Overview of the course
Chemistry 104 is the second of a two-semester sequence designed to facilitate the student’s learning of the nature of the material universe. The second semester extends the principles learned in the first semester to provide an understanding of chemical kinetics, equillibria, acid-base chemistry, and chemical thermodynamics.

Prerequisites
A grade of C or better in Chemistry 102.

Chemistry 104 is open to students who have completed Chemistry 105 as Chemistry 105 is allowed to count as Chemistry 102. In order for you to be successful in this course you will be required to perform algebraic manipulations, work with square roots and logarithms, and solve linear and quadratic equations. If you have difficulties with basic algebra, etc., you should consider dropping the course and taking it at a time when you have acquired these skills.

Dropping the Course, Changing Sections, Incompletes
All drops, adds, and section changes of Chemistry Department courses should first be attempted using PAWS. Any changes to your schedule that cannot be done using PAWS will require the stamp of the Chemistry Department. This may also require my signature. A discussion or laboratory TA can never sign an add/drop form.

You will be responsible for knowing the deadlines for drops or withdrawals as determined by the University. This includes the final day to withdraw from any class for academic reasons. After this day, I will not sign any withdrawals from the course for academic reasons.

An incomplete can be given only for a student who has been doing satisfactory work, but is unable to complete the course for a reason which I judge to be valid, and must be accompanied by appropriate documentation.
**Required Materials**

**Course Texts:**  *General Chemistry: The Essential Concepts* (7th Edition) by Chang (electronic copies are available) – expected cost range $50-$200 (depending on source) and *Chemistry 104 Lecture Activities (Fall 2019)* (available at Clark Graphics, 2915 North Oakland) – expected cost approximately $28

**Classroom Response System:** You will use your own electronic device to enter answers into a classroom response system. To do this, you will need to register on Tophat.com (see page 7 for information about this). Expected cost is $18 or less.

**Laboratory:** *Chemistry 104 Course Manual – Fall 2019* (available at Clark Graphics, 2915 North Oakland) – expected cost approximately $25

Safety goggles – expected cost approximately $10

Bound laboratory notebook with duplication – expected cost approximately $15

**Calculator:** Non-graphing or non-programmable *scientific calculator* with logarithms, exponential functions, etc. – expected cost approximately $20

*Graphing calculators, cell phone calculators, laptops, etc. are strictly forbidden in exams or quizzes. You may only use a NON-PROGRAMMABLE, scientific calculator for exams or quizzes. If you attempt to use something else which is prohibited you will be required to work with pencil and paper only.*

**Lectures and Lecture Activities**  
*MWF at 12:00 – 12:50 am in CHM 190*

One of the most important aspects of lecture is making this time useful. In order to assist you with this, you will be able to use the “Lecture Activities” (a required course text) as the structure for your notes and lecture materials. In addition to taking notes in lecture, actively working problems and thinking and talking about how to understand concepts and work problems is critical. Therefore, you will be expected to be an active participant in lecture through taking notes, working problems and thinking and discussing concepts. Lecture will not be expected to be passive but an exciting and interactive learning environment. Part of the learning process involves thinking about what is being said in lecture, writing it down, and even re-writing it to clarify what you have heard. *Although I expect you to work all problems from the Lecture Activities as a minimum, you are encouraged to take notes and participate in lecture in the manner that best suits you and your learning.*

You are expected to read your textbook before coming to class. We have assembled “Chapter Summaries” to help you with reading your textbook. You will find these in the *104 Course Manual*. These are written and compiled to aid in your studying. It is very important to remember that learning material involves taking time to think things through, develop the knowledge (or process) and practice this. It is also very helpful to test yourself on your knowledge development. Using the quiz or exam as a means to test if you have learned something could be too late to determine you still have a gap in knowledge. Remember, lecture is very important in seeing process and models and hearing concepts and their derivation and application BUT is not the beginning and end of learning. It would be unusual to learn something simply from sitting in lecture. As always, seek help, seek help, seek help!
### Homework, Lecture Questions (classroom responses) and Lecture Quizzes

Homework will be assigned and graded using the Moodle system. This is a **FREE** system. Information on page 8 (and posted online) gives specifics concerning deadlines and procedures for registering. Homework from the textbook (all red-numbered problems) should be completed but will not be collected or graded. Additionally, a classroom response system will be used for a small number of questions per lecture. The procedure for registering for this can be found on page 7 of this syllabus.

Lecture quizzes will be given every week of class except the last week (therefore 13 quizzes will be given). The lecture quizzes will be given in the last 20 minutes of lectures. You quiz score will be the sum of your highest 10 (out of 13) quizzes. Quizzes may include extra credit. Quiz solutions will be posted on my website.

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**Missing a quiz for any reason results in that quiz counting as one of your drops – do not request to take a quiz at any other time since everyone can drop three quizzes.**

Quiz material will be tied to the learning objectives for the course (outlined in the Chemistry 104 Learning Objectives). As each chapter begins you should use the “Chapter Summary and Review” from the *Chemistry 104 Course Manual* that includes important terms, concepts and problems to work. This material will be key in your preparation for your quizzes and exams.

**Homework, lecture questions, and quizzes count as 100 points towards your final grade. A further breakdown of these points is described in the grade section (page 6).**

### Discussion Sections/Problem Solving

You are required to attend your discussion section. Your attendance and participation in discussion sections is essential because your final grade depends critically on your ability to solve problems.

Following each lecture, an assignment from the Lecture Activities (covering the material from that day) will be posted on the board and posted on my website. These problems will form the essential backbone for your discussion material. You are not expected to solve these problems prior to discussion, but you will work on these during discussion, so reading the chapter on these, thinking about the concepts and attempting to work through these problems will greatly help your understanding. In order to have a positive experience in discussion, it is to your benefit to both prepare for discussion and participate. Your discussion section is your opportunity to understand problems further on a more personal basis – you can go over finer details and questions than is simply possible in lecture. Use discussion time wisely.

You will be required to complete supplemental problems in discussion and submit these at the conclusion of each discussion section. These will be graded and contribute 50 points towards your final grade. Missing discussion will reduce your points.

You can only learn to solve problems by doing them. You must attempt to solve all of the assigned problems as an absolute minimum. It is very important for you to make every attempt to solve problems before seeking help elsewhere. The solution to a problem always looks easier when someone else shows it to you. Remember that you will not be afforded this luxury on an exam.
Laboratory

Begin Week of Sep 9th

Chemistry is an experimental science – the concepts and models are based on experiment. Thus, the laboratories are designed to give you a “hands-on” experience in order to reinforce concepts. You may encounter material in the laboratory before you see the material in lecture.

- You must attend the laboratory section for which you are registered.
- You must be prepared to perform the experiment before coming to lab.
  - You will need to complete items 1 through 5 per Chapter 1 in Laboratory Manual Section Part 1 in your laboratory notebook for all experiments prior to the start of the lab period.
  - If you do not have this completed, you will not be allowed to do the experiment and receive a grade of zero for the lab.
- Your completed lab report is due at the start of your next lab period. You must submit the original copy and retain the second copy.
- Your labs will be graded following the rubric given in the lab manual, Part 1, Chapter 1.
- You may not have your laboratory manual (as part of the Chem 102 Manual) at any point during the experiment. You may only use your laboratory notebook. Therefore you must have an appropriate and complete procedure in your notebook to conduct the experiment.
- You may be required to complete some portion of the lab online (on d2l). A report is not due for this lab.
- A lab practical will be given during the last week of lab.
  - The content of the practical will be based on your experiences in lab.
  - You will be allowed to use your bound laboratory notebook for the practical – loose papers, textbooks or photocopies of any other source will not be permitted.
  - You must pass the lab practical (score of 60% or greater) in order to be eligible to pass lab.

No early or make-up laboratories will be given. Each experiment will be worth 100 points. Your final laboratory score may be normalized and will be worth 150 points.

Safety: Wisconsin state law requires all students to wear safety goggles which seal around the eyes and have shielded vents while they are in the laboratory. This will be strictly enforced. Failure to comply will result in removal from the laboratory and assignment of a grade of zero. Be certain to handle and dispose of all chemicals safely (ASK if you are unsure). Students who are not prepared for lab are a hazard to themselves and others. You will be expected to know and follow all rules outlined in the safety handout (given in the first lab period, starting 9/9).

Laboratory Schedule – Labs will begin on Monday, September 9th

<table>
<thead>
<tr>
<th>Week of</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept 2</td>
<td>No Labs – first week of classes</td>
</tr>
<tr>
<td>Sept 9</td>
<td>Safety and Nomenclature I and II (all online)</td>
</tr>
<tr>
<td>Sept 16</td>
<td>Molar mass of a volatile liquid</td>
</tr>
<tr>
<td>Sept 23</td>
<td>Freezing point depression</td>
</tr>
<tr>
<td>Sept 30</td>
<td>Rate and order of a reaction</td>
</tr>
<tr>
<td>Oct 7</td>
<td>Rate and activation energy</td>
</tr>
<tr>
<td>Oct 14</td>
<td>Determination of K</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week of</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 21</td>
<td>Buffers</td>
</tr>
<tr>
<td>Oct 28</td>
<td>Determination of $K_{sp}$</td>
</tr>
<tr>
<td>Nov 3</td>
<td>Hess’s Law</td>
</tr>
<tr>
<td>Nov 10</td>
<td>What’s in a penny; copper and zinc lab</td>
</tr>
<tr>
<td>Nov 17</td>
<td>Electrochemistry</td>
</tr>
<tr>
<td>Nov 25</td>
<td>No Labs – Thanksgiving break</td>
</tr>
<tr>
<td>Dec 2</td>
<td>Lab Practical</td>
</tr>
</tbody>
</table>
Examinations

Three 1-hour exams are scheduled by the university throughout the semester (9/25, 10/23, 11/13 and 12/11) on Wednesday evenings at 5:30 PM (the official time for this exam is 5:30 PM to 7:00 PM, however these are one-hour exams and the additional time is available at my discretion). The final examination will be given on the date found in the schedule of classes.

<table>
<thead>
<tr>
<th>Exam</th>
<th>Date</th>
<th>Time</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour Exam #1</td>
<td>9/25/2019</td>
<td>5:30 pm</td>
<td>BOL 150</td>
</tr>
<tr>
<td>Hour Exam #2</td>
<td>10/23/2019</td>
<td>5:30 pm</td>
<td>BOL 150</td>
</tr>
<tr>
<td>Hour Exam #3</td>
<td>11/20/2019</td>
<td>5:30 pm</td>
<td>BOL 150</td>
</tr>
<tr>
<td>Hour Exam #4</td>
<td>12/11/2019</td>
<td>5:30 pm</td>
<td>BOL 150</td>
</tr>
<tr>
<td>Final Examination</td>
<td>12/20/2019</td>
<td>12:30 pm</td>
<td>TBA</td>
</tr>
</tbody>
</table>

Your graded exam will be returned in the next regularly scheduled discussion section. Your TA will be authorized to correct any blatant grading errors (i.e., incorrect addition of points). Your TA will not be authorized to change the number of points given for partial credit or change your score in any other way. **If you believe that your exam has been unfairly graded you must return the exam to your TA before the end of the discussion section. He/she will get the exam to me and I will re-grade it completely.** You should be aware that if you elect to do this, your grade may be higher, the same, or lower, depending on whether or not other problems may have been graded too generously.

You will be allowed to drop your lowest hour exam score. You must take at least three hour exams. There will be no early exams, no late exams, and no make-up exams. The final exam is mandatory.

You are free to miss one-hour exam, for which you will receive a zero. If you are ill, or cannot make an exam for some reason, you will receive a zero for this exam, which will be dropped. You will not be excused from two exams for any reason. If you have problems with an employer, travel plans, reservations, athletic or music trips, etc. work them out at an early date. Take this syllabus to your employer if necessary. This is not designed to be punitive. With many students, logistics make this policy necessary.

Chemistry Supplemental Instruction (CSI)

There is chemistry supplemental instruction (CSI) available to all students in 100-level courses, located in CHM 271. By attending a CSI session, you will gain insight into particularly challenging concepts or examples. Therefore, there is a very likely benefit to your understanding by attending these sessions. I will provide additional points by attending a CSI session. For each session per week you attend prior to or immediately following (within 2 weeks) an exam, I will award that percent back to your exam grade (so if you attend sessions at 3 of the four weeks, you will get 3% added to your exam grade). You must attend the entire session and sign in to get the points.

Additional Practice / Exam Preparation

I will post additional practice on my website as well as some partially worked examples. Additionally, the problems I work in lecture are meant to provide some examples of the types of questions that you may see on an exam. However, you will not receive exam or quiz questions in advance of the exams or quizzes. The more you practice to prepare for exams by going to lecture, reading your lecture notes, reading your textbook, and working problems the better prepared you will be for exams.

Please ask questions and seek help when you do not understand material – I want you to succeed!
Grading

The total number of points for the class is 800. A general breakdown by letter grade is shown but may be altered as needed. Breakdown of the 800 points is as follows:

<table>
<thead>
<tr>
<th>Points</th>
<th>Score</th>
<th>Letter Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-Hour Exams</td>
<td>300</td>
<td>800-720  A</td>
</tr>
<tr>
<td>Final Exam</td>
<td>200</td>
<td>719-640  B</td>
</tr>
<tr>
<td>Quizzes</td>
<td>50</td>
<td>639-560  C</td>
</tr>
<tr>
<td>Discussions</td>
<td>50</td>
<td>559-480  D</td>
</tr>
<tr>
<td>Homework</td>
<td>30</td>
<td>Below 480 F</td>
</tr>
<tr>
<td>Lecture questions</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Laboratory</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Total 800

Exams: Each one-hour exam is worth 100 points; for a total of 300 (dropping the lowest score).

Final Exam: The cumulative final exam is comprised of 200 points. A standardized final will be used and in order to be eligible to pass the course, you must score in the 35th percentile or higher on the standardized portion of the final.

Quizzes: Each quiz will be worth 10 points and some may include extra credit. The ten highest quiz grades (out of 13 possible) will contribute 50 points to your final grade.

Discussion: Discussion sections points will be accumulated from attending discussion and completing the supplemental problems. These will be graded and will count 50 points towards your final grade.

Homework: Online homework will be assigned prior to each exam (for a total of four timed assignments). Additionally, chapter practice assignments will be graded as 100% for completion of 60% or more. The cumulative score on your chapter assignments can be substituted for your lowest exam homework score. The online homework cumulative score will contribute 30 points to your final grade.

Lecture Questions: Lecture questions will contribute 20 points to your final grade.

Laboratory: Laboratory will be worth 150 points. A failing grade (<60%) in laboratory will result in a failing grade for the class. The lab practical will count as two labs in determining your final lab grade. The lowest lab score will be dropped. The lab practical score cannot be dropped.

Department of Chemistry and University Policies and Academic Dishonesty

Departmental policies can be found in the main office of the Chemistry Building (CHM 144). University policies can be found at http://www.uwm.edu/Dept/SecU/SyllabusLinks.pdf

Cheating on an examination, quiz or other graded material will result in a grade of zero as a minimum consequence. Failure in the course and referral to the Dean may also occur. Academic dishonesty or misconduct in any form will not be tolerated. This includes the use of unauthorized materials during a quiz or exam – such as graphing calculators, etc.
Registering for the personal response system using Tophat
You will be using your own device to give electronic responses into the classroom response system. These devices can be cellphones, laptop computers or tablets. You have the option of downloading an app onto your smartphone. You must also register to do this. To register, you need this information:

1. The **6-digit course code**: 904721
2. The **password**: none

Create an Account
1. Go to http://app.tophat.com/e/904721 to access the class directly (preferred)
   or
2. Go to tophat.com and click on **student sign up**.
3. Select school “UWM” or enter the 6-digit course code.
4. Enter your account details (you must use your UWM email) including your UWM ID number.
5. Enter your cell phone number (only to be used to link to your TopHat account).
6. You will receive a text with a code to enter.

Enroll in this Class
1. Select this course to enroll, “**Chem 104 - Fall 2019**”.
2. At this point, you will need to register/purchase your registration code.
3. Payment information will be requested at this point. Select your code choice (either 1 semester or 5-year code). The costs are:
   1. semester code = $15    or    5-year code = $38
4. Through the check-out process the discount will be applied (you may first see a higher cost for a code but as you check out, the cost will be discounted to the rates above). In the event you would like to upgrade from a 1-semester code to a 5-year code, this can be done by calling Tophat at any time before your 1-semester code expires. You will then only pay the difference in the costs.

To Use Tophat in Class    Remember to bring your device to each and every lecture.
You will be prompted to answer a question or a series of questions.
1. Wait until the question is active
2. Using the mobile app, enter your answer.
3. Using text function, enter your answer by texting to the text number shown on the question.
4. Using a laptop or internet access, go to tophat.com, login and enter your answer.

You can enter answers more than once. Only the answer entered last will be counted. You will receive conformation that your answer was received.

   If you have any difficulties with Tophat, please contact 315-636-0905.
Online Homework

To use Moodle

1. Go to http://homework.chem.uwm.edu/
2. Enter Username: your epanther ID
   Password: your epanther password (just like accessing d2l)
3. Complete your profile using local server time and click update. You may receive an email containing a link to activate your account. Once complete, you should see on the next page a homework button to get to the classes.

To join our class

1. Click on our lecture: Chemistry 104; Fall 2019; Lecture 401
2. You will now be prompted whether you wish to join this class, Click Yes

Homework is listed under the active week – click on the homework (called a “quiz”) to begin working

Exam Homework Assignments (1-4):
- There are 4 exam assignments.
- Each due (24 hour) following each hourly exam.
- Homework assignments will open three weeks before the exam and may start before the material begins in lecture.
- You will have five attempts at each exam assignment as well as be able to submit individual answers for grading.
- Your homework grade is based on the average of your four exam assignments.

Practice Assignments:
- There are eight, chapter review assignments and four CHEM 102 review assignments.
- These are all due on the end of the semester.
- These will be graded as 100% for successful completion of 60% or more (or the score is as is).
- You will have an unlimited number of attempts on each assignment.
- The cumulative score on your practice assignments can be substituted for your lowest exam homework assignment score.

When using Moodle, carefully read the directions – note that all numeric answers must be entered in standard decimal notation and units (unless specifically noted) are not to be included in the answer. Failure to properly enter an answer may result in not receiving credit for an item.

You MUST submit your assignment to obtain a grade – if you do not submit an assignment, it will not be included in the gradebook!

<table>
<thead>
<tr>
<th>Assignments</th>
<th>Start Date</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1</td>
<td>9/4/19 @ 11:00 AM</td>
<td>9/26/19 @ 11:55 PM</td>
</tr>
<tr>
<td>Exam 2</td>
<td>10/2/19 @ 11:00 AM</td>
<td>10/24/19 @ 11:55 PM</td>
</tr>
<tr>
<td>Exam 3</td>
<td>10/30/19 @ 11:00 AM</td>
<td>11/21/19 @ 11:55 PM</td>
</tr>
<tr>
<td>Exam 4</td>
<td>11/20/19 @ 11:00 AM</td>
<td>12/12/19 @ 11:55 PM</td>
</tr>
<tr>
<td>Practice Assignments</td>
<td>9/3/19 @ 11:00 AM</td>
<td>12/12/19 @ 11:55 PM</td>
</tr>
</tbody>
</table>

If you have any difficulties with the system, please send me an email
Some notes on studying

Learning in this class may come with hard work and dedication. Please remember that much of your learning takes place through your own reading of the textbook, reading of your lecture notes, working problems, and conversations with me, your TA, and your classmates. Please do not expect to learn all of the concepts by attending lecture only. Your teaching team (me, your discussion TA, and your laboratory TA) will work cohesively to present you with learning opportunities. To best use these opportunities, please come prepared. Otherwise much of what is discussed may be confusing or frustrating. I am hopeful that by the end of the semester, you will find that learning chemistry is exciting and rewarding.

Here are some tips for success in Chemistry 104:

1. Read the text (on the lecture material for the day) before attending the lecture.

2. Attend lecture, discussion and laboratory sessions. Take these times seriously. Be on time, stay attentive and take notes.

3. Use your lecture notes – how may be very individual to you. This could include recopying or rereading after lecture (the closer to the lecture the better), adding to lecture notes from textbook material, adding problems, or discussing within a study group. Your lecture notes should be considered another source of information for this course (like your textbook).

4. Do as many problems as you are able – more than those assigned. You will probably have to average 3-4 problems a day, seven days a week to be successful in the course. Don’t wait until right before the exam – you will most likely be overwhelmed and unable to properly understand the material. If you have difficulty solving a particular problem, go back to the more straightforward related problems in the text and work them first. Indeed, one of the main purposes of this course is to help you develop your own method of thinking through problems. See your homework as an opportunity to test yourself on your own learning – this will allow you to find where you have succeeded in understanding and where you may still need to work through some concepts. Please do not wait until a quiz or exam to test your learning. See me if you would like help with ways to check your learning.

5. Form a study group or attend the group tutoring sessions – these can be a very effective method of learning.

6. Strive for understanding instead of just familiarity. It may take several attempts to gain the level of understanding that will allow you to articulate and use the models presented in this course. Be patient with yourself!

7. Be proactive! If you are struggling to understand something – seek help. Chemistry builds on previous concepts – without fully understanding one concept, it is very difficult to understand the next concept on which it builds.

I hope your experience this semester will be a rewarding one!
# Tentative Class Schedule

<table>
<thead>
<tr>
<th>Week of</th>
<th>Lecture Topics</th>
<th>Exams and Quizzes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept 2</td>
<td>Syllabus and Review of Chemistry 102 (based on results of Chem 102 test)</td>
<td>Quiz 1 – Chem 102 Test</td>
</tr>
<tr>
<td>Sept 9</td>
<td>Chapter 13 Solutions</td>
<td>Quiz 2</td>
</tr>
<tr>
<td>Sept 16</td>
<td>Chapters 13 and 14 Colligative properties and Kinetics</td>
<td>Quiz 3</td>
</tr>
<tr>
<td>Sept 23</td>
<td>Chapter 14 Mechanisms and Catalysts</td>
<td>Exam 1, Sept 24&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sept 30</td>
<td>Chapter 15 Equilibrium</td>
<td>Quiz 4</td>
</tr>
<tr>
<td>Oct 7</td>
<td>Chapters 15 and 16 Equilibrium and Acids and Bases</td>
<td>Quiz 6</td>
</tr>
<tr>
<td>Oct 14</td>
<td>Chapters 16 Acids and Bases</td>
<td>Quiz 7</td>
</tr>
<tr>
<td>Oct 21</td>
<td>Chapter 17 Acid/Base Reactions and Buffers</td>
<td>Exam 2, Oct 23&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Oct 28</td>
<td>Chapter 17 Solubility Equilibria</td>
<td>Quiz 8</td>
</tr>
<tr>
<td>Nov 4</td>
<td>Chapter 6 Enthalpy</td>
<td>Quiz 10</td>
</tr>
<tr>
<td>Nov 11</td>
<td>Chapter 18 Entropy</td>
<td>Quiz 11</td>
</tr>
<tr>
<td>Nov 18</td>
<td>Chapter 18 Spontaneity and Gibbs Free Energy</td>
<td>Exam 3, Nov 13&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Nov 25</td>
<td>Chapter 19 Redox reactions and Cell Potentials</td>
<td>No Quiz</td>
</tr>
<tr>
<td>Dec 2</td>
<td>Chapter 19 Thermodynamics, Corrosion and Batteries</td>
<td>Quiz 13</td>
</tr>
<tr>
<td>Dec 10</td>
<td>Review</td>
<td>Exam 4, Dec 11&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

**Final Exam – Friday, December 20<sup>th</sup>, 12:30 pm – 2:30 pm**
Learning Objectives

GER outcomes: GER courses provide “students with a broad body of knowledge” (UWM Fac. Doc. 1382, p. 2, II, par 1). This course carries the GER natural sciences distribution designation because it prepares students to achieve the following three learning outcomes. Upon successful completion of this course, you should be able to:

1. Understand and apply the major concepts of a natural science discipline, providing insights into its breadth and its relationship to other disciplines;
2. explain and illustrate the relationships between experiments, models, theories and laws; and,
3. demonstrate an understanding of the process of generating and testing of data, and apply this knowledge to the solution of problems.

Course-specific objectives: In order to set the GER outcomes within the framework of this course, a set of objectives have been designed to give you a better understanding of what you are expected to learn over the course of the semester, and some indication of how it will be measured as to what degree this has occurred. These will be incorporated through all types of assessments but will be formally measured on the weekly quizzes and hourly exams. In order to prepare for this, certain objectives will be presented each week in discussion with exercises for practice.

The examples of how these may be measured are examples ONLY and should not be interpreted as an inclusive ‘checklist’.

| Objective 1: Understand spatial scale, particularly to the very sizes (on the order of atoms). |
| As an example you should be able to: estimate measurement, conceptualize relative sizes, use measurement tools skillfully, correctly compare numbers, convert measurements and scales, be able to compare specific objects (atoms and molecules, for example) by size and use the atom as a starting point in representing matter and changes. |

| Objective 2: Understand the language of chemistry including naming simple compounds. |
| As an example you should be able to: properly define important key terms, give a name for a chemical formula of a simple compound, give the chemical formula for a name, give the charges and names for the monoatomic and polyatomic ions of interest (these will be specified). |

| Objective 3: Understand the relationship between macroscopic, particle and symbolic representations of matter including atom relationships in molecules and compounds. |
| As an example you should be able to: identify macroscopic vs particle representations, read chemical formula, represent bonding detail in molecules, know that some elements exist as diatomic molecules, |
and be able to interpret organic chemical formulas from line drawings.

**Objective 4: Understand the relationship between the composition of atoms and their properties.**

As an example you should be able to: identify the number of protons, neutrons, and electrons for any isotope or ion, approximate the relative abundance of certain isotopes given the periodic table and additional information (for example, the number of isotopes and the number of neutrons in each), and calculate weighted averages, isotopic masses or relative abundances.

**Objective 5: Understand the basics of chemical reactions.**

As an example you should be able to: balance chemical equations, correctly use terms and states of matter and correctly represent chemical formula.

**Objective 6: Understand the basics of mixtures and chemical reactions involving water as a solvent.**

As an example you should be able to: define key terms of mixtures, represent solutions on a macroscopic and particle-level, quantitatively represent concentrations using various units, interpret graphs of solubility and temperature for ionic compounds, quantitatively express solubility of gases, qualitatively and quantitatively use colligative properties.

**Objective 7: Understand quantitative relationships between substances represented in a balanced chemical equation.**

As an example you should be able to: do stoichiometric calculations involving moles, masses, volumes, pressures, particles, and concentrations of reactants and/or products also including limited quantities of a reactant.

**Objective 8: Understand the basics of the properties and behavior of gases on both the macroscopic and particle level.**

As an example you should be able to: relate pressure, volume, temperature and amount of an ideal gas, explain the ideal gas law in terms of gas particles, and calculate properties of a mixture of gases.

**Objective 9: Understand the role of energy in a chemical reaction, particularly heat.**

As an example you should be able to: define key terms including heat, work, and energy, identify key components of the first law of thermodynamics, calculate heat, heat capacity and specific heat, calculate change in enthalpy for a reaction by Hess’s law, and interpret an energy diagram.

**Objective 10: Understand the basics of quantum mechanics as it applies to assigning quantum numbers to electrons in atomic orbitals as well as writing electron configurations.**

As an example you should be able to: define key terms, know the rules for assigning quantum numbers, know the general rules for relative energy of atomic orbitals, apply Hund’s rule and determine paramaticity of elements in the ground state.
Objective 11: Understand periodicity of certain properties of the elements.
As an example you should be able to: define key terms, give periodic trends for certain properties, and give general descriptive chemistry facts.

Objective 12: Understand chemical bonding and molecular shape.
As an example you should be able to: be able to draw a Lewis dot structure, determine a molecular shape from VSEPR theory, determine molecular polarity and determine bond order.

Objective 13: Understand that breaking chemical bonds is an endothermic process.
As an example you should be able to: be able to correctly identify both an energy diagram and thermochemical equation showing the endothermic process of breaking a chemical bond.

Objective 14: Understand properties of liquids and solids.
As an example you should be able to: define key terms, correlate properties of liquids, interpret a phase diagram, identify differences between types of solids, and calculate properties of elemental cubic crystals.

Objective 15: Understand the experimental nature of science.
As an example you should be able to: define all components of the scientific method, identify key experiments and the conclusions made (particularly in atomic and electronic theory), conduct simple experiments in laboratory, use measurement tools accurately, and read equipment to the correct number of significant figures and maintain the correct number of significant figures throughout the calculations.

Objective 16: Understand how reactions take place over time.
As an example you should be able to: define key terms in kinetics, express the rate of reaction by change in concentration over time, graphically depict change of reaction rates over time, use initial rates to determine reaction order and rate constants, write and derive a rate law, graphically the relationship between concentration and time for different reaction orders, write and use integrated rate laws, graphically depict activation energy, calculate activation energy using experimental data, write an overall reaction and rate law given a mechanism, and identify a catalyst and intermediate.

Objective 17: Understand the basic principles of equilibrium.
As an example you should be able to: define key terms in equilibrium, write an equilibrium constant, describe equilibrium in terms of reaction rates, express the difference in large and small equilibrium constants, express equilibrium constants of gases in concentration and partial pressure, convert between these constants, use reaction quotients to determine reaction direction, calculate equilibrium constants and changes in concentrations, express the effect on equilibrium by changing system conditions.
Objective 18: Understand equilibrium of aqueous systems.

As an example you should be able to: define key term in acid/base and solubility equilibria, represent and calculate concentrations of acids or bases in water, represent and calculate concentrations when acids and bases react in water, calculate pH and pOH, order and calculate relative strengths of acids, bases and salts, represent non-aqueous systems of acids and bases, interpret titration curves, represent and calculate concentrations of ionic species in a saturated solution, use equilibrium values to qualitatively analyze a mixture of ionic species.

Objective 19: Understand the role of energy in a chemical reaction and how this applies to spontaneity of a reaction (integrating Objective 9).

As an example you should be able to: define key terms in thermodynamics, represent entropy changes for simple systems, integrate enthalpy and entropy for a system and surroundings, identify key components of the second and third laws of thermodynamics, calculate changes in entropy, enthalpy and Gibbs free energy for a system and integrate spontaneity and equilibrium with thermodynamic calculations and estimations.

Objective 20: Understand reactions involving the transfer of electrons.

As an example you should be able to: define key terms in electrochemistry, balance redox reactions, represent electrochemical cells including cell diagrams, calculate standard cell potentials given standard reduction potentials under both standard and non-standard conditions (Nernst equation), integrate thermodynamics and equilibrium and identify differences between spontaneous (batteries) and non-spontaneous (electrolysis) processes.

In order to measure the degree to which students in this course meet the objectives for this course, the university criterion of understanding and applying the major concepts of a natural science discipline, including its breadth and its relationship to other disciplines will be measured using the final course exam. This final exam will be graded based on correctness of responses and, where appropriate, as supported by student work in problem solving.

UW System Shared Learning Goal: This course also meets shared UW System Shared Learning Goal 2: “Critical and Creative Thinking Skills including inquiry, problem solving, and higher order qualitative and quantitative reasoning.” This is met through the course objectives as described previously.

Time Spent on the Course:

To estimate the time that a student should expect to spend on this course, one can use the standard method of a minimum of 3 hours outside of class for every hour in class. Therefore for a 5 credit course (counting laboratory as only one hour), a student may expect to spend a minimum of 15 hours per week on the course outside of class. This includes studying, reading, doing homework, writing laboratory reports and rewriting class notes.