Adult Basic Education
Science

Chemistry 2102B

From Structures to Properties

Curriculum Guide

Prerequisites: Chemistry 1102
Chemistry 2102A

Credit Value: 1

Chemistry Concentration

Chemistry 1102
Chemistry 2102A
Chemistry 2102B
Chemistry 2102C
Chemistry 3102A
Chemistry 3102B
Chemistry 3102C

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To the Instructor

I. Introduction to Chemistry 2102B

Chemistry 2102B is the third course in the Chemistry Concentration in the Adult Basic Education program. **Chemistry 1102 and 2102A are pre-requisites to Chemistry 2102B.**

This course studies bonding in detail. It examines the different forces of attraction involved in matter and how they influence properties. Students will investigate the structure and properties of atoms, ions, and molecules, and the natural and synthetic products that result from their interactions.

The knowledge and skills that students acquire in this course are essential for the remainder of the ABE Chemistry courses. Therefore, **Chemistry 2102B is a pre-requisite for all remaining chemistry courses in the chemistry concentration.**

II. Curriculum Guides

Each new ABE Science course has a Curriculum Guide for the instructor and a Study Guide for the student. The Curriculum Guide includes the specific curriculum outcomes for the course. Suggestions for teaching, learning, and assessment are provided to support student achievement of the outcomes. Each course is divided into units. Each unit comprises a **two-page layout of four columns** as illustrated in the figure below. In some cases the four-column spread continues to the next two-page layout.

Curriculum Guide Organization:
The Two-Page, Four-Column Spread

Unit Number - Unit Title		**Unit Number - Unit Title**	
Outcomes Specific curriculum outcomes for the unit.	**Notes for Teaching and Learning** Suggested activities, elaboration of outcomes, and background information.	**Suggestions for Assessment** Suggestions for assessing students' achievement of outcomes.	**Resources** Authorized and recommended resources that address outcomes.

III. Study Guides

The Study Guide provides the student with the name of the text(s) required for the course and specifies the sections and pages that the student will need to refer to in order to complete the required work for the course. It guides the student through the course by assigning relevant reading and providing questions and/or assigning questions from the text or some other resource. Sometimes it also provides important points for students to note. (See the *To the Student* section of the Study Guide for a more detailed explanation of the use of the Study Guides.) The Study Guides are designed to give students some degree of independence in their work. Instructors should note, however, that there is much material in the Curriculum Guides in the *Notes for Teaching and Learning* and *Suggestions for Assessment* columns that is not included in the Study Guide and instructors will need to review this information and decide how to include it.

IV. Resources

Essential Resources

Text: Chemistry; Mustoe, Jansen, et al; McGraw-Hill Ryerson; 2004.

Recommended Resources

Teacher's Resource for McGraw-Hill Ryerson Chemistry (including CD-Rom).

Website for the text:
http://www.mcgrawhill.ca/school/booksites/chemistry/index.php

Chemistry 11/12 Computerized Assessment Banks.

Other Resources

Center for Distance Learning and Innovation:
http://www.cdli.ca/

Department of Education website:
http://www.ed.gov.nl.ca/edu/sp/chem_2202.htm

V. Recommended Evaluation

Written Notes	10%
Labs/Assignments	20%
Test(s)	20%
Final Exam *(entire course)*	50%
	100%

The overall pass mark for the course is 50%.

From Structures to Properties

Unit 1 - Chemical Bonding

Outcomes

1.1 Identify and describe the properties of ionic and molecular compounds and metallic substances.

- 1.1.1 Observe the physical properties of representative samples of molecular, ionic and metallic substances.
- 1.1.2 Tabulate the properties of molecular, ionic and metallic substances.

1.2 Classify ionic, molecular, and metallic substances according to their properties.

- 1.2.1 Use the periodic table as a tool for predicting the formation of ionic and molecular compounds.

1.3 Explain the formation of chemical bonds.

- 1.3.1 Understand that chemical bonds are attractive forces that hold all substances together.
- 1.3.2 Define valence electrons, electron pairing, and unpaired electrons.
- 1.3.3 Draw Lewis structures for elements.

Notes for Teaching and Learning

To introduce this unit, the instructor should provide samples of all three types of substances. The chosen samples should exhibit physical properties which differentiate between each bonding type. Where possible, the instructor should demonstrate these properties using the samples. This activity provides the framework for the approach to the study of each bonding theory that will follow.

Students could be asked to complete the ThoughtLab, 'Ionic or Molecular', p. 161, to challenge them to classify compounds as ionic or molecular and to recognize some of their properties.

Science 1102 develops simplified concepts of electron sharing or exchange in chemical bonds and of how atoms bond based on their electron energy level diagrams. Students should understand how to write electron energy level diagrams and how they relate to the number of valence electrons. Instructors may need to review this with students before they move on. The next step is to convert energy level diagrams into Lewis dot diagrams and use them successfully.

Energy level diagrams for main group elements should also be related to valence electrons and to electron dot symbols. A flame colour lab could be performed so that students understand energy level jumps by concrete visual examples.

Suggestions for Assessment

Questions 1.1 - 1.9 in the Study Guide should be assigned to cover Outcomes 1.1 - 1.3.3. Students will find the answers to these questions in Section 5.1 of the text.

Instructors should assess the student's level of understanding by reading student answers to questions from the Study Guide and providing feedback

Full solutions for all *Practice Problems* are in the *Solutions Manual* on the *Teacher's Resource* CD-ROM.

The Center for Distance Learning and Innovation (CDLI) website provides lessons designed for students in high school who will take the Chemistry 2202 course through distance learning. Much of the material available on this site would be useful in delivery of this Adult Basic Education course. Instructors who wish to access this site must obtain a username and password.

Resources

MGH Chemistry, pages 158 - 180.

Teacher's Resource for MGH Chemistry (including CD-Rom).

Chemistry 11/12 Computerized Assessment Bank for MGH Chemistry.

Website for the text: http://www.mcgrawhill.ca/school/booksites/chemistry/index.php

Department of Education website: http://www.edu/.gov.nl.ca/edu/sp/chem_2202.htm

The center for distance learning and innovation (CDLI) website: http://www.cdli.ca/

Outcomes

1.3.4 Explain why noble gases are unreactive and stable.

1.3.5 Explain the octet rule.

1.3.6 Explain the special nature of hydrogen as an exception to the octet rule.

1.4 Explain the formation of ionic bonds.

1.4.1 Predict the ionic charge for ions in the main group elements from their group number and using the octet rule.

1.4.2 Explain the importance of electron transfer in ionic bond formation.

1.4.3 Define ionic crystal lattice, formula unit and empirical formulae as they apply to ionic compounds.

1.4.4 Build models or find images to depict the lattice structure of an ionic compound. e.g., NaCl.

Notes for Teaching and Learning

The octet rule is based upon the concept that a "filled valence level is stable" or a stable atom/ion does not have partially filled valence levels. For this reason, hydrogen may form the hydride ion (H^-) when a hydrogen atom gains an electron, as well as form the more common hydrogen ion (H^+) when the hydrogen atom loses an electron and has no partially filled valence levels.

A common student misconception about ionic compounds is that they exist as separate entities similar to molecules. This does not occur. It is incorrect to say "molecules of NaCl". Instructors should emphasize that an ionic compound's formula is a ratio within a 3-D crystal lattice.

Suggestions for Assessment

Questions 1.10 - 1.20 in the Study Guide should be assigned to cover Outcomes 1.3.4 - 1.6. Students will find the answers to these questions in Section 5.2 of the text.

Resources

MGH Chemistry, pages 165 - 172.

Outcomes

1.5 Explain the formation of covalent bonds.

- 1.5.1 Define covalent bond.
- 1.5.2 Define bonding electron pairs and lone pairs.
- 1.5.3 Define single, double and triple covalent bonds.
- 1.5.4 Define structural formula.
- 1.5.5 Given the molecular formula, draw Lewis dot diagrams and structural formulas for simple molecules containing single, double and triple bonds.

1.6 Explain the formation of metallic bonds.

- 1.6.1 Define metallic bond.
- 1.6.2 Describe the "free electron" model for metallic bonding.

1.7 Recognize the relationships between ionic and covalent bonds.

- 1.7.1 Define electronegativity.

Notes for Teaching and Learning

Students usually have difficulty understanding electronegativity and bond types. Instructors may need to explain these concepts to students and provide additional examples before they will be able to complete the Practice Problems in the text.

Instructors should stress that electronegativity increases across a period and decreases down a group in the periodic table.

Suggestions for Assessment

Questions 1.21 - 1.27 in the Study Guide should be assigned to cover Outcome 1.7. Students will find the answers to these questions in Section 5.3 of the text.

Instructors could choose questions from the Chapter Review and/or Unit Review to assign for additional practice.

Blackline Master 5-3, 'Chapter Test', can be used to assess students' understanding of the concepts covered in Chapter 5.

Resources

MGH Chemistry, pages 165 - 172.

MGH Chemistry, pages 174 - 180.

Blackline Master 5-3, Chapter Test.

Outcomes

1.7.2 Identify trends in electronegativity within periods and families of the periodic table.

1.7.3 Define polar and non-polar covalent bonds.

1.7.4 Define bond dipole.

1.7.5 Compare the strengths of ionic and covalent bonds.

1.7.6 Define bond energy.

Notes for Teaching and Learning

Instructors should ensure that students are aware that they will be provided with a copy of the table of electronegativities when they write a test on this course. They should make sure that students know how to use the table properly.

The CDLI website provides good explanations of all the topics in this course. Instructors could have students go through selected lessons on the website or print selected material for students to study to help them understand the material covered.

Suggestions for Assessment

Instructors will find additional practice problems on the CD-ROM that accompanies the Teacher Resource for the text.

The CDLI website provides a 'Test Yourself' section at the end of each lesson. Instructors could use the questions provided there for assessment of students' understanding of the topics covered in the lesson.

Resources

Teacher's Resource for MGH Chemistry, CD-ROM.

The center for distance learning and innovation website: http://www.cdli.ca/

Unit 2 - Structure and Properties of Substances

Outcomes	Notes for Teaching and Learning
2.1 Draw Lewis structures for simple molecules.	In Outcome 2.1, simple molecules refers to those with 2 electron and 4 electron pairs. It does not include those with co-ordinate bonds or polyatomic ions.
2.2 Explain the structural model of a substance in terms of the various bonds that define it.	Students will likely have problems with the abstract concepts covered in this unit. It would be beneficial to have students work in small groups wherever possible and to explain the concepts to the students before they work through the questions in the study guide.
2.2.1 Explain the three-dimensional nature of molecules using VSEPR theory.	
2.2.2 Determine the shapes about central atoms in simple molecules by applying VSEPR theory.	Investigation 6-A, 'Modelling Molecules', could be done to help students visualize the shapes of molecules. Instructors could use any molecular model kits that might be available.
2.2.3 Identify molecules with molecular polarity based on (i) the presence of lone pairs on the central atom, or (ii) the presence of atoms with different electronegativities attached to the central atom.	Instructors should note that the section on network solids, pages 199 - 200 is not covered in this course.
2.3 Explain hydrogen bonds and van der Waals' forces.	
2.3.1 Compare and contrast intramolecular forces (covalent bonds) with intermolecular forces in terms of strength and species involved.	

Suggestions for Assessment

Questions 2.1 - 2.9 in the Study Guide should be assigned to cover Outcomes 2.1 - 2.2. Students will find the answers to these questions in Section 6.1 of the text.

Note: There is an error in the text in the answer provided for Practice Problem 8(a), page 227. The central atom should be C, not S.

It should be pointed out to students that they need not use the bond polarity notation that is given in the answers on page 227 - 228. They are expected to use the Lewis structure diagrams that they have previously learned.

Instructors could choose questions from the Chapter Review and/or Unit Review to assign for additional practice.

Students could be asked to submit answers to questions 10 - 13 in Part 2 of Investigation 6-A. Instructors should assign a mark that would be used as a part of their evaluation for the course.

Resources

MGH Chemistry, pages 184 - 196.

Investigation 6-A, 'Modelling Molecules', pages 197-198.

Outcomes

2.3.2 Define London dispersion forces, dipole-dipole forces (van der Waals' forces), ion-dipole forces, and hydrogen bonding, and explain how they form.

2.3.3 Explain why some ionic solids dissolve in water.

2.3.4 Compare the strength of London dispersion forces, dipole-dipole forces, and hydrogen bonding.

Notes for Teaching and Learning

Students are expected to be aware of the intermolecular and intramolecular forces. They should be able to rank these forces in terms of strength.

Ionic compounds have permanent positive and negative charged ions. Since polar molecular solvents have a permanent molecular dipole, the positive ions attract the partially negative end of the dipole and vice versa. This is referred to as the ion-dipole attraction.

Suggestions for Assessment

Questions 2.10 - 2.15 in the Study Guide should be assigned to cover Outcome 2.3. Students will find the answers to these questions in Section 6.2 of the text.

Instructors could choose additional questions from the Chapter Review and/or Unit Review to assign for practice.

A comprehensive final exam should be given. The exam should be worth at least 50% of the final mark for the course.

Resources

MGH Chemistry, pages 202 - 210.