**Student Responsibilities for the course**

**Student responsibility #1**. Students must read the student section of the module in depth prior to coming to class.

**Student responsibility #2. Student-generated quiz and discussion questions.** The students will be required to develop six written questions based on the readings. The first two questions are based upon the topic covered in the preceding class meeting. These will be used for the daily quiz. The professor calls on five different students to state their questions. All students write answers. Then the professor calls on five other students to state their responses. The class discusses each answer as needed until everyone understands what constitutes a correct answer. Students score their quizzes based upon the right answer as indicated by the professor. The quiz should take 10–15 min.

**Student responsibility #3.** After the quiz the class will turn to the next four student-generated discussion questions. These are based upon the current readings for the day. Professor-controlled discussion will be used, with the professor calling on one student for a question and another for an answer. Any particular question may involve multiple inputs from different students as the discussion unfolds. The discussion should take around 20 min. Note that "professor-controlled discussion" ensures that all members of the class participate on a near-equal basis. Volunteer-based discussion is typically limited the most vocal 25%.

Students earn points for bringing the quiz and discussion questions, as well as for their performance on the quiz. Emphasis is placed on developing thoughtful questions that go beyond simple definitions or facts, to address higher levels of cognition. The size of the class will determine how often a student is called upon to for a quiz or discussion question.

It is important to explain that science is as much about asking the right questions as it is about finding the correct answer. This will be a new experience for most of the students, and they will need to be taught how to ask a question of higher-level cognition. We suggest that the first class meeting includes an exercise to teach the art of asking good questions. The professor should provide a short reading for the students to do in class. Then the professor will ask the students to write three questions, one being a simple definition or fact-based question, the next requiring synthesis or other higher level of learning, and the last requiring application or evaluation.

**Exercise to teach higher-level question development.** It is important that you learn to ask meaningful questions about the material in this course. Science is as much about asking a useful question as it is about finding a good answer. Good questions probe the material for such things as cause and effect, relationships, evaluations, and applications. Facts and definitions are certainly important as they form the base of the knowledge tree. But if one only learns facts and definitions, they will develop no context for understanding the material and applying their knowledge in a useful way. This course will require you to come to class each day with written questions for quizzes and discussion. Your questions should include those that require higher levels of understanding, and you will be graded on this. To help you develop the skill of question development, you will read the following passage and then write three questions per the instructions below the reading. This passage is taken from the module on Energy from Biomass.

"Currently E10 blend (10% alcohol) is the main form of gasoline on the US market and has been in use since the early 1980s. Ethanol is added to gasoline for two reasons. First, it replaces MTBE (Methyl Ethyl Tertiary Ether) as an additive to give a cleaner burn. Without MTBE or ethanol, car engines produce smog-forming pollutants (organic and nitrogen compounds). In addition, the ethanol is a fuel, and thus replaces a portion of the gasoline that comes from petroleum.

In 2010 the US EPA authorized the use of E15 blend. The idea is that ethanol from biomass is more sustainable than gasoline from petroleum. But there are important objections to using ethanol for energy. The massive use of corn for fuel and animal feed has reduced the supply of corn for people to eat. And that has driven up the price of corn. This is having a devastating effect on poor people in developing nations such as Mexico that had come to rely upon imported corn.

The kind of corn agriculture practiced in the United States is not sustainable. Huge monocultures (single crop of the same variety) of corn require pesticides to kill insects, herbicides to kill weeds, water for irrigation, and vast quantities of nitrogen fertilizers. Those nitrogen fertilizers are made by a process that uses large quantities of fossil fuels. Much of the fertilizer applied to the corn washes away and eventually makes its way into the Mississippi River. The river carries it to the Gulf of Mexico, where the fertilizer promotes the growth of algae. When the algae die, they sink to the bottom waters and the process of decomposition uses up the available oxygen. This produces a "dead zone" where animals like fish cannot live. The herbicides and pesticides are pollutants that degrade soil, air, and water. Most of the corn is also genetically modified. This controversial process may also damage the environment.

Car and boat owners also are less than thrilled about ethanol in gasoline. The alcohol damages rubber hoses and engine seals. This is a larger problem in older vehicles not designed to withstand the ethanol. The problem is more acute for boat owners, as the ethanol attracts water from the moist marine air. The water-gas-ethanol mix produces a gooey mass in fuel tanks and lines, requiring expensive repairs.

a. Write a question that addresses only a simple fact or definition.

Example Question: What is the percentage of ethanol used in most of the gasoline sold in the United States today?

Example Answer: 10%

b. Write a question that requires synthesis of information.

Example Question: If the United States stopped adding ethanol to gasoline, what are three possible consequences for the environment?

Example Answer: The excess nutrients draining off corn fields would no longer contaminate the Mississippi River and the Gulf of Mexico, reducing the dead zone there. About 10% more petroleum would be needed to replace the ethanol, and that would increase the demand for drilling, and other pollution associated with using oil. Much less land would be needed to grow corn, as the demand for it would go down. Other crops less harmful for the environment could be grown there instead.

3. Write a question that requires evaluation and application of knowledge.

Example Question: Suppose you got a job as lobbyist for the Motorboat Owners of America, and you had a meeting with an official in the US EPA to discuss the projected move to E15 gasoline. What argument would you make?

Example Answer: I would tell the US EPA official that E15 fuel will cause damage to marine engines, and that there would be a cost to the environment and economy to having all the boaters in the United States constantly polluting the air and water because their engines are not running properly. I would also say that boaters prize clean water for recreation, and that increased ethanol production means increased pollution of the Mississippi and Gulf of Mexico, prime recreational waters in the United States.

**Student responsibility #4. Student presentations.** The professor will generate a list of topics to be addressed in student presentations. These will appear in the course syllabus. On the first day of class, students will sign up for their chosen presentation topics. The number of topics and the length of presentations will be governed by the size of the class. There should be a minimum of one student presentation per class, and every student should present at least once. The topics will cover an appropriate subject for that day's material. They may drill deeper into an issue from the readings, or be based upon contemporary events that link to that day's work. The rest of the students in the class should be asked to write two questions to ask the presenter at the end of the talk. The professor should use a mix of volunteer and instructor-controlled discussion for these questions. Presenters will be scored with a rubric that incorporates the course and InTeGrate goals.

**Tips for creating effective presentations**.

1. Read the question you are addressing three times to be sure you answer what is asked.
2. Use a variety of sources in developing your presentation rather than just one website.
3. Figure about one slide per minute, so a 10-minute presentation should have about 10 slides.
4. Minimize the use of words on the slides and rely more on images, diagrams, graphs, and maps.
5. Do not use complete sentences. Write in very short phrases.
6. Do not read the slides to the audience.
7. Avoid using note cards. Instead each slide should prompt your speech. Do not worry about forgetting to say something. If it is really important, be sure it is on a slide.
8. Be creative in your presentation and have fun with it!

**Student responsibility #5. Participation in laboratory experiments and writing of the associated report.** The remainder of each class will be devoted to a hands-on laboratory exercise designed to integrate with that day's topic. The students will perform experiments and collect data in class. They may also be called upon to analyze online data sets from outside of class. These analyzed data along with answers to questions around application and understanding will be addressed in the module report. The students will be assessed using a rubric that incorporates the course and InTeGrate goals. Each module requires a report.

**Instructions to students for producing their laboratory reports.** Each course module includes a laboratory component where you will perform experiments and do activities to explore the concepts being studied. The laboratory report you write must be organized according to the form presented below. Note that each section must be labeled as indicated and include the requested information. The assignment must be turned in as an Excel document, with inserts of MS Word text blocks. All calculations and graphs must be done in Excel. To learn about making graphs see ['link to making graphs' /mathyouneed/graphing/index.html]. Be prepared to show the students the basics of putting data into a spreadsheet and the making of simple graphs.

*Title*: Provide a useful title that describes the work.

*Introduction*: This section must state the purpose of the work and provide background information as to why it is important. There should also be a statement of which module and course learning objectives are addressed in the exercise. Two paragraphs are sufficient for this section.

*Methods and Material*: Write this in paragraph form, not as a list. Say what materials were used, how they were used, and when and where the work was done.

*Results*: This section contains two items: (1) displays of the data collected in tables or graphs; and (2) paragraphs that explain in words what was found. In the paragraphs, the writer should refer to tables or figures by their number. In this section just say what you discovered, not the why of it; that comes later. Be sure to label each graph's axes and to use units with all numbers for calculations. Units must also be labeled in tables and graphs. Every figure (graph) or table must be numbered and have a title. Do all calculations using Excel formulas. These can be formulas that you create or those that reside in Excel.

*Discussion*: In this section explain the "why" of your findings. Explain how what you discovered relates to the green technology of interest. To do this, address each of the following questions:

1. What is the purpose of the technology?

2. How does it work?

3. What are the basic underlying scientific principles?

4. What are the environmental consequences (good and bad) of its adoption?

5. What are the social and economic consequences of its adoption?

6. What factors inhibit its adoption?

7. How does this technology compare with traditional technologies and other alternative green technologies?

9. What InTeGrate grand challenge(s) were addressed in this module and how?

One or two sentences for each of the above questions should be sufficient.

*References*: Provide the source for information you cited that you found online, in books, etc.