DATE: August 9, 2011

TO: BOARD OF EDUCATION

FROM: Dr. Joe A. Hairston, Superintendent

SUBJECT: CONSIDERATION OF THE HIGH SCHOOL GIFTED AND TALENTED (G/T) CHEMISTRY CURRICULUM

ORIGINATOR: Dr. Renee A. Foose, Deputy Superintendent

RESOURCE PERSON(S): Roger Plunkett, Assistant Superintendent, Curriculum and Instruction
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Christine Schumacker, Coordinator, Secondary Science
Jeremy Haack, Supervisor, Secondary Science

RECOMMENDATION

That the Board of Education approves the High School Gifted and Talented Chemistry curriculum.

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Attachment I – Executive Summary and Curriculum Pilot Evaluation
Attachment II – AIM Objectives
Attachment III – Phase III - BCPS Course Request
Executive Summary and Curriculum Pilot Evaluation

Pilot Name: Gifted and Talented Chemistry

Executive Summary
The Gifted and Talented Chemistry curriculum was last revised in 1983. Despite the fact that the content was accurate, the 1983 G/T Chemistry curriculum did not incorporate current best instructional practices or technology or other types of electronic resources. The 1983 curriculum also predated the Maryland State Core Learning Goals for Chemistry (Goal 4) and, therefore, was not as closely aligned to state and national standards as desired. Staff from the Office of Science worked with the Chemistry Study Committee and chemistry curriculum writers to review the curriculum guide and determine the areas needing to be strengthened and/or supplemented. Those findings guided the revision and improvement of the guide being submitted for approval.

The overall purpose of revising the Gifted and Talented Chemistry Curriculum was to produce a well-aligned curriculum that reflects the principles and philosophy of STEM, provides the background and framework for chemistry instruction appropriate for 21st Century learners, engages students in hands-on, inquiry-based laboratory and classroom experiences, increases student performance, incorporates teaching strategies for gifted students, and provides improved background and experiences to prepare students for the Advanced Placement Chemistry course. Alignment of the curriculum to the Maryland High School Core Learning Goals and National Science Education Standards has been carefully checked and reconfirmed. Additionally, the revised curriculum guide fully and completely incorporates the elements utilized by Phi Delta Kappa (PDK) in assessing curriculum quality and effectiveness – clarity and specificity of objectives; congruity of curriculum and assessments; delineation of essential prerequisite skills, knowledge, and attitudes; delineation of major instructional resources; and clear approaches and strategies for classroom use. Following the PDK rubric criteria, the revised guide presents a score of 15 out of a possible 15 points.

The curriculum binder contains the portion of the science scope and sequence that identifies the content and skill indicators students learned in the previous grade or course, those addressed in the current grade or course, and those they will encounter in a subsequent grade or course. Additionally, the Articulated Instruction Module provides a lens through which to view alignment of the written, taught, and assessed curriculum with the High School Core Learning Goals and National Science Education Standards. The curriculum guide also provides the teacher with the framework and resources necessary to plan and implement a rigorous and engaging study of chemistry. The curriculum has been designed as an integral part of the PreK-12 science program to help students meet Baltimore County standards and performance goals as outlined in the BCPS Blueprint for Progress. Science is presented in an engaging, hands-on, minds-on approach that is relevant to today and places learning in a real-world setting. The chemistry curriculum has been designed to capture students’ inherent curiosity, to relate natural phenomena to the world in which they live, to engage students in the hands-on doing of real science, and to help them develop problem-solving skills and communicate their understanding of scientific concepts clearly and effectively.

Curriculum Pilot Evaluation Template
Office of Research
Department of Research, Accountability, and Assessment
March 2011
The revised curriculum was piloted during the 2010-2011 academic year in eight high schools across the system. Two textbooks were also piloted along with the curriculum. Pilot teachers met throughout the year to examine and analyze student performance data and to provide anecdotal data relative to content, delivery of instruction, organization, assessment, alignment with standards, and the appropriateness of the piloted textbooks. Professional development was also provided to pilot teachers by the Office of Science.

Based on user feedback, a textbook was selected and final curriculum revisions were completed last spring. The pilot teachers will be trained to deliver professional development on the revised curriculum to all G/T Chemistry teachers at the August 24, 2011, Professional Study Day. The revised curriculum will be implemented systemwide beginning in 2011-2012. Office of Science staff will monitor daily instruction and continue to collect anecdotal feedback.

Research Questions:
1. What are/were the expectations for implementation of the pilot curriculum?
2. How does/did the pilot curriculum impact the approach to content instruction?
3. What is/was the impact of the pilot curriculum on student achievement?

### Research Question 1

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Criteria</th>
<th>Measures Used</th>
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<tbody>
<tr>
<td>Pilot schools will implement the curriculum as prescribed and in the sequence indicated in the guide.</td>
<td>Pilot teachers will attend pilot meetings to provide feedback on their implementation of the curriculum in their classrooms.</td>
<td>Teacher reporting Office of Science observations</td>
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Findings:
- The pilot curriculum was provided to eight pilot teachers to implement in their schools for the 2010-2011 school year.
- One of the teachers started the school year on maternity leave and did not start implementing the curriculum until her return; another teacher left in April to go on maternity leave and stopped implementing the curriculum at that time.
- Six of the schools implemented the pilot curriculum for the entire school year.
- All pilot teachers reported using the pilot curriculum for their instruction with some modification and differentiation for their students and teaching styles.
  - Observations at the pilot schools by the Office of Science staff confirm the implementation of pilot curriculum materials as designed.
  - Most pilot teachers reported that they enjoyed having the pilot curriculum to use for planning instruction compared to the older 1983 version.
Research Question 2

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Criteria</th>
<th>Measures Used</th>
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<tbody>
<tr>
<td>Teachers will report that the pilot curriculum was beneficial to student engagement, teaching and learning.</td>
<td>Teachers will report an increase in the use of instructional technology.</td>
<td>Teacher feedback</td>
</tr>
<tr>
<td>Teachers will report that the pilot curriculum incorporated appropriate instruction technology and was beneficial to the gifted students learning the chemistry content.</td>
<td>Teachers will report that lessons in the guide are appropriate for gifted students.</td>
<td>Office of Science observations</td>
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</table>

Findings:

1. Six of the eight pilot teachers returned the curriculum evaluation near the end of the pilot (one of the teachers not returning the evaluation is on maternity leave).
2. All the pilot teachers completing the curriculum evaluation reported that the content was appropriate for the designated age level and was relevant to the students’ daily lives.
3. All pilot teachers completing the curriculum evaluation reported an increase in the use of instructional technology when they taught the class with the pilot curriculum.
   - Some reported a need for alternatives to some Internet-based technology because of the lack of computers (prior to the deployment of the new laptop carts) or issues with the wireless abilities in their schools.
4. All pilot teachers completing the curriculum evaluation reported that the instructional materials actively engaged the students and provided sufficient experiences and opportunities for students to develop a deep understanding of the content.
   - 34% specifically mentioned the improvement in engagement activities in the pilot guide.
   - 50% specifically mentioned the improved laboratory and inquiry-based activities in the pilot guide.

Notable quotes from pilot teacher feedback:

- “It is nice to have an updated curriculum guide to use for teaching this class.”
- “The content is rigorous for the Grade 10 G/T student and involves the chemistry of everyday life.”
- “The curriculum was written specifically for the G/T population.”
- “Lessons include a variety of strategies to teach the same topic.”
- “The curriculum guide is well written and well organized.”
- “Guidelines for student misconceptions as well as suggestions for activities and alternative activities exist throughout.”
- “Many inquiry-based lessons/labs throughout the guide.”
Research Question 3

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<thead>
<tr>
<th>Outcome</th>
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<th>Measures Used</th>
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<tbody>
<tr>
<td>Student scores on unit assessments will be higher in pilot schools than in non-pilot schools.</td>
<td>Student scores on the four designated unit assessments (Reactions, Stoichiometry, Bonding, Gas Laws), will be higher in pilot schools than in non-pilot schools.</td>
<td>Four of the eight Chemistry Unit Assessments. The four assessments were chosen based on the material covered in the pilot curriculum.</td>
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Findings:

<table>
<thead>
<tr>
<th>Unit Assessment Comparisons</th>
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</thead>
<tbody>
<tr>
<td>Percent Score</td>
</tr>
<tr>
<td>100</td>
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<tr>
<td>Chemical Bonding</td>
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<tr>
<td>Nomenclature</td>
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<tr>
<td>Stoichiometry</td>
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<td>Gases</td>
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Pilot schools showed a slight increase in performance in three of the four Unit Assessments given in the G/T Chemistry classes.
The schools using the pilot curriculum showed higher percentages of As in each quarter and a higher percentage of As in the final grade for the 2010-2011 school year as compared to the non-pilot schools.

**Next Steps:**
- Minor adjustments have been made to the pilot curriculum based on pilot teacher feedback throughout the 2010-2011 academic year. Adjustments will continue to be made as additional data are collected throughout the 2011-2012 implementation.
- Ongoing professional development opportunities for Gifted and Talented Chemistry teachers will be provided throughout the 2011-2012 school year.
- The Office of Science is seeking final approval of the revised G/T Chemistry Curriculum in anticipation of systemwide implementation beginning in the 2011-2012 school year.
Articulated Instruction Module
Objectives List (2010 - 2011)

Subject Area : Science
Course : CHEMISTRY GT (2511005)

Last Revised : 03/28/2011
Report Date : 07/13/2011

Objectives / Knowledge and Skill Indicators

Unit: Atomic Theory

O-1 Using information from readings and observations, the student will conduct laboratory investigations to describe the physical and chemical properties of matter.

The goal of AP Chemistry is to provide students with a depth of understanding of the interaction between matter and energy and a reasonable competence in solving quantitative chemical problems. Additionally, students perform college level laboratory investigations, where appropriate, and are responsible for the correct interpretation and explanation of the implications of the experimental results. (Source : College Board, AP Chemistry )

Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source : Core Learning Goals )

KSI-A Use observations and information derived from readings to differentiate between physical and chemical properties of substances.

KSI-B Use scientific measurements to collect, describe, and interpret observations.

KSI-C Use significant figures and proper scientific techniques to describe uncertainty in measurements.

Unit: Atomic Theory

O-2 Using information from readings, the history of atomic theory, diagrams, and models, the student will describe atomic structure.

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Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source : Core Learning Goals )

KSI-A Use historic models to explain the discovery of and the composition and structure of the atom.

KSI-B Use information from readings, diagrams, and electronic sources to explain the arrangement of sub-atomic particles.

KSI-C Use information provided in readings, class discussions, and electronic resources to distinguish and determine the numbers of subatomic particles in atoms and their isotopes (protons, neutrons, electrons) in terms of mass, location and charge.

Unit: Atomic Theory

O-3 Using information from readings and the periodic table, the student will calculate energy changes and predict inter-atomic behavior based upon periodic trends.

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Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source : Core Learning Goals )

KSI-A Use the periodic table to determine trends in the following: atomic/ionic radius, ionization energy, electronegativity, and reactivity.

KSI-B Apply concepts of light and energy to explain behavior of electrons in atoms.
Objectives / Knowledge and Skill Indicators

KSI-C Apply the rules of Aufbau, Pauli, and Hund to write electron configurations for atoms and ions.

Unit: Nomenclature and Reactions

O-4 Using information from diagrams and models, the student will apply the VSEPR theory to describe the formation of compounds, the shapes of molecules, and the importance of molecular geometry.

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Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source: Core Learning Goals)

KSI-A Apply calculations of the number of valence electrons in a molecule to determine single, double, and triple bonds and draw 2-D structures of molecules.

KSI-B Apply VSEPR theory to determine the 3-D structure of molecules in order to name the shape and bond angle of each.

KSI-C Use diagrams to show the dipoles of molecules in order to determine polarity of molecular structures.

KSI-D Use knowledge of valence electrons and numbers of bonds and molecular shapes to identify the hybridization of molecular structures.

Unit: Chemical Bonding

O-5 The student will use information from readings, observations, and diagrams to compare intermolecular and intramolecular forces and to describe the energy changes in solids and liquids.

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Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source: Core Learning Goals)

KSI-A Apply knowledge of the attractions and repulsions of bonding and nonbonding electrons to differentiate between intermolecular and intramolecular forces.

KSI-B Use observational data and readings to compare the strengths of different types of intermolecular forces (dipoles, hydrogen bonding, and van der Waals forces).

KSI-C Use phase diagrams of substances to explain how changes in conditions (temperature and pressure) can affect the state of matter.

Unit: Nomenclature and Reactions

O-6 The student will explain how and why substances are represented by chemical formulas.

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Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source: Core Learning Goals)
Articulated Instruction Module
Objectives List (2010 - 2011)

Subject Area : Science
Course : CHEMISTRY GT (2511005)  
Last Revised : 03/28/2011
Report Date : 07/13/2011

Objectives / Knowledge and Skill Indicators

KSI-A Use symbols to represent elements and add the use of subscripts to represent the numbers of atoms in molecules and ionic compounds.
KSI-B Use information about the rules of nomenclature to recognize and write formulas for common polyatomic ions, including recognizing the charges of the ions.
KSI-C Apply the rules of nomenclature to name compounds (Stock System/Roman Numerals), molecules (prefixes), acids, and hydrates.
KSI-D Apply the rules of chemical nomenclature to write formulas for molecules, ionic compounds, and acids given their names.

Unit: Nomenclature and Reactions
O-7 The student will use symbolic or word equations to describe the reactants and products.

The goal of AP Chemistry is to provide students with a depth of understanding of the interaction between matter and energy and a reasonable competence in solving quantitative chemical problems. Additionally, students perform college level laboratory investigations, where appropriate, and are responsible for the correct interpretation and explanation of the implications of the experimental results. (Source : College Board, AP Chemistry)

Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source : Core Learning Goals)

KSI-A Apply the standards for nomenclature and correct format for chemical equations to translate word equations into symbolic equations.
KSI-B Apply the standards for nomenclature and correct format for chemical equations to translate symbolic equations into word equations.
KSI-C Use abbreviations (s, g, l, aq) to identify the states of substances in chemical equations.

Unit: Chemical Bonding
O-8 The student will classify chemical reactions and predict and identify the products of those reactions.

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Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source : Core Learning Goals)

KSI-A Use observations of patterns of chemical formulas of products and reactants to describe and recognize the general types of chemical equations including synthesis, decomposition, combustion, single and double replacement reactions, acid base, and redox reactions.
KSI-B Apply knowledge of the general types of chemical equations including synthesis, decomposition, combustion, single and double replacement reactions and acid base reactions to predict the products of reactants when given the reactants.
KSI-C Apply the activity series of metals to determine if a single replacement reaction will occur.
KSI-D Apply solubility rules to predict if a precipitate will be produced in a double replacement reaction.
KSI-E Use oxidation numbers and half reactions in redox reactions to balance redox equations and to identify the substances oxidized and reduced.

Unit: Stoichiometry
O-9 Using information from readings and data from a laboratory investigations, the student will identify and describe the relationships between the mole and forms of matter by calculating the empirical or
Articulated Instruction Module
Objectives List (2010 - 2011)

Subject Area: Science
Course: CHEMISTRY GT (2511005)

Objectives / Knowledge and Skill Indicators

molecular formula and the mass of a compound.
The goal of AP Chemistry is to provide students with a depth of understanding of the interaction
between matter and energy and a reasonable competence in solving quantitative chemical problems.
Additionally, students perform college level laboratory investigations, where appropriate, and are
responsible for the correct interpretation and explanation of the implications of the experimental
results. (Source: College Board, AP Chemistry)

Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and
processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in
which we live. (Source: Core Learning Goals)

KSI-A Apply the relationship between the mole and Avogadro’s number to calculate the number of
moles, particles, mass, or volume (of a gas at STP) of a particular substance given other
quantities.

KSI-B Use Avogadro’s number, the formula of a substance, and atomic masses to calculate formula
mass of a compound including hydrates.

KSI-C Use information about the relative numbers and atomic masses of elements to calculate the
empirical and/or molecular formula from percent composition of a compound.

KSI-D Use experimental data to determine percent yield and theoretical yield for a reaction.

Unit: Kinetics/Equilibrium

O-10 The student will construct and use diagrams to describe and compare rates of chemical reactions.
The goal of AP Chemistry is to provide students with a depth of understanding of the interaction
between matter and energy and a reasonable competence in solving quantitative chemical problems.
Additionally, students perform college level laboratory investigations, where appropriate, and are
responsible for the correct interpretation and explanation of the implications of the experimental
results. (Source: College Board, AP Chemistry)

Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and
processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in
which we live. (Source: Core Learning Goals)

KSI-A Use knowledge of the particulate nature of matter to describe the relationship between reaction
rate and molecular collisions.

KSI-B Use diagrams to show the relationship between concentrations of reactants and products over
time.

KSI-C Use diagrams to show the effect of catalysts on the energy and time of reactions.

KSI-D Use knowledge of kinetics to calculate first order reaction rates.

Unit: The Gases

O-11 Given Graham’s Law, the laws of Boyle, Charles, Gay-Lussac, and Dalton, and the Ideal Gas Equation,
the student will conduct laboratory investigations to identify the mathematical relationships and
qualitative properties of gases.
The goal of AP Chemistry is to provide students with a depth of understanding of the interaction
between matter and energy and a reasonable competence in solving quantitative chemical problems.
Additionally, students perform college level laboratory investigations, where appropriate, and are
responsible for the correct interpretation and explanation of the implications of the experimental
results. (Source: College Board, AP Chemistry)

Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and
processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in
which we live. (Source: Core Learning Goals)

KSI-A Use knowledge of intermolecular forces and states of matter to differentiate between an ideal
gas and a real gas.
Articulated Instruction Module
Objectives List (2010 - 2011)

Subject Area: Science
Course: CHEMISTRY GT (2511005)

Objectives / Knowledge and Skill Indicators

KSI-B Use knowledge of the effects of temperature, pressure and volume conditions to apply the laws of Boyle, Charles, Gay-Lussac, and Dalton to laboratory data and empirical calculations using these laws.

KSI-C Use data from labs and problem sets to apply the Ideal Gas Equation.

KSI-D Use Graham's Law to calculate the relative rates of diffusions of gases.

Unit: Kinetics/Equilibrium

O-12 Using information from readings, graphs, and diagrams of thermodynamics and kinetics, the student will predict, identify, and describe phase, and chemical changes in substances.

The goal of AP Chemistry is to provide students with a depth of understanding of the interaction between matter and energy and a reasonable competence in solving quantitative chemical problems. Additionally, students perform college level laboratory investigations, where appropriate, and are responsible for the correct interpretation and explanation of the implications of the experimental results. (Source: College Board, AP Chemistry)

Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source: Core Learning Goals)

KSI-A Use information about the energies of products and reactants to distinguish between endothermic and exothermic reaction.

KSI-B Use graphs of reaction energies to interpret relative energies of reactants/products, exothermic/endothermic reactions, activation energy, action of catalysts and changes in temperature.

KSI-C Apply knowledge of bonding to explain the energies associated with the formation and breaking of chemical bonds.

KSI-D Apply stoichiometric relationships to calculate the enthalpy of a reaction given specific quantities of reactants or products.

KSI-E Apply knowledge of the nature of state functions to use Hess' Law.

Unit: Acids and Bases

O-13 Using information from readings and teacher demonstrations, the student will conduct investigations to classify solutions and describe their properties and formations.

The goal of AP Chemistry is to provide students with a depth of understanding of the interaction between matter and energy and a reasonable competence in solving quantitative chemical problems. Additionally, students perform college level laboratory investigations, where appropriate, and are responsible for the correct interpretation and explanation of the implications of the experimental results. (Source: College Board, AP Chemistry)

Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source: Core Learning Goals)

KSI-A Apply information from readings and demonstrations to differentiate the terms solute, solvent and solubility. (dilute, concentrated, saturated, unsaturated, and supersaturated).

KSI-B Use information from class discussions and demonstrations to define and distinguish among the terms solution, alloy, colloid, and suspension.

KSI-C Apply information from labs and demonstrations to explain how certain factors can influence the rate of dissociation/ionization.

KSI-D Use knowledge of the effect of particles in solution to explain colligative properties.

KSI-E Use stoichiometric and proportional calculations to determine the concentration of solutions or quantities required for dilutions using molarity, molality, or percent solution.
Articulated Instruction Module
Objectives List (2010 - 2011)

Subject Area: Science
Course: CHEMISTRY GT (2511005)

Objectives / Knowledge and Skill Indicators

O-14 Using the theories of Arrhenius, Bronsted-Lowry, and Lewis, and data from laboratory investigations, the student will compare acids, bases, and salts based on their properties and knowledge of acid-base equilibria.

The goal of AP Chemistry is to provide students with a depth of understanding of the interaction between matter and energy and a reasonable competence in solving quantitative chemical problems. Additionally, students perform college level laboratory investigations, where appropriate, and are responsible for the correct interpretation and explanation of the implications of the experimental results. (Source: College Board, AP Chemistry)

Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source: Core Learning Goals)

KSI-A Use knowledge of dissociation of ionic compounds and water to distinguish between the definitions of acids and bases prescribed by the theories of Arrhenius, Bronsted-Lowry, and Lewis.

KSI-B Use knowledge of the extent of dissociation in ionic compounds to define and give examples of strong and weak acids and bases.

KSI-C Use knowledge of dissociation to describe the auto-ionization of water and solve problems using the ion product constant for water.

KSI-D Apply knowledge of the pH scale to explain how it is used for measuring solution acidity.

KSI-E Apply knowledge of reaction types to predict the products of neutralization and calculate the amount of acid or base needed to neutralize a solution (titration).

Unit: Acids and Bases

O-15 Given LeChatelier's principle, the student will predict how chemical systems are affected by changes in conditions and describe the acid-base properties of solutions.

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Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source: Core Learning Goals)

KSI-A Use the concept of dynamic equilibrium to explain reversible reactions.

KSI-B Use information derived from a chemical equation to write an equilibrium expression.

KSI-C Use LeChatelier's principle to describe qualitatively and to calculate the effects of changes in a reaction system.

Unit: Thermodynamics

O-16 Using information from readings, graphs, and diagrams on spontaneity and kinetics, the student will predict, identify, and describe phase, chemical, and nuclear changes in substances.

The goal of AP Chemistry is to provide students with a depth of understanding of the interaction between matter and energy and a reasonable competence in solving quantitative chemical problems. Additionally, students perform college level laboratory investigations, where appropriate, and are responsible for the correct interpretation and explanation of the implications of the experimental results. (Source: College Board, AP Chemistry)

Goal 4 Concepts Of Chemistry - The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live. (Source: Core Learning Goals)
Articulated Instruction Module
Objectives List (2010 - 2011)

Subject Area: Science
Course: CHEMISTRY GT (2511005)

Objectives / Knowledge and Skill Indicators

KSI-A Use energy and state information to explain spontaneous reactions in relation to enthalpy.
KSI-B Use Standard Entropy values to calculate the change in entropy of a reaction.
KSI-C Use Gibbs Free Energy problems in order to explain entropy and enthalpy.
KSI-D Use knowledge of energy changes and stability of substances to explain the relationship between free energy and equilibrium

Unit: Skills
O-17 Given scientific evidence and sample arguments, the student will identify and explain factors that produce biased or misleading data.

Goal 1 Skills And Processes - The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information. (Source: Core Learning Goals)

KSI-A Recognize that real problems have more than one solution and that decisions to accept one solution over another are made on the basis of many issues.
KSI-B Use accumulated evidence to modify or affirm scientific ideas.
KSI-C Critique arguments that are based on faulty or misleading data or the incomplete use of numbers.
KSI-D Recognize and explain factors that produce biased data, such as errors in investigative procedure, incomplete data, inappropriate use of data, conflict of interest, and/or inappropriate use of numbers.

Unit: Skills
O-18 The student will pose scientific questions and suggest investigative approaches to provide answers to scientific questions.

Goal 1 Skills And Processes - The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information. (Source: Core Learning Goals)

KSI-A Formulate a working hypothesis based on a meaningful, answerable scientific questions.
KSI-B When given a scientific question or problem, identify the need for verifiable data.
KSI-C Solve problems and/or answer questions through investigations using appropriate instruments and materials.
KSI-D Conduct or evaluate an investigation using the steps of the scientific method and identify key components of an investigation, such as independent and dependent variables, proper control, and sample size.
KSI-E Explain phenomena observed outside the laboratory through the use of relationships discovered in the lab.

Unit: Skills
O-19 The student will demonstrate the proper use of scientific instruments, materials, and systems of measurement while conducting scientific investigations.

Goal 1 Skills And Processes - The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information. (Source: Core Learning Goals)

KSI-A Recognize factors that contribute to a safe laboratory environment and safe laboratory procedures.
KSI-B Perform investigations using laboratory equipment, chemicals, and materials of science in acceptable and safe ways.
KSI-C Use laboratory and field equipment and learned skills to perform investigative techniques.
KSI-D Follow written and/or graphic instructions and/or oral directions to demonstrate proper use of
Articulated Instruction Module
Objectives List (2010 - 2011)

Subject Area: Science
Course: CHEMISTRY GT (2511005)

Objectives / Knowledge and Skill Indicators

Unit: Skills

O-20 The student will use data in many forms to demonstrate the importance of data analysis in scientific inquiry and investigation.

Goal 1 Skills And Processes - The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information. (Source: Core Learning Goals)

KSI-A Use techniques such as tables, graphs, and webs to organize and analyze data from research and/or investigations.

KSI-B Analyze data from resources and/or investigations to make predictions, decisions, draw conclusions, and/or validate results.

KSI-C Determine the relationship(s) between mathematical quantities and, when appropriate, develop a mathematical model to describe the relationship(s).

KSI-D Use data from resources and/or investigations to describe trends.

KSI-E Analyze data from resources and/or investigations to confirm, modify, or reject a hypothesis.

Unit: Skills

O-21 The student will demonstrate appropriate methods of communication by summarizing data, interpreting graphics and readings, and explaining and describing scientific concepts.

Goal 1 Skills And Processes - The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information. (Source: Core Learning Goals)

KSI-A Demonstrate the ability to summarize data and create and/or interpret graphics.

KSI-B Use drawing, writing, oral communication, tables, graphs, and/or other types of displays to explain scientific concepts or processes or to support arguments or claims.

KSI-C Read and appropriately interpret a technical reading passage relating to a scientific concept, investigation, or process.

KSI-D Use, explain, and/or construct various types of classification systems to categorize organisms or objects.

KSI-E Synthesize ideas and information gained through research and/or investigation to describe similarities and differences between and among scientific concepts or principles.

Unit: Skills

O-22 The student will use knowledge of and facility with mathematical skills and processes to solve problems, communicate information, and describe relationships.

Goal 1 Skills And Processes - The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information. (Source: Core Learning Goals)

KSI-A Solve problems using ratio and proportion.

KSI-B Perform calculations for tables, graphs, or spreadsheets using computer and/or graphing calculators technology.

KSI-C Use scientific notation and relative order of magnitude to explain and/or compare small and large quantities.

KSI-D Demonstrate the ability to manipulate quantities and/or numerical values in algebraic equations.

KSI-E Use information and/or data to judge the reasonableness of an answer.

Unit: Skills

O-23 The student will apply scientific skills and concepts to illustrate connections within the various fields of science and among science and other disciplines, including mathematics, social studies, language arts.
Articulated Instruction Module
Objectives List (2010 - 2011)

Subject Area: Science
Course: CHEMISTRY GT (2511005)

Objectives / Knowledge and Skill Indicators

fine arts, and technology.

Goal 1 Skills And Processes - The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information. (Source: Core Learning Goals)

KSI-A Apply the skills, processes, and concepts of biology, chemistry, physics, earth/space, or environmental sciences to analyze and explain current societal issues.

KSI-B Use current news and real-world events to evaluate the impact of scientific ideas and/or advancements in technology on society.

KSI-C Recognize the importance of mathematics as an integral component of the scientific process.

KSI-D Use human, print, and/or electronic resources to investigate a selected scientific career path.

KSI-E Use real-world examples from the fields of science to explain how the creation of new technologies is both an outgrowth of and contributor to new scientific accomplishments.
Section I: Course Information

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Name</th>
<th>Master Course File</th>
</tr>
</thead>
<tbody>
<tr>
<td>2511005</td>
<td>Gifted and Talented Chemistry</td>
<td>2011-2012, version 4 June 28, 2011</td>
</tr>
</tbody>
</table>

Section II: Date to be instituted

2011-2012

Sponsoring Office: STEM-Science

Section III: Request to Change Course Content with the Original Course Number

Complete this section only if you desire to change the objectives and/or KSIs for a course number that currently appears in the Master Course File.

Rationale (Be specific):
The Gifted and Talented Chemistry curriculum was last revised in 1983. Despite the fact that the content was accurate, the 1983 G/T Chemistry curriculum did not incorporate current best instructional practices or technology or other types of electronic resources. The 1983 curriculum also predated the Maryland State Core Learning Goals for Chemistry (Goal 4) and, therefore, was not as closely aligned to state and national standards as desired.

The purpose of revising the Gifted and Talented Chemistry curriculum was to produce a well-aligned curriculum that reflects the principles and philosophy of STEM, provides the background and framework for chemistry instruction appropriate for 21st Century learners, engages students in hands-on, inquiry-based laboratory and classroom experiences, increases student performance, incorporates teaching strategies for gifted students, and provides improved background and experiences to prepare students for the Advanced Placement Chemistry course.

Section IV: Request to TERMINATE Course

Complete this section only if you desire to remove a course number from the Master Course File; from STARS, and from AIM. For all other changes, proceed to Section V.

Rationale (Be specific):
Section V: Request to Change School Type, Number of Credits, Course Name, or Course Availability

Rationale (Be specific):

- SCHOOL TYPE change desired
  - No change

- NUMBER OF CREDITS change desired
  - No change

- COURSE NAME change desired
  - Type desired 30-character course name here

- COURSE AVAILABILITY change desired
  - Systemwide: All schools within the “School Type” identified above may offer course.
    - YES
  - Specific School(s): Only school(s) within the “School Type” identified above and listed below may offer course.
    - NO
    - 

Section VI: Request to Change Course Number

Rationale (Be specific):

<table>
<thead>
<tr>
<th>Original Course Number</th>
<th>New Course Number</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type original course number here</td>
<td>Type new course number here</td>
<td>Type 30-character course name here</td>
</tr>
</tbody>
</table>

For Approval Use Only:
Executive Director—Assistant Superintendent of C&I—Executive Leadership Team—Board of Education—Office of Student Data

Executive Director:
After obtaining required signatures, forward this form to Frank Curnoles, manager of the Office of Student Data.

- Executive Director’s Approval: Date:
- Assistant Superintendent of C&I’s Approval: Date:
- Superintendent’s Approval (In accordance with the Executive Leadership Team’s review): Date:
- Board of Education’s Approval: (if necessary) Date:

For Office of Student Data Use Only:
Course details revised in SILK MAIN district course.
Type date here OSD staff name

Parent course deactivated in STARS course maintenance for desired school year, if applicable.
Type date here OSD staff name

Course deactivated in Data Warehouse for desired school year.
Type date here OSD staff name

Course removed from AIM for desired school year.
Type date here AIM staff name