education

**T**he inaugural issue of the *African Journal of Chemical Education* was published in January 2011 by the Federation of African Societies of Chemistry. In addition to research papers from Ethiopia, Egypt, and Nigeria, the issue features an interview with Peter Mahaffy, chair of the IUPAC Committee on Chemistry Education.

The editorial board of the new journal is as follows:

- Editor in Chief: Temechegn Engida, UNESCO-International Institute for Capacity Building in Africa, Ethiopia
- Associate Editor: Sileshi Yitbarek, Department of Chemistry, Kotebe College of Teacher Education, Ethiopia
- Associate Editor: Ahmed Mustefa, Department of Chemistry, Addis Ababa University, Ethiopia

The editors welcome contributions in the form of articles, short communications, opinions, and laboratory experiments. *AJCE* is published biannually in January and June.

 [www.faschem.org/images//african journal of chemical education.pdf](http://www.faschem.org/images//african%20journal%20of%20chemical%20education.pdf)



### Crop Protection Chemistry Award— Call for Nominations

The IUPAC Division on Chemistry and the Environment is now accepting nominations for the second IUPAC International Award for Advances in Harmonized Approaches to Crop Protection Chemistry. The award recognizes individuals in government, intergovernmental organizations, industry, and academia who have exercised personal leadership for outstanding contributions to international harmonization for the regulation of crop protection chemistry.

Awardees receive a USD 3000 honorarium plus travel and per diem reimbursement to attend the award presentation ceremony. Corporate sponsorship for the award is provided by Dow AgroSciences.

Nominations for the 2012 award are due **1 December 2011**, and should be sent to

Dr. John Unsworth, chair  
IUPAC Subcommittee on Crop Protection Chemistry  
25 Vellacotts  
Chelmsford, Essex CM1 7EA  
United Kingdom  
Phone: +44 1245 440 056  
E-mail: [unsworjo@aol.com](mailto:unsworjo@aol.com)

Nominations must include the following:

- A **nomination letter** including the nominee's birthplace, date of birth, citizenship, business address, and a description (200–1000 words) of the reasons why the nominee should receive this award, stressing major accomplishments toward international harmonization for the regulation of crop protection chemistry.
- A **curriculum vitae** that includes places and names of employment, professional affiliations, committee and working group assignments, and a listing of relevant regulatory guidance documents, reports, and/or publications.
- One or more **letters of support**.

The IUPAC International Award for Advances in Harmonized Approaches to Crop Protection Chemistry is presented on a biennial basis during even-numbered years in conjunction with an IUPAC-sponsored conference or special symposium. The first award was presented to Denis J. Hamilton, a retired chemist with a 45-year career at the Queensland Department of Primary Industries, Australia.



### IUPAC Gold Book Online

An updated version of the Gold Book was released in December 2010. The main new feature of Release 2.2 is the availability of a PDF output, which is created from the same source as the HTML version, so it should be totally compatible. However, if users notice a discrepancy between the pdf and html, they are asked to send their feedback to the developers. This release also includes an improved display of automatically added links, which are now distinguished visually from links added by authors.

The Gold Book online is the electronic version of the *IUPAC Compendium of Chemical Terminology*. It is a collection of terminology definitions from IUPAC recommendations previously published in *Pure and Applied Chemistry* and in the other IUPAC Colour Books. Terminology definitions published by IUPAC are drafted by international committees of experts in the appropriate chemistry sub-disciplines, and ratified by IUPAC's Interdivisional Committee on Terminology, Nomenclature and Symbols (ICTNS). In the online edition of the Compendium, these IUPAC-approved definitions are supplemented with some definitions from ISO and from the International Vocabulary of Basic and General Terms in Metrology; both these sources are recognized by IUPAC as authoritative. The result is a collection of nearly 7000 terms, with authoritative definitions, spanning the whole range of chemistry. The online version offers several unique features and indexes, including alphabetical and several thematic indexes, a feature to search by structure and substructure and a tool to goldify your text.

 <http://goldbook.iupac.org>

### Tribute to Pavel Kratochvil\*

by Michael Robert Hess and Máximo Barón

**W**ho is Professor Pavel Kratochvil? To those who have worked with him and shared many hours of heated and fruitful discussions and conversations he is simply Pavel, the “memory” of the IUPAC Commission on Macromolecular Nomenclature, the man with an elephant-like memory, and our good and highly esteemed friend and colleague.

Pavel is a “very private” person, so it was not easy for us to find information about him that goes beyond personal experience. Indeed, we might miss some characteristics and our tribute might give the impression of a rather formal summary, which it is not supposed to be. After all it should reflect the full life of our respected friend, splendid scientist, and best ambassador for his part of the world.

Pavel was born in Prague in 1930, at that time the Capital of the Czechoslovak Republic. In 1949 he finished his studies at the Vančura Grammar School there, in the center of Europe. From 1949 to 1953 he studied at the Prague Chemical Technological College (VŠCHT) and in 1960 he was awarded his Ph.D. at the Institute of Macromolecular Chemistry (ÚMCH) of the Czechoslovak Academy of Sciences (ČSAV). In 1968, he attained the degree of Dr. Sc. (ÚMCH); in 1991, he was habilitated in the field of macromolecular chemistry at the Chemical Technological College (VŠCHT) and in 1992 he received the title of Professor of Macromolecular Science.

This is only a description of his formal education and all those who know him are well aware that there is a great lot of productive and devoted work during this lengthy period. However, both of us know him best through his service in IUPAC.

He started his activities as an observer in the Commission on Macromolecular Nomenclature in 1977. He was elected a titular member of this Commission



*Pavel Kratochvil.*

in 1979 and served as its chairman from 1985 to 1991. In the years from 1985 to 1995, he was a member of the Interdivisional Committee on Nomenclature and Symbols. He became a member of the Macromolecular Division Committee in 1994. He has been closely involved in various IUPAC-sponsored meetings in Prague, including the International Symposia on Macromolecules in 1965 and 1992 (he was chairman of the 1992 Symposium) and most of the Prague Meetings on Macromolecules (Microsymposia and Discussion Conferences) over the last 32 years. He acted as the IUPAC official representative at about ten meetings. Prof. Kratochvil is currently serving his second term as the chairman of the Czech National Committee for Chemistry, the IUPAC National Adhering Organization of the Czech Republic.

 [www.iupac.org/publications/ci/2011/3302/iw6\\_tribute-kratochvil.html](http://www.iupac.org/publications/ci/2011/3302/iw6_tribute-kratochvil.html)

### In Memoriam: Joachim Meissner

Joachim Meissner, longtime member of the Subcommittee on Structure and Properties of Commercial Polymers, died in January 2011 after a long battle with cancer.

Prof. Meissner was born in Sehma/Annaberg in Saxony, Germany, in 1929. He graduated with a degree in physics in 1958. The same year, he joined BASF, where the melt flow behavior of polyethylene caught his attention, and he set up the famous BASF Rheology Research Laboratory. In 1974, he followed a call of the Eidgenössische Technische Hochschule in Zurich, Switzerland. Famous is his outstanding experimental work on elongational melt rheology. His IUPAC project “Basic Parameters, Melt Rheology, Processing and End-Use Properties of Three Similar Low Density Polyethylene Samples” became what is probably the most successful project of our working party.

We will remember Joachim not only as an outstanding rheologist, but also a very active, humorous, and companionable member of our working party/subcommittee who loved to confront theoretical rheologists with unexpected (but reliable) experimental data.

His name is indelibly linked with the invention of the RME elongational rheometer, also known as the Meissner rheometer. He was a gifted experimentalist and published many important and memorable rheological experiments.

Joachim is survived by his wife, Lilo, who accompanied him to several of our meetings.

\*Find the full version of this article online at [www.iupac.org/publications/ci/2011/3302/iw6\\_tribute-kratochvil.html](http://www.iupac.org/publications/ci/2011/3302/iw6_tribute-kratochvil.html).

## Physisorption of Gases, with Special Reference to the Evaluation of Surface Area and Pore Size Distribution

Gas physisorption experiments are essential for the development of areas such as gas separation and production, gas analysis (e.g., of concentration of trace amounts and of chromatography), gas storage (e.g., of hydrogen and methane), and purification of gas exhausts (e.g., the elimination of sulphides and carbon dioxide). Now characterization of adsorbents by gas physisorption is also required when they are to be used in liquid media (e.g., for the delayed release of drugs or fertilizers, for high-performance liquid chromatography, or for the analysis and separation of bio-liquids). In fact, surface area, pore size, and porosity characterization of porous solids and powders by physical adsorption is a standard tool in academia and industry. To aid such characterization, an IUPAC report entitled "Reporting Physisorption Data for Gas/Solid Systems, with Special Reference to the Determination of Surface Area and Porosity," was published in 1985 (K.S.W. Sing, D.H. Everett, R.A.W. Haul, L. Moscou, R.A. Pierotti, J. Rouquerol, and T. Siemieniewska, *Pure and Applied Chemistry*, vol. 57, issue 4, 603-619 [1985]). The recommendations in the 1985 report have been broadly followed and frequently cited by the scientific and industrial community. In fact, the report is included in more than 4000 citations according to Web of Science!

Over the past 25 years, major advances have been made in the development of nanoporous materials with uniform, tailor-made pore structures (e.g., mesoporous molecular sieves, carbon nanotubes and nanohorns, microporous-mesoporous carbons, and silicas with hierarchical pore structures). Their characterization has required the development of high-resolution experimental protocols for adsorption of various sub-critical fluids (e.g., nitrogen at 77K, argon at 87K, carbon dioxide at 273K), organic vapors, and super-critical gases. Furthermore, novel methods based on density functional theory and molecular simulation (e.g., Monte-Carlo simulations) have been developed to allow a more accurate and comprehensive pore-structure analysis to be obtained from the high-resolution physisorption data. It is evident that these new procedures, terms, and concepts now necessitate the updating and extension of the 1985 recommendations. As a consequence an international, well-balanced

IUPAC task group on Physisorption of Gases, with Special Reference to the Evaluation of Surface Area and Pore Size Distribution was approved by IUPAC in March 2010. The first meeting of this task group was held on 25 May 2010, in Hyoo, Japan. It is notable that K.S.W. Sing and J. Rouquerol are task group members of this new Division I project, as both were leading members of the 1985 task group. The objectives of the new project are the following:

- i. to provide authoritative, up-to-date guidance on gas physisorption methodology
- ii. to draw attention to the advantages and limitations of using physisorption techniques for studying solid surfaces and pore structures, with particular reference to the determination of surface area and pore size distribution (hence the work of this IUPAC task group will allow one to recommend the changes required to clarify and standardize the presentation, nomenclature, and methodology associated with the use of gas physisorption in different areas of pure and applied research)
- iii. to publish this work as an *IUPAC Technical Report*, which should be considered an update of the 1985 report

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 [www.iupac.org/web/ins/2010-009-1-100](http://www.iupac.org/web/ins/2010-009-1-100)

## Relation between Rheological Properties and Foam Processability for Polypropylene

Polypropylene (PP) foam is in great demand in industry for a variety of applications (e.g., automobile parts, food trays and packaging, insulators, and shock absorbers) because of its heat resistance, stiffness, and recyclability. However, it is difficult to obtain low-density foams with fine cell structure, especially from uncross-linked PP, because of the lack of melt elasticity. In this project, a newly developed processing modifier, acrylic-modified polytetrafluoroethylene (PTFE), will be employed to enhance the strain-hardening in elongational viscosity of PP. PTFE deforms into a fibrous structure during mixing



*The padding in hockey helmets is made of polypropylene foam.*





in a molten PP, and the interdigitated network structure of the PTFE fibers is responsible for the marked strain-hardening. As a result, PP containing a small amount (0.5–5 wt%) of the modifier exhibits prominent melt tension with a small increase in shear viscosity. Further, foaming processability will be evaluated by various processing operations as follows: chemical blowing agent microfoaming by supercritical CO<sub>2</sub>, batch foaming, and continuous extrusion foaming.

For more information, contact Task Group Chair Masayuki Yamaguchi <m\_yama@jaist.ac.jp>.

 [www.iupac.org/web/ins/2010-029-3-400](http://www.iupac.org/web/ins/2010-029-3-400)

## Quantitative Review and Analysis of Pesticide Sorption and Its Effect on Degradation in Relation to Soil and Climate

When pesticides are applied to the field for crop protection, they undergo two important processes: binding to the soil surfaces (sorption), and degradation in the porous media through either chemical or biological pathways. These two processes largely govern pesticide fate and transport behavior in the environment and are critical for pesticide environmental exposure assessments. Several public databases (e.g., The FOOTPRINT Pesticide Properties Database, <[www.eu-footprint.org/ppdb.html](http://www.eu-footprint.org/ppdb.html)>) have accumulated a significant amount of sorption and degradation data from published literature. The majority of these data originated from studies in Europe and North America; thus they may not represent regions in other parts of the world. In regions in other parts of the world, local data on pesticide sorption and degradation are often unavailable; thus environmental exposure assessments often rely on databases that are drawn primarily from regions that may have very different soil and environmental conditions. Obviously such data extrapolation requires careful quantitative analysis of sorption and degradation in relationship with environmental factors (soil and climate conditions).

Although sorption and degradation in soil may depend on environmental conditions differently, research has increasingly shown that the two processes are dynamically interrelated. Sorption in soil is a microscopically heterogeneous and time-dependent

process,<sup>1,2</sup> which may depend on not only the content but also the chemistry of soil organic matter and mineralogy.<sup>3,4,5</sup> Degradation through biological pathways relies on microbial populations that are highly localized in the partially water-filled soil pore space, with limited mobility to reach out for adsorbed substrates.<sup>6,7,8</sup> Because of this, binding to or release from the soil microscopic surfaces plays a critical role in determining the overall rate of degradation. It is expected that this effect varies among different classes of pesticide chemistry, soil types, and climatic zones.

The goal of this project is to focus on the quantitative evaluation of the relationship between sorption and broader soil properties, the coupling effect of sorption on degradation, and potential molecular structure-activity relationships that differentiate environmental fate behavior. The project will take advantage of IUPAC worldwide expertise to assemble and assimilate diverse data from published literature around the world. The outcome from the completed project may offer a set of quantitative tools for estimating sorption and degradation based on local environmental conditions and pesticide structural activity. This effort is expected to help address data deficiency problems in regions of the world with limited pesticide degradation studies and provide refinement of pesticide environmental exposure assessment models in general.

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For more information, contact Task Group Chair Wenlin Chen <wenlin.chen@syngenta.com>.

 [www.iupac.org/web/ins/2010-018-2-600](http://www.iupac.org/web/ins/2010-018-2-600)

## The Project Place

### Rare Earth Metal (Sc, Y, Lanthanoids) Bromides and Iodides in Water and Aqueous Systems (Solubility Data Series)

A complete set of compilations will be prepared for the solubilities of all rare earth metal bromides and iodides in water as well as in aqueous solutions containing inorganic and organic substances. The set of compilations related to a selected metal will be introduced with a critical evaluation of all related solubility results, equilibrium solid phases, and a selection of suggested solubility data.

Rare earth metal bromides and iodides are of increasing importance in the production of mercury-free lamp fillings, materials used in spectroscopy, cor-

rosion protection, and catalysis of polymerization and various organic reactions.

This report continues the previous elaborations dealing with rare earth metal halides in nonaqueous<sup>1</sup> and aqueous<sup>2</sup> solvents:

1. T. Mioduski and M. Salomon, IUPAC *Solubility Data Series*, vol. 22 (Oxford: Pergamon, 1985).
2. T. Mioduski, C. Gumiński, and D. Zeng, "IUPAC-NIST Solubility Data Series, Vol. 87," *J. Phys. Chem. Ref. Data* 37, 1765-1853 (2008); 38, 441-562 (2009); 38, 925-1011 (2009).

For more information, contact Task Group Chair Cezary Guminski <cegie@chem.uw.edu.pl>.

 [www.iupac.org/web/ins/2010-005-2-500](http://www.iupac.org/web/ins/2010-005-2-500)

## Stamps International

See also [www.iupac.org/publications/ci/indexes/stamps.html](http://www.iupac.org/publications/ci/indexes/stamps.html)

### IYC 2011: Ready, Set, Go!

Personalized or "customized" stamps constitute an alternative form of postage in which a photograph or picture provided by an individual or company is added to the stamp's design. In the past few years they have become increasingly popular in Europe and North America, particularly for the delivery of personal greetings or the announcement of special occasions (e.g., births, weddings) that could not possibly be featured on "regular" stamps issued by official postal authorities. Since the United States Postal Service will, unfortunately, not be issuing a stamp to honor the International Year of Chemistry (I'll spare you the details of the story), I decided a few months ago to create and order my own. Illustrated herein is the brainchild of my philatelic stubbornness, a self-adhesive stamp with a rather simple design that features the IYC logo on a white background. My hope is that many readers of *Chemistry International* will follow through on this idea and create stamps showcasing the chemistry theme of their choice (perhaps a favorite element or molecule?),



and thus help promote and commemorate the IYC.

I would also like to mention here three stamp-related events that will take place during 2011. A Global Stamp Competition is the focus of a new IUPAC project intended to draw attention to chemistry as a cultural enterprise. Schoolchildren all over the world are invited to submit entries that recognize the multiple contributions of chemistry to society and highlight its role in the welfare, safety, and health of all people. (Follow this activity on the IYC website @ [www.chemistry2011.org/participate/activities/show?id=110](http://www.chemistry2011.org/participate/activities/show?id=110)) In addition, a "Chemistry on Stamps" Symposium and an associated Stamp Exhibition will take place during the 242nd national meeting of the American Chemical Society in Denver, Colorado, between 28 August and 1 September. Everyone is invited to join in the celebrations!

Written by Daniel Rabinovich <[drabinov@uncc.edu](mailto:drabinov@uncc.edu)>.

Follow the IYC Postage Stamp Central @[www.chemistry2011.org/participate/activities/show?id=533](http://www.chemistry2011.org/participate/activities/show?id=533)

## Provisional Recommendations

*Provisional Recommendations are drafts of IUPAC recommendations on terminology, nomenclature, and symbols made widely available to allow interested parties to comment before the recommendations are finally revised and published in Pure and Applied Chemistry. Full text is available online.*

### Definition of the Hydrogen Bond

This recommendation provides a short definition for the hydrogen bond, followed by a list of experimental and/or theoretical criteria, which can be used as evidence for the presence of the hydrogen bond. Finally, some characteristics that are typical of hydrogen bonded systems are given. A brief explanation of the terms used is provided after the definition. The task group has also produced a comprehensive technical report, which provides a summary of the past work on hydrogen bonding and also the rationale for the proposed definition.

#### Comments by 31 March 2011

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 [http://media.iupac.org/reports/provisional/abstract11/arunan\\_310311.html](http://media.iupac.org/reports/provisional/abstract11/arunan_310311.html)

### Definitions of Terms Relating to Crystalline Polymers

The recommendations embodied in this document concern the terminology relating to the structure of crystalline polymers and the processes of polymer crystallization. Reference to actual polymer crystals of microscopic dimensions is essential to define the characteristic properties of crystalline polymers. Such crystals correspond only very approximately to the infinite, three-dimensionally periodic arrangements of atoms defining the ideal crystalline state.

#### Comments by 31 May 2011

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 [http://media.iupac.org/reports/provisional/abstract11/allegra\\_31052011.html](http://media.iupac.org/reports/provisional/abstract11/allegra_31052011.html)

### Terminology for Biorelated Polymers and Applications

The science and application of biorelated polymers require cooperation among different disciplines and scientific domains. Scientists whose research involves using polymer-based compounds and devices in contact with living systems tend to use the terms and definitions recommended by IUPAC. However, scientists in other fields have often developed incoherent terminologies.

The aim of the following recommendation is to provide a standard terminology that can be used across all fields of science involved with biorelated polymers, namely medicine, surgery, pharmacology, agriculture, packaging, biotechnology, and polymer waste management. This is necessary because i) human health and environmental sustainability are more and more interdependent; ii) research, applications, norms and regulations are still developed independently in each sector; and iii) nonspecialists such as journalists and politicians need a common language.

#### Comments by 31 May 2011

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 [http://media.iupac.org/reports/provisional/abstract11/vert\\_31052011.html](http://media.iupac.org/reports/provisional/abstract11/vert_31052011.html)

# Bookworm



## Pure and Applied Chemistry Recognizes the “Hand of Youth” in Shaping Chemistry

For nearly 10 years, IUPAC has been awarding the Prize for Young Chemistry “to encourage outstanding young research scientists at the beginning of their careers.” To date, 46 young scientists have been recognized with

this award. As the International Year of Chemistry gets underway, the January 2011 issue of *Pure and Applied*

*Chemistry (PAC)* features a collection of articles from past winners of the IUPAC Prize for Young Chemists, from inception of this annual competition in 2000 up to 2009. The issue is available online at [www.iupac.org/publications/pac/83/1](http://www.iupac.org/publications/pac/83/1).

Fittingly subtitled “**Perspectives and Challenges for the International Year of Chemistry**,” this special issue of *PAC* will hopefully inspire and enthuse readers with fascinating insights into new and emerging aspects of the chemical sciences. The special issue, the brainchild of *PAC* scientific editor James Bull, features 17 articles covering a rich variety of topics such as the following:

- Graphene oxide as surfactant sheets
- Energy, supramolecular chemistry, fullerenes, and the sky
- Chemistry meets nutrition: Toward a systems biological description of human metabolism

 [www.iupac.org/publications/pac/83/1/](http://www.iupac.org/publications/pac/83/1/)

## Heat Capacities: Liquids, Solutions and Vapours

Trevor Letcher and Emmerich Wilhelm (editors)  
RSC Publishing, 2010  
ISBN (print) 978-0-85404-176-3  
ISBN (online) 978-1-84755-979-1  
doi:10.1039/9781847559791

Many of the most significant developments in physical chemistry and chemical engineering during the last century have been influenced by chemical thermodynamics. The increase in articles containing experimental data on thermodynamic properties and on phase equilibria, as well as on new experimental techniques and advances in theory and computer simulation, demonstrates the unabated growth of this field. Most noteworthy is the accelerating trend in biophysical chemistry toward achieving a broader, quantitative thermodynamic basis for the physicochemical phenomena involved in biological processes. Heat capacity is one of the most important thermodynamic/thermophysical properties, playing a central role in the pure sciences as well as in chemical engineering and industrial applications.

This monograph, which contains 22 articles, is a natural complement to the general coverage of the field in *Experimental Thermodynamics*, vols. 1–7 (1968–2003). The outcome of an IUPAC project, it has its origins in committee meetings of the International

Association of Chemical Thermodynamics (IACT). In true IUPAC fashion, the authors, including some of the most important names in their respective fields, hail from countries around the world, including Austria, Belarus, Belgium, Canada, the Czech Republic, France, Germany, Israel, Italy, Japan, Poland, South Africa, the United Kingdom, and the United States.

In a monograph of this kind, the timeliness of the topic and the coverage and critical evaluation of pertinent publications are of paramount importance. This book meets both requirements: it highlights the underlying theory and some of the most important experimental techniques—modeling and computer simulation—as well as significant and new results related to heat capacity. The authors have endeavored to cover the relevant literature up to about 2008.

One of the objectives of this book is to bring together research from disparate disciplines that have a bearing on heat capacities. Connections between the different chapters of this book, the editors believe, could lead to new ways of solving problems and of looking at both new and old issues related to heat capacity. Underlying this philosophy is the inherent belief that a book is still an important vehicle for the dissemination of knowledge. This book is intended for researchers in chemical thermodynamics, whether in academia or in applied chemical engineering.

 [www.iupac.org/web/ins/2007-059-1-100](http://www.iupac.org/web/ins/2007-059-1-100)

## Applied Thermodynamics of Fluids

Anthony Goodwin, Jan Sengers, and Cor J. Peters (editors)

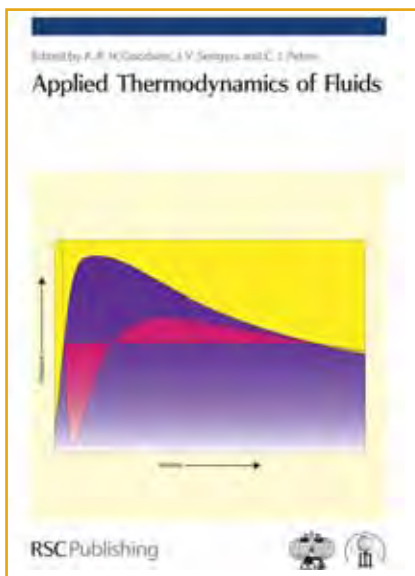
RSC Publishing, 2010

ISBN (print) 978-1-84755-806-0

ISBN (online) 978-1-84973-098-3

doi:10.1039/9781849730983

Published under the auspices of both IUPAC and its affiliated body, the International Association of Chemical Thermodynamics (IACT), this book is intended as a guide for scientists or technicians who use equations of state for fluids. Concentrating on the application of theory, the book discusses the practical use, and strengths and weaknesses, of each type of equation. The outcome of IUPAC Project 2008-014-1-100, it updates the equations of state for fluids and fluid mixtures and includes material on significant



developments in the equations of state for chemically reacting and nonequilibrium fluids.

*Applied Thermodynamics of Fluids* brings together an international team of distinguished experts to address the needs of practitioners within academia, government, and industry. The topics presented are relevant to the energy industry, particularly the hydrocarbon economy and the development of new power sources, and are also significant for the application of liquid crystals and ionic liquids to commercial products. This reference will be useful for postgraduate researchers in the fields of chemical

engineering, mechanical engineering, chemistry, and physics.

 [www.iupac.org/web/ins/2008-014-1-100](http://www.iupac.org/web/ins/2008-014-1-100)

## Chemical Laboratory Safety and Security: A Guide to Prudent Chemical Management

National Research Council, U.S. National Academies

Good safety and security procedures can lead to greater productivity, efficiency, savings, and, most importantly, greater sophistication and cooperation in the chemical laboratory. Yet improvement of safety and security is often mistakenly seen as inhibitory, because of poor understanding of safety and security procedures, cultural barriers, lack of skills, or financial constraints.

In conjunction with the U.S. Chemical Security Program and the U.S. State Department, the U.S. National Research Council has developed educational materials on laboratory safety and security based on two reports, *Prudent Practices in the Laboratory* and *Promoting Chemical Laboratory Safety and Security in Developing Countries*. These new materials include the reference book *Chemical Laboratory Safety and Security: A Guide to Prudent Chemical Management*, appendix material on CD, and the following “toolkit”:

- an instructor’s guide, with a total of 10 lessons, for laboratory managers, staff, and students

- a brochure on essential aspects of laboratory safety and security for institutional leaders
- a quick guide on prudent chemical management for laboratory supervisors and managers



The purpose of *Chemical Laboratory Safety and Security: A Guide to Prudent Chemical Management* and its accompanying toolkit is to assist chemists in developing countries to overcome the barriers they face and to increase the level of safety and security in their labs through improved chemicals management and the best laboratory practices possible. These educational materials are intended both as a key reference on chemical laboratory safety and security and as a guide for laboratory managers in training other lab managers, staff, and students in developing countries.

 [www.chemistry2011.org/participate/activities/show?id=57](http://www.chemistry2011.org/participate/activities/show?id=57)

# Conference Call

## Chemistry Education

by Mei-Hung Chiu

The IUPAC Committee on Chemistry Education (CCE) plays an influential and leading role in promoting chemistry education around the world. Since 1969, CCE has held the **International Conference on Chemical Education (ICCE)** every two years in a different country. The 21st ICCE, held 8–13 August 2010 in Taipei, Taiwan, was focused on “Chemistry Education and Sustainability in the Global Age.”

This theme was chosen to encourage participants to reflect on global environmental and ethical issues, to pose and answer hard questions, and to suggest possible solutions for the problems we are all facing in the real world. To achieve these goals, the Organizing Committee organized 10 plenary lecturers, five workshops, three symposia, one presidential panel discussion, one chemical demonstration, 145 oral presentations, 74 posters, and a variety of other activities. The distribution of the conference presentations among the 11 topics was as follows (with the number of presentations in parentheses): Environmental and Sustainable Development Education (17); Promoting the Globalization in Chemical Education (4); Public Understanding of Chemistry (15); E-learning and Innovative Instruction (24); Learning, Understanding, and Conceptual Change in Chemistry (31); Teaching Chemistry: Grades K-12 (37); Teaching Chemistry: College and Lifelong Education (34); Curriculum, Evaluation, and Assessment of Chemistry (36); Microscale Lab Chemistry (17); Promoting Female Students' Interest and Self-Confidence in Learning Science (3); and International Year of Chemistry (1).

The 10 plenary lecturers and their topics were as follows:

- Yuan-Tseh Lee: “Scientists in a Globalized World”
- Richard N. Zare: “The Power of a Failed Lecture Demonstration”

- Akira Fujishima: “How to Encourage Young People”
- John K. Gilbert: “The Place of the Informal Sector in the Development and Exercise of Chemical Literacy”
- Jorge G. Ibáñez: “Teaching Introductory Environmental Chemistry through Microscale Experiments”
- Joe Krajcik: “Supporting Learners in Developing Integrated Understandings of Core Ideas of Chemistry”
- Terry Collins: “Green Chemistry: On the Responsibility of Chemists to Advance Science with Human Health and the Environment Clearly in Mind”
- David Treagust: “The Development and Use of Diagnostic Instruments for Assessing Students' Chemistry Knowledge and Understanding”
- Ilka Parchmann: “Competencies in Chemistry—A Critical Reflection”
- Lei Wang: “Exploring Internet-Based Training Model for Cross-Provincial Large-Scale Chemistry Teachers' Preparation for the New Curriculum in Mainland China—A Significant Approach of Developing High School Teachers' PCK”

The conference also featured a presidential panel that discussed chemical education, sustainability in the global age, and the purpose of, and plans for, the International Year of Chemistry. Chaired by CCE chair Peter Mahaffy, the panel included Yuan-Tseh Lee (president of the International Council for Science), Choon H. Do (president of the Korea Chemistry Society), Ilka Parchmann (chair of the Division of Chemical Education of EuChemS), Joseph S. Francisco (president of the American Chemical Society), Maribel G. Nonato (president of the Philippine Federation of Chemistry Societies), Ting-Kueh Soon (president of the Institut Kimia Malaysia), and Wen-Ent Pan (president of the Chemical Society Located in Taipei). In



addition, two outstanding scholars, Nobel Prize winner Yuan-Tseh Lee and Richard Zare, held a forum on chemical education and sustainability.

Five workshops were organized during the conference:

1. "Chemical Demonstration: Educational Experiments to Enhance Students' Realistic Understanding," Masahiro Kamata and Takukya Miyauch
2. "Low-Cost Instrumentation for Microscale Chemistry Experiments," Fortunato B. Sevilla III
3. "Microscale Environmental Chemistry Workshop," Jorge G. Ibáñez
4. "Young Ambassadors for Chemistry," Lida Schoen and Erica Steenberg
5. "Chemistry, Geometry, and Art: Constructing Arbitrary Fullerenes with Beads," Bih-Yaw Jin



The more-than 100 participants who attended the workshops and engaged in hands-on activities were very appreciative of the workshop speakers. Lida Schoen even held the Young Ambassadors for Chemistry (YAC) Event at Taipei City Hall to get the public involved in the activities, which involved cosmetics created by students. One especially noteworthy chemical demonstration was presented by George T. Shiau, who is well known in Taiwan and regularly appears on the Disney Channel where he presents magic shows with chemical demonstrations.

Aside from academic activities, the conference offered participants a welcome party with a quartet performance; a conference banquet, featuring a traditional instrument performance and puppet show at the famous Grand Hotel in Taipei City; a calligraphy performance at the opening ceremony; a conference tour to the National Yehliu Geopark and to the Center for Traditional Arts in Yi-Lan County.

The total number of participants at the 21st ICCE was 333 from 36 countries. The largest groups of participants came from Taiwan (170), Korea (25), USA (18), Japan (15), China (10), Germany (9), and Malaysia (8).

In order to acknowledge individuals who have con-



*International flags representing participants' countries along with the participants' signatures.*

tributed to CCE in various ways over the years, the Organizing Committee initiated a set of awards for distinguished chemistry educators. The awardees in 2010 were Peter W. Atkins of the University of Oxford, UK, and Lida Schoen, an educational consultant in the Netherlands. The IUPAC Travel Scholarship Awardees were Huanhuan Chen of Nanjing Normal University, China; Antonius Indarto of Institut Teknologi Bandung in Indonesia; Mashita Abdullah of University Sains Malaysia in Malaysia; and Maryam Sulaiman of the University Sains Malaysia in Malaysia. The Chemical Education Network of the Federation of Asian Chemical Societies also offered a Travel Scholarship Award to Ronaldo Reyes who teaches at Tabaco National High School in the Philippines.

Mei-Hung Chiu <mhchiu@ntnu.edu.tw> (photo to the left, speaking at the YAC event) is professor at National Taiwan Normal University. She is a member of IUPAC Committee on Chemistry Education and its subcommittee on Chemistry Education for development. She was the organizer of the 21st ICCE.

### The CCE Meets in Taiwan

The Committee for Chemistry Education met during the ICCE in Taipei, with the initial meeting on Sunday 8 August, followed by a midweek meeting the evening of Wednesday 11 August. Chair Peter Mahaffy and Vice Chair Eva Åkesson were joined by Titular Members Lida Schoen, Choon Do, Mei-Hung Chiu, Ram Lamba, and Mustafa Sözbilir. National Representatives from Malaysia, Australia, USA, Finland, Japan, Italy, and South Africa also were present. In addition, the meeting featured representatives from Divisions V (Filomena Camões) and VIII (Richard Hartshorn) and three guests: Ilka Parchmann (chair of the Chemistry Education Division of EuChemS), Rachel Mamlok-Naaman (Israel), and Y.N. Lohdip (Nigeria).

Once routine matters had been dealt with, the meeting engaged in discussions on various IYC2011 initiatives, such as assisting countries to run their own science weeks; planning and executing a Global Experiment with the theme "Water – a Chemical Solution"; and running an International Stamp Competition to portray chemistry as a cultural enterprise.

## Conference Call

### Photochemistry

by Franco Scandola and Silvia Braslavsky

The XXIII IUPAC Symposium on Photochemistry was held 11–16 July 2010 in Ferrara, Italy, in the historic center of the city. Plenary lectures were held in the 18th-century opera theatre Teatro Comunale and the poster sessions in the cellars of the 14th-century Estense Castle. Over 500 participants (including 133 Ph.D. students) from 40 countries attended the symposium, which offered the contrasting mix of an ancient setting with modern science.

Symposium topics covered all fields of photochemistry from organic, inorganic, and physical photochemistry to theory, spectroscopy, photobiology, materials science, microscopy, nanotechnology, and—to a large extent—solar energy. The scientific program consisted of 8 plenary lectures, 23 invited lectures, 97 selected oral presentations in parallel sessions, and 354 posters. The plenary lectures were as follows:

- Thomas J. Meyer (University of North Carolina, USA): “Making Solar Fuels at Interfaces”
- Rienk van Grondelle (Vrije Universiteit, Amsterdam, The Netherlands): “How Conformational Switching in Plant Light-Harvesting Complexes Regulates Photosynthesis”
- Yoshihisa Inoue (Osaka University, Japan): “Supramolecular Photochirogenesis with Biomolecular Hosts”
- Massimo Olivucci (University of Siena, Italy): “From Computational Photobiology to the Design of Biomimetic Molecular Devices”
- Luisa De Cola (University of Münster, Germany): “Luminescent Metal Complexes and Their Soft Crystalline Assemblies”
- Stefan Matile (University of Geneva,



View of the Teatro Comunale (Ferrara) during a plenary session.

Switzerland): “Supramolecular Architectures for Artificial Photosystems”

- Devens Gust (Arizona State University, USA): “Controlling Light with Light: From Photosynthesis to Molecule-Based Signal Transduction”

A selection of papers will appear this year in *Pure and Applied Chemistry*.

David Phillips (Imperial College London, UK) received the prestigious Porter Medal, awarded by the three photochemistry societies: InterAmerican Photochemical Society, the European Photochemical Society (EPA), and the Asian Photochemical Society. His award lecture was “Targetted Sensitisers for Photodynamic Therapy.” The EPA Ph.D. prize was given to Anne Kotiaho (Tampere University of Technology, Finland). The EPA/*Photochemical and Photobiological Sciences Journal* award went to Werner M. Nau (Jacobs University, Bremen).

During the lunch breaks, several committee meetings took place, including that of the IUPAC’s Subcommittee on Photochemistry. The EPA had its general assembly on Monday evening.

Social events included, besides the welcome reception at the Ferrara City Hall, a boat excursion to the Venetian villas over the Brenta River, and a banquet dinner at the Lospida Castle on the Euganean Hills.

All in all, the conference was successful, both scientifically and socially. All the sessions were highly attended and animated by lively discussions. Once more, the photochemistry community showed its strength and vitality.

At the end of the conference, it was announced that the next IUPAC Symposium on Photochemistry will be held in Coimbra, Portugal, in July 2012. The scientific chair is Hugh Burrows (Portugal).

Franco Scandola is scientific chair of XXIII Symposium and Silvia Braslavsky is chair of the IUPAC Subcommittee on Photochemistry.



Lunch meeting of the IUPAC Subcommittee on Photochemistry in Ferrara.



## Conference Call

### Polymer Synthesis

by Petr Vlček

The **Prague Meetings on Macromolecules (PMM)**, held 18–22 July 2010, was the 74th in the long series of conferences organized since 1967 by the Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic. The meetings are themed events, addressing academic and industrial researchers in the specific field of polymer science.

Conference topics were as follows:

- controlled and living polymerization, including ionic and radical processes, “click” chemistry
- modifications of polymers, reactions on polymers, reactive and functionalized polymers
- polymers from natural sources, modifications of natural polymers using controlled processes, novel materials
- polymers for special use in bioapplications and technology
- ordered and hybrid polymer systems, multi-component polymer systems
- synthesis of polymers for photonics and electronics

The 90 attendees from 22 countries presented 7 keynote lectures, 28 special lectures, and 47 poster communications. The keynote lectures were delivered by the following top scientists:

- Christopher Barner-Kowollik, University of Karlsruhe, Germany
- Virgil Percec, University of Pennsylvania, USA
- Roderic P. Quirk, University of Akron, USA
- Mitsuo Sawamoto, Kyoto University, Japan
- Lawrence R. Sita, University of Maryland, USA
- Yasuyuki Tezuka, Tokyo Institute of Technology, Japan
- Yusuf Yagci, Istanbul Technical University, Turkey



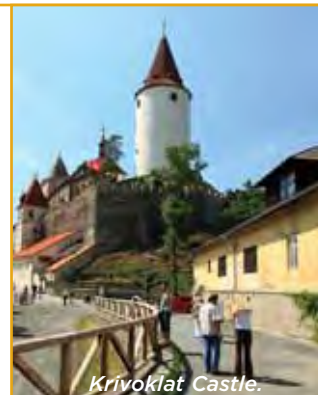
Participants at the 74th PMM Conference, Prague, Czech Republic, July 2010.

In addition to the keynote lectures, a number of interesting oral and poster contributions were presented by leading scientists, but also by young researchers and students, documenting the interest among young people in synthetic polymer chemistry. The program was run in one session in one lecture room with thematically different blocks and with two poster sessions.

During the opening ceremony, the institute director and conference chair welcomed the participants and informed them of the organization details. Mitsuo Sawamoto, as the IUPAC representative, gave an introduction to IUPAC and its activities.

The next PMM conference will be held in the Institute of Macromolecular Chemistry on July 2011 and will be focused on conductive polymers.

Petr Vlček <vlcek@imc.cas.cz> is a senior scientist in the Department of Controlled Macromolecular Synthesis, Institute of Macromolecular Chemistry in Prague.



### Chemical Thermodynamics

by Kazuya Saito and Mary Anne White

The **21st IUPAC International Conference on Chemical Thermodynamics (ICCT-2010)**, held 31 July to 6 August 2010 at Tsukuba Science City, Japan, was the 21st conference in a series of biennial meetings organized by the International Association of Chemical Thermodynamics; the previous two were held in Warsaw, Poland (2008), and in Boulder, Colorado, USA (2006).

About 600 participants from 36 countries on five continents attended this conference. In addition, about 100 audience members attended two pre-conference public lectures presented by Conference Chair T. Atake (Tokyo Institute of Technology, Japan) and M.A. White (Dalhousie University, Canada). In the scientific sessions, 10 plenary lectures (including the 2010 Rossini award lecture), 40 invited talks, and 198 oral and 302 poster contributions were presented.

The conference officially began on 1 August with the opening ceremony and welcome reception, both of which were attended by special guests, Their Majesties: The Emperor and The Empress of Japan. In the opening ceremony, delegates were welcomed by

## Conference Call

T. Atake. He was followed by I. Kanazawa (SCJ president), Y. Iwasawa (CSJ president), K. Tatsumi (IUPAC vice president and official IUPAC representative), and A. Goodwin (IACT president). T. Kawabata, Minister of Education, Culture, Sports, Science and Technology and also Minister of State for Science and Technology Policy, offered a message of welcome from the prime minister of Japan and gave an address that emphasized the importance of science and technology for human society. The ceremony was closed with remarks by H. Yoshida (JSCTA president).

The scientific program covered a variety of topics:

- Gerd Maurer (Germany): "Phase Equilibria in Chemical Reactive Fluid Mixtures" (2010 Rossini Award lecture)
- Peter W. Atkins (UK): "Teaching Thermodynamics: The Challenge"
- Michael L. Klein (USA): "Computer Simulation Studies of Self-Assembling Macromolecules"
- Bill Jones (UK): "Mechanochemistry, Cocrystals, and New Pharmaceutical Solid Forms"
- S. Prasanna Kumar (India): "Global Warming and Regional Response: An Example from the Indian Ocean"
- Pertti Koukkari (Finland): "Gibbs Free Energy Methods for Constrained and Partial Equilibria"
- Costas Panayiotou (Greece): "From Molecular Cavities to Macropores for Tissue Engineering: A Journey with Thermodynamics"
- Suphat Watanasiri (USA): "On-Demand Critically Evaluated Thermophysical Properties Data in Process Simulation"
- Marcelo Jaime (USA): "Testing Exotic States of Matter in Extreme Magnetic Fields"
- Masao Doi (Japan): "Variational Principle in Non-Equilibrium Thermodynamics"

Oral contributions and invited talks were presented in seven parallel sessions of 16 symposia/workshops: Fluids and Fluid Mixtures; Phase Equilibria; Foods and Pharmaceuticals; Biothermodynamics; Colloids & Interfaces; Thermochemistry and Molecular Energetics; Environmental Issues; Industrial Applications, Databases, and Software; Theory and Simulation; Organic Materials and Polymers; Inorganic Materials and Metals; New Techniques; Education in Chemical Thermodynamics; Special Session in Honor of Prof. S. Seki and Prof. H. Suga; Energy with Subsections on Petroleum, Coal, and Alternative Sources; Calorimetry with Commercial Relaxation Instruments.

From the 302 posters presented, three IUPAC Poster Prizes were chosen by a selection committee consisting of six international members; the awards were presented at the closing ceremony.

The IUPAC-sponsored conference was supported by the Science Council of Japan, The Chemical Society of Japan, and The Japan Society of Calorimetry and Thermal Analysis. Additional financial assistance was provided by the Commemorative Organization for the Japan World Exposition '70, The Japan Society for the Advancement of Calorimetry and Thermal Analysis, Tsukuba Expo '85 Memorial Foundation, The Asahi Glass Foundation, City of Tsukuba, The Federation of Pharmaceutical Manufacture's Associations of Japan, Hitachi Chemical Co. Ltd., Miwa MFG Co. Ltd., and by the University of Tsukuba.

The social program included a half-day excursion to a historic shrine and science exhibits inside Tsukuba Science City (National Institute of Advanced Industrial Science and Technology, High Energy Accelerator Research Organization, and Japan Aerospace Exploration Agency), followed by a banquet.



*IUPAC Vice President Kazuyuki Tatsumi delivers the opening address in the presence of Their Majesties, The Emperor and The Empress of Japan (right).*

## Conference Call

ICCT-2010 provided an open, collaborative environment for researchers from a wide range of fields of science and engineering. ICCT-2012 will be held in August 2012 in Búzios, Brazil.

Kazuya Saito <kazuya@chem.tsukuba.ac.jp>, a professor at the University of Tsukuba, Japan, was executive secretary of the conference. Mary Anne White, a professor at Dalhousie University, Canada, was a member of the international advisory board, a presenter of a public lecture, and co-chair of a workshop at ICCT-2010.

## Polymer-Solvent Complexes and Intercalates

by Jean-Michel Guenet

The 8th International Conference on Polymer-Solvent Complexes and Intercalates, held in Strasbourg, France, from 5 to 8 July 2010, was the first of the series to be granted IUPAC sponsorship.

The topic of this series of international conferences was originally centered on polymer systems that are obtained through the co-crystallization, or in a broader sense through the co-organization, of polymer chains or macromolecules with solvent molecules. These systems, which are also designated as polymer-solvent molecular compounds, crystallosolvates, intercalates, form typically through molecular recognition (intercalates) and/or through specific molecular interactions (complexes). It, however, turned out that more and more other systems, such as supramolecular polymers (self-assembled systems) and proteins complexes, were discussed, as the scientists involved in their study clearly shared common concerns, and in many cases similar scientific approaches. To acknowledge the broader range of systems presented and to convey the general idea of specific interactions of large molecules with smaller ones, a new name was coined: POLYSOLVAT.

Participants at POLYSOLVAT-8 numbered 92 people from 5 continents. They were welcomed by C. Marquès, deputy director of Institut Charles Sadron, a CNRS laboratory where the conference was held, and J.M. Guenet, chairman of the conference and chairman of the scientific committee of POLYSOLVAT.

The program included 14 invited talks:

- Christophe Daniel, Università di Salerno, Italy, "Nanoporous Polymeric Crystalline Materials for Environmental and Energy Applications"
- Nicolas Giuseppone, Université de Strasbourg, France "Responsive Multicomponent

Supramolecular Systems"

- Gaetano Guerra, Università di Salerno, Italy "Polymer Co-crystalline Phase"
- Akira Harada, Osaka University, Japan "From Supramolecular Chemistry to Polymer Science"
- Wim E. Hennink, Utrecht University, The Netherlands "Self-Assembling Hydrogels for Proteins Release"
- Erdogan Kiran, Virginia Tech, Blacksburg, USA "Polymorphic Transformations and Morphological Modifications of Polymers in Dense Fluids"
- Jean-François Luz, Fraunhofer Institute, Potsdam, Germany "Design of Synthetic Hydrogels with a Sol-Gel or a Gel-Sol Thermoreversible Transition in Aqueous Medium"
- Yasushi Maeda, Fukui University, Japan "Hydration of Temperature-Responsive Polymers Observed by IR Spectroscopy"
- Ulrich Maschke, Université de Lille, France "Dispersions of Liquid Crystals in Polymers: Investigation of Thermo-Physical, Morphological, and Electro-Optical Properties"
- Philippe Mesini, Institut Charles Sadron, France "Self-Assembled Nanotubes: Structural Studies and Use as Templates for Porous Materials"
- Aline Miller, Manchester University, UK "Designing Functional Biomaterials Exploiting Peptide Self-Assembly"
- Jean-Luc Putaux, CERMAV, France "Helical Conformation in Crystalline Complexes of V-Amylose"
- Francesco di Renzo, Inst. Charles Gerhardt, Montpellier, France, "Physisorption Methods for the Characterization of Biopolymers"
- Jiri Spevacek, Inst. Macromolecular Chemistry, Prague, Czech Republic, "Stimuli-Responsive Polymers in Solution Investigated by NMR Methods"

The conference proceedings will be published in *Macromolecular Symposia*. The conference received financial support from CNRS, Université de Strasbourg, Alsace regional government, and the French Polymer Group. The next conference, POLYSOLVAT-9, will be held in Crimea at the seashore resort of Gurzuf.

Jean-Michel Guenet <guenet@ics.u-strasbg.fr> is director of research at the Institut Charles Sadron in Strasbourg, France. He was chair of the Local Organizing and Program Committees for POLYSOLVAT-8.

# Where 2B & Y

## Applied Thermodynamics

24-27 June 2011  
St. Petersburg, Russia

The **European Symposia on Applied Thermodynamics** (ESAT) were founded in 1974 by Prof. Helmut Knapp to bring together engineers and scientists from universities, industry, and research institutes and to promote international cooperation in the field of applied thermodynamics. ESAT meetings always sensitively reflect the modern trends of a number of disciplines where thermodynamics play an important role. ESAT meetings are unique in helping to bridge the gap between the fundamental science and industrial application. These meetings serve as communication media between industrial needs and practical means on the

one hand, and scientific curiosity and academic expertise on the other.

The scientific program of ESAT-2011, the 25th European Symposium on Applied Thermodynamics, includes Phase Equilibria, Molecular Thermodynamics of Complex Fluids, Process and Product Design, Electrolytes and Ionic Liquids, Supercritical Fluids, Polymers and Biochemical Systems, Sustainable Development (Resources, Energy, Environment, Storage and Capture of Greenhouse Gases). The goal is to discuss applications of thermodynamics with an emphasis on the recent trends and new advances.

See **Mark Your Calendar** on page 38 for contact information.

 <http://onlinereg.ru/esat2011>

## Colloquium Spectroscopicum Internationale XXXVII

28 August–2 September 2011  
Armação de Búzios, RJ, Brazil

The **Colloquium Spectroscopicum Internationale XXXVII** will be held in Brazil, from 28 August to 2 September 2011. This is the first time in its 60-year history that the event will take place in South America. It is expected to be attended by renowned scientists from around the world, who will discuss the following:

- Atomic and plasma spectrometry (ICP, GD, AAS)
- Molecular spectrometry (UV-Vis, NMR, Raman, IR, etc.)
- Organic and inorganic mass spectrometry (TIMS, MALDI, LC-MS, GC-MS)
- X-ray spectrometry (XRF, XRD, XANES, PIXE)
- Hyphenated techniques
- Laser spectroscopy
- Imaging techniques
- Nuclear techniques (Mössbauer spectroscopy, Gamma spectroscopy, NAA)
- Material sciences (micro, surface, and interface analysis)
- Environmental and geochemical analysis
- Archaeometry and cultural heritage
- Biological applications
- Food analysis
- Clinical and pharmaceutical analysis



- Speciation analysis
- Mass spectrometry in post-genomics and proteomics
- Miniaturization and nanotechnology
- Fuels and biofuels

The venue of the conference, the Hotel Atlântico Búzios, is located at Armação de Búzios, a seaside resort, just a three-hour drive from Rio de Janeiro. The city offers a wide range of restaurants and hotels for all tastes and budgets. Transfer services will be offered from and to Rio de Janeiro International Airport. A full social program will be organized for accompanying persons, such as beach buggy tours and boat rides, as well as a visit to the City of Rio de Janeiro.

See **Mark Your Calendar** on page 39 for contact information.

 [www.csixxxvii.org](http://www.csixxxvii.org)

## Chemistry for Life Sciences

31 August–3 September 2011  
Budapest, Hungary

The **4th European Conference on Chemistry for Life Sciences**, which is the official biennial Conference of EuCheMS, will be held between August 31 and September 3 at the Eötvös University in Budapest, one of the largest in Hungary.

This Conference follows the first in Rimini, Italy in October 2005 (I. Bertini), the second in Wrocław, Poland (H. Kozłowski) in September 2007, the third in Frankfurt, Germany (J. Engels) in September 2009.

The scientific program covers the roles chemistry can play in life sciences, in biology, in medicinal chemistry, in pharmaceutical chemistry etc. The topics will include, among others, artificial photosynthesis, biogeochemistry, bioinspired organocatalysis, bioinorganic chemistry, bio-nanotechnology, compu-



tational aspects of biomolecules, dynamics in biology, genomics, glycochemistry, metals in medicine, neurochemistry, nucleic acid chemistry, peptide/protein bioconjugates for diagnosis and therapy, proteomics, structure of biomolecules, and synthetic biology.

A short tutorial course in biology will also be offered for non-specialists.

The scientific program will include invited plenary and keynote lectures and contributed papers (oral and poster).

The deadline for abstract submission is 15 April 2011. Oral presentations will be selected on the basis of the quality and creativity of the research presented in the provided abstract.

The official language of the symposium is English.

See **Mark Your Calendar** on page 39 for contact information.

 [www.4eccls.mke.org.hu](http://www.4eccls.mke.org.hu)

## Boron

11–15 September 2011, Niagara Falls, Canada

The **IME Boron XIV Conference** will be held 11–15 September 2011 in Niagara Falls, Canada and promises to continue the tradition of inspiring collaboration and discussion expected of the IME Boron meetings. This year our focus is on emerging areas of boron chemistry including recent advances in organic synthesis, inorganic chemistry, material science, and medicinal chemistry. We are assembling a scientific program that will foster new relationships and opportunities for those in the early stages of their career and that is designed to attract talented young scientists to work in this exciting field. We are also committed to recognizing the significant contributions of established leaders in the field and we believe strongly that all boron chemists will benefit immensely from attendance at the conference. The program will be divided into three sections: organic, inorganic, and medicinal chemistry, with one plenary lecture for each section as well as several invited speakers during two parallel sessions over four days. We invite applications for the Young Boron Chemist Award as well as oral and poster



contributions from researchers who would like to present their accomplishments. The venue for the meeting will be the new Scotiabank Convention Centre, a mere 500 metres from the Canadian Horseshoe Falls. September in Niagara Falls is a particularly beautiful time of year; the location is a world-class destination with unmatched scenery, award-winning cuisine and innumerable entertainment options.

See **Mark Your Calendar** on page 40 for contact information.

 [www.imeboronXIV.com](http://www.imeboronXIV.com)

## Where 2B & Y

### Analytical Chemistry

11–15 September 2011, Belgrade, Serbia

The 16th edition of **Euroanalysis**, the well-known conference series, will be held in Belgrade, from 11 to 15 September 2011. With its motto “Challenges in Modern Analytical Chemistry,” this European Conference on Analytical Chemistry is open for contributions from all areas addressing theory, methods, or applications and highlights of new prospects and developments of current importance.

Euroanalysis is the biennial meeting of the Division of Analytical Chemistry of EuCheMS, the association of the national chemical societies throughout Europe. Euroanalysis, as a meeting place for analytical chemists from all of Europe and overseas, is attracting an increasing number of colleagues, regardless of whether they work in academia or industry, education or the regulatory offices, to discuss their research, and recent findings and to form networks.

The conference will also include exhibitions of leading companies showing novel concepts of smarter



technologies and the latest innovations and solutions for increased analytical demands to produce better and faster results.

The conference venue is the Congress Center SAVA, located in one of the modern quarters in New Belgrade but still very close to the old historical and charming city center.

Don't miss this excellent opportunity to share some enthusiasm and learn more about trends and future prospects in analytical chemistry in the inspiring atmosphere of the city of Belgrade!

See Mark Your Calendar on page 40 for contact information.

 [www.euroanalysis2011.rs](http://www.euroanalysis2011.rs)

### Drug Discovery and Development

18–22 September 2011, Zadar, Croatia

Physical chemistry underlies most of the tools medicinal chemists have at hand to assist them in their research. The vast armada of physico-chemical methods and techniques available enable fast and accurate measurements of specific parameters facilitating identification and selection of drug candidates. However, the appropriate applications of physico-chemical techniques or their combination, the proper choice of the corresponding methods, as well as the accurate interpretation of the results, rely not only on good knowledge of physical chemistry but also on open and active communication among scientists.

The **2nd World Conference on Physico-Chemical Methods in Drug Discovery and Development**, 18–22 September 2011, Zadar, Croatia, focuses on the advanced directions and new achievements in physical chemistry methods applied to the research processes in drug discovery and pharmaceutical development. A diverse, well-balanced scientific program is planned. Topics covered in the conference program include



separation techniques, methods of spectroscopy and microscopy, polymorphism and solid-state analytics, bio-molecular interactions, and physico-chemical profiling including dissolution and permeability. However, this list is by no means exhaustive. The intention of the Organizing Committee is to provide a forum where scientists from both academic institutions and industry settings can meet and, in the relaxed and stimulating atmosphere, exchange their ideas and challenges.

See Mark Your Calendar on page 40 for contact information.

 [www.iapchem.org/2pcmdddScope](http://www.iapchem.org/2pcmdddScope)

## Where 2B & Y

### General and Applied Chemistry

25-30 September 2011, Volgograd, Russia

In the spirit of the International Year of Chemistry, the **XIX Mendeleev Congress** will provide an excellent opportunity to showcase international cooperation of scientists and their professional unions. The Mendeleev Congresses are usually conducted every four to five years in world-famous scientific and cultural centers of our country. The First Mendeleev Congress was held in Saint-Petersburg in 1907 in commemoration of the great Russian scholar D.I. Mendeleev (1834-1907).

Volgograd, Russia, was selected as the home city for the 2011 Congress, to be held 25-30 September. This is a city with a glorious history and one of the largest centers of chemical industry in Russia. Companies in the region include LUKOIL, EuroChem Mineral and Chemical Company, NIKOCHEM, RUSAL,

and Sibur holdings, as well as the chemical giants Volzhsky Orgsynthet and Chimprom Volgograd.

Traditionally, the scientific program of the Mendeleev Congresses covers the main areas of chemical science, technology, industry, and chemical education. These issues are discussed in plenary and oral sessions, satellite symposia, and roundtable discussions. The program includes exhibitions of chemical facilities, equipment, technological developments, and chemistry literature.

Leading Russian and foreign scientists, including Nobel Prize winners, will present plenary lectures. Russian and foreign companies dealing with the production of chemicals and materials will present their activities.

See **Mark Your Calendar** on page 40 for contact information.

 [www.mendeleev2011.vstu.ru/en/start](http://www.mendeleev2011.vstu.ru/en/start)

### Functional $\pi$ -Electron Systems

13-17 October 2011, Beijing, China

The **10th International Symposium on Functional  $\pi$ -Electron Systems** (F- $\pi$ -10) will take place at the Friendship Hotel in Beijing, China, 13-17 October 2011. It will be hosted by the Institute of Chemistry, Chinese Academy of Sciences, and Tsinghua University.

F- $\pi$ -10 will follow the format of previous conferences organized in Japan (Osaka in 1989, 1999, and 2006 and Kobe in 1992), USA (Santa Cruz in 1995, Ithaca in 2004, and Atlanta in 2010), Germany

(Ulm in 2002), and Austria (Graz in 2008). F- $\pi$ -10 is expected to attract about 500 participants from all over the world to discuss achievements in the fields of design and synthesis of new  $\pi$ -conjugated molecules and polymers, organic and polymeric semiconducting materials and devices, organic and polymeric photovoltaic and photo-detective materials and devices, organic light-emitting materials for display and lighting application, carbon electronic materials including graphene and carbon nanotubes, and conjugated polymers and oligomers in chemo/bio-sensors.

 [www.fpi10.org](http://www.fpi10.org)

### Green Chemistry


25-29 August 2012, Foz do Iguaçu, Brazil

The **4th International IUPAC Conference on Green Chemistry** (4th ICGC) will focus on broad topics such as benign synthesis/process, green chemistry for energy/production, chemicals from renewable resources, green engineering, education in green chemistry, and engineering and policy.

This conference is organized in partnership with the IUPAC project on Sustainable Education and Environmental Development (SEED) in Latin America (2009-014-2-300). The aim of the project is to disseminate the green chemistry philosophy in all Latin

American countries. The 4th ICGC will bring together the academic, industrial, governmental, and non-governmental sectors in order to promote a more profound and extensive discussion in this emerging scientific movement.

The conference will be held 25-29 August 2012 in Foz do Iguaçu, located in the heart of South America, on the border of Brazil, Argentina, and Paraguay. Foz do Iguaçu is one of the most beautiful tourist destinations in Latin America, with incomparable natural richness.

 [www.ufscar.br/icgc4](http://www.ufscar.br/icgc4)

# Mark Your Calendar

Upcoming IUPAC-sponsored events  
See also <http://www.iupac.org/indexes/Conferences>  
for links to specific event websites

## 2011 (later than 1 May)

 IUPAC poster prizes to be awarded

### 5-6 May 2011 • Clinical Laboratory and In Vitro Diagnostic Industry • Barcelona, Spain

*6th European Symposium on Clinical Laboratory and In Vitro Diagnostic Industry*

Dr. Xavier Fuentes-Arderiu, Hospital L'University de Bellvitge, L'Hospitlet de Llobregat, E-08907 Barcelona, Spain  
Tel.: +34 93 260 76 44, Fax: +34 93 260 75 46, E-mail: xfa@csusb.sc.es

### 8-11 May 2011 • Pesticide Residue • Montevideo, Uruguay

*3rd Latin American Pesticide Residue Workshop*

Dr. Horácio Heinzen, Universidad de la Republica, Montevideo, Uruguay  
Tel.: +598 2 924 4068, Fax: +598 2 924 1906, E-mail: heinzen@fq.edu.uy

### 22-26 May 2011 • Analytical Sciences • Kyoto, Japan

*IUPAC International Congress on Analytical Sciences 2011 (ICAS-2011)*

Prof. Koji Otsuka, Department of Material Chemistry, Graduate School of Engineering, Kyoto University, Katsura, Nishikyo-ku, Kyoto 615-8510, Japan  
Tel.: +81 75-383-2447, Fax: +81 75-383-2450, E-mail: otsuka@anchem.mc.kyoto-u.ac.jp

### 23-27 May 2011 • Advanced Materials • Pretoria, South Africa

*11th International Conference on Frontiers of Polymers and Advanced Materials*

Prof. Walter W. Focke, University of Pretoria, Department of Chemical Engineering, Menlo Park, Pretoria 0102, South Africa, Tel.: +27 21 12 420 3728, Fax: +27 21 12 420 2516, E-mail: walter.focke@up.ac.za

### 6-10 June 2011 • Molecular Mobility and Order • St. Petersburg, Russia

*7th International Symposium on Molecular Mobility and Order in Polymer Systems*

Prof. A.A. Darinskii, Russian Academy of Sciences, Institute of Macromolecular Compounds, Bolshoi Pr. 31, RF-199004 St. Petersburg, Russia, Tel.: +7 812 328 56 01, Fax: +7 812 328 68 69, E-mail: adar@imc.macro.ru

### 6-10 June 2011 • Organic Chemistry • Novosibirsk, Russia

*Current Topics in Organic Chemistry (dedicated to Professor Valentin Koptuyug)*

Prof. Igor Grigoriev, Russian Academy of Sciences Siberian Branch, Vorozhtsov Institute of Organic Chemistry, 9 Acad. Lavrentiev Avenue, RF-630090 Novosibirsk, Russia  
Tel.: +7 383 330 8850, Fax: +7 383 330 9752, E-mail: benzol@nioch.nsc.ru

### 19-22 June 2011 • Trace Elements in Food • Aberdeen, UK

*4th International IUPAC Symposium on Trace Elements in Food*

Prof. Jörg Feldmann, University of Aberdeen, Department of Chemistry, Meston Walk, Aberdeen AB24 3UE, United Kingdom, Tel.: +44 122 427 2911, Fax: +44 122 427 2921, E-mail: j.feldmann@abdun.ac.uk

### 24-27 June 2011 • Applied Thermodynamics • St. Petersburg, Russia

*25th European Symposium on Applied Thermodynamics*

Prof. Alexey Victorov, Saint Petersburg State University, Department of Chemistry, Universitetsky Prospekt 26, RF-198504 Saint Petersburg, Russia, Tel.: +7 812 328 2713, Fax: +7 812 428 6939, E-mail: victorov\_a@yahoo.com

### 3-7 July 2011 • Photophysics and Photochemistry • Strasbourg, France

*XIXth International Symposium on Photophysics and Photochemistry of Coordination Compounds*

Dr. Chantal Daniel, Université de Strasbourg, CNRS-Institut de Chimie, 4, Rue Blaise Pascal, F-67070 Strasbourg, France, Tel.: +33 368 85 13 14, Fax: +33 368 85 15 89, E-mail: c.daniel@chimie.u-strasbg.fr

### 3-7 July 2011 • Carbohydrates • Sorrento, Italy

*16th European Carbohydrate Symposium*

Prof. Antonio Molinaro, Università di Napoli Federico II, Complesso Universitario Monte Santangelo, Via Cynthia I-80125 Napoli, Italy, Tel.: +39 081 674 123, Fax: +39 081 674 123, E-mail: molinaro@unina.it

### 10-14 July 2011 • Biodiversity and Natural Products • Brisbane, Australia

*7th International Conference on Biodiversity & 27th International Symposium on the Chemistry of Natural Products*

Prof. Mary J. Garson, School of Chemistry & Molecular Biosciences, University of Queensland, Chemistry Building, Room 307, Brisbane, QLD 4072, Australia  
Tel.: +61 7 3365 3605, Fax: +61 7 3365 4273, E-mail: m.garson@uq.edu.au



**10–15 July 2011 • Ionic Polymerization • Akron, Ohio, USA** 🏛️

*International Symposium on Ionic Polymerization*

Prof. Judit E. Puskas, University of Akron, Department of Polymer Science, Akron, OH 44325-3909, USA

Tel.: +1 330 972 6203, Fax: +1 330 972 5290

E-mail: jpuskas@uakron.edu

**10–14 July 2011 • Macromolecules • Prague, Czech Republic** 🏛️

*75th Prague Meeting on Macromolecules: Conducting Polymers*

Dr. Jaroslav Stejskal, Academy of Sciences of the Czech Republic, Institute of Macromolecular Chemistry,

Heyrovský Sq. 2, CZ-162 06 Praha, Tel.: +420 296 809 351, Fax: +420 296 809 410, E-mail: stejskal@imc.cas.cz

**24–29 July 2011 • Plasma Chemistry • Philadelphia, Pennsylvania, USA**

*20th International Symposium on Plasma Chemistry*

Professor Alexander Fridman, Drexel University, A. J. Drexel Plasma Institute, Philadelphia, PA, USA

Tel.: +1 215 895 1542, Fax: +1 215 895 1478, E-mail: fridman@drexel.edu

**24–28 July 2011 • Organic Synthesis • Shanghai, China** 🏛️

*16th International Conference on Organometallic Chemistry Directed Toward Organic Synthesis*

Dr. Shuli You, Chinese Academy of Sciences, Shanghai Institute of Organic Chemistry, State Key Laboratory of Organometallic Chemistry, 345 Fenglin Lu, Shanghai 2000032, China

Tel.: +86 21 6223 7360, Fax: +86 21 6260 9305, E-mail: slyou@mail.sioc.ac.cn

**24–29 July 2011 • Novel Aromatic Compounds • Eugene, Oregon, USA** 🏛️

*14th International Symposium on Novel Aromatic Compounds*

Prof. Michael M. Haley, Department of Chemistry, University of Oregon, Eugene, OR 97403-1253, USA

Tel.: +1 541 346 0456, Fax: +1 541 346 0487, E-mail: haley@uoregon.edu

**29 July–4 August 2011 • IUPAC 46th General Assembly • San Juan, Puerto Rico** 🏛️

IUPAC Secretariat

Tel.: +1 919 485-8700, Fax: +1 919 485-8706, E-mail: secretariat@iupac.org

**30 July–7 August 2011 • 43rd IUPAC Congress • San Juan, Puerto Rico** 🏛️

*Chemistry Bridging Innovation Among the Americas and the World*

Gabriel A. Infante, Pontifical Catholic University of Puerto Rico

E-mail: ginfante@iupac2011.org, www.iupac2011.org

**30 July–5 August 2011 • Heterocyclic Chemistry • Glasgow, UK** 🏛️

*23rd International Conference on Heterocyclic Chemistry*

Prof. Colin J. Suckling, University of Strathclyde, Department of Pure and Applied Chemistry, Glasgow G1 1XL, UK

Tel.: +44 141 548 2271, Fax: +44 141 548 5743, E-mail: c.j.suckling@strath.ac.uk

**14–17 August 2011 • Macromolecular Complexes • Helsinki, Finland**

*14th International Symposium on Macromolecular Complexes*

Prof. Heikki Tenhu, University of Helsinki, Department of Chemistry, Postbox 55, FIN-00014 Helsinki, Finland

Tel.: +358 919 150 334, Fax: +358 919 150 330, E-mail: heikki.tenhu@helsinki.fi

**28 August–2 September 2011 • Solution Chemistry • La Grande Motte, France** 🏛️

*32nd International Conference on Solution Chemistry*

Prof Pierre Turq, Université Pierre & Marie Curie, Laboratoire Liquides Ioniques & Interfaces, 4 Place Jussieu,

F-75005 Paris, France, Tel.: +33 1 44 27 31 08, Fax: +33 1 44 27 31 08, E-mail: pierre.turq@umpc.fr

**28 August–2 September 2011 • Spectroscopicum • Armação de Búzios, Brazil**

*Colloquium Spectroscopicum Internationale XXXVII*

Prof Bernhard Welz, Universidade Federal de Santa Catarina, Departamento de Química, Florianópolis 88040-900, Brazil, Tel.: +55 48 3733 8876, Fax: +55 48 3733 8876, E-mail: welz@qmc.ufswc.br

**31 August–3 September 2011 • Chemistry for Life Sciences • Budapest, Hungary**

*4th European Conference on Chemistry for Life Sciences*

Prof Tamas Kiss, University of Szeged, Department of Chemistry, P.O. Box 440, H-6701 Szeged, Hungary

Tel.: +36 62 544 337, Fax: +36 62 420 505, E-mail: tkiss@chem-u.szeged.hu



## Conference Call

### 5–8 September 2011 • Sustainability & Economic Sufficiency • Bangkok, Thailand

#### *14th Asian Chemical Congress*

Prof. Supa Hannongbua, Kasetsart University, Department of Chemistry, 50 Phaholyothin Road, Chatuchak, Bangkok 10900, Thailand, Tel.: +66 2 562 5555 x 2140, Fax: +66 2 579 3955, E-mail: fscisph@ku.ac.th

### 11–15 September 2011 • Boron Chemistry • Niagara Falls, Canada

#### *XIVth International Meeting on Boron Chemistry*

Prof. John F. Valliant, McMaster University, Department of Chemistry, 1280 Main Street West, Hamilton, ON L8S 4M1, Canada, E-mail: valliant@mcmaster.ca

### 11–15 September 2011 • Analytical Chemistry • Belgrade, Serbia

#### *Euroanalysis XVI*

Prof. Slavica Ražić, University of Belgrade, Department of Analytical Chemistry, P.O. Box 146, SRB-11001 Belgrade, Serbia, Tel.: +381 11 3951 208, Fax: +381 11 3951 208, E-mail: slavica.razic@pharmacy.bg.ac.rs

### 18–22 September 2011 • Drug Discovery • Zadar, Croatia

#### *2nd World Conference on Physico-Chemical Methods in Drug Discovery and Development*

Professor Biserka Cetina-Cizmek, PLIVA d.o.o., Zagreb, Croatia

Tel.: +385 98 196 6807, Fax: +385 1 373 3640, E-mail: Biserka.Cetina-Cizmek@pliva.com

### 18–23 September 2011 • Nuclear Chemistry • Palermo, Italy

#### *3rd International Nuclear Chemistry Congress*

Prof. Flavia Groppi, Università degli Studi di Milano, LASA Laboratory, Via F. Cervi, 201, I-20090 Segrate, Milano, Italy, Tel.: +39 250 319 568, Fax: +39 250 319 543, E-mail: 3rdINCC@mi.infn.it

### 25–30 September 2011 • General and Applied Chemistry • Volgograd, Russia

#### *XIXth Mendeleev Congress on General and Applied Chemistry*

Prof. Alexander Navrotsky, Volgograd State Technical University, Polymer Chemistry Department, Lenin Avenue, 28, RF-400131 Volgograd, Russia, Tel: +7 1 44 27 31 08, Fax: +7 1 44 27 38 34, E-mail: navrotsky@vstu.ru

### 27–29 September 2011 • Renewable and Sustainable Energy • Kuala Lumpur, Malaysia

#### *19th International ChemRAWN Conference on Renewable and Sustainable Energy from Biological Sources*

Prof. Ting-Kueh Soon, Institut Kimia Malaysia, 127 B Jalan Aminuddin Baki, Tam Tun Dr Ismail, 60000 Kuala Lumpur, Malaysia, Tel.: +60 3 7728 3272, Fax: +60 3 7728 9909, E-mail: soontk@ikm.org.my

### 11–14 October 2011 • Novel Materials and Their Synthesis • Shanghai, China

#### *7th International Symposium on Novel Materials and Their Synthesis*

Prof. Yuping Wu, Fudan University, Department of Chemistry, New Energy and Materials Laboratory, Shanghai 200433, China, Tel.: +86 21 545 664 223, Fax: +86 21 545 664 223, E-mail: wuyup@fudan.edu.cn

### 29 November–2 December 2011 • Medicinal Chemistry • Tokyo, Japan

#### *8th International Medicinal Chemistry Symposium*

Professor Yuusako Yokoyama, Toho University, Chiba, Japan

Tel: +81 47 472 1589, Fax: +81 47 472 1595, E-mail: yokoyama@phar.toho-u.ac.jp

## Visas

It is a condition of sponsorships that organizers of meetings under the auspices of IUPAC, in considering the locations of such meetings, should take all possible steps to ensure the freedom of all bona fide chemists from throughout the world to attend irrespective of race, religion, or political philosophy. IUPAC sponsorship implies that entry visas will be granted to all bona fide chemists provided application is made not less than three months in advance. If a visa is not granted one month before the meeting, the IUPAC Secretariat should be notified without delay by the applicant.

## How to Apply for IUPAC Sponsorship

Conference organizers are invited to complete an Application for IUPAC Sponsorship (AIS) preferably 2 years and at least 12 months before the conference. Further information on granting sponsorship is included in the AIS and is available upon request from the IUPAC Secretariat or online.

 [www.iupac.org](http://www.iupac.org)



2011 International Year of Chemistry

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de Puerto Rico**

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# International Union of Pure and Applied Chemistry

Advancing the worldwide role of chemistry for the benefit of Mankind

**Mission Statement**—IUPAC is a non-governmental organization of member countries that encompass more than 85% of the world's chemical sciences and industries. IUPAC addresses international issues in the chemical sciences utilizing expert volunteers from its member countries. IUPAC provides leadership, facilitation, and encouragement of chemistry and promotes the norms, values, standards, and ethics of science and the free exchange of scientific information. Scientists have unimpeded access to IUPAC activities and reports. In fulfilling this mission, IUPAC effectively contributes to the worldwide understanding and application of the chemical sciences, to the betterment of the human condition.

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Bangladesh Chemical Society (*Bangladesh*)  
The Royal Academies for the Sciences and Arts of Belgium (*Belgium*)  
Brazilian Chemistry Committee for IUPAC (*Brazil*)  
Bulgarian Academy of Sciences (*Bulgaria*)  
National Research Council of Canada (*Canada*)  
Sociedad Chilena de Química (*Chile*)  
Chinese Chemical Society (*China*)  
Chemical Society located in Taipei (*China*)  
Croatian Chemical Society (*Croatia*)  
Sociedad Cubana de Química (*Cuba*)  
Pancyprian Union of Chemists (*Cyprus*)  
Czech National Committee for Chemistry (*Czech Republic*)  
Det Kongelige Danske Videnskabernes Selskab (*Denmark*)  
National Committee for IUPAC (*Egypt*)  
Chemical Society of Ethiopia (*Ethiopia*)  
Suomen Kemian Seura—Kemiska Sällskapet i Finland (*Finland*)  
Comité National Français de la Chimie (*France*)  
Deutscher Zentralausschuss für Chemie (*Germany*)  
Association of Greek Chemists (*Greece*)  
Hungarian Academy of Sciences (*Hungary*)  
Indian National Science Academy (*India*)  
Royal Irish Academy (*Ireland*)  
Israel Academy of Sciences and Humanities (*Israel*)  
Consiglio Nazionale delle Ricerche (*Italy*)  
Caribbean Academy of Sciences—Jamaica Chapter (*Jamaica*)

Science Council of Japan (*Japan*)  
Jordanian Chemical Society (*Jordan*)  
Korean Federation of Science and Technology Societies (*Korea*)  
Kuwait Chemical Society (*Kuwait*)  
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Russian Academy of Sciences (*Russia*)  
Serbian Chemical Society (*Serbia*)  
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Ministerio de Educación y Ciencia (*Spain*)  
Institute of Chemistry, Ceylon (*Sri Lanka*)  
Svenska Nationalkommittén för Kemi (*Sweden*)  
Swiss Chemical Society (*Switzerland*)  
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## IUPAC Periodic Table of the Elements

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1	<b>H</b> hydrogen [1.007; 1.008]	2	<b>He</b> helium 4.003	3	<b>Li</b> lithium [6.938; 6.997]	4	<b>Be</b> beryllium 9.012	5	<b>B</b> boron [10.80; 10.83]	6	<b>C</b> carbon [12.00; 12.02]	7	<b>N</b> nitrogen [14.00; 14.01]	8	<b>O</b> oxygen [15.99; 16.00]	9	<b>F</b> fluorine 19.00	10	<b>Ne</b> neon 20.18	11	<b>Na</b> sodium 22.99	12	<b>Mg</b> magnesium 24.31	13	<b>Al</b> aluminium 26.98	14	<b>Si</b> silicon [28.08; 28.09]	15	<b>P</b> phosphorus 30.97	16	<b>S</b> sulfur [32.05; 32.08]	17	<b>Cl</b> chlorine [35.44; 35.46]	18	<b>Ar</b> argon 39.95	19	<b>K</b> potassium 39.10	20	<b>Ca</b> calcium 40.08	21	<b>Sc</b> scandium 44.96	22	<b>Ti</b> titanium 47.87	23	<b>V</b> vanadium 50.94	24	<b>Cr</b> chromium 52.00	25	<b>Mn</b> manganese 54.94	26	<b>Fe</b> iron 55.85	27	<b>Co</b> cobalt 58.93	28	<b>Ni</b> nickel 58.69	29	<b>Cu</b> copper 63.55	30	<b>Zn</b> zinc 65.38(2)	31	<b>Ga</b> gallium 69.72	32	<b>Ge</b> germanium 72.63	33	<b>As</b> arsenic 74.92	34	<b>Se</b> selenium 78.96(3)	35	<b>Br</b> bromine 79.90	36	<b>Kr</b> krypton 83.80	37	<b>Rb</b> rubidium 85.47	38	<b>Sr</b> strontium 87.62	39	<b>Y</b> yttrium 88.91	40	<b>Zr</b> zirconium 91.22	41	<b>Nb</b> niobium 92.91	42	<b>Mo</b> molybdenum 95.94(2)	43	<b>Tc</b> technetium	44	<b>Ru</b> ruthenium 101.1	45	<b>Rh</b> rhodium 102.9	46	<b>Pd</b> palladium 106.4	47	<b>Ag</b> silver 107.9	48	<b>Cd</b> cadmium 112.4	49	<b>In</b> indium 114.8	50	<b>Sn</b> tin 118.7	51	<b>Sb</b> antimony 121.8	52	<b>Te</b> tellurium 127.6	53	<b>I</b> iodine 126.9	54	<b>Xe</b> xenon 131.3	55	<b>Cs</b> caesium 132.9	56	<b>Ba</b> barium 137.3	57-71	lanthanoids	72	<b>Hf</b> hafnium 178.5	73	<b>Ta</b> tantalum 180.9	74	<b>W</b> tungsten 183.8	75	<b>Re</b> rhenium 186.2	76	<b>Os</b> osmium 190.2	77	<b>Ir</b> iridium 192.2	78	<b>Pt</b> platinum 195.1	79	<b>Au</b> gold 197.0	80	<b>Hg</b> mercury 200.6	81	<b>Tl</b> thallium [204.3; 204.4]	82	<b>Pb</b> lead 207.2	83	<b>Bi</b> bismuth 209.0	84	<b>Po</b> polonium	85	<b>At</b> astatine	86	<b>Rn</b> radon	87	<b>Fr</b> francium	88	<b>Ra</b> radium	89-103	actinoids	104	<b>Rf</b> rutherfordium	105	<b>Db</b> dubnium	106	<b>Sg</b> seaborgium	107	<b>Bh</b> bohrium	108	<b>Hs</b> hassium	109	<b>Mt</b> meitnerium	110	<b>Ds</b> darmstadtium	111	<b>Rg</b> roentgenium	112	<b>Cn</b> copernicium



## Notes

- IUPAC 2009 Standard atomic weights abridged to four significant digits [Table 4 published in *Pure Appl. Chem.* 83, 359-396 (2011); doi: 10.1351/PAC-REP-10-09-14]. The uncertainty in the last digit of the standard atomic weight value is listed in parentheses following the value. In the absence of parentheses, the uncertainty is one in that last digit. An interval in square brackets provides the lower and upper bounds of the standard atomic weight for that element. No values are listed for elements with no stable isotopes. See PAC for more details.

- "Aluminium" and "caesium" are commonly used alternative spellings for "aluminum" and "caesum."

For updates to this table, see [iupac.org/reports/periodic\\_table/](http://iupac.org/reports/periodic_table/). This version is dated 21 January 2011.  
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International Year of  
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57	<b>La</b> lanthanum 138.9	58	<b>Ce</b> cerium 140.1	59	<b>Pr</b> praseodymium 140.9	60	<b>Nd</b> neodymium 144.2	61	<b>Pm</b> promethium	62	<b>Sm</b> samarium 150.4	63	<b>Eu</b> europium 152.0	64	<b>Gd</b> gadolinium 157.3	65	<b>Tb</b> terbium 158.9	66	<b>Dy</b> dysprosium 162.5	67	<b>Ho</b> holmium 164.9	68	<b>Er</b> erbium 167.3	69	<b>Tm</b> thulium 168.9	70	<b>Yb</b> ytterbium 173.1	71	<b>Lu</b> lutetium 175.0
89	<b>Ac</b> actinium	90	<b>Th</b> thorium 232.0	91	<b>Pa</b> protactinium 231.0	92	<b>U</b> uranium 238.0	93	<b>Np</b> neptunium	94	<b>Pu</b> plutonium	95	<b>Am</b> americium	96	<b>Cm</b> curium	97	<b>Bk</b> berkelium	98	<b>Cf</b> californium	99	<b>Es</b> einsteinium	100	<b>Fm</b> fermium	101	<b>Md</b> mendelevium	102	<b>No</b> nobelium	103	<b>Lr</b> lawrencium