QualityCore®

Course Description and Syllabus
Chemistry

Description

Are the dyes in washable markers safe for children? Why do engineers use steel rather than iron in construction? How do companies manufacture pills that dissolve in acids? From questions such as these, a rigorous Chemistry course is made. In such a course, students apply their knowledge of chemical processes and physical properties in ways that are relevant to their world. It is a dynamic learning environment, and it does not happen by chance. Research (National Research Council, 2002) shows that a rigorous Chemistry course is created when it aims to

- create a supportive environment that fosters collaboration, questioning, and investigation;
- invite students to be responsible for their learning by building upon their interests;
- emphasize higher-order reasoning through discussion, relevant learning, and experimentation; and
- assert that process teaches content and vice versa.

In other words, a rigorous Chemistry course relies upon processes that are central to science itself—investigation, experimentation, collaboration—in order to develop deep understanding and, consequently, raise student achievement.

A rigorous Chemistry course covers the primary aspects of the discipline. The makeup of the physical world, from the properties and structures of matter to the laws explaining the activity of gases, is explored, as are the chemical structures of elements, molecules, and compounds. Like other Chemistry courses, a rigorous course studies the periodic table of elements and the proper symbolic nomenclature of elements as well as the symbolic representation of chemical reactions in formulas and equations. Investigations into the microscopic world lead to deeper understanding of the macroscopic world, from atomic structure and bonding to the properties of salts, acids, and bases. More advanced subjects, such as REDOX reactions or nuclear chemistry, are also introduced in a rigorous Chemistry course. In support of students' introduction to the discipline, a rigorous course emphasizes the foundations and practices of science in general, teaching the basic processes of scientific inquiry and emphasizing the importance of mathematics and measurement. A rigorous Chemistry course, moreover, affirms what the National Science Teachers Association claims in its position statement on scientific inquiry: "Understanding science content is significantly enhanced when ideas are anchored to inquiry experiences" (2004, p. 1). In other words, in the study of chemistry, a rigorous Chemistry course emphasizes problem solving, critical thinking, and decision making. In doing so, it reflects an understanding of the ways that students learn.

Students learn when topics are organized in meaningful, coherent ways. Such organization encourages students to build understanding, then to expand upon it. For example, a lesson exploring how the changes in the order of atomic structures are a result of energy changes might be connected to previous lessons about how the modern view of atomic structure and the behavior of atoms is based on the combined work of scientists across time, including Ernest Rutherford, Robert Millikan, Niels Bohr, James Chadwick, and Werner Heisenberg. Discussions can further lead students to discover how properties can be used to identify matter and predict its behavior, thereby building a deep understanding of how matter is composed of a limited

number of elements created through nuclear events in the universe. Conceptually organized content empowers students to make such connections on their own.

Addressing issues that affect a student's world is one of the primary ways that a rigorous Chemistry course uses context to teach content. For example, a rigorous course might ask students to discover through research and laboratory experiments why sodium bicarbonate—baking soda—is a necessary component in common substances from bread to deodorant, tooth whitener, and fungicides. While studying nuclear chemistry, students might discuss why the disposal of nuclear waste poses long-term environmental dilemmas. Chemistry concepts, in other words, are taught in the context of the real world.

Similarly, a rigorous Chemistry course emphasizes skills in the context of their use. In the laboratory students apply and refine their skills of observation; they practice how to collect data accurately and efficiently. Meanwhile, they also develop facility with the basic tools of science. In laboratory investigations, they work with precision measurement tools (e.g., computer-linked probes, balances, titration materials, pipettes, thermometers, graduated cylinders) and in the process learn how to understand the data they collect as they investigate scientific questions. Introducing students to common indicators, such as Universal Indicator, phenolphthalein, or litmus paper (to indicate a substance's acidity or alkalinity), reveals other important ways to collect data.

Analysis and interpretation of data thus become vital for students' success. Students come to understand that precision and accuracy are crucial to measurement. Moreover, asking students to then write reports that require them to interpret data accustoms them to the choices they must make when presenting scientific information. With guidance from the teacher and their peers, they discover which method of representation—a table to identify the best catalyst in a chemical reaction, a line graph to represent a phase change from liquid to solid—best illustrates what the data reveal.

In the process of inquiry, students also read and carry out other research. They become steeped not only in the language of scientific study, learning to identify the independent and dependent variables and controls in experiments, but also in the language of the discipline. In their research, students seek valid and pertinent information in print and other sources. Meanwhile, teachers emphasize reading strategies that enable students to better understand scientific articles. As they read, students further learn how professional scientists approach problems, perform research, test findings, analyze and effectively present data, and write and publish results. Throughout the course, therefore, teachers emphasize academic integrity and the responsible reporting of all research.

Because students must present data and research, a rigorous Chemistry course hones students' writing and oral presentation skills. Through lab notebooks, notes taken during class, and written or spoken responses to challenging, open-ended questions, students reflect on learning and extend thinking. Students also write and speak formally. After a laboratory investigation, for example, not only do students prepare well-written, organized, and complete lab reports, but also present their findings to the class. A rigorous course therefore teaches valuable writing and speaking skills that students will need for future education or work.

In order to ensure that a rigorous Chemistry course facilitates students' building a solid base of knowledge, students are asked many different types of questions in labs and other activities. Literal, inferential, and application questions require them to think about the processes they study. Throughout the course, particularly as students respond to broader questions that allow

them to describe their thought processes, teachers listen carefully, then respond with probing and clarifying questions. Teachers adjust instruction as necessary to help students gain deeper understanding of content and concepts.

Students learn in a rigorous course because it is strongly interactive. A rigorous Chemistry course is interactive when the course's content is relevant to students' lives. When students are asked to explain why cars in Minnesota are more prone to rust than cars in Florida, they are being asked to connect their own knowledge of chemical processes with their experience. Laboratory investigations that allow students to experience and experiment also encourage learning, particularly when they are asked to reconcile new discoveries with their current understanding. During a lab in which students discover that water beads on an oily surface but oil disperses on water, a teacher in a rigorous course will take advantage of the discovery to confront the common misconception that oil and water repel each other. Such discussions encourage students to formulate new perspectives and to understand firsthand the concept of dipole-dipole attraction.

A rigorous course also gives students an opportunity to make progressively more significant decisions. Students establish research questions and designs; they decide how many measurements are appropriate; they form, present, and defend their conclusions. As the course progresses, students refine and revise their approaches, generating more sophisticated questions and reaching more authoritative conclusions.

From the fundamental assumptions of science and the foundations of chemistry to relevant instruction that sets high standards of performance and enables students to achieve those standards, a rigorous Chemistry course is a vibrant learning environment. Through investigation, experiment, and collaboration, the course places students in the best position to achieve.

Model Course Syllabus—Chemistry

On Course for Success (2004) revealed that rigorous Chemistry syllabi share several important characteristics. Not only do they describe the course and identify the content it will cover, but also they outline policies to which teachers and students are held accountable. This model syllabus is a composite drawn from the syllabi studied in *On Course for Success.* As a model, it is addressed to students and should be used as a general guideline, adapted according to a particular district's, school's, or teacher's policies.

Course Overview

Chemistry is an inquiry-based course designed to familiarize you with the science processes, skills, and understandings related to a wide range of topics in chemistry. During this course, you will learn to identify the basic questions and concepts that guide scientific investigation and to design and conduct your own investigations. Some important skills you will develop include titration, graphing and measurement, identification of research questions, making connections, and the ability to be a self-directed learner.

Course Content

- Scientific Inquiry
- Mathematics and Measurement in Science
- Science in Practice
- Introduction to Chemistry
- Properties of Matter and Gases
- Formulas and Equations
- Microscopic Nature of Matter
- Atomic Structure and Chemical Bonding
- Solutions
- Kinetics, Equilibrium, and Thermodynamics
- Salts, Acids, and Bases
- REDOX Reactions and Electrochemistry
- Nuclear Chemistry

Course Materials

- Textbook: (Title, Author, Publisher, Year of Publication)
- Class/Laboratory notebook (a three-ring binder)
- Pen/pencil
- Calculator

Course Policies

Attendance/Absences/Makeup Work: According to school policy, you must make up, within one week, tests, quizzes, and laboratory work missed due to excused absences. Homework assigned prior to an absence must be turned in the day you return, and homework assigned during your absence the day after you return, unless I extend the deadline because of unusual circumstances.

Classroom Rules/Expectations: You are expected to arrive each day on time and ready for instruction, to act responsibly and contribute to an orderly learning environment, and to follow the behavior guidelines outlined in the school handbook.

Homework Policy: Assignments are to be completed on appropriate paper. Late work will receive only partial credit.

Grading Policy

Grade Distribution: Quarter grades will be calculated as follows: 50% will be determined by homework, lab reports, and activities, and 50% will be determined by tests and special projects. For most assignments, I will provide the rubrics and/or explain the expectations in advance.

Extra Credit: Extra credit will be available only to students who have completed all assignments.

Course Procedures

Lectures and Labs: Lectures will emphasize chemistry concepts. They are intended to help you become conversant with the language chemists use and the type of work that chemists do. Labs will familiarize you with skills needed to investigate scientific questions, allow you to establish effective research habits, and reinforce information learned during lecture. Communication is an important part of science, and clearly written lab reports are essential.

Laboratory Notebook: You will be expected to write lab reports in your laboratory notebook (see "Laboratory Report Format," below). Notebooks will be collected and graded.

Scientific Literature: To make scientific progress, it is important for scientists to share information with each other and with the public both orally and in writing. You will be responsible for reading, summarizing, critiquing, discussing, and presenting information from scientific articles.

Laboratory Report Format

Directions: Each lab report should include the following sections:

- *Title:* What is the activity called?
- *Purpose:* What do you hope to accomplish, or what is your reason for doing this lab? (Include sufficient background information.)
- *Hypothesis:* What are you testing with this lab?
- *Materials/Equipment:* List the materials and/or equipment that you used for this procedure.
- *Procedures:* Describe how the lab is done (include safety precautions). Be thorough enough to be able to do the experiment again using your lab report as a guide.
- *Data and Observations:* Record all the information that you collected during the exercise. This should include sensory observations (e.g., the appearance of reactants, the motion of objects). Organize the data in a chart, table, or graph. Include any experimental error determinations, if appropriate. Use the correct number of significant figures. Be as complete as possible.
- *Calculations:* Show all work and results of any calculations made using the collected data.
- *Questions:* Answer all assigned questions. Questions may be found in the lab handout or on the board.
- *Conclusions:* Summarize what happened in the lab and evaluate the results. Use complete paragraphs. Also, tell what you learned by doing this lab.

Personal Statement

It is very important that you review your notes, homework, and labs frequently! This is especially true when homework has a purpose. Most homework has one or more of the following aims:

- *Practice* reinforces the learning of material already presented in class and helps you master specific skills.
- *Preparation* provides information—history, skills, definitions—for forthcoming information; it is intended to allow you to benefit when the new material is covered in class.

- *Extension* or elaboration involves the transfer of previously learned skills to new situations.
- *Integration* asks you to apply skills and concepts to produce a single product (e.g., book report, science project).

I will make every effort to communicate the purpose of homework assignments to you. If you are having difficulties with any of the topics covered in this course, see me as soon as possible. Times when I am available for extra help are included below.

This will be an exciting and interesting class if we all work together. *Remember, the more effort you put in the more reward you get out!*

Laboratory Safety

Please read and sign the attached laboratory safety contract.

Additional Information

Contact Information: I will be in my classroom or office for most of the school day. I am also available for help after school on Monday, Tuesday, and Thursday and some mornings by appointment.

School telephone number:
Best time to call:
E-mail:

Science Fair: The school science fair will be held in March. The science fair is optional; however, I encourage you to participate.

Internship Opportunities: Information about internship opportunities will be made available throughout the course.

Signatures: Discuss this course syllabus with your parent(s) or guardian(s). You were given two copies—the blue one is for you and your parent/guardian to sign, and the yellow one is for you to keep. Please have your parent/guardian sign the bottom of the blue copy and return it in ___ days. I am looking forward to working with you this year.

I, _____ (Student Name), have read and understand the Chemistry course syllabus and expectations.

I, _____ (Parent/Guardian Name), have read and understand the Chemistry course syllabus and expectations.

Student Signature: _____ Date: _____

Parent/Guardian Signature: _____ Date: _____

References

ACT, Inc., and The Education Trust. (2004). *On course for success: A close look at selected high school courses that prepare all students for college.* Iowa City, IA: Author.

National Research Council. (2002). *Learning and understanding: Improving advanced study of mathematics and science in U.S. high schools.* Washington, DC: National Academy.

National Science Teachers Association. (2004). NSTA position statement: Scientific inquiry. Retrieved June 8, 2007, from the National Science Teachers Association Web site: http://www.nsta.org/about/positions/inquiry.aspx

