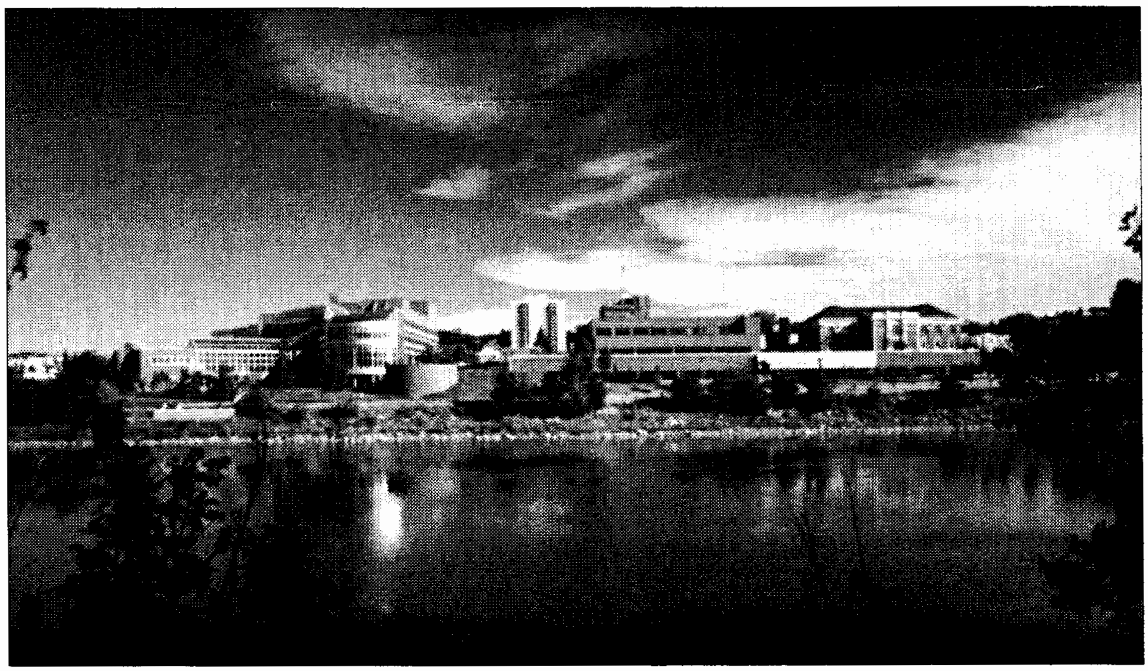
Spring 1998

C3 News

Newsletter of College Chemistry Canada / La Chemie Collégiale au Canada

Chemistry under the tepee



A view across the South Saskatchewan River towards Downtown Medicine Hat (City Hall and the Courthouse)

General information

Medicine Hat is situated in the south-east corner of Alberta, surrounded by ranches that raise prime Alberta beef. It is also known as the Gas City since it sits on top of a natural gas field, inspiring Rudyard Kipling in 1907 to describe the city as possessing "all hell for a basement." It is now home to the world's tallest tepee. Used during the 1988 Winter Olympics in Calgary, the tepee was moved to Medicine Hat where it stands as a symbol of native heritage on the site of an ancient buffalo camp.

Medicine Hat College was established in 1965 and moved to its present location in 1971. It provides a broad curriculum which includes university transfer, certificate and diploma programs, apprenticeship and college preparation to over 2,000 students. A satellite campus is located at Brooks, one hour's drive west of "the Hat".

Medicine Hat is known as the sunniest spot in Alberta and at the end of May the days should be warm and dry (average temperature 20°C). Bring a sweater or jacket for the "cooler evenings".

See page 4 for complete conference details.

In this issue

C_3 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 3.5" disk, Mac or IBM format using Microsoft Word 6.0, or IBM format using WordPerfect 6.0 or lower, or any word processor producing ASCII output.

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Designed by R. Franchuk

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President's message

Here we are, it is finally March, and all around my college you can hear both the faculty and students crying out....Only five more weeks to go! Which means: only five more weeks to finish covering all the material, three more term exams and three finals to prepare, only five more weeks until P.D. starts, and less than two months until the C3 conference.

Around here anyways, I think everyone is looking forward to some time to recover, relax, and re-energize, and of course to re-connect with colleagues from across the country. I hope to see many of you at this year's conference, the conference planners sound like they will have a great program for us. I would also like to remind (and formally notify) everyone of the elections that will be taking place this year. In following our rotating cycle of elections to the executive, this year we need to elect a new Editor, as well as regional directors for the Board.

Nominations for both of these positions can be submitted to any executive member prior to the AGM. It is not necessary for the nominee to attend the conference, so if you are interested in becoming a regional director (or Editor) and you are unable to attend the conference, please contact an executive member before the conference. So, start making those travel plans, put together that presentation proposal (and send it to the folks at Medicine Hat), and remember Spring is on its way! I can hear my marking calling, so until next issue........

Suzanne Pearce

"If you can speel at a grade eight level and have a pulse send your name to We-desparately-need-an–Editor!"

Nominees Needed!

C_3 is looking for new Regional Directors and a new Editor for C_3 News to start in the upcoming year. If you are interested and would like to get more involved, please contact any of the members on the executive (addresses on page 8) before the conference in Medicine Hat on May 28-30.

Renewals

If you would like to continue receiving C_3 News, please remember to renew your annual membership. Forward a $20 cheque to the Treasurer, Jacky McGuire, payable to "College Chemistry Canada."

A Convenient Classroom Stoichiometry Experiment

John Teggins and Chris Mahaffy, Auburn University at Montgomery

Stoichiometry calculations involving mass relationships among reactants and products in an equation are of fundamental importance at all levels of chemical education. For example, the thermal decomposition of potassium chlorate to produce potassium chloride and oxygen has been used for this purpose in many basic laboratory manuals. There are situations such as demonstrations outside of a formal laboratory setting where it is beneficial to illustrate this concept using safe readily available reactants at room temperature. We have found that the following procedure meets the above criteria.

The basic reaction involves adding water to a mixture of solid sodium bicarbonate and citric acid. The evolved carbon dioxide is trapped in a balloon. The volume of this balloon is then measured by water displacement in a beaker. In circumstances where citric acid is not available, lemon-flavoured Kool-Aid is an effective alternate.

Approximately 500 mg. of sodium bicarbonate is accurately weighed. This is transferred with an excess of citric acid to a test tube which has a lip. The reactants are mixed by shaking. A suitably-sized spherical balloon containing about 5 mL. of water is attached to the lip of the test-tube as illustrated in Plate 1.

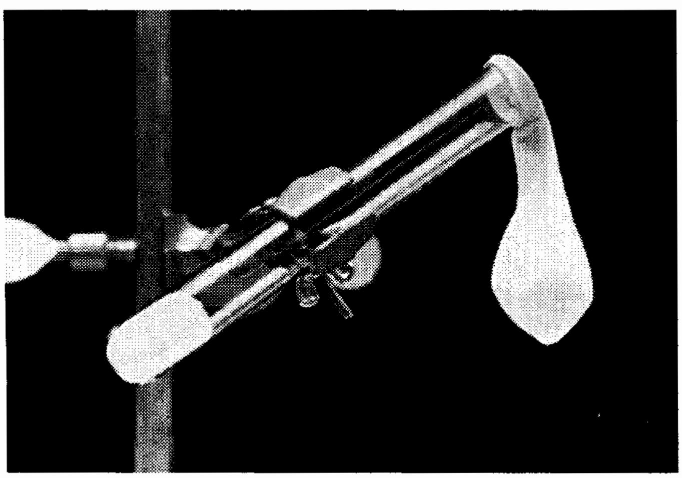

Plate 1: Setting up the experiment

Inversion of the balloon initiates the reaction which proceeds to completion. The evolved carbon dioxide expands the balloon as seen in Plate 2. About 250 mL. of water is placed in a large beaker and the water level is marked on the outside of the beaker. The balloon attached to the test-tube is then immersed into the water until the water level reaches the lip of the test-tube as is seen in Plate 3. This level is marked with a permanent marker. After removal of the rest-tube and balloon the volume between the two marks is determined by addition of water from a graduated cylinder.

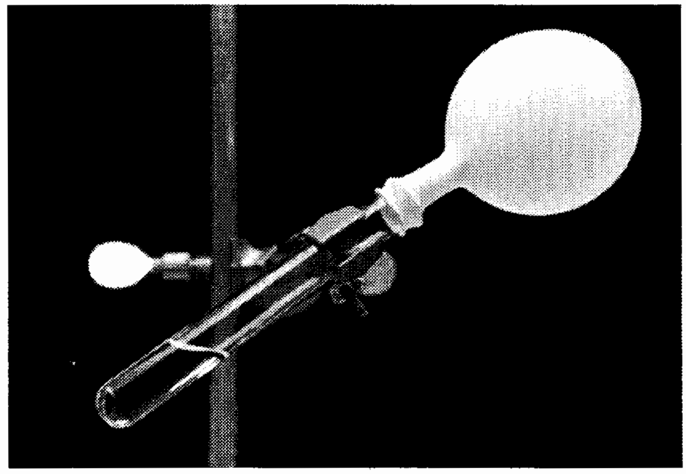

Plate 2: Collecting the CO_2

Either the number of milliliters of carbon dioxide per gram of sodium bicarbonate or the mole ratios of the reactants can be calculated. The entire procedure can now be repeated with a mixture of sodium bicarbonate and inert sodium chloride replacing the original pure sodium bicarbonate. The composition of this unknown mixture can then be determined from the volume of carbon dioxide evolved by the reaction.

The experiment produces reasonably accurate results if the same balloon is used for both parts of the experiment and the 'unknown' mixture contains at least 70% sodium bicarbonate. Under these circumstances both samples of gas are produced at comparable pressures. The main advantage of the experiment involve the facts that safe readily-available inexpensive materials are employed that produce no waste disposal problems. Consequently, data to be employed in a valid stoichiometry calculation can be generated in any location.

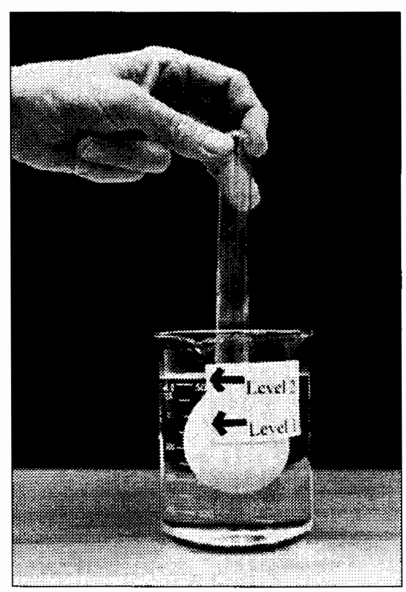

Plate 3: Measuring the displaced volume

25th Conference of College Chemistry Canada

MAY 28 - 30, 1998 Medicine Hat College, Medicine Hat, Alberta

Transportation

By air

Medicine Hat has an airport which is serviced by Air Canada through their partner Air B.C. and by Canadian Airlines through their partner Canadian Regional.

Official Carrier

Canadian Airlines International and their regional partners have been selected as the Official Carrier for the Conference. Canadian Airlines Conventionair Reservations Office will guarantee you 35% off the full economy fare and even greater savings for advance booking (certain purchase requirements apply).

Delegates are strongly urged to contact the Conventionair Office toll-free at 1-800-665-5554 and quote the College Chemistry Canada file number M02133 when making reservations.

If you are staying at the conference hotel there is a courtesy taxi service from the airport. A taxi ride from the airport to the college campus costs $7.00.

Car rentals can be arranged through Budget. Advanced booking is advised (1-403-527-7368).

By road

Medicine Hat is situated on the Trans Canada Highway three hours drive east of Calgary and six hours drive west of Regina. The college campus and the conference hotel are both situated just north of the highway and are well sign-posted. There is ample parking available on campus at no charge.

Accommodation

The official conference hotel is the Medicine Hat Lodge, which is offering a conference rate of $84 per night (tax included). All major credit cards are accepted. For reservations please book directly with the hotel.

In Canada (toll free) 1-800-661-8095
Outside Canada (collect) 1-403-529-2222

*Be sure to indicate that you are making a registration for the C3 conference. Taxi fare between the hotel and college currently costs $6.00.

Accommodation is also available in the Medicine Hat College Student Residence at a cost of $21.00 per night (tax included). Registrants will have a private room in a 4-bedroom unit that includes 2 bathrooms and a sitting room. Please note that, except for conference events, there is a limited food service on campus, including continental breakfast (coffee, juice, assorted pastries) for residence guests. The residence is 5 minutes walk from the main campus. Reservations should be requested on the Conference Registration Form.

Applications for accommodation should be made as soon as possible as space and rates are not guaranteed after May 1st.

There are other hotels in town: the Travelodge (tel. 403-527-2275 or 1-800-403-442-8279; the Imperial Inn (tel. 403-527-8811 or 1-800-661-5322; and the Best Western Inn (tel. 403-527-3700 or 1-800-528-1234). None of the hotels are within easy walking distance of the college.

Field trip

A field trip "On the Trail of the Dinosaurs" has been planned for Sunday, May 31st. This will include a visit to Dinosaur Provincial Park (a UNESCO World Heritage Site) to see the badlands topography and the area where many important dinosaurs have been discovered, lunch at a local inn followed by a tour of the Royal Tyrrell Museum of Paleontology at Drumheller where you will have a chance to see the dinosaurs "face to face".

Conference highlights

Thursday, May 28

- registration
- wine and cheese reception

Friday, May 29

- Presentations from local industry and the Defense Research Establishment at Suffield
- banquet featuring Alberta prime rib

Saturday, May 30

- fun run to the tepee
- presentations on chemical education

Sunday, May 31

- Field trip to Dinosaur Provincial Park and the Royal Tyrrell Museum

For more information contact:
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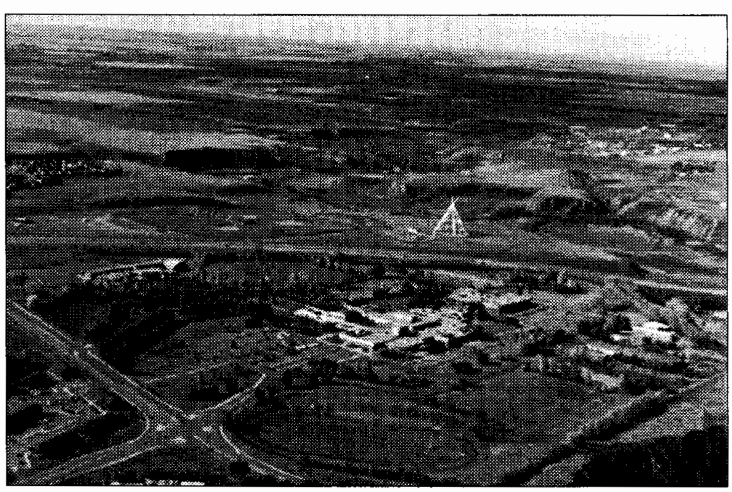

Aerial view of campus, with tepee and coulees in background. College residences in lower left corner.

Curriculum design for introductory environmental chemistry

Nigel J. Bunce, University of Guelph

The appropriate chemistry curriculum for students in their first year of post-secondary education is a perennial topic for discussion, as can be seen by perusing journals such as *Journal of Chemical Education.* Textbooks at this level have become ever larger, now running to 1000 pages and weighing a couple of kg. This makes the book, and by extension the chemistry course, daunting to the first year student, who imagines on the first day of class that everything in the book must be learned. In addition, the content of traditional chemistry courses at this level tends to be very "principles-oriented" and removed from real life; as a result, students fail to appreciate the importance of chemistry in their everyday lives.

It has long been my belief that more effort should be made to include chemistry of societal importance into the curriculum, and I have written about this subject elsewhere. It is profoundly unsatisfying to me that the typical student, home for the summer vacation, would not know the chemistry associated with stratospheric ozone depletion; all s/he would know about ozone from the first-year course would be that it has an angular geometry and a dipole moment. Textbooks in recent years have made some effort to include descriptive material, but this is very clearly labelled "not important" by being relegated to special "boxes" on the page or to "interchapters". Most tellingly, the assigned problems typically do not reflect this material, and neither for the most part do our exams.

A few years ago, I had the opportunity to develop a freshman course in environmental chemistry as part of my department's contribution to a (then) new degree program offered by the University of Guelph: the B.Sc. in environmental science. This is a full year program taken by all students registered in the B.Sc.(Env). The purpose of this article is to narrate some of the thinking that underlies the curriculum of that course.The following questions surround the issue at hand.

1. What material should be presented to students in their freshman chemistry course?
2. Should environmental chemistry be part of the curriculum of the generalist course?
3. Should students in Environmental Science programs take the same chemistry course as other science students, or should they be offered a course directed more specifically to environmental issues?

Question (1) raises the more general issue of how course content should be distributed between principles and descriptive chemistry. Instructors' desires to include "relevant" material in their courses is restricted because the traditional curriculum is very crowded. In trying to decide what to include, we have to take note of the fact that most students in any freshman class are not planning to be chemists; they may be prospective biologists, engineers etc. Some may not even practice science directly after graduation, but may become policy-makers, politicians, and journalists. We can hardly wonder at the negative press accorded to chemistry when we recall how bored these folks were in the freshman chem class, possibly their last exposure to the subject.

On Question (2), I would argue an unequivocal "yes", on the grounds that this is the chemistry reported in the newspapers and on TV; it is inherently interesting, and from our perspective as teachers has the advantage that much of it involves small molecules that are already part of the curriculum. This is not true if we decide to excite the students' interests by covering biochemistry or rational drug design in first year.

Question (3) could go either way, presupposing that the generalist course included a significant content of environmental chemistry. However, I have already noted that the choice at Guelph was to develop a special course for the environmental students, leaving the generalist course more traditionally oriented towards chemical principles.

It was immediately clear that if environmental topics were to be included into the freshman curriculum, something else had to go to make room for them. The following seemed to be "must have" topics in any freshman curriculum (environmental or "regular"). The indented topics could be regarded as related to thermodynamics, but in practice they are taught independently in first year courses.

- Stoichiometry (how much?)
- Thermodynamics (how energetic?)
- Kinetics (how fast?)
- Equilibrium
- Electrochemistry

Next are the major topics that were omitted, with a brief justification.

- Atomic and molecular structure (atomic structures of atoms, Lewis structures, geometry, MOs and hybrid orbitals)
- Organic chemistry
- Transition metal chemistry

We have taught our introductory environmental chemistry course successfully assuming a knowledge only of valence, reinforced by the periodic table, and the concepts of ionic and covalent compounds. Personally, I would cheerfully remove atomic and molecular structure from the regular freshman program also, on the grounds that (a) all Canadian students have previously met concepts of bonding in high school; (b) the typical freshman course does not significantly amplify what was taught in high school; (c) very few students in the first year chemistry course plan to become chemists and will have no use for this material (does the average biologist care about the electronic structure of Cr^{2+}?). Instead, structure and bonding should be taken up in a second year course aimed at chemistry specialists.

It is frequently argued by organic chemists that geometry and hybrid orbitals are needed in order to introduce organic chemistry. However, this subject is covered in all standard organic chemistry texts, and can therefore be left to the organic chemistry course. Organic chemistry at the first year level is often little more than a boring litany of nomenclature, which can likewise be deferred to a course in organic chemistry; the same argument can be made about teaching transition metal chemistry in first year as a potted account of crystal field theory, from which most students take away zero in understanding.

Finally, having created some space in the curriculum, what should be inserted? As an aside, I note that what follows relates specifically to an environmentally oriented course. It would be equally possible to fill in the spaces by pursuing other avenues of chemistry, keeping in mind the needs of the target student audience in their future programs, and the desire to present chemistry as alive and interesting. After all, we would like to keep our students on the edges of their seats, rather than have them fall off their seats.

Here are some possible environmental topics that could be covered at the first year level.

- Atmospheric chemistry, including some or all of
  - Global warming
  - Stratospheric ozone depletion
  - Pollution by tropospheric ozone
- Acidic emissions/acid precipitation
- Water and water pollution; BOD
- Environmental problems of the mining industry
- Environmental problems of electrochemical processes
- Environmental problems of the energy industry
- Environmental problems of the pulp and paper industry

There was not sufficient time in the course developed at the University of Guelph to cover all of these, and the last two were omitted. Seventeen units are covered during two semesters; these will be discussed briefly.

Unit 1: Introduction to Environmental Chemistry. This unit includes brief reviews of ionic/covalent bonding, nomenclature, SI units, dimensional analysis and significant figures. Environmental topics in this unit introduce the concepts of compartments of the environment (lithosphere, hydrosphere, atmosphere), and residence times for transport between compartments.

Unit 2: Mole Relationships. In this unit we present a standard treatment on mass/mole calculations, molecular formula, % composition, and solutions. Environmental flavour is added through examples, particularly "environmental" quantities of substances (Tmol to pmol); additionally, concentrations in ppm and ppb are related to the "chemists' units" of moles per liter.

Unit 3: Chemical Equations and Chemical Reactions. Again, this is a standard treatment of mass/mole relations, sequential reactions, limiting reactants, percent yield, and material balance. Principles of gravimetric, volumetric, and instrumental analysis are presented briefly in order to link the lecture material to the laboratory course.

Unit 4: Industrial Processes. In this unit, stoichiometry is applied to high volume chemical products (the Top 50 published annually by *Chemical and Engineering News*). Chemical pollution is discussed in the context of yield maximization and waste minimization in industrial processes.

Unit 5: Energetics in Chemical Reactions, Part I. A standard treatment of thermochemistry is supplemented by discussions of fuels and combustion, and the energetics of photochemical reactions. The latter topic is needed for subsequent discussions of the energetics of chemical reactions in the atmosphere.

Unit 6: Gases and the Atmosphere. The properties of gases, including the ideal gas equation, concentrations in ppmv and ppbv, and enthalpies of vaporization and sublimation; these topics are followed by discussion of the major and minor components of the atmosphere, temperature regulation of the atmosphere, greenhouse gases and climate change.

Unit 7: Kinetics. In addition to the standard topics of first and second order reactions and their integrated forms, emphasis is placed on second order reactions of the type $A + B \rightarrow$ products (rather than the uncommon $2A \rightarrow$ products) and pseudo-1st order reactions, including the cases where reactant B is present in large excess, or reactant B is continuously regenerated. Both these cases are common in atmospheric chemistry. Standard treatments of kinetics vs. mechanism, activation energy and catalysis are presented. Half-lives and lifetimes are related to the residence times developed in Unit 1.

Unit 8: Gas Phase equilibria. This unit is mostly illustrated through four reactions of commercial importance: the Haber process for NH_3, contact process for SO_3, decomposition of $CaCO_3$, and Mond process for $Ni(CO)_4$. Calculations are introduced by the method of successive approximations; systems not at equilibrium are discussed by means of Le Chatelier's principle and the concept of reaction quotient.

Unit 9: Photochemical Smog and Ground Level Ozone. This unit comprises the formation of the hydroxyl radical and its role in the oxidation of tropospheric gases, the nature and mechanism of formation of photochemical smog, vehicular emission controls and catalytic converters, along with the rationale for the elimination of lead from gasoline.

Unit 10: Water. As the principal solvent on the planet, the chemistry of water is of immense importance. Topics discussed include water quality, hard vs. soft water and water softening, osmosis and reverse osmosis, and drinking water quality.

Unit 11: Acids and Bases. Besides a standard treatment of weak acids, weak bases, and buffers, we emphasize bicarbonate buffers (pH control in blood and in natural water) rather than acetate buffers, and introduce the concepts of speciation diagrams and alkalinity.

Unit 12: Solubility Equilibria. Most of Unit 12 does not appear in standard texts. Its three topics are gas-solution equilibria (Henry's Law, BOD), solubility equilibria (with recognition that simple K_{sp} calculations give only very approximate answers), and partition equilibria, including K_{ow}.

Unit 13: Acid Rain. This treatment of the sources and chemistry of acid rain builds directly on concepts from Units 11 and 12; the mechanism of oxidation of SO_2 builds upon the material of Units 7 and 9. The unit concludes with a discussion of the effects of acidic precipitation and abatement strategies.

Unit 14: Energetics in Chemical Reactions, Part II. This is a standard treatment introducing entropy and free energy. We make the important distinction between ΔG and $\Delta G^{\circ\circ}$, because processes of environmental interest virtually never involve standard state conditions. $\Delta G^{\circ\circ}$ is related to the equilibrium constant, following which the rationale underlying Le Chatelier's principle is reviewed, particularly in the context of the solubilities of solids, liquids, and gases in water.

Unit 15: Stratospheric Ozone Depletion. Descriptive material includes the "ozone layer", polar ozone holes, CFCs and the Montréal Protocol, and CFC replacements. The formation and destruction of ozone is introduced mechanistically, and the atmospheric concentration is recognized as a non-equilibrium steady state that is kept from equilibrium by the absorption of solar energy.

Unit 16: Electrochemistry. Conceptual topics include redox chemistry, the Nernst equation, and electrolytic reactions. Topics of environmental interest include batteries, electric cars and fuel cells, as well as industrial electrolytic reactions and their environmental problems, such as Cl_2 production and electroplating.

Unit 17: Metals and Mining. This is a topic that has largely disappeared from the conventional curriculum, yet is of enormous commercial and environmental importance. It comprises the occurrence, extraction and use of metals, corrosion, metal toxicity, and acid mine drainage.

We have attempted to produce a course with two guiding principles. First, that concepts are used in a practical and environmental context as they are introduced. Second, that the "environmental" material is not relegated to "assigned reading"; it is an integral part of the course, problems associated with the environmental topics are comparable in number with those associated with the standard chemical principles, and both types of material feature on our examinations. The course has been developed into a textbook [*Introduction to Environmental Chemistry* by N.J. Bunce: Wuerz Publishing, Winnipeg, MB, together with a complete Answer Guide to the problems], whose length is 550 pages and whose mass is < 1 kg.

This article was prepared from a presentation in the symposium "Relevant content for general chemistry" at the 5th North American Chemical Conference, Cancun, Mexico, November 1997.

The BCIT On-line Chemistry Resource Center

Rosamaria Fong, British Columbia Institute of Technology

At the British Columbia Institute of Technology (BCIT), there are up to eleven programs that require high school chemistry 11 or equivalent for admission. Learners that seek enrollment into these programs are often faced with the decision of whether their background knowledge in Chemistry is adequate for entry into a first year Chemistry course at BCIT. A Web-based Chemistry Resource Center was developed under the support of a BCIT Instructional Enhancement Grant. The Uniform Resource Location (URL) for the On-line Chemistry Resource Center is:

http://nobel.scas.bcit.bc.ca/resource/

Its main goal is to establish a base line of adequate Chemistry knowledge for admission into first year programs at BCIT.

The On-line Chemistry Resource Center is an on-line facility available to those who wish to assess and/or upgrade their Chemistry skills. It is a 24-hour on-line multi-media tutor to guide students to solve Chemistry problems, to direct students to find textbook references, and to explore interesting Chemistry links in the World-Wide Web.

The content of the On-line Chemistry Resource Center include:

An On-line Self-Assessment test - The assessment test contains ten multiple-choice questions that learners can submit their answers for on-line instant evaluation. The score that they receive on-line is strictly for their own personal information.

The Element Pages - A descriptive approach is taken to introduce the elements on the Periodic Table, as we know them today.

The Interactive Instant Self-evaluation Problems - Over 500 interactive problems are available on 26 topics of Chemistry. Learners can go through the problems topic-by-topic to identify the areas of Chemistry that require upgrading. The degree of difficulty of all the problems in the Resource Center is about the equivalent of a high school Chemistry 11 course. Therefore, it is the minimum level of Chemistry that students entering a BCIT program requiring Chemistry should have as background knowledge.

The Textbook Reference Pages - Three textbooks are chosen as reference textbooks for this site. Each of the 26 topics of Chemistry is linked to the pages in the textbooks to guide learners in their studies.

A Hypertext Glossary - A hypertext glossary of more than 200 chemical terms is compiled for the convenience of the learners. As various topics are discussed, chemical terms appear as hypertexts, which link learners back to their definitions in the glossary.

The World-Wide Web Links Pages - These pages contain many Chemistry-related sites that learners may find interesting. They include:

- Educational sites
- National Laboratories
- Industrial sites
- Fun! Fun! Fun Sites!

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