

## General Education Submission Form

Electronic submissions are preferred.

A. GE component for which course is being proposed: QAR

B. Submitted by Stephen Contakes

C. Ideally, submissions should be discussed by the entire department prior to submittal.

**Chair has reviewed and approved the course.**

D. Course being proposed (please attach syllabus):  
CHM 121

E. This course

- Has not been modified, but is being submitted to check its suitability
- Has had its syllabus rewritten to communicate the course's contribution to GE
- Has had its contents modified to address the relevant GE issues
- Is a new course designed to fulfill the GE requirement

F. This course is being submitted as

**A Template.** Applicable to courses with multiple sections which require only general training in the discipline. The submission should come from the department chair and should clearly identify what course content and what elements of the syllabus the department has agreed will common to all sections. Upon approval by the GE Committee, any course whose syllabus is determined by the department to meet the specifications of the template is approved to satisfy this area requirement. A copy of each syllabus should be forwarded to the GE Committee for record keeping purposes.

**An Individual Course.** Applicable to courses requiring specialized training in the discipline or are typically offered by a particular instructor. The course should be resubmitted and reassessed in the event of a change in staffing or syllabus.

G. Statement of rationale:

(Include a list of the area certification criteria (former called GE objectives) and GE Student Learning Outcomes (if applicable). These certification criteria and GE SLOs are listed in the GE Committee Combined document. After each certification criterion and GE SLO, list several course activities (lectures, readings, assignments, etc.) that address it. If it is not completely obvious, explain how the activities relate to the certification criterion or outcome. Please attach a copy of the syllabus which has been annotated to identify the corresponding activities. Electronic annotations are required. Please use the *comment* feature in Word to annotate electronic copies).

Quite frankly, ever since I oversaw the college's Quantitative Literacy GE assessment during the 2015-16 academic year it has bothered me that our department has not sought QAR GE approval for our nonmajors *Chemistry, Culture, & Society* course.

First, I think the course meets the QAR GE certification criteria, which read

Students will be able to

1. make use of mathematical (including statistical) models for physical or social systems  
-and/or-  
compute and interpret numeric data, summative statistics and/or graphical representations;
2. reflect on the strengths and weaknesses of particular quantitative models or methods as tools in the natural and social sciences;
3. be able to interpret, reflect on, and use quantitative models and data in public, vocational, and/or private decision making.

Specifically, students in the CHM 4 course

- Make use of mathematical models that describe the behaviour of chemical systems, most notably the experiment-based modelling which culminated in the development of modern atomic theory, mathematical models describing the behaviour of light, geometric models that describe molecular shapes and polarity, stoichiometric models for the calculation of material compositions and chemical reaction outcomes, and thermodynamic models that describe the flow of energy in physical and chemical systems (criterion 1).
- Use units, prefixes, conversion factors, and mathematical relationships to assess and calculate scientific quantities and to track mass and energy flows in chemical systems (criterion 1).
- Reflect on the strengths and weaknesses of various quantitative models for the fundamental structure of matter, especially in terms of assessing the experimental evidence for atomic views of matter and the plum pudding, solar system, and quantum mechanical models of atomic structure (criterion 2).
- Use various types of graphs, charts, and tabular data to quantitatively assess various issues associated with the use of chemicals in society. These include the scale of humankind's use of various natural resources, the contributions of various human activities to those uses, and various correlative and predictive models for assessing the likely impact of those activities (criterion 3).
- Reflect on the actual and potential implications of scientific data and models for personal, economic, and public policy decision making (criteria 1 & 3).

The development of these skills is central to the content and pedagogy of the course. They are developed through in-class presentations, worked examples, and homework assignments and assessed on exams.

Second, several of the course's SLOs align with the QAR SLO, which reads:

Students will apply relevant scientific, mathematical and logical methods to analyze and solve problems effectively and be able to utilize the results appropriately when making decisions.

Specifically, the following individual CHM 4 SLOs contribute to the meeting of this QAR SLO:

1. You will develop an ability to use the language and symbolism of chemistry to communicate and understand chemical concepts.

This CHM 4 SLO involves the use of mathematical quantities, algebraic symbols and relationships, and the embedding of mathematical relationships in chemical drawings and symbols.

2. You will develop an ability to apply mathematical reasoning to work with scientific quantities; understand how scientific inferences are formed; analyze and calculate the properties of elements, compounds, and reaction systems; interpret trends in the use and impact of chemicals in human society and the wider environment; and, as appropriate, make decisions about the best way to address a chemical problem. The specific quantitative literacy skills you will be expected to demonstrate involve
  - The representation and interpretations of scientific quantities using units, scientific notation, and prefixes.
  - The calculation of scientific quantities using proportional reasoning, algebraic analysis, percentages, and fractions.
  - The representation and interpretation of data using various types of tables and graphs.
  - The drawing of logical inferences using quantitative scientific data

This CHM 4 SLO describes some specific ways in which CHM 4 students are expected to apply scientific, mathematical and logical methods to analyze and solve problems effectively and be able to utilize the results appropriately when making decisions.

3. You will learn the basic postulates of atomic-molecular theory and understand how it can be used to explain the properties of solids, liquids, gases, and solutions both in general and in terms of particular substances.

As part of students' mastery of this SLO they are expected to understand how quantitative measurements (mass ratios, scattering cross sections, mass to charge ratios, spectroscopic line positions, etc.) contributed to the development of atomic-molecular theory.

4. You will learn how chemical bonds and intermolecular forces form, what properties they confer on the chemical systems that possess them, and how they can be used to understand the properties of inorganic salts, small molecule organic compounds, organic polymers, biochemical systems, and pharmaceuticals.

As part of this SLO students will be expected to develop an understanding of the mathematical relationships between elements, compounds, and chemical reactions and to interpret scientific data used to determine the identity and structure of chemical compounds.

5. You will become more aware about how chemical technology impacts human history and culture and understand a few contemporary issues raised by the large-scale application of chemical technology.

As part of this SLO students will be exposed to data related to humankind's use of various naturally-occurring materials, human energy use patterns, agrochemistry, pharmaceuticals, and the evidence for anthropogenic climate change. They also will be asked to estimate the relative impact of various activities.

6. You will gain some understanding of how chemical knowledge and technology raises issues for and helps shape philosophical, theological, pastoral, and/or ethical discourse in Christian communities.

As part of this SLO students are asked to bring their assessment of the quantitative measures encountered in connection with SLO 5 into dialogue with broader political, economic, philosophical, and theological perspectives with the goal of developing their own views on what actions and policies should be taken at individual and various corporate levels.