Spring 1990
Vol. 15, No. 1

C3 News

Newsletter of College Chemistry Canada / La Chimie Collégiale au Canada

In the *News*

It's time to start applying for funds to travel to the annual C3 Conference. This year's conference will be held jointly with the Two Year College Chemistry Conference (2YC3) and the program which you will find on pages six and seven reflects the combined interests of the two groups. You'll find everything you need, registration form, travel and accomodaton information, and much more, in the eight page section in the centre of the *C3 News*.

I have been asked to remind you that March is membership renewal time. You may already have heard from your regional director about this, but if not, you will find a membership form on the back page. If you prefer, you will be able to pay your fees at the Conference.

You will notice that Canada Packers has agreed to sponsored a new award in chemical education. It is important that good candidates are nominated for this year's award if this is to be continued in future years. If you are thinking about nominating, you'll have to move quickly.

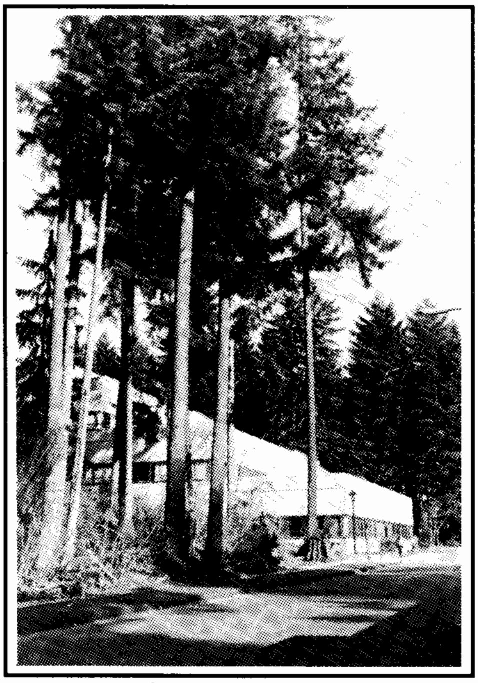
And finally, many thanks to Bob Perkins and Gary Wilson for sending me the thought-provoking articles which have been printed in this issue. By the way, there is no nepotism involved in Gary's article; he and Harry are not related. And from my prospective, both stories were sent to me on disk. Thanks guys, you have no idea how much time that saves me.

We'll see you at the Conference.

Bob Browne, Editor

College Profile

Capilano College, C3/2YC3 Conference Host



The "H" Building at Capilano College which contains science and computer labs.

Driving to Capilano College is simply a matter of pointing your car in the direction of the ridge of mountains dominating the horizon just north of the city of Vancouver. Nestled in these mountains are the three ski resorts which give bragging rights to the residents of the North Shore; "I'm just ten minutes away from the gondola", they like to say. I don't know how many of them actually *ski* there, they probably drive the 100 km or so to Whistler Mountain, but they *could*, and that's the important thing. When you find yourself on one of the two major bridges over Burrard Inlet you know that you are about to arrive in one of the most desirable residential areas on the West coast. From the fabled British Properties west to Horseshoe Bay you'll find homes clinging precariously to the rocks with magnificent views of the ocean. To the east, and almost self consciously hidden in an area of second growth forest you will find the main campus of Capilano

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College. The buildings are a mixture of construction styles, some being "semi-permanent" while others bear a more permanent appearance. Half hidden in the trees, and appearing to be in the process of sliding down the hill to the south end of the campus is the "H" building. Opened in 1982, this building houses the science labs, computer labs, and music studios, and is the home of the Chemistry Department at Capilano.

Like most of the colleges in the B.C. system, Capilano started from rather humble beginnings. In 1968, the College opened its doors to 784 students enroled in academic and career programs in two portable buildings attached to the West Vancouver Secondary School. Over the next five years expansion was rapid and in 1973 the College moved to its present Lynnmour site in North Vancouver. Also shared with the other colleges in the province is the concept of serving a large college region with a series of "satellite" campuses; Capilano serves the Howe Sound region with a campus in Squamish, and the Sunshine Coast from its campus in Sechelt.

Today the student population stands at 5300, with 47% of these being full-time students. Most (45%) are enroled in academic studies, with the remainder in career/vocational or preparatory programs. With 420 faculty and 180 staff, the College is the seventh largest employer on the North Shore. The Chemistry Department is made up of instructors Penny Le Couteur, Alan Gilchrist, Dale Read, and lab supervisor Ian Smith. Rounding out the staff are part-time lecturer, 2 part-time lab supervisors and a full-time lab technician. Two complete years of chemistry courses are offered, including a very successful second year organic chemistry (60 students) and a second-year physical/inorganic course. All courses transfer directly to courses at the three major universities in the province to accommodate the 74% of academic graduates who continue their studies at a university.

Overseeing the operation of Capilano College is President Doug Jardine, who happens to be a chemist. Doug played an active role in organizing the 1978 C3 Conference at Capilano and will no doubt be watching to see how we do this time around. ☐

Hot From the Presses!

By Bob Perkins

R. Hegstrom and D. Kondepudi give an excellent account of the handedness of nature, suggesting that an asymmetric weak nuclear force is responsible. Scientific American p108-115, January 1990.

The decline in the number of undergraduate science majors and the shift to business majors over the past twenty years is the focus of a study by K. Green. American Scientist **77**, p475-480, Sept/Oct 1989.

Two patents have recently been issued for electrified water pistols in which two streams of water (carrying opposite electrical charges) can be directed at a plant to kill insects. Increasing the current could lead to sting, stun, and kill settings for humans. New Scientist p36, #1688, Oct. 28 1989.

Chemists are now studying weakly bonded molecules which only exist at very low temperatures. The Ar-H-Cl system has been examined at -268°C using a carbon dioxide laser and an applied electric field to vary the energy level of the molecules. Accounts of Chemical Research **22**, p295, 1989.

Novel new compounds of phosphorus and carbon which have the cubane and homopentaprismane structures are forcing chemists to rethink the ways in which atoms should bond together. The compounds (and others) are prepared by heating a compound containing a P-C triple bond. Angew. Chemie. **28**, p900 and 1013, 1989.

Xenon is becoming the solvent of choice for a variety of organic and organometallic reactions, especially for those involving hydrogen and nitrogen gas. New Scientist p20, #1695, Dec 16 1989.

Scientists have studied the mummified remains of Chilean Indians with a view to determining whether dioxins have been present in the environment ever since man has been burning wood. No traces of dioxin were found at the ppt level. New Scientist p21, #1696/1697, Dec 23/30 1989.

Palytoxin ($C_{129}H_{223}N_3O_{54}$), one of the most poisonous naturally occurring chemicals ever isolated, has been recently synthesized in the laboratory. A team of two chemists at Harvard University required eight years to perform the total synthesis (64 chiral carbons and six double bonds capable of geometric isomerism). Journal of American Chemical Society **111**, p7525 and 7530, 1989.

The November issue of the Journal of Chemical Education contains several articles of interest: Confusion in the polarity of cells in electrochemistry, p912-916; Research and daily life applications, p917-920; Cold fusion and exam questions, p932-933; Textbook errors - catalysis, p935-937; Microscale synthesis -three experiments, p956-967. ☐

C3 News

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Articles of any length will be gladly accepted. Please send typewritten copy to the Editor at the above address or send by fax. Copy can also be sent on a 5 1/4" floppy disk, IBM format, using WordPerfect, WordStar, Microsoft Word or any wordprocessor producing ASCII output. Deadline for the next issue is June 20, 1990..

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Canada Packers Award Established

The hard work of former president Dick Kroeger has paid off. Dick reports that Canada Packers has agreed to sponsor an annual award in Chemical Education to be given to a member of College Chemistry Canada, and awarded at the Conference each year. The award will consist of a scroll and $600 which is to be used by the award winner to attend the annual C3 Conference. Normally, nominations for the award are to be submitted to the Secretary by January 1, but since negotiations with Canada Packers were not finalized until after the new year, the deadline for receipt of nominations has been extended to May 1 for this year.

The criteria for selection of the winner were approved at the 1989 meeting of the C3 Board, and are reproduced below. Since the award is subject to approval each year by Canada Packers, it is very important that a suitable recipient be selected to receive the first award. Nominations should be sent as soon as possible to the secretary of C3, Dinesh Bhatnagar, Algonquin College, 200 Lees, Avenue, Ottawa, Ontario, K1S 0C5.

Canada Packers Award in Chemical Education

Criteria

1. The Award shall be offered annually to honour a person who has made substantial contributions to chemical education at the College level.
   In selecting the recipient of the Award, the committee shall consider primarily the contributions of the nominee to enhancing the quality of teaching in an area of chemistry, biochemistry, or chemical technology. Meritorious contributions to furthering chemical education through C3 is also to receive due consideration.
2. The Award shall be presented at the annual College Chemistry Canada Inc. (C3) Conference with the appropriate ceremony and publicity.
3. The Award shall consist of an appropriate scroll and $600.00 to assist the award winner to attend the annual C3 Conference.
4. The Award winner must be a member of C3 in good standing and have been a member of C3 for the past five (5) consecutive years.
5. Nominations for the Award must be submitted in writing to the Secretary of C3 by January 1 of the year the award is to be presented. The nominations shall include a detailed description of the contributions of the candidate to chemical education and to the C3 organization. Each nomination is to remain in effect for three years. Each nomination is to be accompanied by three letters of recommendation from peers of the nominee.
6. The Selection Committee for the Award shall consist of the President, Past President or President Elect, Secretary, Treasurer and Editor of College Chemistry Canada. ❒

C3 Awards Presented at NAIT

The Northern Alberta Institute of Technology has presented the College Chemistry Canada Awards to two of its Chemistry Technology students, Michael Wilchewski and Dilbir Banipal. These awards, in the amount of $300 each, are given to the two students who demonstrate the greatest improvement in academic acheivement between the first and second semesters of the programme.

The money for these awards comes from the interest earned in a trust account that was set up from some of the proceeds from the C3 Conference which was held at NAIT a few years ago. ❒

Ontario Colleges Conference

Centennial College in Scarborough will be the location of a conference for faculty and technical support staff of Ontario Colleges in the biological, chemical, environmental, and related programs. The conference will be held on June 4 and 5 and will have as its theme "Cooperation and Survival". A number of workshops are planned over the two days including ones on funding, better recruitment, and linking with industry. The cost of the conference is $50 which includes lunches and a mixer. To be place on the mailing list, contact Mary Clare Lambden, Registration, Applied Science Programs Conference, Chemical Engineering Technology Department, Centennial College, P.O. Box 631, Station A, Scarborough, ON, M1K 5E9 or phone (416) 439-7180 ext 2360. ❒

Notice of Business Meetings

College Chemistry Canada Inc.

Capilano College, North Cafeteria

Thursday June 14th

2:00 pm: C3 Executive Meeting
3:00 pm: C3 Board of Directors Meeting
5:00 pm: C3/2YC3 Joint Board Dinner

Saturday June 16th

4:00 pm: C3 Annual General Meeting

Nominations will be received for the following positions at the C3 AGM: Conference Coordinator (1 year term), Program Coordinator (1 year term) Editor of the C3 Newsletter (2 year term), CIC Liaison (1 year term), 2YC3 Liaison (1 year term), Regional Directors (1 year term, two positions each region): Atlantic Provinces; Quebec; Ontario; MB, SK, AB, NWT; BC, Yukon.

PROBLEM SOLVING CHEMISTRY

AN APPROACH TO THE TEACHING OF EXPERIMENTAL SCIENCE

By Gary Wilson
John Abbott College

It began for Harry Wilson, as a search for a better way to teach laboratory exercises. The members of the Chemistry Department at John Abbott had long since abandoned "recipe" or "cookbook" lab procedures, and had developed a wide variety of laboratory exercises tailored to its four semester chemistry program, and to its available equipment. In addition, the integration of experimental work within the "complementary" science-for-the-non-science-student courses had proven popular. "Desk Top Experiments" had been successful at the introductory course level; their full set of course modules which integrated lab and theory, placed significant emphasis on the importance of chemistry as an experimental science. Experimental work and its demonstration became the trademark of the department's team teaching efforts. Indeed, the policies of the department stipulated that a student must pass the course laboratory component, regardless of performance on theory, in order to pass chemistry at John Abbott. Clearly, the department placed a high priority on the teaching of chemistry as an experimental science.

It was in this environment that Harry proposed to eliminate the laboratory manual. Rather than have students follow a lab exercise which outlined the theory and procedure, as well as the format and content of the results and conclusions, students would, each week, be presented with a *problem*. A short manual would describe the chemical and equipment resources available for the entire course. The *students* would design the experiment. The *students* would solve the problem.

That's how it started. Harry began a collection of problems, distilled from the literature, and written out ironically on three by five inch recipe cards. Assistance from other teachers and technicians helped to build this collection, now to number in the hundreds.

At the College Chemistry Canada Conference held at John Abbott College in 1984, Harry presented a paper which outlined the new technique, and gave examples of some of its successes and difficulties. His original implementation had been with an upper level course, and there was some scepticism about its effectiveness at the introductory levels. In the five years since that conference, significant changes have been introduced and tested.

Harry defined a particular challenge involving the integration of experimental and theoretical work. While the Desk Top Experiment technique had brought laboratory work directly into the classroom, this new technique brought classroom work directly into the laboratory. The distinction between the lecture and laboratory had become blurred. He found that it was not enough simply to run "Problem Solving Labs"; in order to meet his vision of success, the "lectures" must encompass the philosophical approach of the laboratory work. Thus, his lectures became a series of problem solving exercises as well.

> *Rather than have the students follow a lab exercise...students would, each week, be presented with a problem. The students would design the experiment.*

Harry had always argued that students can make no sense of the theoretical framework of chemistry without some very concrete experience with experimental results. It had been one of his successes to convince the department of this fact. The department had, early in its history, changed the ministry of education's recommended course sequence as a consequence. A significant number of its teachers also routinely outlined experimental results as a prerequisite to the introduction of the model used to interpret them. Harry has carried this concept one step farther. The laboratory is now at the centre of the course. Lectures, workshops and seminars serve to illuminate the lab work. The solving of problems is the *process* used. Chemistry provides the illustrative examples.

An outcome of this approach is that not only has the need for the traditional lab book been eliminated, Harry's students are no longer required to purchase a textbook. Publishing companies will be pleased to know that students still buy the optional text, but teachers will be pleased to know that the students use it usually only as an adjunct to their prime resource, the library.

And what about the students at the introductory levels? They do just fine thanks. Harry has introduced Problem Solving Chemistry to each course in the roster. One cohort of students has now had the opportunity to take the complete sequence of courses, and student success stories provide some evidence of the strength of this approach. But first, how is the technique organized at this point in its development ?

Student material consists of an optional text and three manuals for each course. The text is that currently identified as the course text and is chosen to ensure its usefulness over a two semester course sequence. The key materials are the three manuals. The first, "The Student Guide" presents an illustrated description of the problem solving approach and is a common guide to the courses taught using this technique. Chapter headings include Laboratory Safety, Apparatus Guide, Instruments, and Practical Techniques. The course material itself is presented in "Problem Solving Chemistry". Unique to each course, this manual outlines the essential course material, and the information absolutely required to solve the problems in the "Problem Pack" (manual three). The "Problem Pack" is the cornerstone of the course and it contains the Problem Solving Labs (P.S.L.), and Problems Not Exercises

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Problem Solving Chemistry *Continued from page 4*

(P.N.E.). The P.S.L.'s give the students practice in experimental design and practical problem solving. The P.N.E.'s give the student practice in the treatment and interpretation of data. Both Labs and Exercises come from the current and historical literature, or are invented; they are carefully chosen so that their solutions illustrate the chemical principles within the course. They require that the students read, consult (each other as well as the teacher), and question. They require that the student manipulates data. Their solutions require critical and often original thought.

The Problem Solving Lab; what a difference from what we grew up with. A typical exercise at the introductory level consists, in its entirety of the following:

PROBLEM:

To determine the density of an unknown liquid using a graphical procedure.

CHEMICALS AVAILABLE:

(i) Unknown liquid
(ii) Distilled water

APPARATUS:

(i) 25.00 mL burette
(ii) 50 mL erlenmeyer
(iii) Funnel

INSTRUMENTS:

(i) Top loading electronic balance

Hints are part of the problem definition. They may be implied as in the example given, or they may be explicit. Safety hazards are always outlined. The problem may seem simple enough, but to solve it using a graphical method requires the student to gain some insight of experimental procedure.

"It must be nice to have the students learn everything on their own." It would be nice, if it were true. If anything, it increases the time that the teacher spends with students. As a prime resource, the teacher is constantly in student demand. The plus side of this constant demand is the lack of extra pressure "just before finals".

Do Harry's students learn any chemistry? He encourages his students to write the "Chem 13" exam, sponsored by the University of Waterloo; they all place in the 95th percentile or above. He offers this challenge as an exercise to *any* of his classes and does not screen his invitations. For the past two years Harry has encouraged his students as well, to write the exams necessary to be considered for a spot on the four person Canadian team to enter the Chemical Olympics. This international event attracts top scholars from around the world and has spawned "training camps" to prepare candidates to represent their countries. In the spring of 1988, Julia Kubanek, one of Harry's students and daughter of a long standing C3 member won a bronze medal at the Chemical Olympics held in Helsinki, Finland. In the spring of 1989, of the three Quebec representatives to the Canadian team selection competition held in Vancouver, two were from Harry's class. Marilena Fitzsimons was selected as a team member and at the Olympics held in Halle, East Germany, she won a silver medal. She was the top placing North American student, and the top woman in the world. The Gazette, the Montreal English daily newspaper published a three column article entitled "WORLDBEATER" and which included the following quotations:

How did she get so smart? "You have to have some ability to do science but you also have to work hard," she replied.

Fitzsimons said she spends at least eight hours a weekstudying chemistry.

Does she enjoy the study of chemistry? You bet!

In 1986, Harry published an article on Problem Solving Chemistry in the Journal of Chemical Education (1). As regular class exercises, groups of students were presented with series of Problems to solve, and one from the literature was repeatable, almost. One group's resulting investigations have been accepted for publication in the Journal of Chemical Education and will appear under the title "NMR Analysis of Product Mixtures in Electrophilic Aromatic Substitution" (2). I think Harry has something here. In their acknowledgements the students write:

The authors would like to thank Dr. Harold Wilson, whose unique approach to teaching chemistry has given us the opportunity and ability to solve lab problems.

The 1990 College Chemistry Canada conference is to be held at Capilano College in North Vancouver. I hope that I have persuaded Harry to give a follow-up paper to the one presented in 1984. I have left some of the interesting Problems out of this discussion. These are best answered by Harry himself. See you in Vancouver. You too Harry. ❐

Acknowledgements

Thanks Harry

References

1. Wilson H., *J. Chem. Educ.*, 63, 510, (1986)
2. Clark M.A., Duns G., Golberg D., Karwowska A., Turgeon A., and Turley J., *J. Chem. Educ.* in publ.

Chemical Charges

By Bob Perkins
Kwantlen College

Do you know what a selective lie is? Several years ago, some of my students observed that as they progressed through the sequence of chemistry courses from Grade 11 equivalency to second year physical/inorganic chemistry and organic chemistry that the rules of the game seem to change from one course to the next. Of course I said, that is indeed the case as it is impossible to tell you the truth, the whole truth, and nothing but the truth concerning all topics at all times. The next course may examine a topic from a point of view which is different than the one in the present course, and leave you somewhat confused about what had been presented in the lower level course. The students then indicated that if they had not been lied to, then at least someone had been bending the truth. We decided that **selective lie** best described the situation, and the term has stuck to become part of my teaching. When we come to a topic in which I know some confusion will arise at a later date, I indicate that a selective lie is about to appear. It is not really, but I use the opportunity to explain that we often use different conventions, theories, hypotheses to account for the world around us, and that quite often, one theory is not sufficient to rationalize all observations.

One such area involves the word **charge** and what it means to different levels of students. The beginning student learns that atoms are composed of three sub-atomic particles, and if one has a sample of a pure element, then all atoms of that element are neutral. Once an element undergoes a chemical reaction, it is only the electrons which are involved. If a metal and a nonmetal react, cations and anions are formed from the transfer of valence electrons. An atom of magnesium (12 protons and 12 electrons) will form a Mg^{2+} cation (12 protons and 10 electrons) whether the nucleus of the atom contains 12, 13, or 14 neutrons (the three naturally occurring isotopes). An atom of sulfur (16 protons and 16 electrons) would gain these two electrons to form an S^{2-} anion (16 protons and 18 electrons) whether the nucleus of the atom contains 16, 17, 18, or 20 neutrons (the four naturally occurring isotopes). Thus for the beginning student, charge (I use the term **actual charge**) is easy to understand, simply the difference between the number of protons and electrons.

The concept of a polyatomic anion like sulfate SO_4^{2-} does not pose a significant problem as the 2- charge is still a result of the extra two electrons relative to the number of protons (50 to 48). The problems arise when the student is confronted with the problem of the structure of the sulfate anion, or its use in a redox reaction. Unlike the **actual charge** of 2- the terms **formal charge** and **oxidation number** do not refer to any real property of the sulfate anion. They are rather merely different ways of examining the same anion, each based on different assumptions.

> *"When we come to a topic in which I know some confusion will arise at a later date, I indicate that a selective lie is about to appear."*

Formal charge is the charge assigned to an atom in a Lewis Structure based on the **assumption that the bonding in the structure is covalent in nature**. The number of electrons contributed to the structure by an atom is compared to the number of valence electrons held by the neutral isolated atom, any difference will lead to the postulation of a formal charge for that atom. If the sulfur atom is connected to the four oxygen atoms via single bonds in the sulfate anion, then the sulfur atom will have contributed four electrons to the structure, and be assigned a formal charge of 2+ as a neutal sulfur atom has six valence electrons. Each oxygen atom would then be assigned a formal charge of 1- on the basis of having contributed seven electrons to the structure. They are all imaginary charges since we cannot determine the exact location of the electrons in the anion, proposing a different Lewis Structure will lead to the assignment of different formal charges. If the sulfur atom has three single bonds and one double bond to the oxygen atom, then we would assign a formal charge of 1+ to the sulfur atom. We could continue the process of drawing different Lewis Structures until we had four double bonds and a formal charge of 2- for the sulfur atom. All the Lewis Structures would have the same feature in common, that is the tetrahedral shape, but we could indicate the exact location of the electrons.

When we are considering the redox chemistry of the sulfate anion, oxidation numbers are used as a book-keeping tool to indicate how many electrons are involved in a particular half-reaction. Here the **assumption is that the bonding is ionic in nature,** and that the more electronegative element has become the anion. The oxidation number refers to the number of electrons gained or lost by the element in forming the compound or ion under consideration. The sum of the oxidation numbers of all the atoms must equal the actual charge on the compound or ion. Thus for the sulfate anion, the oxidation number of sulfur will be 6+. If the reaction converts the sulfate anion SO_4^{2-} to the sulfite anion SO_3^{2-} (oxidation number of 4+ for sulfur) we can readily see that two electrons have been transferred in the process. We can also use the fact that sulfur only has six valence electrons to rationalize the experimental fact that the sulfate anion cannot function as a reducing agent (and in the process becoming oxidized), the sulfur atom has already achieved its highest oxidation number of 6+.

Students who can see how these three types of chemical charges may be used to describe the same species will be better able to understand that chemistry is not simply a collection of facts to be memorized. A certain percentage are uncertain about some of the material in our courses because of their inability to separate fact from theory. I have used the term **selective lie** to flag areas where assumptions about the way in which we view a molecule or an ion may prejudice the way in which a student answers a given problem. Many other examples exist in our courses, it would be incongruous of us as instructors not to fully explain some of the assumptions which have been made "behind the scenes" before the material has appeared in the textbook. It might help to answer one of the common themes of our courses: **"That's not what my high school chem teacher taught us"**. The high school teacher has not taught the students something which is incorrect

Chemistry Instruction

From an artilce by B. Wruck and J. Reinstein, *J. Chem. Educ.* **66**, p1029-1030, 1989:

Hypothesis One:

The amount of effort put forward by the students is inversely proportional to their prior exposure to the material.

Hypothesis Two:

The amount of work carried out by the student in class and outside of class is inversely proportional to the effort and intensity of the instructor.

Hypothesis Three:

The lecture material has no application whatsoever to the general chemistry laboratory; or, to put it another way, the laboratory is not the real world of chemistry.

Hypothesis Four:

The less the student gives, the more the student expects.

A thought-provoking article which every instuctor should read.

Submitted by Bob Perkins

(we hope), but rather they have misunderstood the nature of the **"selective lie"** which may have taken place during the presentation of the material. ❐

College Chemistry Canada / La Chimie Collégiale au Canada

Application for Membership

Name: ______________________________

College Affiliation: ______________________________

Position: ______________________________

Address: ______________________________

City: ______________ *Province* ____________ *Postal Code* __________

Renewal _____ *New Member* _____

Individual Membership: $20.00 per year, payable annually in March
Membership Fee for Institutions: $50.00

Method of Payment: Cheque _____ Money Order_____

Please return this form, with payment, to:

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