A Teacher's Guide to

Addenda To Hebden: Chemistry 11

I am giving these supplemental materials away at no cost to users of ***Hebden: Chemistry 11, A Workbook for Students***. It is my hope that present users of this Workbook will be able to continue using the Workbooks when teaching the new curriculum becomes mandatory.

The documents have been reviewed and edited by Joanne Treacy (St. Thomas Aquinas Secondary). She has given many, many hours of her time to make suggestions as to how all the documents could be improved. I cannot begin to thank her adequately for the gift of her time, insight and advice. Bless you lady! If the documents contain any errors, the fault is mine alone.

As of the time that I am writing this Teacher's Guide (November 2016), the "about-to-be-mandatory-in-September 2018" curriculum is apparently lacking in specific details as to the breadth and depth of topics to be covered. My understanding is that this is intentional so as to give teachers greater flexibility in the amount of detail and depth of coverage they wish to cover with their students. Pursuant to an e-mail inquiry to the Ministry of Education, a curriculum representative informed me that "**elaborations** are meant to be suggestions and are not prescriptive."

I am donating this set of 20 documents (one document, ***Chem 12 Topic Comparison***, relates to the Chem 12 curriculum), including the one you are presently reading, to the public domain. Sixteen of the documents are *Addenda* dealing with topics that are not in the present curriculum but are in the new curriculum. I have also included the document **Grade 8 to 10 Chem.docx** which is referred to by the next document mentioned. If you look at the document titled **Chem 11 Topic Comparison.docx**, you will see a side-by-side comparison of topics in the present and new curricula. This document is the basis of a concern that I do not know how to answer or advise on. Examining this document shows that there are very few topics (shown in red) that are in the present curriculum and not in the new curriculum. This means the limited time that teachers have to present Chem 11 is going to be VERY TIGHTLY squeezed, rather than giving them extra time for being more flexible. Some comments:

- The topics that are newly-introduced in the new curriculum will require a substantial cumulative amount of time to present to students. My **minimal** time guestimates (13 years after I retired) are:

  Uncertainty of Derived Units = 1 hour
  Gas Laws = 3 hours
  Graphing Data = 0.5 hour
  VSEPR Theory = 2 hours
  Lewis Acids and Bases = 0.5 hour
  Colligative Properties = 2 hours
  Solubility = 7 hours
  Functional Groups = 4 hours

  Total = about 20 hours

  If your students are trained as self-learners and can plow through difficult topics by themselves, the new topics added to the already-in-the-curriculum topics may present no time problems. All knowledge is valuable but time to finish teaching a course is even more valuable.

- Safety is not mentioned at all, but the legal responsibilities of a Chemistry teacher require this topic to be taught and tested so as to preserve and demonstrate evidence (that can be presented in court if need be) that students are aware of safety concerns in the Chemistry lab. (My safety quiz used to have two possible marks: 100% and fail. Students re-wrote the safety quiz until they achieved a perfect mark. Each failure resulted in a lowered value eventually being recorded in my mark book. The same test was always used; safety rules never change.)

- Both the present and new curricula are silent on using unit conversions. I always used to set aside time to teach this because unit conversions are the basis of later calculations.

- Inorganic nomenclature is not mentioned in the new curriculum. True, it doesn't take a great deal of time to teach, but **IF** Science 9 teachers thoroughly cover this topic and include hydrates, and **IF** students can be relied upon to remember everything two years later (good luck on that one!), then this topic can be omitted and a couple of hours can be saved.

- One way to gain extra time is to completely eliminate lab work. This is a stupid solution that ultimately works to a student's detriment. Chemistry is an experimental science! No further comment need be made.

At present, I have no plans to re-write the Workbooks. The only topics that might conceivably be removed are **Safety** and **Inorganic Nomenclature**, but I strongly suspect that teachers will have to refer back to these sections to ensure their students are adequately prepared to continue in the course. Hence, eliminating these sections seems unwarranted. Until I know whether the Addenda I have prepared to supplement the present Workbook meet the needs of teachers and students, I do not want to invest the considerable monies required to have my printers prepare new "masters" and print off a new edition. Since the Addenda are donated to teachers to be used as they please, photocopying the documents or placing the documents on a school website for students to download both seem to be reasonable ways to get the documents into students' hands. Teachers may also simply want to use the Addenda to make teaching notes better suited to their style. I only ask that you acknowledge the source of material that ultimately gets into students' hands.

There has been no attempt to include material directly related to Curricular Competencies concerned with philosophies, viewpoints, societal thrusts, Aboriginal concerns, etc. These competencies are the joint responsibilities of the teacher and student.

A final note: The new topics being introduced have heavily "back-loaded" the final units of the new curriculum, especially the unit on Solubility. Hence, plan accordingly.

If you have any comments, concerns or suggestions regarding these Addenda or the Workbook itself, I can be reached at: jhebden@shaw.ca.

Have fun,

Jim Hebden

Four Corrections to *Hebden: Chemistry 11, A Workbook for Students*

1. The new curriculum introduces **SATP** (Standard Ambient Temperature and Pressure). While preparing these Addenda, I discovered (to my horror!) that the definition for **STP** had been changed several years ago. I had not kept my knowledge current, which is always a danger for a teacher. Hence, Units V [The Mole Concept] and VII [Calculations Involving Reactions (Stoichiometry)] are incorrect wherever "STP" is mentioned.

   It is my intention to correct the definition for STP and add the definition of SATP in the next printing of ***Hebden: Chemistry 11, A Workbook for Students***. The changed/added definitions have necessitated changes on each of the following ***Workbook*** pages:
   Unit V: 82-90, 94, 95, 267-274, 277-279. Unit VII: 125-127, 129, 131,137, 291-295, 297, 298.
   Corresponding changes have also been made to the Glossary.

   This leads to a problem: some teachers may have a mixture of the corrected and uncorrected versions of the ***Workbook*** in their classrooms. (I used to have to teach Science 10 with 3 different versions of the text, and hence am well aware of the frustration this causes!) Both the changed definition for STP and the added definition for SATP are given in a brief note at the beginning of the Addendum ***The Gas Laws***. Individual teachers will have to decide how to deal with the problem until everyone has the same version. My deepest apologies!

2. **This is not really a correction; rather, it is an extension.** Page 6 of the new curriculum asks students to consider (in Curricular Competencies – Elaborations/Processing and analyzing data and information/trends/Solution Chemistry) "How is the solubility of ions related to their position on the periodic table?" The Workbook is mute on this question because this is essentially a former Chemistry 12 solubility topic. However, teachers might want to ask students to look at the table **Solubility of Common Compounds in Water** (included on the last page of the file "Addendum.Solubility.docx" and ask what solubility trends exist, based on an ion's position in the Periodic Table. For example:

   +1 ions (alkali) are soluble, +2 ions (alkaline earth) have mixed solubilities and +3 ions (Al^{3+}, Ga^{3+} etc.) are part of "All others" and are soluble with chlorides and sulphates but insoluble with sulphide, hydroxide, etc.;

   transition metals tend to be insoluble with sulphide/hydroxide/phosphate etc.;

–1 ions (such as chloride) are generally soluble but –2 ions (such as sulphide) are generally insoluble; oxides, selenides and tellurides are also generally insoluble but not listed in this simplified table.

A general summary statement can therefore be made: the greater the charge on an ion, the stronger the ionic bonds holding an ionic compound in the solid state and the lower the resulting solubility in water. (Hence, the arguments presented on pages 174-5 of the Chemistry 11 Workbook are applicable to both melting temperature and solubility.)

3. The definition of Atomic Mass on page 146 is incorrect. (No, it wasn't changed; it has ALWAYS been incorrect. Mea Culpa!) The following definitions should be used instead:

   Definition: The **MASS NUMBER** of an atom is the total number of protons and neutrons.

   Until the correct definition of Atomic Mass is introduced on page 150, all references to Atomic Mass should be corrected to read Mass Number. After the concept of an **isotope** is introduced, the section **Natural Mixtures of Isotopes** then introduces:

   Definition: The **ATOMIC MASS** is the average mass of a mixture of isotopes.

   Again, this has necessitated changes to the following ***Workbook*** pages: 146-151, 302, 303, as well as changes to the Glossary

4. The reaction between ethanoic acid and methanol in acidic conditions to produce an ester (p.238) is incorrect. The corrected version is given on p.11 of the Addendum ***Functional Groups: A Revision***.

A description of the Addenda follows on pages 4-6.

The Addenda:

1. Calculating the Uncertainty of a Derived Unit

Files: Addendum.Uncertainty of Derived Units.docx
Addendum.Uncertainty of Derived Units.Answers.docx

Description: The new curriculum (page 7, Curricular Competencies– Elaborations/Evaluating:/uncertainty) introduces the calculation of uncertainty in derived values. This Addendum introduces the concepts of Absolute versus Percentage uncertainties, gives examples of how to convert between them in example calculations, and follows up with several exercises. The separate Answers section gives complete answers to all exercises.

Suggested placement: This topic will fit best at the conclusion of Unit II, since it presumes an understanding of significant figures and uncertainties.

2. The Gas Laws

Files: Addendum.Gas Laws.docx
Addendum.Gas Laws.Answers.docx

Description: The new curriculum (page 8, Content Elaborations/The Mole/gases) introduces the Ideal Gas Law and the laws leading up to its development. The initial note in this Addendum re-defines STP and introduces SATP. Boyle's Law, Charles' Law and Gay-Lussac's Law are introduced, including a calculation example and two exercises for each law. Dalton's Law is also introduced, without examples or exercises because derivation of the Ideal Gas Law requires introduction of a relationship between moles of gas present and pressure (such a necessary relationship is omitted in the new curriculum). After introducing PV = nRT, the value of R is calculated using STP values. Gas Law calculations are then introduced, with examples, to introduce calculations involving a gas at one set of conditions and a gas subjected to "before-and-after" conditions. The separate Answers section gives complete answers to all exercises.

Suggested placement: To be of any practical use, calculations involving the Ideal Gas Law require some fluency with mole calculations. Hence, the earliest this Section should be introduced is just after introducing "Multiple Conversions Between Moles, Mass, Volume and Number of Particles". In this case, students will either have to omit (or delay until later) Exercises 21, 29, 33 and 36. If the introduction of this Section is delayed until after introducing molar concentration, Exercise 33 can be included in student calculations. If this Section is introduced after completing the Unit on Stoichiometry, all Exercises can be assigned.

3. Graphing Data: Electronegativity, Atomic Radii and Ionic Radii Data

Files: Addendum.Graphing Data.docx
Addendum.Graphing Data.Answers.docx

Description: The new curriculum (page 7, Curricular Competencies – Elaborations/Processing and analyzing data and information/analyze and interpret graphs) suggests students should graph and analyze data for electronegativity, atomic radii and ionic radii. This Addendum collects electronegativity, atomic radius and ionic radius data (where known) for the first 88 elements in the Periodic Table, and requires students to graph data and analyze the results. The separate Answers section gives complete answers to all exercises.

Suggested placement: If this Addendum is used just after introducing electronegativity, the graphing and analysis complements the previous section **An extension to "ionization energy,"** which also requires graphing and analysis.

4. Valence-Shell Electron-Pair Repulsion (VSEPR) Theory

Files: Addendum.VSEPR Theory.docx
Addendum.VSEPR Theory.Answers.docx

Description: The new curriculum (page 8, Content – Elaborations/Atoms and Molecules/electron configuration) introduces VSEPR theory. Launching directly into VSEPR theory requires a student to deal with concepts such as lone pair orbitals and bonding orbitals when previous experience has been limited to being told that atomic orbitals exist. Hence, this Addendum gives background information regarding shapes of electron orbitals in an isolated atom, forming bonding orbitals by overlapping atomic orbitals, and hybridization. Following this introduction, VSEPR theory is introduced (including a Table of Molecular Shapes), the rules for writing the Lewis structures and shapes of molecules are given, with examples, and numerous exercises are presented. The exercises include assigning shapes to neutral inorganic molecules, ions, free radicals and organic molecules. Students usually enjoy this section. The separate Answers section gives complete answers to all exercises.

Suggested placement: This section logically belongs immediately after **Writing Lewis Structures, Extension: The Lewis Structures of covalent compounds that violate the octet rule**.

5. Lewis Acids and Bases

Files: Addendum.Lewis Acids and Bases.docx
Addendum.Lewis Acids and Bases.Answers.docx

Description: The new curriculum (page 9, Content – Elaborations/Solution Chemistry/dissociation of ions) introduces Lewis acids and bases. This Addendum gives a brief background as to why Lewis acid and bases were proposed, the definitions of such species, how to recognize Lewis acids and bases (with examples) and exercises to help students classify species as Lewis acids or bases. The separate Answers section gives complete answers to all exercises.

Suggested placement: This section logically belongs just after **The Nature of Solutions of Ions.**

6. Colligative Properties

Files: Addendum.Colligative Properties.docx
Addendum.Colligative Properties.Answers.docx

Description: The new curriculum (page 9, Content – Elaborations/Solution Chemistry/properties) introduces colligative properties. This Addendum defines a colligative property, examines three consequences of the definition and examines vapor pressure depression, boiling point elevation, freezing point depression and osmotic pressure. Examples and exercises are given. The separate Answers section gives complete answers to all exercises.

Suggested placement: Since colligative properties deal directly with the concentrations of particles in solution, the best place for this section is likely at the end of **Calculating the Concentration of Ions in Solution.**

7. Solubility

Files: Addendum.Solubility.docx
Addendum.Solubility.Answers.docx

Description: This is a VERY LARGE section and includes three major additions to the new curriculum:

Page 6, Curricular Competencies – Elaborations/Planning and conducting:/Solution Chemistry: Use a solubility chart to predict whether ions can be separated from solution through precipitation, and outline an experimental procedure that includes compound added, precipitate formed, and method of separation.

Page 6, Curricular Competencies – Elaborations/Planning and conducting:/Solution Chemistry: Use solution chemistry analysis techniques to investigate local water, soil, and/or air samples.

Page 9, Content – Elaborations/Solution Chemistry:/non-metal oxide solutions

This Addendum includes some material taken from ***Hebden: Chemistry 12, A Workbook for Students***.

- The section **Calculating Solubility and Ion Concentrations** includes calculations of solubility (grams/L) and molar solubility (mol/L), and how to determine experimentally the solubility of a substance.
- **Predicting the Solubilities of Salts** introduces use of the table *Solubility of Common Compounds in Water* (reproduced at the end of the Addendum) to be able to predict whether or not a particular salt is soluble in water or has low solubility.
- **Separating Mixtures of Ions by Precipitation Methods** introduces students to classical qualitative analysis of cations and anions ions in solution. By the end of this section, students are asked how to separate a mixture of ions, what reagents they would add and in what order, and how to separate compounds out of solution as the analysis proceeds.
- **Some Chemical Analysis Techniques** introduces students to quantitative analysis using classical and modern spectrophotometric techniques. The analysis procedures include:
  – measuring dissolved oxygen
  – measuring pH (does NOT introduce logarithms; uses whole-number pH units)
  – analysis of nitrates
  – analysis of phosphorus

All the above sections include examples and exercises. The separate Answers section gives complete answers to all exercises.

- **Environmental Impacts of Non-Metal Oxides Solutions** discusses the environmental impacts of the oxides of carbon, nitrogen and sulphur. No exercises are given since this is largely a discussion topic.

Suggested placement: This section is probably best placed as the last set of topics in the Solubility unit, since it assumes substantial background knowledge.

8. Functional Groups: A Revision

Files: Addendum.Functional Groups.Revised.docx
Addendum.Functional Groups.Revised.Answers.docx

Description: The new curriculum introduces two new organic chemistry topics: phenols and organic synthesis.

Page 10, Content – Elaborations/Organic Chemistry/functional groups
Page 10, Content – Elaborations/Organic Chemistry/organic synthesis

More importantly, the new curriculum does NOT require (as does the present curriculum) that more-or-less the only thing students need to do with functional groups is recognize them and point them out. Hence, this Addendum completely re-writes the entire section on functional groups. The revised material includes a *Functional Group Table of Precedence for Nomenclature*, rules for naming a functional group, examples of molecules having the functional group, properties of the functional group, and exercises that ask students to draw compounds having specific functional groups and name compounds that are drawn. Keeping the naming relatively simple (no compound prefixes), compounds with multiple functional groups are introduced. An optional functional group, amides, is introduced so as to allow students to see the way amino acids use amide linkages to form di- and polypeptides. Phenols are introduced in the same way as for other functional groups. The section **A Summary of the Functional Groups** brings everything together and presents numerous mixed exercises. The final section, **Organic Synthesis**, introduces students to four types of organic reactions. A series of single-step and multi-step synthesis exercises are presented. The separate Answers section gives complete answers to all exercises.

Suggested placement: This Addendum is meant to completely replace section ***X.6 Functional Groups***.