

SECONDARY SCIENCE

SC-72 Chemistry

Course #: SC-72	Grade Level: 11-12
Course Name: College Prep Chemistry	Level of Difficulty: High
Prerequisites: MA-27 with "B" or better, MA-30	# of Credits: 1

Strand 1: Inquiry Process

"Science as inquiry is basic to science education and a controlling principle in the continuing organization and selection of students' activities. Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry..." (National Science Education Standards, 1995).

Inquiry Process establishes the basis for students' learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Concepts

Concept 1: Observations, Questions, and Hypotheses

- Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.

Concept 2: Scientific Testing (Investigating and Modeling)

- Design and conduct controlled investigations.

Concept 3: Analysis, Conclusions, and Refinements

- Evaluate experimental design, analyze data to explain results and propose further investigations. Design models.

Concept 4: Communication

- Communicate results of investigations.

Students should know and be able to...

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S1C1	Observations, Questions, and Hypotheses	1	Evaluate scientific information for relevance to a given problem. - Draw conclusions from reading assignments	Theory Laws	Atomic Theory Clue Sets (Lawson's)
		2	Develop questions from observations that transition into testable hypotheses. - Create hypothesis from observations in inquiry labs, teacher demonstrations, and reading assignments	Observation Inference	

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S1C1 (cont.)		3	<p>Formulate a testable hypothesis.</p> <ul style="list-style-type: none"> - Write a hypothesis using if...and...then...Format. - Identify independent and dependent variables 		Practice worksheets Many labs
		4	<p>Predict the outcome of an investigation based on prior evidence, probability, and/or modeling (not guessing or inferring).</p> <ul style="list-style-type: none"> - Predictions in many inquiry labs 		Class discussions, writing practice

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S1C2	Scientific Testing (Investigating and Modeling)	1	<p>Demonstrate safe and ethical procedures (e.g., use and care of technology, materials, and organisms) and behavior in all science inquiry.</p> <ul style="list-style-type: none"> - Safety Rules - Scientific Method - Equipment use - Scientific technique - Measurement 	Hypothesis Conclusion All Lab equipment All safety equipment Contamination	Equipment Exploration Accuracy Lab
		2	<p>Identify the resources needed to conduct an investigation.</p> <ul style="list-style-type: none"> - Write lab procedures in lab reports 		All labs
		3	<p>Design an appropriate protocol (written plan of action) for testing a hypothesis:</p> <ul style="list-style-type: none"> • Identify dependent and independent variables in a controlled investigation. • Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes). • Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators). <ul style="list-style-type: none"> - Write lab procedures in lab reports - Create data tables in lab reports 		All Labs
		5	<p>Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.</p> <ul style="list-style-type: none"> - Create data tables 		All labs

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S1C3	Analysis and Conclusions, and Refinements	1	<p><i>Interpret data that show a variety of possible relationships between variables, including:</i></p> <ul style="list-style-type: none"> • positive relationship • negative relationship • no relationship <ul style="list-style-type: none"> - density lab - gas laws - solubility (gases and solids) - temperature and energy 		Density Lab Boyles Law Lab (pressure probes) Heating Curve Lab
		2	<p>Evaluate whether investigational data support or do not support the proposed hypothesis.</p> <ul style="list-style-type: none"> - Discussion section of lab reports 		All Labs
		3	<p>Critique reports of scientific studies (e.g., published papers, student reports).</p> <ul style="list-style-type: none"> - Reading assignments, peer editing of lab reports 		
		4	<p>Evaluate the design of an investigation to identify possible sources of procedural error, including:</p> <ul style="list-style-type: none"> • sample size • trials • controls • analyses <ul style="list-style-type: none"> - Discussion section of lab reports 		All labs

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S1C3 (cont.)		5	<p>Design models (conceptual or physical) of the following to represent "real world" scenarios.</p> <ul style="list-style-type: none"> • carbon cycle • water cycle • phase change <ul style="list-style-type: none"> - solid-liquid-gas on a particle level - energy and temperature (heat curve lab) • collisions <ul style="list-style-type: none"> - kinetic molecular theory - gas laws 		Heat curve lab Kinetic molecular theory mini lab
		6	<p>Use descriptive statistics to analyze data, including:</p> <ul style="list-style-type: none"> • mean • frequency • range (see MHS-S2C1-10) 		
		7	<p>Propose further investigations based on the findings of a conducted investigation.</p> <ul style="list-style-type: none"> - Discussion section of lab report 		
S1C4	Communication	1	<p>For a specific investigation, choose an appropriate method for communicating the results.</p> <ul style="list-style-type: none"> - Write lab reports 		Excel Lesson Density Lab Boyles Law Lab
2	<p>Produce graphs that help communicate data. (See MHS-S2C1-02)</p> <ul style="list-style-type: none"> - Graph independent and dependent variables 				
3	<p>Communicate results clearly and logically.</p> <ul style="list-style-type: none"> - Write lab reports 				
4	<p>Support conclusions with logical scientific arguments.</p> <ul style="list-style-type: none"> - Conclusion section of lab reports 				

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Strand 2: History and Nature of Science

Knowledge of the nature of science is central to the understanding of the scientific enterprise” (National Assessment of Educational Progress, 2000).

Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Concepts

Concept 1: History of Science as a Human Endeavor

- Identify individual, cultural, and technological contributions to scientific knowledge.

Concept 2: Nature of Scientific Knowledge

- Understand how science is a process for generating knowledge.

Students should know and be able to...

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S2C1	History of Science as a Human Endeavor	1	<p>Describe how human curiosity and needs have influenced science, impacting the quality of life worldwide.</p> <ul style="list-style-type: none"> - Student reports of scientific discoveries 	Special Topic reports may or may not address these.	Scientific Topics Project—Research a science topic (How does a match work..etc.) Special Topic reports may or may not address these. PO 1-4
		2	<i>Describe how diverse people and/or cultures, past and present, have made important contributions to scientific innovations.</i>		
		3	Analyze how specific changes in science have affected society.		
		4	Analyze how specific cultural and/or societal issues promote or hinder scientific advancements.		

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S2C2	Nature of Scientific Knowledge	1	<p>Specify the requirements of a valid, scientific explanation (theory), including that it be:</p> <ul style="list-style-type: none"> • logical • subject to peer review • public • respectful of rules of evidence 		
		2	<p>Explain the process by which accepted ideas are challenged or extended by scientific innovation.</p>		
		3	<p>Distinguish between pure and applied science.</p>		
		4	<p>Describe how scientists continue to investigate and critically analyze aspects of theories.</p> <ul style="list-style-type: none"> - Atomic theory discussions 		

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Strand 3: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Concepts

Concept 1: Changes in Environments

- Describe the interactions between human populations, natural hazards, and the environment.

Concept 2: Science and Technology in Society

- Develop viable solutions to a need or problem.

Concept 3: Human Population Characteristics

- Analyze factors that affect human populations.

Students should know and be able to...

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S3C1	Changes in Environments	1	Evaluate how the processes of natural ecosystems affect, and are affected by, humans.		
		2	Describe the environmental effects of the following natural and/or human-caused hazards: <ul style="list-style-type: none"> • pollution 		
		3	Assess how human activities (e.g., clear cutting, water management, tree thinning) can affect the potential for hazards.		
		5	Evaluate the effectiveness of conservation practices and preservation techniques on environmental quality and biodiversity.		

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S3C2	Science and Technology in Society	1	<p>Analyze the costs, benefits, and risks of various ways of dealing with the following needs or problems:</p> <ul style="list-style-type: none"> • various forms of alternative energy • storage of nuclear waste • abandoned mines • greenhouse gases • hazardous wastes 		
		2	<p>Recognize the importance of basing arguments on a thorough understanding of the core concepts and principles of science and technology.</p>		
		3	<p>Support a position on a science or technology issue.</p>		

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Strand 5: Physical Science

The physical science component ... should probe the following major topics: matter and its transformations, energy and its transformations, and the motion of things” (NAEP 2000).

Physical Science affords students the opportunity to increase their understanding of the characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

Concepts

Concept 1: Structure and Properties of Matter

- Understand physical, chemical, and atomic properties of matter.

Concept 2: Motions and Forces

- Analyze relationships between forces and motion.

Concept 3: Conservation of Energy and Increase in Disorder

- Understand ways that energy is conserved, stored, and transferred.

Concept 4: Chemical Reactions

- Investigate relationships between reactants and products in chemical reactions.

Concept 5: Interactions of Energy and Matter

- Understand the interactions of energy and matter.

Students should know and be able to...

Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources	
S5C1	Structure and Properties of Matter	1	<p>Describe substances based on their physical properties.</p> <ul style="list-style-type: none"> - Observe and measure physical properties - Use physical properties to identify substances - Differentiate between physical and chemical properties 	Density Mass Melting point Temperature Boiling point Specific Heat	Volume Solubility Celsius Kelvin	Physical Chemical Lab Density Lab Specific Heat Lab
		2	<p>Describe substances based on their chemical properties.</p> <ul style="list-style-type: none"> - Observe and describe chemical changes - Differentiate between physical and chemical properties 	flammability reactivity acidity Alkalinity	Precipitation Lab Evidence of reaction Lab Activity of Metals Lab What Q's about matter lab? (LC)	

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C1 (cont.)		3	<p>Predict properties of elements and compounds using trends of the periodic table (e.g., metals, non-metals, bonding – ionic/covalent).</p> <ul style="list-style-type: none"> - Use properties such as malleability, luster, electrical conductivity, mp and bp to distinguish between metals and non-metals. - Predict trends in atomic radius, electro negativity, IE and reactivity - Describe the differences between ionic compounds and molecular compounds. 	Malleable Ductile Conductivity Ionic Semiconductor Covalent Electronegativity Periodicity Ionic molecular	Ceramic Fixative Lab
		4	<p>Separate mixtures of substances based on their physical properties.</p> <ul style="list-style-type: none"> - Use filtration, evaporation to separate mixtures 	Filtration Evaporation Distillation Homogeneous mixtures Heterogeneous mixtures	Physical Chemical Change Lab Separation lab
		5	<p>Describe the properties of electric charge and the conservation of electric charge.</p> <ul style="list-style-type: none"> - State evidence for the fact that we observe two kinds of electric charge. - Describe the interaction (attractive/repulsive) between charged particles and the effect of distance on this interaction. - Recognize if an object loses charge, something else gains charge 	Positive Negative Neutral Cation Anion	Formula writing activities Sticky Tape Ionic compound models

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C1 (cont.)		6	<p>Describe the following features and components of the atom:</p> <ul style="list-style-type: none"> • protons • neutrons • electrons • mass • number and type of particles • structure • organization <ul style="list-style-type: none"> - Know charge, location and relative mass of protons, electrons and neutrons. - Differentiate atomic mass and mass number - Describe the number of each in a neutral or charged atom - Describe nucleus and atom density 	amu Nucleus Electron clouds Ion Isotope Proton Neutron Electron Nucleus Atomic mass	Atomic Structure worksheets Model building Video: Atoms Conceptual Physics Alive Video: Ring of Truth video 3
		7	<p>Describe the historical development of models of the atom.</p> <ul style="list-style-type: none"> - Trace atomic theory from Dalton, Thomson, Rutherford, Bohr to Quantum theory - Describe cathode ray tube, gold foil experiment and bright-line spectrum. 	Cathode ray tube Energy levels Dalton Model Thomson Model Rutherford Model Bohr Model Quantum Model	Clue Sets Flame tests and Bright line Spectrum Lab (LC) Demo electron Apparatus. Video resources Conservation of mass labs Electrolysis Cathode ray tube (demo or video) Video: Ring of Truth part 2 Nature of matter

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C1 (cont.)		8	<p>Explain the details of atomic structure (e.g., electron configuration, energy levels, isotopes).</p> <ul style="list-style-type: none"> - Given the isotopic symbol of an element, determine the #p and #n - Write Lewis structures for representative elements - Orbital filling order and electron configuration 	Electron configuration Isotopes	Calculating valence electron activities Describing isotopes Vegium lab (LC)
S5C2	Motions and Forces	1	<p>Determine the rate of change of a quantity (e.g., rate of erosion, rate of reaction, rate of growth, velocity).</p>	Activation energy Collisions Particle size Catalyst Surface area	

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C3	Conservation of Energy and Increase in Disorder	1	<p>Describe the following ways in which energy is stored in a system:</p> <ul style="list-style-type: none"> • mechanical • electrical • chemical <ul style="list-style-type: none"> - Given a balanced equation in which energy is a term, state whether the reaction is endothermic or exothermic - Given a chemical potential energy diagram determine whether the reaction is endothermic or exothermic 	endothermic exothermic joules	
		2	<p>Describe various ways in which energy is transferred from one system to another (e.g., mechanical contact, thermal conduction, electromagnetic radiation.)</p> <ul style="list-style-type: none"> - Recognize the transfer of chemical energy to thermal energy in chemical reactions 	temperature heat Specific heat joules calories vs. Calories	Specific Heat lab Calorie Lab Combustion (candle) Lab Video: Conceptual Physics Alive, Heat and Temperature
		3	<p>Recognize that energy is conserved in a closed system.</p> <ul style="list-style-type: none"> - Recognize conservation of energy 	Calorimetry Law of Conservation of Energy	Calorimetry labs
		4	<p>Calculate quantitative relationships associated with the conservation of energy.</p> <ul style="list-style-type: none"> - Calculate specific heat, change in temperature and energy lost or gained (SC 72) 	$q = m c_p \Delta$	Specific Heat lab Calorie Lab Combustion (candle) Lab
		5	<p>Analyze the relationship between energy transfer and disorder in the universe (2nd Law of Thermodynamics)</p>		

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C3 (cont.)		6	<p>Distinguish between heat and temperature.</p> <ul style="list-style-type: none"> - Describe heat as the transfer of energy from a hotter system to a colder one and temperature as the measure of the average kinetic energy of the particles in the system - Draw and label a heating curve 	Heat Temperature Joules calories	Heat Curve lab
		7	<p>Explain how molecular motion is related to temperature and phase changes.</p> <ul style="list-style-type: none"> - Describe what is taking place at the particle level in relation to regions of the heating curve - Relate temperature to the kinetic energy of the particles. - Relate kinetic and potential energy to the different regions of the heating curve 	condensation vaporization freezing melting boiling vapor pressure solid, liquid, gas potential and kinetic energy heat of fusion Heat of vaporization	Heat curve lab Story problems State of Matter Lab
S5C4	Chemical Reactions	1	<p>Apply the law of conservation of matter to changes in a system.</p> <ul style="list-style-type: none"> - Recognize the conservation of matter in story problems - Given a description of a physical or chemical change, predict how the mass of the products compares to the mass of the reactants 	Law of Conservation of mass	Conservation of mass lab Teacher demos Reaction in a bag
		2	<p>Identify the indicators of chemical change, including formation of a precipitate, evolution of a gas, color change, absorption or release of heat energy.</p> <ul style="list-style-type: none"> - Observe and identify evidence of reactions - Determine whether changes are physical or chemical 	Precipitate Endothermic Exothermic	Metal activity lab Evidence of Reaction mini lab Precipitation Lab Qualitative analysis lab Physical/chemical lab

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S5C4 (cont.)		3	<p>Represent a chemical reaction by using a balanced equation.</p> <ul style="list-style-type: none"> - Write balanced equations from word problems. Including proper writing of formulas 	Coefficient Subscript Reactant Product	Worksheets Precipitation Lab Stoichiometry Lab Molecular models
		4	<p>Distinguish among the types of bonds (i.e., ionic, covalent, metallic, hydrogen bonding).</p> <ul style="list-style-type: none"> - Recognize ionic, covalent bonds from formulas. - Describe the characteristics of ionic and covalent bonds - Draw Lewis Dot and structural formulas - Recognize hydrogen bonding 	Ionic Covalent	Ceramic fixative Lab
		5	<p>Describe the mole concept and its relationship to Avogadro's number.</p> <ul style="list-style-type: none"> - Describe the relationship and solve problems 	Mole Avogadro's number Atoms Molecules Formula units Molar mass Molar volume Molarity	Molar Mass Chalk Lab
		6	<p>Solve problems involving such quantities as moles, mass, molecules, volume of a gas, and molarity using the mole concept and Avogadro's number.</p> <ul style="list-style-type: none"> - Perform mole relationship problems using molar volume, molar mass and avogadro's number. - Perform mole relationship using molarity of solutions. 	Molar mass Molar volume Molarity	Stoichiometry Lab Solution preparation

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C4 (cont.)		7	<p>Predict the properties (e.g., melting point, boiling point, conductivity) of substances based upon bond type.</p> <ul style="list-style-type: none"> - Identify ionic, polar, nonpolar and in molecules and predict melting, boiling points and conductivity - Identify hydrogen bonding in molecules and predict melting, boiling points and conductivity 	Molecular shapes Intermolecular forces Hydrogen bonding	Ceramic Fixative Lab
		8	<p>Quantify the relationships between reactants and products in chemical reactions (e.g., stoichiometry, equilibrium, energy transfers).</p> <ul style="list-style-type: none"> - Perform stoichiometry problems with an excess of one reactant. - Identify and Predict equilibrium reactions 	limiting reactant percent yield Equilibrium Stress LeChatelier's	Equilibrium lab
		9	<p>Predict the products of a chemical reaction using types of reactions (e.g., synthesis, decomposition, replacement, combustion)</p> <ul style="list-style-type: none"> - Recognize the type of reaction - Predict the products of each type of reaction 	Combination Decomposition Single replacement Double replacement Combustion	Predicting and classifying worksheets Teacher demos
		10	<p>Explain the energy transfers within chemical reactions using the law of conservation of energy.</p> <ul style="list-style-type: none"> - Recognize endo and exothermic reactions - Draw and label reaction energy diagrams 	enthalpy Law of conservation of energy Activation energy	

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Concept Number	Concept	PO No.	Performance Objective	Vocabulary	Notes/Integration/Resources
S5C4 (cont.)		11	<p>Predict the effect of various factors (e.g., temperature, concentration, pressure, catalyst) on the equilibrium state and on the rates of chemical reaction.</p> <ul style="list-style-type: none"> - Recognize the effect of concentration, particle size temperature and catalyst on <u>chemical</u> reaction rates 	Equilibrium reactions Concentration Catalyst Equilibrium	Rate of reaction mini lab Equilibrium lab
		12	<p>Compare the nature, behavior, concentration, and strengths of acids and bases.</p> <ul style="list-style-type: none"> - Recognize weak versus strong acids - Compare characteristics of acids and bases - Calculate pH from hydrogen ion concentration - 	Endpoint Titration	Titration labs
		13	<p>Determine the transfer of electrons in oxidation/reduction reactions.</p>		Why do Metals Corrode Lab

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S5C5	Interactions of Energy and Matter	1	<p>Describe various ways in which matter and energy interact (e.g., photosynthesis, phase change).</p> <ul style="list-style-type: none"> - Describe relationship between energy changes and phase changes. 	Phase changes	
		2	<p>Describe the following characteristics of waves:</p> <ul style="list-style-type: none"> • wavelength • frequency • period • amplitude 		
		3	<p>Quantify the relationships among the frequency, wavelength, and the speed of light.</p>		
		4	<p>Describe the basic assumptions of kinetic molecular theory.</p> <ul style="list-style-type: none"> - Explain kinetic molecular theory 	Kinetic Molecular Theory Kinetic energy	
		5	<p>Apply kinetic molecular theory to the behavior of matter (e.g., gas laws).</p> <ul style="list-style-type: none"> - Describe gas laws in terms of pressure, volume, moles and temperature 	Pressure Volume Avogadro's Law Charles' Law Boyle's Law Dalton's Law Gay-Lussac's Law Combined Law Ideal Gas Law	
		6	<p>Analyze calorimetric measurements in simple systems and the energy involved in changes of state.</p>		
		7	<p>Explain the relationship between the wavelength of light absorbed or released by an atom or molecule and the transfer of a discrete amount of energy.</p>		

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Italics denote a repetition of a performance objective (learned in an earlier grade) that is to be applied to grade level content or at a higher level of complexity.