



This document is designed to help North Carolina educators teach the Essential Standards (Standard Course of Study). NCDPI staff are continually updating and improving these tools to better serve teachers.

## Chemistry

### 2009-to-2004 Standards Crosswalk

This document is a general comparison of the current 2004 Science Standard Course of Study and the new 2009 Science Essential Standards. It provides initial insight into sameness and difference between these two sets of standards. This document is not intended to answer all questions about the nuance of the new standards versus the old - in fact, we imagine you will develop questions as you do a close reading of the new standards. Please send the science section of NC DPI any thoughts, feedback, questions and ideas about additional resources that would help you start preparing to teach the Essential Standards. Email Beverly Vance at [bvance@dpi.state.nc.us](mailto:bvance@dpi.state.nc.us).

**Important Note: The current 2004 SCOS will continue to be the operational standards in the 2010-11 and 2011-12 school years** as resource materials are developed to support the new Science Essential Standards, professional development is conducted and assessments are designed to align to the new Science Essential Standards. We expect the new Essential Standards to be taught and assessed in schools for the first time in the 2012-13 school year. That said, we are providing Essential Standards resources now and over the next two-years so that schools and teachers can get a head start on internalizing and planning to teach the new standards.

2009 Essential Standards			2004 NC SCOS			
Strand	Objective	Essential Standard	Goal	Objective	Text of objective	Comments
		Text of Clarifying objective				
Matter: Properties and Change	Chm.1.1.1	<b>Analyze the structure of atoms and ions.</b>	Structure and Properties of Matter	2.02	Examine the nature of atomic structure <ul style="list-style-type: none"> <li>• Subatomic particles: protons, neutrons, and electrons</li> <li>• Mass number</li> <li>• Atomic number</li> <li>• Isotopes</li> </ul>	
		Analyze the structure of atoms, isotopes, and ions.				

2009 Essential Standards			2004 NC SCOS		
Strand	Objective	Essential Standard	Goal	Objective	Comments
		Text of Clarifying objective			
	Chm.1.1.2	Analyze an atom in terms of the location of electrons.		2.01 Analyze the historical development of the current atomic theory: <ul style="list-style-type: none"> <li>• Early contributions: Democritus and Dalton</li> <li>• The discovery of the electron: Thomson and Millikan</li> <li>• The discovery of the nucleus, proton and neutron: Rutherford and Chadwick</li> <li>• The Bohr model</li> <li>• The quantum mechanical model</li> </ul>	
	Chm.1.1.3	Explain the emission of electromagnetic radiation in spectral form in terms of the Bohr model.	Energy Changes in Chemistry	4.01 Analyze the Bohr model in terms of electron energies in the hydrogen atom. <ul style="list-style-type: none"> <li>• The spectrum of electromagnetic energy</li> <li>• Emission and absorption of electromagnetic energy as electrons change energy levels</li> </ul>	
	Chm.1.1.4	Explain the process of radioactive decay using nuclear equations and half-life.		4.04 Analyze nuclear energy. <ul style="list-style-type: none"> <li>• Radioactivity: characteristics of alpha, beta and gamma radiation</li> <li>• Decay equations for alpha and beta emission</li> <li>• Half-life</li> <li>• Fission and fusion</li> </ul>	
Matter: Properties and Change	<b>Understand the bonding that occurs in simple compounds in terms of bond type, strength, and properties.</b>		Structure and Properties of Matter	2.06 Assess bonding in metals and ionic compounds as related to chemical and physical properties.	Addressed throughout Chm.1.2 (except Chm.1.2.4)
	Chm.1.2.1	Compare (qualitatively) the relative strengths of ionic, covalent, and metallic bonds.		2.07 Assess covalent bonding in molecular compounds as related to molecular geometry and chemical and physical properties. <ul style="list-style-type: none"> <li>• Molecular</li> </ul>	

2009 Essential Standards			2004 NC SCOS		
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		Text of Clarifying objective			
					dispersion)
Chm. 1.2.2		Infer the type of bond and chemical formula formed between atoms.	2.06	Assess bonding in metals and ionic compounds as related to chemical and physical properties.	Addressed throughout Chm.1.2 (except Chm.1.2.4)
			2.07	Assess covalent bonding in molecular compounds as related to molecular geometry and chemical and physical properties. <ul style="list-style-type: none"> <li>Molecular</li> </ul>	This is the only bullet of objective 2.07 addressed in Chm.1.2.1. The following bullets are addressed in Chm.1.2.5. <ul style="list-style-type: none"> <li>Macromolecular</li> <li>VSEPR theory</li> </ul> The following bullet is addressed in Chm.1.2.3 and Chm.1.2.5. <ul style="list-style-type: none"> <li>Hydrogen bonding and other intermolecular forces (dipole/dipole interaction, dispersion)</li> </ul>
			2.06	Assess bonding in metals and ionic compounds as related to chemical and physical properties.	Addressed throughout Chm.1.2 (except Chm.1.2.4)
			2.07	Assess covalent bonding in molecular compounds as related to molecular geometry and chemical and physical properties. <ul style="list-style-type: none"> <li>Molecular</li> <li>Hydrogen bonding and other intermolecular forces (dipole/dipole interaction, dispersion).</li> </ul>	These are the only bullets addressed specifically by Chm.1.2.3. The following bullets are addressed in Chm.1.2.5. <ul style="list-style-type: none"> <li>Macromolecular</li> <li>VSEPR theory</li> </ul>
Chm. 1.2.3		Compare inter- and intra- particle forces.	2.06	Assess bonding in metals and ionic compounds as related to chemical and physical properties.	Addressed throughout Chm.1.2 (except Chm.1.2.4)
			2.07	Assess covalent bonding in molecular compounds as related to molecular geometry and chemical and physical properties. <ul style="list-style-type: none"> <li>Molecular</li> <li>Hydrogen bonding and other intermolecular forces (dipole/dipole interaction, dispersion).</li> </ul>	These are the only bullets addressed specifically by Chm.1.2.3. The following bullets are addressed in Chm.1.2.5. <ul style="list-style-type: none"> <li>Macromolecular</li> <li>VSEPR theory</li> </ul>
Chm. 1.2.4		Interpret the name and formula of compounds using IUPAC convention.	2.03	Apply the language and symbols of chemistry. <ul style="list-style-type: none"> <li>Name compounds using the IUPAC conventions</li> <li>Write formulas of simple compounds from their names</li> </ul>	

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Strand	Objective	Essential Standard	Goal	Objective	Text of objective	Comments
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Chm.1.2.5		Compare the properties of ionic, covalent, metallic, and network compounds.		2.06	Assess bonding in metals and ionic compounds as related to chemical and physical properties.	Addressed throughout Chm.1.2 (except Chm.1.2.4)
				2.07	Assess covalent bonding in molecular compounds as related to molecular geometry and chemical and physical properties. <ul style="list-style-type: none"> <li>• Molecular</li> <li>• Macromolecular</li> <li>• Hydrogen bonding and other intermolecular forces (dipole/dipole interaction, dispersion)</li> <li>• VSEPR theory</li> </ul>	Also addressed in other areas of Chm.1.2 (except Chm.1.2.4)
Matter: Properties and Change	<b>Understand the physical and chemical properties of atoms based on their position on the Periodic Table.</b>		Regularities in Chemistry	3.01	Analyze periodic trends in chemical properties and use the periodic table to predict properties of elements. <ul style="list-style-type: none"> <li>• Groups (families)</li> <li>• Periods</li> <li>• Representative elements (main group) and transition elements</li> </ul>	These bullets are the only ones of objective 3.01 that are addressed by Chm.1.3.1. The following bullets are addressed in other parts of Chm.1.3. <ul style="list-style-type: none"> <li>• Electron configuration and energy levels</li> <li>• Ionization energy</li> <li>• Atomic and ionic radii</li> <li>• Electronegativity</li> </ul>
	Chm.1.3.1	Classify the components of a periodic table (period, group, metal, metalloid, nonmetal, transition).				
	Chm.1.3.2	Infer the physical properties (atomic radius, metallic and nonmetallic characteristics) of an element based on its position on the Periodic Table.				
				3.01	Analyze periodic trends in chemical properties and use the periodic table to predict properties of elements. <ul style="list-style-type: none"> <li>• Atomic and ionic radii</li> </ul>	This is the only bullet of objective 3.01 addressed by Chm.1.3.2. These bullets are addressed in other parts of Chm.1.3. <ul style="list-style-type: none"> <li>• Groups (families)</li> <li>• Periods</li> <li>• Representative elements (main group) and transition elements</li> <li>• Electron configuration and energy levels</li> <li>• Ionization energy</li> <li>• Electronegativity</li> </ul>

2009 Essential Standards			2004 NC SCOS			
Strand	Objective	Essential Standard	Goal	Objective	Text of objective	Comments
		Text of Clarifying objective				
	Chm.1.3.3	Infer the atomic size, reactivity, electronegativity, and ionization energy of an element from its position on the Periodic Table.		3.01	Analyze periodic trends in chemical properties and use the periodic table to predict properties of elements. <ul style="list-style-type: none"> <li>• Electron configuration and energy levels</li> <li>• Ionization energy</li> <li>• Atomic and ionic radii</li> <li>• Electronegativity</li> </ul>	These are the only bullets of objective 3.01 addressed in Chm.1.3.3. These bullets are addressed in other parts of Chm.1.3. <ul style="list-style-type: none"> <li>• Groups (families)</li> <li>• Periods</li> <li>• Representative elements (main group) and transition elements</li> </ul>
Energy: Conservation and Transfer	<b>Understand the relationship among pressure, temperature, volume, and phase.</b>		Structure and Properties of	2.08	Assess the dynamics of physical equilibria. <ul style="list-style-type: none"> <li>• Factors that affect phase changes</li> </ul>	This is the only bullet of objective 2.08 addressed by Chm.2.1.1. The following bullet is addressed in Chm.2.1.3. <ul style="list-style-type: none"> <li>• Interpret phase diagrams</li> </ul>
	Chm.2.1.1	Explain the energetic nature of phase changes.				
	Chm.2.1.2	Explain heating and cooling curves (heat of fusion, heat of vaporization, specific heat, melting point, and boiling point).	Energy Changes in Chemistry	4.02	Analyze the law of conservation of energy, energy transformation, and various forms of energy involved in chemical and physical processes. <ul style="list-style-type: none"> <li>• Differentiate between heat and temperature</li> <li>• Analyze heating and cooling curves</li> <li>• Endothermic and exothermic processes including interpretation of potential energy</li> </ul>	These are the only bullets of objective 4.02 addressed in Chm.2.1.2. The following bullet is addressed in Chm.2.1.4. <ul style="list-style-type: none"> <li>• Calorimetry, heat of fusion and heat of vaporization calculations</li> </ul> The following bullet is addressed in Chm.2.2.1. <ul style="list-style-type: none"> <li>• Diagrams (energy vs. reaction pathway), enthalpy, and activation energy</li> </ul>

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Strand	Objective	Essential Standard	Goal	Objective	Text of objective	Comments
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	Chm.2.1.3	Interpret the data presented in phase diagrams.	Structure and Properties of	2.08	Assess the dynamics of physical equilibria. <ul style="list-style-type: none"> <li>Interpret phase diagrams</li> </ul>	This is the only bullet of objective 2.08 addressed in Chm.2.1.3. The following bullet is addressed in Chm.2.1.1. <ul style="list-style-type: none"> <li>Factors that affect phase changes</li> </ul>
	Chm.2.1.4	Infer simple calorimetric calculations based on the concepts of heat lost equals heat gained and specific heat.	Energy Changes in Chemistry	4.02	Analyze the law of conservation of energy, energy transformation, and various forms of energy involved in chemical and physical processes. <ul style="list-style-type: none"> <li>Calorimetry, heat of fusion and heat of vaporization calculations</li> </ul>	This is the only bullet of objective 4.02 addressed in Chm.2.1.4. The following bullets are addressed in Chm.2.1.2. <ul style="list-style-type: none"> <li>Differentiate between heat and temperature</li> <li>Analyze heating and cooling curves</li> <li>Endothermic and exothermic processes including interpretation of potential energy</li> </ul> The following bullet is addressed in Chm.2.2.1. <ul style="list-style-type: none"> <li>Diagrams (energy vs. reaction pathway), enthalpy, and activation energy</li> </ul>
	Chm.2.1.5	Explain the relationships among pressure, temperature, volume, and quantity of gas, both qualitative and quantitative.	Structure and Properties of Matter	2.05	Analyze the basic assumptions of kinetic molecular theory and its applications: <ul style="list-style-type: none"> <li>Ideal Gas Equation</li> <li>Combined Gas Law</li> <li>Dalton's Law of Partial Pressures</li> </ul>	

2009 Essential Standards			2004 NC SCOS				
Strand	Objective	Essential Standard	Goal	Objective	Comments		
		Text of Clarifying objective				Text of objective	
Energy: Conservation and Transfer	Chm.2.2.1	<b>Analyze chemical reactions in terms of quantities, product formation and energy.</b>	Energy Changes in Chemistry	4.02	<p>Analyze the law of conservation of energy, energy transformation, and various forms of energy involved in chemical and physical processes.</p> <ul style="list-style-type: none"> <li>Diagrams (energy vs. reaction pathway), enthalpy, and activation energy</li> </ul>	<p>This is the only bullet of objective 4.02 addressed in Chm.2.2.1. The following bullets are addressed in Chm.2.1.2.</p> <ul style="list-style-type: none"> <li>Differentiate between heat and temperature</li> <li>Analyze heating and cooling curves</li> <li>Endothermic and exothermic processes including interpretation of potential energy</li> </ul> <p>The following bullets are addressed in Chm.2.1.4.</p> <ul style="list-style-type: none"> <li>Calorimetry, heat of fusion and heat of vaporization calculations</li> </ul>	
		Explain the energy content of a chemical reaction.					
	Chm.2.2.2	Analyze the evidence of chemical change.		5.03			<p>Identify and predict the indicators of chemical change:</p> <ul style="list-style-type: none"> <li>Formation of a precipitate</li> <li>Evolution of a gas</li> <li>Color change</li> <li>Absorption or release of heat</li> </ul>
	Chm.2.2.3	Analyze the Law of Conservation of Matter and how it applies to various types of chemical equations (synthesis, decomposition, single replacement, double replacement, and combustion).		5.01			<p>Evaluate various types of chemical reactions</p> <ul style="list-style-type: none"> <li>Analyze reactions by types: single replacement, double replacement (including acid-base neutralization), decomposition, synthesis, and combustion of simple hydrocarbons</li> <li>Predict products</li> </ul>
				5.02			<p>Evaluate the law of conservation of matter to the balancing of chemical equations.</p> <ul style="list-style-type: none"> <li>Write and balance formulas and equations</li> <li>Write net ionic equations</li> </ul>

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Strand	Objective	Essential Standard	Goal	Objective	Comments	
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	Chm.2.2.4	Analyze the stoichiometric relationships inherent in a chemical reaction.	Regularities in Chemistry	3.02	Apply the mole concept, Avogadro's number and conversion factors to chemical calculations: <ul style="list-style-type: none"> <li>• Particles to moles</li> <li>• Mass to moles</li> <li>• Volume of a gas to moles</li> <li>• Molarity of solutions</li> </ul>	These are the only bullets of objective 3.02 addressed in Chm.2.2.4. Molarity is also addressed in Chm.3.2.3. The following bullets are addressed in Chm.2.2.5. <ul style="list-style-type: none"> <li>• Empirical and molecular formula</li> <li>• Percent composition</li> </ul>
				3.03	Calculate quantitative relationships in chemical reactions (stoichiometry): <ul style="list-style-type: none"> <li>• Moles of each species in a reaction</li> <li>• Mass of each species in a reaction</li> <li>• Volumes of gaseous species in a reaction</li> </ul>	
Chm.2.2.5	Analyze quantitatively the composition of a substance (empirical formula, molecular formula, percent composition, and hydrates).	3.02		Apply the mole concept, Avogadro's number and conversion factors to chemical calculations: <ul style="list-style-type: none"> <li>• Empirical and molecular formula</li> <li>• Percent composition</li> </ul>	These are the only bullets of objective 3.02 addressed in Chm.2.2.5. The following bullets are addressed in Chm.2.2.4. <ul style="list-style-type: none"> <li>• Particles to moles</li> <li>• Mass to moles</li> <li>• Volume of a gas to moles</li> <li>• Molarity of solutions</li> </ul> Molarity is also addressed in Chm.3.2.3.	
Interaction of Energy and	<b>Understand the factors affecting rate of reaction and chemical equilibrium.</b>		Chemical Reactions	5.06	Analyze the factors that affect the rates of chemical reactions. <ul style="list-style-type: none"> <li>• The nature of the reactants</li> <li>• Temperature</li> <li>• Concentration</li> <li>• Surface area</li> <li>• Catalyst</li> </ul>	
	Chm.3.1.1	Explain the factors that affect the rate of a reaction (temperature, concentration, particle size and presence of a catalyst).				



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Strand	Objective	Essential Standard	Goal	Objective	Text of objective	Comments
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	Chm.3.1.2	Explain the conditions of a system at equilibrium.				New to 2009 Essential Standards
	Chm.3.1.3	Infer the shift in equilibrium when a stress is applied to a chemical system (LeChatelier's Principle).				New to 2009 Essential Standards
Interaction of Energy and Matter	<b>Understand solutions and the solution process.</b>		Chemical Reactions	5.04	Assess the physical and chemical properties of acids and bases. <ul style="list-style-type: none"> <li>• General properties of acids and bases</li> <li>• Concentration and dilution of acids and bases</li> <li>• Ionization and the degree of dissociation (strengths) of acids and bases</li> <li>• Indicators</li> <li>• pH and pOH</li> </ul>	This following bullet is addressed in Chm.3.2.3. <ul style="list-style-type: none"> <li>• Acid-base titration</li> </ul>
	Chm.3.2.1	Classify substances using the hydronium and hydroxide concentrations.			Assess the physical and chemical properties of acids and bases. <ul style="list-style-type: none"> <li>• General properties of acids and bases</li> </ul>	This is the only bullet of objective 5.04 addressed by Chm.3.3.2. The following bullets are addressed in Chm.3.2.1 and Chm.3.2.3. <ul style="list-style-type: none"> <li>• Concentration and dilution of acids and bases</li> <li>• Ionization and the degree of dissociation (strengths) of acids and bases</li> <li>• Indicators</li> </ul> The following bullet is addressed in Chm.3.2.3. <ul style="list-style-type: none"> <li>• Acid-base titration</li> </ul> The following bullet is addressed in Chm.3.2.1. <ul style="list-style-type: none"> <li>• pH and pOH</li> </ul>
	Chm.3.2.2	Summarize the properties of acids and bases.			5.04	

2009 Essential Standards			2004 NC SCOS			
Strand	Objective	Essential Standard	Goal	Objective	Text of objective	Comments
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Chm.3.2.3		Infer the quantitative nature of a solution (molarity, dilution, and titration with a 1:1 molar ratio).	Regularity in Chemistry	3.02	Apply the mole concept, Avogadro's number and conversion factors to chemical calculations: <ul style="list-style-type: none"> <li>Molarity of solutions</li> </ul>	This is the only bullet of objective 3.02 addressed in Chm.3.2.3. The following bullets are addressed in Chm.2.2.4. <ul style="list-style-type: none"> <li>Particles to moles</li> <li>Mass to moles</li> <li>Volume of a gas to moles</li> </ul> The following bullets are addressed in Chm.2.2.5. <ul style="list-style-type: none"> <li>Empirical and molecular formula</li> <li>Percent composition</li> </ul>
			Chemical Reactions	5.04	Assess the physical and chemical properties of acids and bases. <ul style="list-style-type: none"> <li>Concentration and dilution of acids and bases</li> <li>Ionization and the degree of dissociation (strengths) of acids and bases</li> <li>Indicators</li> <li>Acid-base titration</li> </ul>	These are the only bullets of objective 5.04 addressed in Chm.3.2.3. The following bullet is addressed in Chm.3.2.1 and Chm.3.2.2. <ul style="list-style-type: none"> <li>General properties of acids and bases</li> </ul> The following bullet is addressed in Chm.3.2.1. <ul style="list-style-type: none"> <li>pH and pOH</li> </ul>
	Structure and Properties of Matter	2.04	Identify substances using their physical properties: <ul style="list-style-type: none"> <li>Solubility</li> </ul>	This is the only bullet of objective 2.04 specifically addressed in Chm.3.2.4. The following bullets are addressed prior to the Chemistry course. <ul style="list-style-type: none"> <li>Melting points</li> <li>Boiling Points</li> <li>Density</li> </ul>		
Chm.3.2.4		Summarize the properties of solutions.				

2009 Essential Standards			2004 NC SCOS			
Strand	Objective	Essential Standard	Goal	Objective	Text of objective	Comments
		Text of Clarifying objective				
	Chm.3.2.5	Interpret solubility diagrams.		2.04	Identify substances using their physical properties: <ul style="list-style-type: none"> <li>Solubility</li> </ul>	This is the only bullet of objective 2.04 specifically addressed in Chm.3.2.5. The following bullets are addressed prior to the Chemistry course. <ul style="list-style-type: none"> <li>Melting points</li> <li>Boiling Points</li> <li>Density</li> </ul>
	Chm.3.2.6	Explain the solution process.				Related to objectives 2.04, 4.02, and 5.04, but not specifically written as an objective in the 2004 SCOS

**Goal 1 in 2004 SCOS, “develop abilities necessary to do and understand scientific inquiry,” should be integrated in classroom instructional unit design.**

**Objective 4.03 not addressed, it is an enrichment topic and may be used to differentiate the honors course.**

**Objective 5.05 not addressed, it is an enrichment topic and may be used to differentiate the honors course.**