

Science Assessment Proposal

March 15, 2002

Institution: University of Virginia – School of Engineering and Applied Science

Standards/Definition of Science Competency

The University of Virginia's School of Engineering and Applied Science (SEAS) expects each of its graduates to have mastered essential fundamental knowledge in the chemical sciences and in calculus-based physics. These two areas provide the science base upon which engineering science and applications are built.

- I. In the chemical sciences, the SEAS expects each of its graduates to have mastered the following seven chemical concepts and to be able to demonstrate competency in appropriate problem solving skills related to these seven concepts:
 1. Atoms, Elements and Compounds: Chemical formulae. Avogadro's Number. Calculations of atomic, mole, and mass percent.
 2. Chemical Reactions: Stoichiometry & balancing of chemical reactions, Calculation of reaction yield and identification of limiting reactants.
 3. Solution Chemistry Concepts: Ions, electrolytic solutions hydration. Acids, bases, and pH. Neutralization and equivalency. Balance oxidation/reduction reactions.
 4. Energy Considerations: Concepts of enthalpy, entropy, Gibbs free energy and equilibrium. Use LeChatelier's Principle to determine direction of reaction.
 5. Electronic Structure of Atoms. Definition of Bohr Atom Model and its limitations. Quantum theory and spectroscopy. Identification of trends in properties of elements in the Periodic Table.
 6. Electronic Structure of Molecules: Construct Lewis structures of atoms and molecules. Electronegativity. Identify geometries of simple molecules. Hybridization and molecular orbital concepts. Relationship between reaction enthalpy and chemical bond energies.
 7. Intermolecular Interactions: Liquids, solids and the basis of molecular recognition.
- II. In calculus based physics, the SEAS expects each of its graduates to have mastered the following nine concepts and to be able to set up problems from first principles, arrange the proper force or circuit diagrams as needed, and obtain a solution:
 1. Forces: Newton's laws of motion, gravitation.

2. Work, energy, momentum and their conservation laws.
3. Rotational motion including torque and angular momentum.
4. Simple harmonic motion and waves.
5. Thermodynamics and microscopic properties of gases.
6. Electrostatics and electric currents.
7. Magnetic fields and their applications.
8. Capacitors, inductors, AC circuit equations and oscillations.
9. Optics

Description of Measure To Be Used

All SEAS students are required to complete successfully certain science courses in which the concepts listed above are taught. In the chemical sciences, the required course is Chemistry 151, Introductory Chemistry for Engineers. It is in this course that students develop a deeper understanding of the basic concepts of chemistry and the problem solving skills associated with those concepts as described above. In calculus based physics, the two required courses are Physics 142E & W and Physics 241E & L. It is in these two courses that students are expected to learn the knowledge of physics and the problem solving skills described above.

The final examinations in these courses are designed, and include questions, to assess the students' knowledge and mastery level of the science competencies listed above. These final examinations, therefore, provide a ready assessment tool.

We will collect and copy the final examinations of a randomly selected sample of 20% (about 50 students in total) of the students enrolled in the three courses listed above (Chemistry 151, Physics 142, and Physics 241) in the sequence in which the courses are taught so that the examinations collected are those of the same 50 students throughout. We will choose and train a panel of independent and knowledgeable evaluators, consisting of faculty members not associated with the teaching of these courses but who have knowledge of the subject areas, to assess the competencies demonstrated by the final examinations. The following is an explanation of the 4, 3, 2, 1 scale to be used in the assessment:

4 (strong competence): A score of 4 will indicate that the student is able to understand the required concept and solve advanced problems and express solutions clearly.

3 (reasonable competence): A score of 3 will indicate that the student is able to understand most of the concept and solve most of the problems.

2 (some competence): A score of 2 will indicate that the student understands some of the concept but is not able to carry out the specific steps or solve the problems accurately.

1 (little competence): A score of 1 indicates that the student does not have a basic understanding of the defined concept and does not have the necessary problem solving skills.

Description of the Methodology to be Used to Gather Evidence of Competency:

The Office of Institutional Assessment and Studies will select a random sample of 20% of the students enrolled in the courses listed above, and will collect and make copies of those students' examinations before they are graded. There will be two separate assessment committees for chemical sciences and physics. These committees will review the final examinations after they have been prepared to assure that questions on the examinations require students to demonstrate the competencies listed above, and to identify specifically those questions. The examinations will be copied prior to their being graded by the course instructors, and the names of the students will be removed to assure privacy and anonymity. At no time will it be possible to associate assessment results with the names of students.

The assessment committees then will evaluate the final examinations and make a determination of whether students have demonstrated mastery of the competencies or concepts listed. Each examination will be assessed by two evaluators, and in the event of disagreement on the scores assigned, the two scores will be averaged. A competency score for each of the competencies or concepts listed will be assigned using a 4, 3, 2, 1 scale defined above. From the scores on each of the competencies or concepts, we will calculate a separate composite score for chemical science and physics, and it is these composite scores that will be reported to SCHEV. The scores on each of the competencies or concepts will be reported to the appropriate administrators and faculty members of the SEAS for their information and for them to use in making changes and improvements in teaching techniques and/or to the curriculum as appropriate. It is planned that the assessment of student competency in science will take place every three years.

Plan for Disseminating the Results of the Competency Assessment to Publics with a Stake in the Quality of Virginia Higher Education.

The Office of Institutional Assessment and Studies will provide the following results of the Science Competency Assessment of SEAS students:

1. A description of SEAS' expectations for student learning in this area
2. A description of how students are taught or can learn these skills.
3. A description of the assessment process.
4. The percent of students who were determined by the evaluators to be in each of the four categories described above.

Submitted by: _____
Vice President and Provost