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# From the Chairman………

**Martin Apple, PhD FAIC**
**President, Council of Scientific Society Presidents**

Whatever your field of chemistry, you and your colleagues have probably dedicated a large part of your life to discovering and applying new knowledge that improved the lives of all around you. In myriad ways and with thousands of important discoveries over the 20th Century, chemistry and chemists have been a very major force in forming the exciting world of the present. We can each list hundreds of ways that chemistry transformed us, how we live, what we do, and what we can do. Chemists have made this world a better place for every aspect of human life.

We are now becoming a major force in shaping the 21st century. We discover new problems; we creatively solve new problems. The 20th Century was an era in which we believed in not only unlimited opportunity, but behaved as though we lived in a nearly infinite world, and we were at the center. But we are not alone. Our new perspective from which we will lead the progress of the 21st Century is that we not only have a very finite world, but we all live in a thin film of life +/- 2miles from the surface of our small planet, in a very delicately balanced dynamic ecosystem interacting with over a million non-human species. Our economy, as we are now learning, is a subset of the world ecosystem, not the reverse. If we ever push and stress that fragile film of life beyond its resilient limits, the underlying resources for our economy will fail with it. We are charged to become good stewards of this rich gift so that we may pass on to every next generation a better world.

The AIC has a rich and significant history. It is now in a period of transition from what it was into what it will be. The whole world of chemistry is also undergoing many rapid changes. Such transitions can create a difficult period. Not only are new branches of knowledge opening up, but they will coincide with many unplanned events that together will generate numerous unforeseen threats and many, many more exciting opportunities.

Our nation faces many daunting challenges–both a trade gap and federal deficit of unprecedented size and growth, a resulting constrained federal investment in crucially important merit reviewed "patient capital" basic research, our students graduating high school with math and science achievement far below our needs, fortress America slowing international scientific exchange and hanging a "not welcome" sign on our Statue of Liberty, offshoring of chemistry-related jobs at home at the same time that there is a rapid growth of such degrees and jobs in Asia, a geriatric society with fast rising demands on healthcare resources and entitlements–and whose science workforce averages about 10 years from retirement, an overwhelmed public in Future Shock, and a world transformed from national into corporate into individual globalization and pandemonium by the 'Net and the WWW.

Organizations balance their roles among two verbs: ***to be*** or ***to do.*** AIC's 21st Century operative verb is "***to do.***" AIC will seek to grow in quality of achievement and leadership, both in increasing our membership and what we undertake. AIC is the home of the highest achievers in the chemical sciences. We will call upon you to use your accumulated wisdom to see and solve the important problems ahead of us. Our future will bring the best of our past forward, and grow into the best that chemistry in all its forms can provide for the world in the future. All areas of chemistry can provide immense good to the whole world in the 21st Century–it is your challenge to ensure that it does so. In our rapidly changing world, patience is not an option.

Our task, *Your* task, is Carpe Diem !

# SUPERCRITICAL CATALYTIC CO HYDROGENATION

J. W. Rathke,* M. J. Chen, and R. J. Klingler

## Abstract

Cobalt carbonyl hydride catalyzed hydrogenation of carbon monoxide in a homogeneous supercritical carbon monoxide medium is reported for the first time. The reaction rate and products and the cobalt containing species associated with the catalytic reaction were measured in situ at 180 and 200 °C and at total pressures of hydrogen and carbon monoxide near 260 atm using a high-pressure nuclear magnetic resonance (NMR) probe. The second order rate constant at 200 °C, $12 \times 10^{-8}$ s$^{-1}$ atm$^{-1}$, measured in supercritical carbon monoxide is close to the reported value for the nonpolar solvent, benzene ($15 \times 10^{-8}$ s$^{-1}$ atm$^{-1}$) and considerably smaller than that reported in the more polar solvent, 2,2,2-trifluoroethanol ($84 \times 10^{-8}$ s$^{-1}$ atm$^{-1}$). The products of the reaction including methanol and methyl formate were quantified by in situ $^{1}$H NMR, while in situ $^{59}$Co NMR revealed cobalt carbonyl hydride and dicobalt octacarbonyl as the only detectable cobalt species. Separate experiments established that the homologation of methanol, the pathway for production of higher alcohols under CO hydrogenation conditions in polar solvents, did not occur to a measurable extent in the nonpolar supercritical CO medium used here.

## Introduction

Considerable research on homogeneous catalysts for the hydrogenation of CO was undertaken in several laboratories in the late 1970's and early 1980's. Work on these systems has been reviewed (1,2). The most studied of homogeneous CO hydrogenation catalysis systems is the cobalt carbonyl catalyzed reaction (3), which has been shown to follow a rate law that is first order in both $HCo(CO)_4$ and $H_2$ pressure (4). The reaction is believed to proceed through an early coordinated formaldehyde intermediate which produces, dependent upon the reaction conditions and solvent, variable amounts of methanol, methyl formate, and ethylene glycol as initial reaction products. In the proposed mechanism, higher alcohols and higher formate esters are produced by secondary homologation and transesterification reactions associated mainly with the initially produced methanol and methyl formate (4, 5).

Since most of the early kinetic studies on these systems were accomplished using high-pressure autoclaves, it seems possible that recent advances in high-pressure spectroscopic techniques that would allow in situ scrutiny of these systems might provide more information on them, today. Here we test the use of a high-pressure toroid NMR probe on the cobalt carbonyl catalyzed CO hydrogenation in supercritical carbon monoxide medium for the first time. Use of a single-phase homogeneous supercritical system containing catalyst and reactant gases was utilized to avoid gas-liquid mixing problems that might otherwise interfere with kinetic studies in an unstirred NMR pressure vessel using conventional liquid media.

## Experimental Section

$^{1}$H and $^{59}$Co NMR spectra were recorded using a General Electric GN 300 spectrometer equipped with an 89-mm Oxford magnet at 300.5 and 71.1 MHz, respectively. The measurements employed a variable temperature multinuclear high-pressure Be-Cu NMR probe containing an internal toroid detector that was designed in-house and has been described previously (6). Kinetic studies were initiated by loading fresh samples of $Co_2(CO)_8$ (purchased from Alfa and stored under refrigeration) into the pressure probe in a helium atmosphere glove box. The probe was then pressurized with the requisite gases and heated to the desired temperature. Pressures were measured to within ± 0.07 atm using a strain gauge pressure transducer (Omega Model PX302-5KGV). Temperature control utilized a copper-constantan thermocouple built into the probe and was constant to within ± 0.1. Measured temperatures agreed to within ± 1.0 °C with independent chromel-alumel thermocouple measurements covering the range 25-175 °C. Concentrations of $HCo(CO)_4$, $CH_3OH$, and $CH_3O_2CH$ were measured by integration of their $^{1}$H NMR signals at $\delta = -11.8$, 3.36, and 3.60 PPM, respectively, relative to the $^{1}$H signal for $H_2$ at 4.45 PPM (TMS = 0.0 PPM). Absolute concentrations of each species were determined

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on the basis of the known concentration of $H_2$, which was calculated from its pressure using the ideal gas law. First-order rate constants were determined in accord with earlier work (4, 5) from the slope of linear plots of the sum of the molar concentrations of the organic reaction products vs. time. Note that this rate differs from the overall rate of CO consumption, but instead is a measure of the rate of conversion of a putative formaldehyde complex, which is believed to be at or near the transition state of the catalytic process (5). Second-order rate constants were obtained by dividing the slopes of the first-order rate plots by the hydrogen pressure, $P(H_2)$, and the measured concentration of $HCo(CO)_4$, which varied due to sampling methods used in the earlier work (5), but which was constant during the in situ experiments described here. Cobalt containing species were also monitored using $^{59}$Co NMR spectra recorded between the $^1$H NMR measurements. Signals for $Co_2(CO)_8$ at -2200 PPM and $HCo(CO)_4$ at -3000 PPM (external $K_3Co(CN)_6$ = 0.0 PPM) were the only ones observed during the CO hydrogenation experiments.

Higher alcohols and ethylene glycol were not produced in detectable quantities in the supercritical CO medium. Separate experiments established that $HCo(CO)_4$ catalyzed homologation of methanol, responsible for higher alcohol production in more polar media under CO hydrogenation conditions, does not occur to a significant extent in supercritical CO. Thus, methanol (43 mg) and $Co_2(CO)_8$ (50 mg) were heated to 180 °C with $P(H_2)$ = 108 atm, P (CO) = 152 atm, for 70 hours in the NMR probe without detectable production of ethanol.

## Results and Discussion

The $HCo(CO)_4$ catalyzed hydrogenation of carbon monoxide is an extremely sluggish reaction that requires long reaction times even at high-pressures and temperatures. At 180 °C, the small $^1$H NMR signals from the organic products were difficult to resolve from the baseline of the large signal due to $H_2$ at the high pressure required for reaction. However, $^{59}$Co NMR spectra showed substantial and well separated signals for $HCo(CO)_4$ and $Co_2(CO)_8$, even at concentrations used here of ≤0.01 M. Typical in situ $^1$H and $^{59}$Co NMR spectra measured during CO hydrogenation at 180 °C are shown in Fig. 1. Although 180 °C is probably near the lowest temperature useful for rate measurements by this method, the resultant rate plots in Fig. 2 are quite linear, and yield a second-order rate constant, $k(2) = 4.8 \times 10^{-8}$ $atm^{-1}\ s^{-1}$, as shown in Table 1. The reaction has a substantial temperature coefficient, and at 200 °C the reaction is significantly faster and more easily measurable, with $k(2) = 12 \times 10^{-8}\ atm^{-1}\ s^{-1}$. As expected, this latter value agrees well with the rate constant for another non-polar medium, benzene, for which k(2) was measured at $15 \times 10^{-8}\ atm^{-1}\ s^{-1}$ at 200 °C, albeit using high-pressure autoclave methods (4).

## Conclusions

The results reported here show that the rate of CO hydrogenation in supercritical carbon monoxide medium is comparable to that measured earlier in nonpolar benzene medium (4). Methanol homologation to produce higher alcohols and the production of ethylene glycol are reactions favored by highly polar media (4,5) and did not proceed to any measurable extent in the nonpolar supercritical CO medium. The results also establish that kinetic studies of the homogeneous hydrogenation of carbon monoxide are feasible in a supercritical medium in a high-pressure NMR probe. This is the case, even though CO hydrogenation with the $HCo(CO)_4$ catalyst normally requires long reaction times under severe pressure and temperature conditions.

In future work on this system, accurate determinations of such parameters as activation barriers and kinetic isotope effects, afforded by high-pressure NMR in a gas-like medium that is highly amenable to theoretical calculations will allow scrutiny of the early steps in this important reaction. The earlier work with autoclaves had established a strong temperature coefficient and a significant isotope effect on this system, but the uncertainties and complexities associated with sampling from autoclaves discouraged attempts to accurately determine these parameters with the high-pressure techniques available at that time. Evaporation of the volatile $HCo(CO)_4$ into the autoclave headspace increased by removal of liquid samples, and uncertain quenching of samples containing this unstable species are problems associated with autoclave sampling methods that are alleviated by the high-pressure NMR technique used here.

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**Table 1**
Second-order rate constants, k(2), for CO hydrogenation in various solvents.

| Solvent | Temp., °C | P ($H_2$), atm | P (CO), atm | [$HCo(CO)_4$, M | k(2), $atm^{-1}s^{-1}$ |
|---|---|---|---|---|---|
| benzene | 200 | 145 | 145 | See Ref. 4 | $15 \times 10^{-8}$ |
| 1,4-dioxane | 196 | 148 | 148 | See Ref. 4 | $25 \times 10^{-8}$ |
| $CF_3CH_2OH$ | 200 | 153 | 153 | See Ref. 4 | $84 \times 10^{-8}$ |
| scCO | 200 | 103 | 156 | $10 \times 10^{-3}$ | $12 \times 10^{-8}$ |
| scCO | 180 | 103 | 156 | $6.0 \times 10^{-3}$ | $4.8 \times 10^{-8}$ |

**Figure 1**
In situ $^{59}$Co NMR spectrum (upper trace) and $^{1}$H NMR spectrum (lower trace) during CO hydrogenation in supercritical CO at 180 °C.

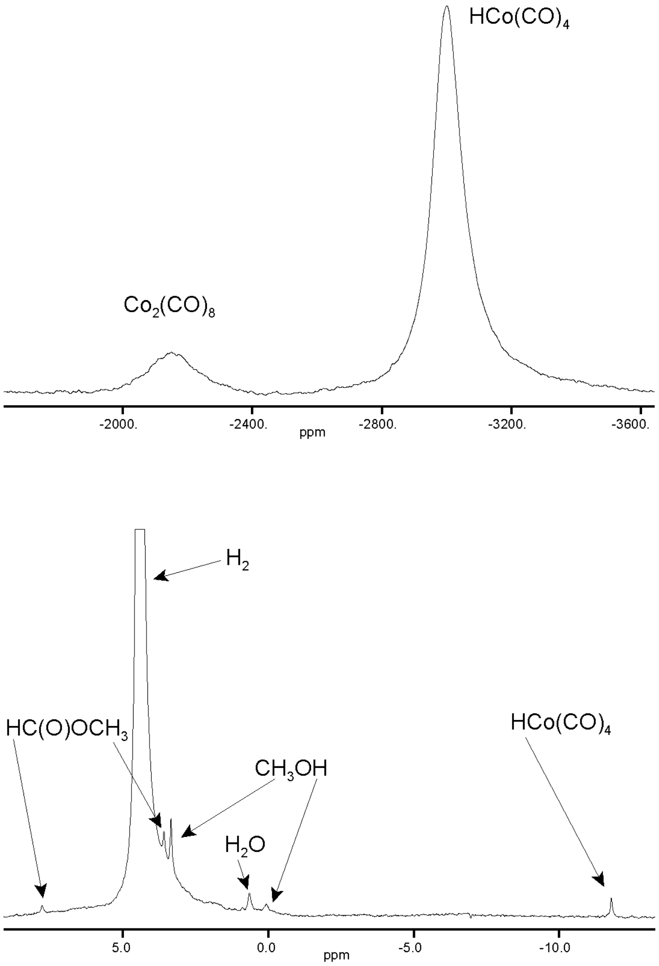
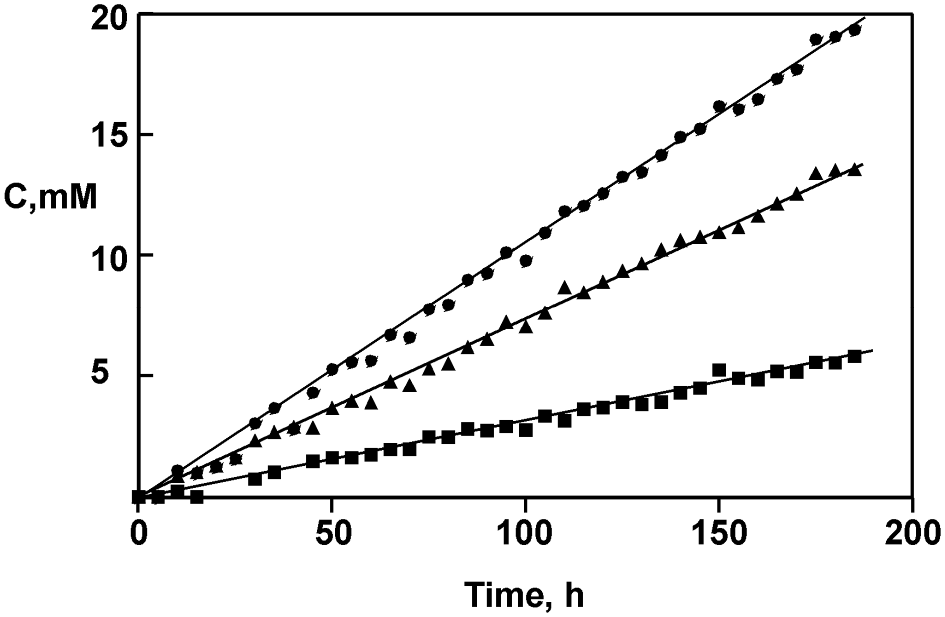


**Figure 2**

Rate plot showing the production of methanol, ▲, methyl formate, ■, and their sum, ●, from CO hydrogenation in supercritical CO at 180 °C.



# NANOWORLD OF SCIENCE AND TECHNOLOGY

Dr. David Devraj Kumar, FAIC*

## Introduction

Nanoworld of science and technology is of great interest to governments, industries and academia. The prefix "nano" denotes sizes of the order of one-billionth of a meter. "Nanostructure science and technology is a broad and interdisciplinary area of research and development activity that has been growing explosively worldwide in the past few years. It has the potential for revolutionizing the way in which materials and products are created and the range and nature of functionalities that can be accessed" (Siegel, 1999, p. xvii). "Motors, turbines that go from zero to half a million RPM's in a microsecond; clamps that can literally fit onto the back of a flea – science fiction? No" (Carraher, Jr., 1994a, p. 109).

According to the Semiconductor Industry Association (2003), in 1971 it cost 10 cents to manufacture a computer chip which contained 2,300 transistors and had a clock speed of 0.8 million cycles/second. In 2003 the cost of manufacturing a computer chip (e.g., Pentium) containing 108 million transistors and a clock speed of 3,000 million cycles/second was 1/1000 cents. Notably the size of the technology has decreased from 10,000 nm in 1971 to a mere 65 nm in 2003 and is predicted to reach 32 nm by the year 2007.

The number of articles (registered by the Institute for Scientific Information) with "nano" as a topic increased from approximately 60 in year 1995 to over 3,000 by year 2004, indicating an increase in the level of interest in this critical area. In 2004, the US spent an estimated 1.6 billion dollars on nanotechnology and registered over 800 nanotechnology patents (Loder, 2005). In the United States "nanotechnology is the largest federally funded science initiative since the country decided to put a man on the moon" (Loder, 2005, p. 4). According to Roco (1999), "nanotechnology is presently at a level of development similar to that of computer information technology in the 1950s" (p. 132).

## Nanoscience and Nanotechnology

The two terms often used in the literature with reference to the world of nano materials are nanoscience and nanotechnology. Nano materials denote "divided matter." As Rao (1999) said, "if you take a piece of solid matter (say a metal) containing an Avogadro number of atoms and go on dividing it to smaller bits, you will ultimately end up with an atom of the substance. Before that, you will reach a stage of very tiny particles containing 100 to 10,000 atoms. Such particles with diameters of 1-50nm (10-500 $A^o$) are referred to as nanoparticles. Nanomaterials exhibit properties entirely different from bulk materials and constitute materials of the future" (p. 59).

Increased surface area and quantum effects are the two key factors that separate nanomaterials from bulk materials (The Royal Society and The Royal Academy of Engineering, 2004). A substance of size 3 nm has 50% of its atoms on the surface compared to a substance of size 30 nm with 5% of its atoms on its surface. As size decreases more quantum effects begin to manifest in the form of electrical, magnetic and optical properties.

*Nanoscience* refers to the scientific study of materials of nanometer size, i.e., one billionth of a meter (The Royal Society, 1994). It is a combination of developments in solid state chemistry, synthetic chemistry, molecular biology, solid state physics and engineering, and scanning tunneling microscopy. According to Alfred Nordmann (cited in Schummer, 2003), it is a "site-oriented technoscience approach that differs both from classical theory-driven and problem-driven research" (p. 2). For example, nanosized indium melts at much lower temperature than respective bulk metal (Allen, 2002). Copper in extremely thin layers, in the presence of magnetic field, becomes a poor conductor of electricity (Loder, 2005).

*Nanotechnology* refers to various technologies to produce materials of extra high precision and dimensions on the scale of one-billionth of a meter. (Norio Taniguchi of Tokyo Science

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University is credited with coining the term "nanotechnology" in 1974.). Nanotechnology "implies the ability to generate and utilize structures, components, and devices with a size range from about 0.1nm (atomic and molecular scale) to about 100nm (or larger in some situations) by control at atomic, molecular, and macromolecular levels" (Roco, 1999, p. 131). One of the most interesting aspects of nanotechnology is building molecule-by-molecule materials similar to those produced by biological self-assembly, self-organization and self-regulation (Carraher, Jr., 1994b). As Stoddart (cited in The Royal Society, 1994) described, "think of atoms as the equivalent to letters, molecules as words, assemblages of molecules as sentences, and supramolecular arrays as paragraphs" (p. 2). Nanotechnology examples and applications include the following (*Institute of Nanotechnology*, n.d.).

*Nanotechnology Examples*

Cell Pharmacology: Use of medical nanomachines for site-specific delivery of drugs, and useful in chemotherapy of targeted cancer cells.

Cell Surgery: Use of medical nanomachines to manipulate cellular structures in genetic engineering.

Molecular Electronics: Use of atomically precise molecular parts for molecular switches, circuits and nanocells for creating miniaturized nanocomputers.

Scanning Tunneling Microscopy (Carraher, Jr., 1995): Useful for imaging conducting surfaces.

*Nanotechnology Applications*

Nanocrystals: Formed by combining two or more molecules of inorganic substances, i.e., silica and aluminum to form commercial grade heat and rust resistant coatings.

Nanotubes: Carbon atom aggregates in various forms at nanoscale, for example in the shape of cylinders which are electrical conductors, can be mixed with special polymers to make nanofibres and painted on rooftops as part of solar cells.

Quantum Dots: Size and arrangement of nanocrystals impact physical properties such as color (Carraher, Jr., 1994c). For example, nanogold appears orange (<1nm) or red (3-30nm) depending on the size and arrangement of gold aggregates. Clear Sunscreen containing nanosized Zinc Oxide particles allows visible light to pass through and absorbs UV rays, hence appears colorless whereas bulk Zinc Oxide in regular sunscreens scatters visible light resulting in white color.

## Organization

The National Science and Technology Council (NSTC) Committee on Technology, The Interagency Working Group on NanoScience, Engineering and Technology (IWGN) (1999) broadly organized nanoscience and nanotechnology into four groups as follows:

- Dispersions and coatings (e.g., functional nanocoatings, optical and thermal insulators, ink-jet, recording devices)
- High surface area materials (e.g., bacterial filters, molecular sieves, adsorption surfaces, energy storage devices)
- Functional nanodevices (e.g., biomedical sensors, nanotubes in color displays, DNA sizing and sequencing). The functional nanodevices have a large biological component compared to the other three categories.
- Consolidated materials (nanocomposite cement, ultra-high strength materials, soft magnets, magnetic refrigerants).

## Nanoscale Dimensions

Nanoworld is a highly integrated and extensively broad area of research and development. The Royal Society and The Royal Academy of Engineering (2004) have categorized nanoscience into nanoscale in one dimension; nanoscale in two dimensions; and nanoscale in three dimensions.

Nanoscale in one dimension includes thin films, layers and engineered surfaces. They provide large surface area support in catalysts useful for "on-site" manufacturing of pharmaceuticals in smaller quantities.

Nanoscale in two dimensions consists of materials such as carbon nanotubes, inorganic nanotubes, nanowires and biopolymers. Carbon nanotubes in the form of wires and tubes exhibit a wide range of electrical and mechanical properties. Inorganic nanotubes are potentially useful as catalysts and lubricants.

Nanoscale in three dimensions includes nanoparticles, fullerenes, dendrimers and quantumdots. Nanoparticles show optical properties, high chemical reactivity and are useful for targeted drug delivery while fullerenes resemble miniature ball bearings.

### Potential Uses

The joint Center for Bioethics in Canada ranked potential uses of nanosciences and nanotechnologies with respect to development. The top ten uses follow (BBC News, 2005).

- Energy production, conservation and storage
- Enhancement of Agricultural productivity
- Treatment and remediation of water
- Screening and diagnosing diseases
- Systems for drug delivery
- Processing and storing food
- Controlling air pollution
- Construction
- Monitoring health
- Detecting and controlling pests

### Issues

The nanoworld is not without issues. The National Science and Technology Council (NSTC) Committee on Technology in the United States raised concerns over the short term and long term health issues originating from nanotechnology products. Certain types of single walled carbon nanotubes are water soluble and shown to enter T cells (King, 2005). Carbon nanotubes are pulmonary toxicants. The British Government (2005) in a regulatory effort required all new nano materials be treated with caution as new chemicals in terms of registration, evaluation, authorization, and restriction.

### End Note

The nanoworld is perhaps the fastest growing world in the twenty-first century. Global competition among nations in nanotechnology research, development and marketing is on the rise. Advantages of nanotechnology towards improving the quality of life are many. [Whether the nanoworld holds any solutions for problems faced by science education is a critical question which must be addressed in its entirety.] However, disadvantages of nanotechnology especially related to human health and the environment are only beginning to surface raising serious concerns. Systematic exploration, characterization, organization, and regulation of the nanoworld are warranted to make the best use of nanoscience and nanotechnology. The nanoworld will continue influence science and technology.

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# WHY JOHNNY CAN'T CALCULATE PH: ISSUES AND ANSWERS

## [An Open Discussion Shared with the Members of AIC at the 2005 Annual Meeting]

**Margot Hall, Ph.D., FAIC (CPC), FACB, FRACI (CChem), MRSC (CChem)***

**Abstract**

In this paper, the author addresses some of the educational issues which she has encountered in teaching her clinical chemistry and biochemistry courses and outlines some approaches to these issues that have worked for her. Suggestions by which industrial chemists can help their academic counterparts are also offered. It is hoped that this paper will serve as a stimulus to others to share their information and any solutions that have worked for them. This paper is a brief recapitulation of a presentation given at the 2005 annual meeting of the American Institute of Chemists (AIC).

## BACKGROUND

### *Essential Skills/Knowledge for Chemistry and Clinical Chemistry Students:*

A short list of essential skills and knowledge needed by chemistry and clinical chemistry students would have to include the following: 1) reading, 2) writing, 3) speech, 4) math, 5) critical thinking, and 6) other fundamental knowledge required of students and citizens. If you think that this is a given, let me assure you that during the past 20 years of teaching at a southern university I have interacted with several thousand students who had difficulty in some or all of these areas. Additionally my colleagues have reported similar observations from their institutions in different parts of the country. I have even been advised by some that these skills have been rendered obsolete and unnecessary by the introduction of "intelligent computers". Such statements force me to defend the importance of these essential skills.

### *In Defense of Essential Skills:*

The proposition that computers and other instruments will substitute for individual knowledge and skills presupposes that the computers will always be on line and properly programmed. One need only consider the possibility of a massive power outage to realize that this is an unreasonable assumption. One might also wonder if we really want our young people to be subjected to the subtle form of mind control that occurs when an individual is dependent on an instrument to do the analysis, complete the interpretation, and determine the course of action.

Reading, writing, and speech are required for good communication. Students who have difficulty reading invariably have difficulty completing their assignments. Students who write poorly receive lower grades and students whose speech is inadequate tend to be passed over for the better jobs. Not only is good communication required for upwards mobility but it is essential in the clinical laboratory as mistakes can lead to incorrect diagnoses, improper treatment, and even death. For example, insulin is not the same as inulin and should not be substituted for it, nor is castration the same as cannulation, which is not the same as canonization. In the clinical laboratory, the most common error is a transcription error but there is no shortage of miscommunication arising from language barriers. Some errors are easily recognizable and hence correctable but others are not.

Math is required for all of the sciences and mathematical errors may alter the strength of support structures for a building or bridge, the lift factor for an airplane or the perceived kinetics of an enzyme. In clinical chemistry mathematical mistakes cost lives, dollars and jobs. The most common mathematical error in the clinical lab is indubitably a dilution error. It is also the most costly. Examples include: 1) a reported white blood cell count of 3,300 per cubic millimeter when the correct value was 33,000, 2) a reported serum glucose of 650 mg/dL versus 65 mg/dL, and 3) a serum potassium of 15 mmol/L. In the first case, the patient was subjected to ill advised elective surgery from which he died. In the second case, the patient was treated with unnecessary insulin but survived. Similarly, in the third case, the technologist was royally chewed out by her supervisor who reminded the technologist that this result was incompatible with human life. As a teacher, my favorite math error came from a student who had calculated a blood pH of 15.46 and truly believed that this

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was the correct answer. It was at that time that I realized that for many students a logarithm is a blue button on a hand calculator….

Critical thinking skills are needed in all professions and life choices. Good thinking skills lead to proper decisions and poor skills lead to unsuccessful choices. One need only think of the “infallible computer” which when asked whether a patient’s blood pressure value was significant or not responded that the value was not significant. The computer reasoned that statistically speaking 5% of the values will be outside the normal reference interval, thus a single value of zero for the patient’s blood pressure should not be considered to be significant. Please note that this is not to be construed as a diatribe against computers which are a very useful adjunct both in the lab and in the classroom, but rather it is a form of advocacy for the importance of stressing critical thinking skills for our young students.

Chemistry students also need a broad based background of general knowledge and discipline related knowledge. Clearly, the more knowledge students have in the sciences the better prepared they are to learn, apply, and make the appropriate scientific connections. But our young students are also the future of the nation. Like all other young people, they may vote, hold office, serve on a jury, and help lead the nation. During the past 20 years I have put a free question to hundreds of students. To date, not one student has correctly answered the question: “Please list the three branches of the US government and state their functions”. If our government is important to us, then it is perhaps important that our students know how it functions and have the essential skills and knowledge to address the issues and make the necessary choices that they and the nation will be faced with.

### *The Need:*

There is a real need for educated citizens who can help make important decisions. Major issues affecting life on this planet will be presented to our younger generation and the young people need to be able to make good choices. Examples of issues that they will be faced with include stem cell research, genetically engineered plant and animal life, industrial and chemical toxic wastes, radiation research/use, global warming and numerous others. The decisions that they make will dictate the future of this country and others. Thus the more people who are engaged in the debates and the better educated they are the better the choices that are likely to be made. There is also a need for more professionals in the sciences and in particular in chemistry. At a recent American Association for Clinical Chemistry (AACC) meeting, it was stated that best estimates suggest that the United States will require at least 20,000 additional clinical chemists within the very near future (1). In the industrial nations, national economies and workers’ salaries are somewhat dependent on the level of science and technology. Thus there is a need to prepare our young people adequately in these disciplines. Finally, today’s students need a greater knowledge in the sciences upon graduation than students of prior generations did. Simply put, there is a lot more chemistry/science for them to know today.

## THE PROBLEM

Unfortunately, while more scientific knowledge is required of today’s students, they often enter college less well prepared than those of prior generations. As the gap between matriculation and graduation widens, so does the difficulty facing the student and the professor. From 1970 to the present (2005), two changes/trends have been observed with respect to the typical undergraduate student placement scores. First there has been a shift from a Gaussian curve to a bimodal curve with one mode reflecting college/university students with the expected level of preparation and the other mode including college/university students who are seriously under-prepared. The second change involves a reduced emphasis on national college-board exam scores (ACT or SAT) and other placement scores as a part of the college/university admission requirements. Combined with grade inflation, this results in the admission of students who are increasingly deficient in fundamental knowledge and skills. Consequently, students struggle academically and become frustrated and demoralized. Some even become hostile as the gap between their expectations and performance becomes evident. Similarly, members of the faculty become increasingly drained from the effort of trying to teach to a bimodal class.

Some causes of student under-preparedness include student health, teacher ability, class size, the extent of television viewing, the use of hand calculators and computers, and decreased volume and frequency of student homework assignments. Clearly, exposure to any chemical toxicants or other toxins that affect the central nervous system (CNS) will have a profound effect on neuronal development and function, and hence on student learning. In the South, one is particularly concerned with exposure to heavy metals and pesticides through contaminated ground and well water. Additionally, the timing of vaccinations and the nutritional status of children can affect their neurological development and academic performance. There is even an apparent "neurological switch effect" seen in children with autistic spectrum disorders. This problem is of major concern to parents, teachers, and physicians. It has been postulated by Dr. Stephanie Cave (2) that the use of mercury containing preservatives (e.g. thimerosal) in multi-dose vials of vaccine and the vaccination of children at very young ages (e.g. hepatitis B vaccination of neonates) may account for the increased incidence of autistic spectrum disorders observed in American children. It should also be acknowledged that some young people experiment with drugs of abuse and other toxic chemicals which can diminish neuronal function.

A teacher's mastery of his subject area will affect his ability to transmit discipline related knowledge/information to the students. Since many K-12 and community college (CC) teachers have received considerable instruction in pedagogy (teaching methods courses) but perhaps less instruction in their specific subject area (content based courses), and many other teachers are forced to teach outside of their major discipline (e.g. one teacher for physics, chemistry, and biology), it is not surprising that these teachers and their students sometimes feel stressed. Additionally, many teachers cite experiencing difficulty with keeping abreast of new developments in chemistry and the other scientific disciplines. Class size and the student/teacher ratio have also been cited as causes of poor teacher-student communication and hence a possible source of student failure to learn. One very specific effect of large class size and increased student/teacher ratio is the inevitable decrease in volume, frequency, and quality of student homework assignments. Homework serves to reinforce concepts and this leads to concept retention. To put it mildly: "use it or lose it". High school and community college students who never work chemistry problems are more likely to "memorize and regurgitate" on an exam important chemical concepts which they then quickly forget.

Three byproducts of the modern technological age (TV, hand calculators, and computers) are both a blessing and a curse when it comes to student learning and preparedness. The visual and auditory impact of a good TV program is tremendous. Unfortunately, all too often the script writer has tried to appeal to the lowest common denominator and therefore uses very poor English and incorporates little useful content. The more often students listen to poor English the more they are inclined to use poor English and frankly their time could be better spent elsewhere. The use of hand calculators has the advantage that one obtains answers relatively quickly but it also has the disadvantage that the students don't get the reinforcement necessary to really understand and learn math. The most obvious example of this is the difficulty that many college students have making serial and other dilutions of solutions in the laboratory. The students are having obvious difficulty with common fractions and they cannot use a hand calculator to obtain the correct answer. Another place where their mathematical difficulties are evident is in the calculation of pH which requires the use of logarithms. The calculator will give them a correct answer but many students have no clue whether the answer calculated is reasonable or not because they have no understanding of what a logarithm is. Finally, computers can be a wonderful teaching tool and source of information, and I have observed that today's high school graduate is increasingly computer literate. However, often the speed with which the students obtain information and the availability of "prepackaged and predigested" information has led to compromised critical thinking skills. Today's high school graduate wants instant answers but tomorrow's chemist must be able to analyze a problem and synthesize a (the) correct response.

## SOME APPROACHES TO THE PROBLEM

There are many different possible solutions to the problem of poor student performance. Some of the approaches can be applied directly by faculty and teachers. Other approaches require the concerted effort of scientists, business leaders, physicians, parents, educators, and voters….to name but a few. It is my opinion that it is worth the investment of time, energy, and money required by these approaches because improved student learning will change the future for our young people and hence for the nation. One thing which I stress is to *never give up* on young people because they will surprise and amaze us with their motivation and their ability to overcome obstacles.

*General Approaches:*

A few general approaches to the problem outlined above would include improved student health, improved teacher preparation, improved class size, and, where appropriate, remediation. Clearly, there is a role for industrial chemists in the reduction of toxic wastes (e.g. heavy metals) from the environment. Similarly, there is a role for research chemists in developing better drugs, vaccines, and nutritional substances plus better strategies for their use. All Americans should collaborate in efforts to reduce the incidence of chemical dependency and abuse. This should lead to healthier young people who can better profit from their scholastic work.

Industrial chemists are ideally situated to offer current and relevant science workshops for teachers and to help fund rewards for good science teachers. It is my hope that AIC might offer a high school science teacher award with a small monetary award to be spent by the teacher for instructional needs. There has also been a movement at some colleges and universities to return control of the curriculum for education majors to the home department. Thus the chemistry department faculty would control the curriculum (certificate program) for education majors planning to teach high school chemistry. This should lead to better prepared high school teachers which in turn could lead to better prepared high school graduates. There are opportunities for industrial, research, and academic chemists to serve as guest lecturers at local schools and to serve on local school boards where they can advocate better teacher/student ratios and class sizes.

Since the television and film industry commands an important place in the development of language skills and the transmission of knowledge to our children, one could encourage the industry's leaders and script writers to use better English and introduce more interesting content into their programming. Finally, the introduction of drill and, where needed, remedial work with individual tutoring can be an effective approach.

*Specific Approaches:*

Some approaches that I have used in my classes include: 1) tutorials with a lot of drill, 2) increased emphasis on written English, 3) increased emphasis on math, and 4) exercises in critical thinking. I spend about 4-5 hours per day tutoring students who are struggling academically. Additionally, I offer a recitation period from 3-5 PM on Fridays for students in my courses. And I meet with students who have questions within 24 hours so that the students get rapid feedback and don't waste time on unproductive work. Exams are both cumulative and comprehensive. When the students sit for the second semester of clinical chemistry (Clinical Chemistry II), they are required to take a comprehensive exam covering the material from the first semester clinical chemistry course (Clinical Chemistry I). If a student fails this entrance exam, he is required to sit for a 2 hour/day review of the first semester material in addition to the usual requirements for the second semester course. The final exam for Clinical Chemistry II covers the material from both courses (Clinical Chemistry I & II). Homework assignments, laboratory questions and report forms, and tutorial exercises are designed to reinforce concepts and to drill the students ("practice makes perfect"). Additionally, the students are given review lectures with homework sets and weekly exams during their final clinical work (hospital practicum) in preparation for taking their national certification exams and state licensure exams. It is my policy not to give partial credit and not to curve grades. However, I do give a lot of exams and exam questions as this allows the students to overcome a weak beginning.

To address an apparent weakness in our students' English language skills, our faculty recently implemented a system of writing intensive and senior capstone courses. In each of these courses, the students are required to write major term papers which will be graded on the use of English as well as content. It is too early to say whether this will correct the reading and writing deficiencies of the students.

To help correct their math deficiencies, we have introduced a laboratory mathematics course into the curriculum. In this course, students do some work without the use of a hand calculator. Similarly, they are required to learn to use log tables and I demonstrate the use of a slide rule. It is at this point that my mathematically challenged students finally grasp the concept of what a logarithm's function is. This naturally leads to calculations involving acid base status. In their first clinical chemistry course, I have the students derive the equations involving pH and perform pH titrations in lab. When introducing the concepts of metabolic and respiratory acidosis and alkalosis, I color code the parts of the Henderson-Hasselbalch equation. This allows the students to see the relationship between pH and the base/acid ratio. It helps enormously when I am teaching them about compensatory mechanisms to acid base imbalance. Next, I have the students calculate pH, given values for pCO2 and bicarbonate or pCO2 and TCO2. Likewise, I have them calculate bicarbonate from pH and pCO2 and also from TCO2 and pCO2. Then I have them analyze and interpret the results using the 4-step method. Refinements involving body temperature, DPG concentrations, hemoglobin concentrations can then be mentioned and algorithms can be introduced. Additionally, I have acid-base and other laboratory math problems on every exam in each of the clinical chemistry courses (Clinical Chemistry I, II, III, and Special Chemistry). This helps to reinforce the concepts learned.

To address the need for the students to learn to do critical thinking, I have developed and used a series of case studies. With each case study there is a brief description of the patient's symptoms and physical exam results, a list of presenting laboratory values, and in some cases further symptoms and lab values. The case study will include a series of questions designed to lead the student to a diagnosis for the patient and to reinforce concepts learned in class. In some cases, the student will be required to select further tests to be ordered or recognize a discordant value and determine why the analysis failed. To help the students "connect the dots" I have included some case studies that cross disciplines (e.g. hematology, microbiology, and clinical chemistry). Answers to the case study questions follow each case. Additionally, I have included some critical thinking questions on each exam. For example, I might ask the students to think of multiple factors which could lead to obtaining a physiologically impossible blood gas (acid/base) result and then indicate how they could correct the system.

In conclusion, some issues relating to chemical education have been discussed and possible ways of addressing them offered. It is hoped that others will add to this list and share their findings with us.

## REFERENCES

1. American Association for Clinical Chemistry Annual Meeting. Orlando, FL. July 28-August 1, 2002.

2. Cave, Stephanie. "Vaccine Controversies: Past and Present". Dodgen Lecture. Mississippi Academy of Science Annual Meeting. Biloxi, MS. February 21-22, 2002.

## ABOUT THE AUTHOR

Margot Hall, Ph.D., FAIC, CPC, FACB, FRACI (CChem), MRSC (CChem) is a professor of clinical chemistry in the Department of Medical Technology at the University of Southern Mississippi, Hattiesburg, Mississippi 39406-0001, USA. Telephone (601) 266-4912, Fax (601) 266-4913, E-mail Margot.Hall@usm.edu She received her Ph.D. in Biochemistry from the University of North Carolina at Chapel Hill where she worked as a research assistant (UNC Medical Center). Since moving to Mississippi, she has taught in the Medical Technology Department at the University of Southern Mississippi and as an adjunct in the Department of Chemistry and Biochemistry.

# BOOK REVIEWS

**Bioanalytical Chemistry**

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| Author: | Susan R. Mikkelsen and Eduardo Corton |
| Publisher: | John Wiley & Sons, Inc. |
| ISBN# | 0-471-54447-7 |
| Price of Book: | $94.95 |

Bioanalytical Chemistry authored by Susan R. Mikkelsen and Eduardo Corton is a book that will serve as text for advanced undergraduates and graduate students. This interdisciplinary book will also serve as a reference work for researchers, students, and industrial scientists working in chemistry, biology, biochemistry, pharmacy and medicine. This 361-page title has an index.

The authors review all aspects of using analytical methodology to solve biological problems and describe many of the techniques used by biochemists and molecular biologists. Each chapter begins with coverage of basic concepts and then progresses to applications that involve real samples and has problems and the explained answers are included in the appendix. The mathematical derivations are limited to those that are essential for an understanding of each method. Suggested readings and references are included for further information. Graphs, diagrams and structural formulas are included throughout the book.

Bioanalytical chemistry is divided into 16 chapters. Chapter one entitled “Spectroscopic Methods for Matrix Characterization” discusses total protein, total DNA, total RNA, total carbohydrate, and free fatty acids. Chapter two entitled “Enzymes” includes enzyme nomenclature, enzyme commission numbers, enzymes in bioanalytical chemistry, enzyme kinetic, enzyme activators, enzyme inhibitors, enzyme units and concentration. Chapter three entitled “Quantitation of Enzymes and Their Substrates” includes substrate depletion or product accumulation, direct and coupled measurements, instrumental methods (optical, electrochemical and other methods), ultra-high throughput assays (HTA) and practical considerations for enzymatic assays. Chapter four entitled “ Immobilized Enzymes” presents immobilization methods, properties of immobilized enzymes, immobilized enzyme reactors and theoretical treatment of packed-bed enzyme reactors. Chapter five entitled “Antibodies” discusses structural and functional properties of antibodies, polyclonal and monoclonal antibodies, antibody-antigen interactions, and analytical applications of secondary antibody-antigen interactions (agglutination and precipitation). Chapter six entitled “Quantitative Immunoassays with Labels” discusses labeling reactions, heterogeneous immunoassays (labeled-antibody methods, labeled-ligand assays, radioisotopes, flurophores, chemiluminescent labels and enzyme labels) and homogeneous immunoassays (fluorescent labels and enzymes labels) and evaluation of new immunoassay methods. Chapter seven entitled “Biosensors” discusses the response of enzyme-based biosensors, evaluation of biosensor performance and examples or biosensor configuration. Chapter eight entitled “Direct Evolution for the Design of Macromolecular Bioassay Reagents” presents rational design and directed evolution, generation of genetic diversity, linking genotype and phenotype, identification and selection of successful variant, and direct evolution of galactose oxidase. Chapter nine entitled “Electrophoresis” presents electrophoretic support media, effect of experimental conditions on electrophoretic separations, and detection of proteins and nucleic acids after electrophoretic separation. Chapter ten is entitled Applications of Zone Electrophoresis”. Chapter eleven is entitled “Isoelectric Focusing”. Chapter twelve is entitled “Capillary Electorphoresis”. Chapter thirteen entitled “Centrifugation Methods” discusses forces, gradients, techniques and examples. Chapter fourteen entitled “Chromatography of Biomolecules” includes units, definitions, plate theory, rate theory, size exclusion (gel filtration), affinity and ion-exchange chromatography. Chapter fifteen entitled “ Mass Spectrometry of Biomolecules” discusses instrumentation, interpretation, protein identification, protein-peptide sequencing, nucleic acid applications, bacterial applications and biomolecular weight determinations. Chapter sixteen entitled “Validation of New Bioanalytical Methods” includes mean, variance, estimators or precision and accuracy figures of merit and examples.

***Submitted by: Anne T. Sherren, PhD, FAIC***

## Principles and Applications of Ion Scattering Spectrometry

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| Editors: | J. Wayne Rabalais |
| Publisher: | John Wiley & Sons, Inc. |
| ISBN# | 0-471-20277-0 |
| Price of Book: | $ 99.95 |

Principles and applications of Ion Scattering Spectrometry authored by J. Wayne Rabalais is a book that will serve as an invaluable resource for a wide audience - research scientists, students and technicians. This authoritative account will also serve as a textbook for graduate courses. This monograph authored by the leading researcher in the field merges theoretical fundamentals and cutting-edge practical applications. The first chapters are written for advanced undergraduates and graduate students and the latter chapters cover applications and cutting edge research. This book is part of the Wiley-Interscience Series on Mass Spectrometry. Each chapter includes references specific to that chapter. There are many diagrams and figures in each chapter. The book has an index and is 306 pages in length.

The book is divided into ten chapters. Chapter one entitled “Introduction” discusses ion scattering spectrometry, the importance of surfaces, ion-surface interactions, the historical development of ion scattering spectrometry, other types of ion spectrometries and features of ion scattering spectra. Chapter two entitled “Theoretical Descriptions of Atomic Collisions” includes the Kinematics and dynamics of atomic collisions and multiple collisions. Chapter three entitled “Experimental Methods” includes a general description of an ion-scattering spectrometer system (including the components. Also included in this chapter are discussions of a time-of-flight scattering and recoiling spectrometer, a coaxial scattering spectrometer, a scattering and recoiling imaging spectrometer, mass and charge selection of pulsed ion beams using sequential deflection pulses and ion scattering and recoiling from liquid surfaces. Chapter four entitled “ General Features of Ion Scattering and Recoiling Spectra discusses energy spectra, time-of-flight spectra (interpretation, intensities, sensitivity and examples of TOF spectra), recoiling spectra without scattering spectra, sampling depth, attributes of the ion-scattering technique and a comparison to other surface elemental analysis. The methods compared include diffraction methods, high-energy ion scattering, helium atom scattering, scanning microscopy, electron scattering and ionization and bonding-breaking techniques. Chapter five entitled “Structural Analysis from Time-of-Flight Scattering and Recoiling Spectrometry” includes atomic collisions in the keV range, structural analysis, azimuthal alignment of the incident ion beam, TOF-SARS and LEED. Chapter six entitled “Real Surface Crystallography form Scattering and Recoiling Imaging Spectrometry (SARIS) includes the details of the technique, interpretation of the SARISgrams, quantitative analysis of the SARIS images and the advantages of SARIS. Chapter seven discusses the applications of TOF-SARIS and SARIS to Surface Structure Analysis. Areas included are clean surface reconstruction and relaxation, hydrogen surfaces, oxygen surfaces, metal oxide surfaces, organic molecules on surfaces, semiconductor surfaces and epilayers on nickel. Chapter eight presents the process and examples of Ion-Surface Charge Exchange and Inelastic Energy Losses. Chapter nine discusses hyperthermal reactive ion scattering for molecular analysis of surfaces. Chapter ten is a bibliography of ion scattering publications.

***Submitted by: Anne T. Sherren, PhD, FAIC***

## Modern Practice of Gas Chromatography, 4th Edition

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| Author: | Robert L. Grob and Eugene F. Berry |
| Publisher: | John Wiley & Sons, Inc. |
| ISBN# | 0-471-22983-0 |
| Price of Book: | $150.00 |

Modern Practice of Gas Chromatography, 4th Edition by Robert L. Grob and Eugene F. Berry is a through treatment of the subject of gas chromatography. Each chapter of this volume is written by expert in the particular field of gas chromatography. A suitable quote introduces each chapter of the book. This title is suitable for a textbook for university courses, workshop book, or a guide for the practicing chemists analysts, analytical chemists, technicians or scientists. In some ways this volume is the bible of gas chromatography–offering everything the professional and the novice need to know about running, maintaining, and interpreting the results from GC. Analytical chemists, technicians, and scientists in allied disciplines have come to regard Modern Practice of Gas Chromatography as the standard reference in gas chromatography, the fourth edition will be no exception. In addition to serving as an invaluable reference for the experienced practitioner, this best selling work provides the beginner with a solid understanding of gas chromatographic theory and basic techniques. This new Fourth Edition incorporates the most recent developments in the field, including entirely new chapters on gas chromatography/mass spectrometry (GC/MS); optimization of separations and computer assistance; high speed or fast gas chromatography; mobile phase requirements: gas system requirements and sample preparation techniques; qualitative and quantitative analysis by GC; updated information on detectors; validation and QA/QC of chromatographic methods; and useful hints for good gas chromatography. The book is written in a fashion that is easy to understand by novice and experienced chromatographers. The chapters include wonderful details about mechanism of separations, valuable information on flash vaporization process, and the utilities of the various detectors. This book is comprehensive and comprehensible. This volume has a good balance of theoretical explanation, and also inclusion of commercially available technology. Each chapter has many references, adequate figures, graphs and pictures.

The book is presented in four sections. Chapter one is the Introduction. Part I – Theory and Basics includes four chapters. The four chapters are entitled:“Theory of Gas Chromatography;” “Columns: Packed and Capillary; Column selection in Gas Chromatography;” “Optimization of Separations and Computer Assistance;” and “High Speed Gas Chromatography.” Part Ii –Techniques and Instrumentation has five chapters. The five chapters are entitled “Detectors in Modern Gas Chromatography;” “Techniques for Gas Chromatography/Mass Spectrometry;” “Qualitative and Quantitative Analysis by Gas Chromatography;” “ Inlet Systems for Gas Chromatography;” and “Gas Management Systems for Gas Chromatography.” Part III – Applications has seven chapters. The seven chapters are entitled “Simple Preparation Techniques for Gas Chromatography;” “Physicochemical Measurements by Gas Chromatography;” “Petroleum and Petrochemical Analysis by Gas Chromatography;” “Clinical and Pharmaceutical Analysis by Gas Chromatography;” “Environmental Applications of Gas Chromatography;” “Forensic Science Applications of Gas Chromatography;” and “Validation and QA/QC of Gas Chromatographic Methods.”

Part 4 - Appendices includes 3 appendixes and an index. Appendix A - “Effect of Detector Attenuation Change and Chart Speed on Peak Height, Peak Width and Peak Area.” Appendix B - “Gas Chromatographic Acronyms and Symbols and Their Definitions.” Appendix C - Useful Hints for Gas Chromatography.”

***Submitted by: Anne T. Sherren, PhD, FAIC***

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**Inorganic Chemistry Highlights**

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| Editor: | Gerd Meyer, Dieter Naumann, Lars Wesemann |
| Publisher: | John Wiley & Sons, Inc. |
| ISBN# | 3-527-30265-4 |
| Price of Book: | $90.00 |

Inorganic Chemistry Highlights edited by Meyer, Naumann and Wesemann is a book for the person looking for an insight in the inorganic world beyond the person's specific research area. The publishers hope that this will be volume one of a series for inorganic chemists similar to the series Organic Synthesis Highlights. The editors stress that this collection of highlights by no means covers the entire wealth of inorganic chemistry. This book contains nineteen chapters each written by a different specialist or group of specialists. Each chapter begins with an introduction and contains many figures and diagrams. Each chapter has a reference section at the end of the chapter. The book has a subject index and is 324 pages in length.

Chapter one entitled *Molten Zintl Alloys* has eight sections. Chapter 2 entitled *Structure and Bonding Around the Zintl Border* contains six sections. Chapter three entitled *Structure Prediction and Determination of Crystalline Compounds* contains five sections. Chapter 4 entitled *Multivalent Cation Conductors* contains five sections. Chapter five is entitled *The Potential of Pentagonal Building Blocks from Giant Ring-shaped to Spherical Polyoxometalate Clusters*. Chapter six with three sections is entitled *Molybdenum Peroxo Complexes as Catalysts* in Olefin Epoxidation. Chapter seven is entitled *Syntheses of Rare Earth Organometallics, Organo amides, and Aryloxides from the Metals*. It contains three sections. Chapter eight entitled *Enzyme Structure: Active Site Structural and Functional Aspects of Purple Acid Phosphatase and Catechol Oxidase* and has three sections. Chapter nine entitled *Aminotroponiminates as Ligands for Group 3 and Lanthanide Complexes - Coordination Chemistry and Catalysis* has four sections. Chapter ten entitled *Metalla-calix[4]arenes: How they Assist the Transformations of Hydrocarbons into Metalla-alkylidenes, of Dinitrogen into Metalla-nitrides, and of Carbon Monoxide into Metalla-carbides* has four sections. Chapter eleven is entitled *Metal Carbonyl Cations and their Derivatives - A New Class of Superelectrophiles*. Chapter twelve entitled *Borylene Complexes* has three sections. Chapter thirteen is entitled *Silaboranes*. Chapter fourteen entitled *Carbaalanes - A New Class of Compounds Containing Clusters of Aluminium and Carbon Atoms has seven sections. Chapter 15 entitled Molecular Aluminum and Gallium Subhalides* has four sections. Chapter sixteen entitled *Recent Developments in the Chemistry of Covalent Main Group Azides* has seven sections. Chapter seventeen is entitled Silacalix-[n]-phosphinines:sp$^2$-phosphorus Equivalents of CO Matrices. Chapter 18 entitled Dinitrogen as a Raw Material: Is there a Future? has six sections. Chapter nineteen entitled Organoxenon Compounds has five sections. Upon examination of the topics one realizes that a wide breadth of inorganic chemistry is covered in the Highlight volume.

***Submitted by: Anne T. Sherren, PhD, FAIC***

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**Multidimensional Chromatography**

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| Editors: | Luigi Mondello, Alastair C. Lewis, Keith D. Bartle |
| Publisher: | John Wiley & Sons, Inc. |
| ISBN# | 0-471-98869-3 |
| Price of Book: | $140.00 |

Multidimensional Chromatography authored by Luigi Mondello, Alastair C. Lewis, Keith D. Bartle is a book that will serve as an invaluable resource for a wide audience - research scientists and technicians. This volume will also serve as a textbook for graduate courses. This monograph, edited by pioneers in the field, is the first book to review all multidimensional techniques including LC-GC, GC-GC, and GC-Supercritical Fluid Chromatography. Separation Science is a mature and unified subject in which now conventional chromatographic and electrically driven processes are applied in the analysis of mixtures of compounds in a wide range of applications. As the boundaries between the distinct techniques becomes more blurred, it is becoming evident that a single theory may be applicable to chromatography whatever the physical state of the mobile phase. The different techniques can be regarded as special cases of the same procedure. In many of the applications the chromatography is combined with electrophoresis. Each chapter includes references specific to that chapter. The book has an index and is 436 pages in length.

This book is divided into two parts - an introduction to the various techniques and applications for a number of types of samples. Part 1 is entitled "General" and has nine chapters. Chapter one entitled "Introduction" includes items related to packed capillary column and unified chromatography, the resolving power of chromatographic systems, two-dimensional separations and multidimensional chromatography. Chapter two entitled "Coupled High Performance Liquid Chromatography with High Resolution Gas Chromatography." The topics of transfer techniques, vaporization with hot injectors, transfer of water-containing solvent mixtures and the indirect introduction of water are discussed. Chapter three entitled "Multidimensional High Resolution Gas Chromatography". This chapter presents practical two-dimensional gas chromatography and some practical examples. Chapter four entitled "Orthogonal GC-GC." The subsections include introduction to multidimensional gas chromatography, introduction to GC x GC Separation, introduction to modular technology, orthogonality of analysis, quantitative aspects, future opportunities and challenges of GC x GC technology. Chapter five entitled "Coupled-Column Liquid Chromatography" presents theoretical aspects and LC-LC techniques. Chapter six entitled "Supercritical Fluid Techniques Coupled with Chromatographic Techniques" discusses on-line coupling of Super Fluid Extraction (SFE) with chromatographic techniques, on-line coupling of Super Fluid Extraction (SFE) with capillary electrodriven separation techniques, and multidimensional to unified chromatography passing through supercritical fluids. Chapter seven entitled " Unified Chromatography: Concepts and Considerations for Multidimensional Chromatography" discusses the instrumentation, a phase diagram view,

advantages and challenges for unified chromatography techniques in multidimensional systems and the column efficiency and plate heights in Unified chromatography. Chapter eight entitled "Multidimensional Planar Chromatography"
discusses two-dimensional or multidimensional planar chromatography, coupling of techniques, and multiple directions. Chapter nine entitled "Multidimensional Electrodriven Separations" discusses many aspects of multidimensional electrokinetic separations. Part two entitled "Applications" has six chapters. Each of the chapters discusses applications for a specific type of sample or industry. The types of samples presented include: foods, flavors and fragrances; biomedical and pharmaceutical; industrial and polymers; environmental; oil; and forensic and toxicological applications. *Reviewed by Anne Sherren, Ph.D., FAIC*

***Submitted by: Anne T. Sherren, PhD, FAIC***

### The Raman Effect: A Unified Treatment of the Theory of Raman Scattering by Molecules

Author: Derek A. Long
Publisher: John Wiley & Sons
ISBN# 0-471-49028-8
Price of Book: $296.00

*The Raman Effect: A Unified Treatment of the Theory of Raman Scattering by Molecules* by Derek A. Long presents a unified theoretical treatment, which is complete and rigorous but never the less readable. The systems treated are limited to scattering by systems of freely orienting, non-interacting molecules, or systems that approximate them. The necessary mathematical and physical tools are developed in appendices, and references made to them from the text. This volume is theoretical and mathematical. The theoretical treatment requires a variety of mathematical and physical tools. To keep the main text uncluttered, these tools are developed in comprehensive Appendices to which cross-references are made in the main text. These Appendices also ensure that the main text is useful to readers with a wide variety of scientific backgrounds and experience. These include not only spectroscopists, but also chemists, physicists, biochemists and analytical chemists. The presentation is such that postgraduate and postdoctoral students as well as more established research workers will find it valuable. One rarely finds a book of 597 pages that has 248 pages devoted to the Appendices. Part one is entitled “Theory.” Each of the 10 chapters includes many diagrams, tables, and references. Chapter one is “Survey of Light-scattering Phenomena.” Chapter two is “Introduction to Theoretical Treatments of incoherent Light Scattering.” Chapter three is “Theory of Rayleigh and Raman Scattering.” Chapter four in “Quantum Mechanical Theory of Rayleigh and Raman Scattering.” Chapter 5 is “Vibrational Raman Scattering.” Chapter six is “ Rotational and Vibrational-Rotational Raman Scattering.” Chapter seven is “Vibrational Resonance Raman Scattering.” Chapter eight is “ Rotational and Vibrational-Rotational Resonance Raman Scattering.” Chapter nine is “Normal and Resonance Electronic and Vibrational Raman Scattering.” Chapter ten is “Rayleigh and Raman Scattering by Chiral Systems.” Part two is the Appendices. Each of the 21 appendices include and introduction definitions and formulae. The book is well cross-referenced and has an index.

The chemist seeking only those aspects of Raman theory and spectrum interpretation that bear directly on chemical analysis should consult *Raman Spectroscopy for Chemical Analysis, Volume 157 in Chemical Analysis* by Richard L McCreery and other volumes containing compendia of spectra and frequencies.

***Submitted by: Anne T. Sherren, PhD, FAIC***

### Topics in Sterochemistry, Volume 23

Author: Scott E. Denmark, Editor
Publisher: John Wiley & Sons, Inc.
ISBN# 0-471-17622-2
Price of Book: $158.00

Topics in Sterochemistry, Volume 23, edited by Scott E. Denmark is one volume in the series *Topics in Sterochemistry* that first began in 1967. The field has grown and the impact that stereochemistry has impacted all reaches of the chemical enterprise. In addition to chemistry this topic is important for biology, medicine, physics, materials science, chemical engineering, and environmental science. The book has a subject index, cumulative author index for all 23 volumes and a cumulative title index for all 23 volumes. The length of the book is 369 pages.

The book is divided into five sections. Each of the five sections is authored by individuals expert to that field. Each section begins with an introduction and includes numerous figures, structures, and references. Section one is entitled “Chirality in Fullerene Chemistry”. Topics presented include: configurational description of chiral fullerenes and fullerene derivatives with a chiral functional group; inherently chiral fullerenes; chiral fullerene derivatives. Section two is entitled “Transition-Metal-Templated Synthesis of Rotaxanes. Topics included are: general aspects of rotaxane, transition-metal-templated-synthesis; transition-metal-controlled threading-a new principle of rotaxane synthesis; and functional rotaxanes. Sections three is entitled “Memory of Chirality: Asymmetric Induction Based on the Dynamic Chirality of Enolates”. Topics included are: memory of chirality; asymmetric synthesis via enolate intermediates; dynamic chirality; designed memory of chirality in alkylation of a ketone; direct asymmetric α-alkylation of phenylalanine derivatives; asymmetric α-methylation of various α-amino acid derivatives; mechanism of memory of chirality in asymmetric methylation of α-amino acid derivatives; memory of chirality in diastereoselective α-alkylation of β-branched α-amino acid derivatives; memory of chirality in the literature; perspectives and conclusions. Section four is entitled “Chiral Discrimination during Crystallization”. Topics presented include: chiral discrimination phenomena during crystallization; molecular design of novel nonnatural resolving agents in diastereometric resolution (acidic and basic agents); and chiral discrimination of racemates by conventional resolving agents. Section five is entitled “Asymmetric Aldol Reactions Using Aldolases. The asymmetric reactions include: DHAP-dependent aldolases; pyruvate and phospoenolpyruvate –dependent aldolases; 2-deoxyribose-5phosphate aldolases; glycine-dependent aldolases; transketolase; transaldolase; and aldolase catalytic antibodies.

***Submitted by: Anne T. Sherren, PhD, FAIC***

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# MANUSCRIPT STYLE GUIDE
## *The Chemist*

***The Chemist*** is the official publication of The American Institute of Chemists (AIC). *The Chemist* is published quarterly with peer-reviewed articles plus reviews and briefs on all topics related to chemistry. We accept submissions from all fields of chemistry. *The Chemist* will not consider any paper or part of a paper that has been published or is under consideration for publication anywhere else. The editorial office of *The Chemist* is located at:

Editor – *The Chemist*
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### Categories of Submissions

***Research Papers*** (up to ~5000 words) which are original will only be accepted. Research Papers are peer-reviewed and include an abstract, an introduction, up to 5 figures or tables, sections with brief subheadings and a maximum of approximately 30 references.

***Reports*** (up to ~3000 words) present new research results of broad interest to the chemistry community. Reports are peer-reviewed and include an abstract, an introductory paragraph, up to 3 figures or tables, and a maximum of approximately 15 references.

***Brief Reports*** (up to ~1500 words) are short papers that are peer-reviewed and present novel techniques or results of interest to the chemistry community.

***Review Articles*** (up to ~6000 words) describe new or existing areas of interest to the chemistry community. Review Articles are peer-reviewed and include an abstract, an introduction which outlines the main point, brief subheadings for each section and up to 80 references.

***Letters*** (up to ~500 words) discuss material published in *The Chemist* in the last 8 months or issues of general interest to the chemistry community.

***Book Reviews*** (up to ~ 500 words) will be accepted.

### Manuscript Preparation

#### *Research Papers, Reports, Brief Reports and Review Articles*

**The first page** should contain the title, authors and their respective institutions/affiliations and the corresponding author. The general area of chemistry the article represents should also be indicated, i.e. General Chemistry, Organic Chemistry, Physical Chemistry, Chemical Education, etc.

**Titles** should be 55 characters or less for Research Papers, Reports, and Brief Reports. Review articles should have a title of up to 80 characters.

**Abstracts** explain to the reader why the research was conducted and why it is important to the field. The abstract should be 200 words or less and convey the main point of the paper along with an outline of the results and conclusions.

**Text** should start with a brief introduction highlighting the papers significance and should be understood to readers of all chemistry disciplines. All symbols, abbreviations, and acronyms should be defined the first time they are used. All tables and figures should be cited in numerical order.

**References and notes** should be numbered in the order in which they are cited, starting with the text and then through the table and figure legends. Each reference should have a unique number and any references to unpublished data should be given a number in the text and referred to in the references. References should follow the standards presented in the AIC Guideline for References available on the AIC website or from the AIC National Office.

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**Tables** should be included at the end of the references and should not duplicate the text. Tables should be completely understandable without reading the text. Every table should have a title. Each table should be on a separate page.

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The general format for citations should be in the order: **author(s), journal, year, volume, page**. Page number ranges are preferred over single values, but either format is acceptable. Where page numbers are not yet known, articles may be cited by DOI (Digitial Object Identifier).

For example:

Booth DE, Isenhour TL. The Chemist, 2000, 77(6), 7-14.

### Books

For example:

Turner GK in Bioluminescence and Chemiluminescence: Instruments and Applications, ed. Knox Van Dyke, CRC Press, Boca Raton, 1985, vol 1, ch. 3, pp 43-78.

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Patents should be indicated in the following form:

McCapra F, Tutt D, Topping RM, UK Patent Number 1 461 877, 1973.

### Reports and bulletins, *etc.*

For example:

Smith AB, Jones CD, “Environmental Impact Report for the US”, final report to the National Science Foundation on Grant AAA-999999, Any University, Philadelphia, PA, 2006.

### Material presented at meetings

For example:

Smith AB. Presented at the Pittsburgh Conference, Atlantic City, NJ, March 1983, paper 101.

### Theses

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Jones AB, Ph.D. Thesis, Columbia University, 2004.

### Reference to unpublished material

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Jones AB, presented in part at the 20th American Institute of Chemists National Meeting, Philadelphia, PA, June, 2004.

For material accepted for publication, but not yet published, the following form should be used:

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The submission and review process is completely electronic. Submitted papers are assigned by the Editors, when appropriate, to at least two external reviewers anonymously. Reviewers will have approximately 10 days to submit their comments. In selected situations the review process can be expedited. Selected papers will be edited for clarity, accuracy, or to shorten, if necessary. The Editors-in-Chief will have final say over the acceptance of submissions. Most papers are published in the next issue after acceptance.

Proofs will be sent to the corresponding author for review and approval. Authors will be charged for excessive alterations at the discretion of the Editors-in-Chief.

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- The submission will remain a privileged document and will not be released to the public or press before publication.
- The authors certify that all information described in their submission is original research reported for the first time within the submission and that the data and conclusions reported are correct and ethically obtained.
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### Submissions

Authors are required to submit their manuscripts and letters or reviews electronically. They can be submitted via email at aic@theaic.org with "Submission for consideration in *The Chemist*" in the subject line. Submissions may also be sent via surface mail on 3 1/2" computer floppy disks. All submissions should be in Microsoft Word, Wordperfect or RTF format.

**For further information** or if you can any questions please contact the Publisher of *The Chemist* at (215) 873-8224 or via email at aic@theaic.org.

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