North Carolina Department of Public Instruction
INSTRUCTIONAL SUPPORT TOOLS
FOR ACHIEVING NEW STANDARDS

This document is designed to assist North Carolina educators in effective instruction of the new Common Core State and/or North Carolina Essential Standards (Standard Course of Study) in order to increase student achievement. NCDPI staff are continually updating and improving instructional tools to better serve teachers.

North Carolina Essential Standards Assessment Examples
Chemistry

What is the purpose of this tool?
Assessment is a vital component of the teaching and learning process. These assessment examples are aligned to new content standards and reinforce teaching the standards to their intended level of deep mastery. The purpose of providing examples is to illustrate ways in which the standards or part(s) of the standards might be assessed in the classroom.
How do I send Feedback?
We intend the examples in this document to be helpful and specific. That said, we believe that as this document is used, educators will find ways in which the tool can be improved and made even more useful. Please send feedback to us at feedback@dpi.nc.gov and we will use your input to refine our instructional tool. Thank You!
Where are the new Common Core State and North Carolina Essential Standards?
All standards are located at http://www.ncpublicschools.org/acre/

Essential Standards • Chemistry

Matter: Properties & Change
Chm.1.1 Analyze the structure of atoms and ions.
Chm.1.2 Understand the bonding that occurs in simple compounds in terms of bond type, strength, and properties.
Chm.1.3 Understand the physical and chemical properties of atoms based on their position in the periodic table.

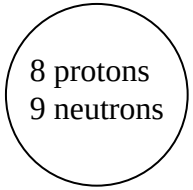
Energy: Conservation & Transfer
Chm.2.1 Understand the relationship among pressure, temperature, volume, and phase.
Chm.2.2 Analyze chemical reactions in terms of quantities, product formation, and energy.

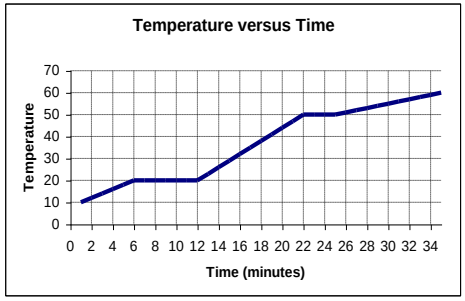
Interactions of Matter and Energy
Chm.3.1 Understand the factors affecting rate of reaction and chemical equilibrium.
Chm.3.2 Understand solutions and the solution process.

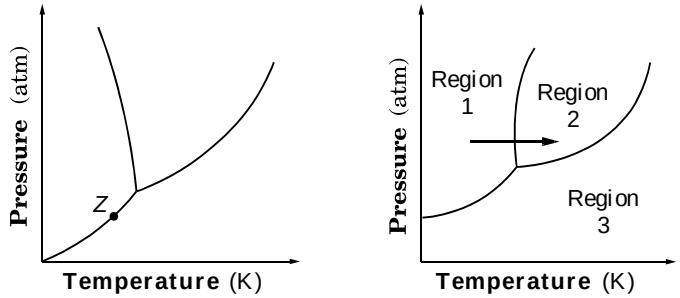
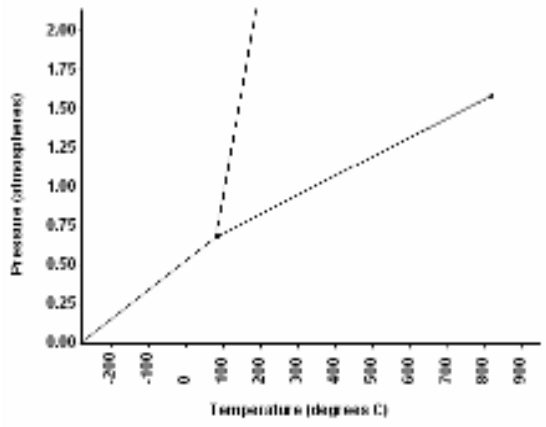
Matter: Properties & Change		
Essential Standards	**Clarifying Objectives**	**Assessment Examples**
Chm.1.1 Analyze the structure of atoms and ions.	Chm.1.1.1 Analyze the structure of atoms, isotopes, and ions.	1.1.1 Draw pictures to illustrate the differing isotopes and ions of a given element. 1.1.1 Which atomic symbol represents an isotope of sulfur with 17 neutrons? a. $^{17}_{16}X$ **b.** $^{33}_{16}X$ c. $^{17}_{32}X$ d. $^{49}_{32}X$
	Chm.1.1.2 Analyze an atom in terms of the location of electrons.	1.1.2 Predict the electron configuration for an element with no more than 36 electrons. 1.1.2 Which is the electronic configuration of calcium? a. $1s^2 2s^2 2p^6 3s^2 3p^8$ **b.** $\mathbf{1s^2 2s^2 2p^6 3s^2 3p^6 4s^2}$ c. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$ d. $1s^2 2s^2 2p^8 3s^2 3p^6$
	Chm.1.1.3 Explain the emission of electromagnetic radiation in spectral form in terms of the Bohr model.	1.1.3 Use the Bohr model to explain the release of energy in the return of electrons to a ground state. 1.1.3 An electron in an atom of hydrogen goes from energy level 6 to energy level 2. What is the wavelength of the electromagnetic radiation emitted? **a. 410 nm** b. 434 nm c. 486 nm d. 656 nm
	Chm.1.1.4 Explain the process of radioactive decay by the use of nuclear equations and half-life.	1.1.4 Use M&M-type candies to map a decay plot for a hypothetical decay.

		1.1.4 The half-life of a radioactive isotope is 20 minutes. What is the total amount of 1.00 g of sample of this isotope remaining after 1 hour? a. 0.500 g b. 0.333 g c. 0.250 g **d. 0.125 g**
Chm.1.2 Understand the bonding that occurs in simple compounds in terms of bond type, strength, and properties.	Chm.1.2.1 Compare (qualitatively) the relative strengths of ionic, covalent, and metallic bonds.	1.2.1 Construct an energy diagram that indicates the relative energies of the different types of bonds. 1.2.1 Which statement compares the amount of energy needed to break the bonds in $CaCl_2$ (E_1) and $C_{12}H_{22}O_{11}$ (E_2)? a. $E_1 > E_2$, as $CaCl_2$ is a covalent compound. b. $E_1 < E_2$, as $CaCl_2$ is a covalent compound. c. $E_1 > E_2$, as $CaCl_2$ is an ionic compound. **d. $E_1 < E_2$, as $CaCl_2$ is an ionic compound.**
	Chm.1.2.2 Infer the type of bond and chemical formula formed between atoms.	1.2.2 Given pairs of atoms, predict whether the bond formed between the atoms is either ionic or covalent, and write the formula for the predicted compound. 1.2.2 Which statement describes the compound formed between sodium and oxygen? a. It is NaO_2, which is ionic. b. It is NaO_2, which is covalent. c. **It is Na_2O, which is ionic**. d. It is Na_2O, which is covalent.
	Chm.1.2.3 Compare inter- and intra- particle forces.	1.2.3 Use data to create a table of evaporation rates of different substances, justifying the order of placement for each (using those inter- and intra-particle forces). 1.2.3 At STP, fluorine is a gas and iodine is a solid. Why? a. Fluorine has lower average kinetic energy than iodine. b. Fluorine has higher average kinetic energy than iodine. **c. Fluorine has weaker intermolecular forces of attraction than iodine.** d. Fluorine has stronger intermolecular forces of attraction than iodine.

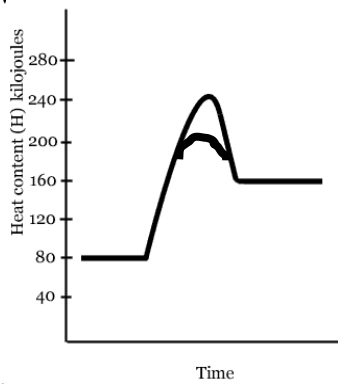
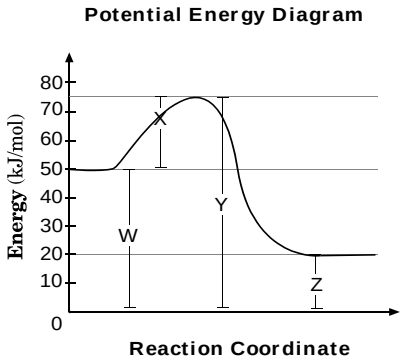
	Chm.1.2.4 Interpret the name and formula of compounds using IUPAC convention.	1.2.4 Given the IUPAC name of a compound, infer its formula, and given a formula and write the IUPAC name, recognizing the differing nomenclature systems for ionic and covalent compounds. 1.2.4 What is the IUPAC name for the compound represented by the formula $Mg(OH)_2$? **a. Magnesium hydroxide.** b. Magnesium dihydroxide. c. Magnesium (II) hydroxide. d. Magnesium (II) dihydroxide.
	Chm.1.2.5 Compare the properties of ionic, covalent, metallic, and network compounds.	1.2.5 Using a group of selected compounds, determine their physical properties (melting point, boiling point, solubility, electrical conductivity) and compare them to known compounds in the various groups: network solids, covalent compounds (polar and non-polar), ionic solids, metallic solids. 1.2.5 An unknown substance is tested in the laboratory. The physical test results are listed below. • Nonconductor of electricity • Insoluble in water • Soluble in oil • Low melting point Based on these results, what is the unknown substance? a. ionic and polar. b. ionic and nonpolar. c. covalent and polar. **d. covalent and nonpolar.**
Chm.1.3 Understand the physical and chemical properties of atoms based on their position in the periodic table.	Chm.1.3.1 Classify the components of a periodic table (period, group, metal, metalloid, nonmetal, transition).	1.3.1 Given a list of elements, classify whether or not they are metals/nonmetals/metalloids. Identify transition metals. Identify each element's group and period

		1.3.1 The nucleus of an atom is shown.  Which statement describes the element?? a. It is a nonmetal in group 2. **b. It is a nonmetal in group 16.** c. It is a metal in group 2. d. It is a nonmetal in group 17.
	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.	1.3.2 What will the properties of element 117 be when it is discovered? 1.3.2 Which atom has the largest radius? Justify your answer. a. Bromine b. Chlorine **c. Selenium** d. Sulfur
	Chm.1.3.3 Infer the atomic size, reactivity, electronegativity, and ionization energy of an element from its position in the periodic table.	1.3.3 Arrange the following elements in order of increasing electronegativity, from lowest to highest: F, K, Si, and S. a. F < K < S < Si **b. K < Si < S < F** c. Si < F < K < S d. S < Si < F < K 1.3.3 In groups, complete a real estate prospectus for each assigned area of the periodic table. Include a description of the area of the table, the physical setting (properties), and the local amenities (atomic sizes, reactivity, electronegativities, ionization energies). Then, working together, classify real estate listings (elements) as to which area they belong given their characteristic physical and chemical properties.

Energy: Conservation & Transfer		
Essential Standards	**Clarifying Objectives**	**Assessment Examples**
Chm.2.1 Understand the relationship among pressure, temperature, volume, and phase.	Chm.2.1.1 Explain the energetic nature of phase changes.	2.1.1 What causes the process of perspiration to be cooling for human skin? a. It involves condensation and is exothermic. b. It involves evaporation and is exothermic. c. It involves condensation and is endothermic. **d. It involves evaporation and is endothermic.** 2.1.1 When is a liquid considered to be boiling? Explain your reasoning. *As energetic molecules escape the liquid, the pressure they exert increases. The liquid and gas reach equilibrium: liquid molecules evaporate and gas molecules condense at the same rate. The boiling point of a liquid is the temperature where the pressure created by the gas molecules is equal to atmospheric pressure.*
	Chm.2.1.2 Explain heating and cooling curves (heat of fusion, heat of vaporization, heat, melting point, and boiling point).	2.1.2 Given the heating curve below, what is occurring between minutes 6 to 12?  a. There is an increase in kinetic energy and vaporization is occurring. b. There is an increase in kinetic energy and condensation is occurring. c. There is an increase in potential energy and freezing is occurring. d. **There is an increase in potential energy and melting is occurring.**

	Chm.2.1.3 Interpret the data presented in phase diagrams.	**Phase Diagram of Water** **Phase Diagram of a Substance**  2.1.3 Compare these phase diagrams. What can be said about the relationship between the processes of melting for the two substances above? What can you determine about the densities of the solids compared to the liquids of each substance? Explain your reasoning. 2.1.3 According to the phase diagram below, what is the boiling point of this substance at a pressure of 1.25 atmospheres?  a. 100°C b. 150°C c. 300°C d. 500°C

	Chm.2.1.4 Infer simple calorimetric calculations based on the concepts of heat lost equals heat gained and specific heat.	2.1.4 An 8.80 g sample of metal is heated to 92.0 °C and then added to 15.0 g of water at 20.0 °C in an insulated calorimeter. At thermal equilibrium the temperature of the system was measured as 25.0 °C. What is the identity of the metal? 2.1.4 1000 J of heat is added to 2 g of the following substances. Which one will experience the biggest change in temperature? a. aluminum b. copper c. iron **d. lead**
	Chm.2.1.5 Explain the relationships between pressure, temperature, volume, and quantity of gas both qualitative and quantitative.	2.1.5 What causes an inflated balloon to shrink when it is cooled? a. because cooling the balloon causes gas to escape from the ball b. because cooling the balloon causes the gas molecules to collide more frequently c. because cooling the balloon causes gas molecules to become smaller **d. because cooling the balloon causes the average kinetic energy of the gas molecules to decrease** 2.1.5 The Kevin temperature and the pressure of a sample of gas are doubled? What will be the effect on the density of gas?

Chm.2.2 Analyze chemical reactions in terms of quantities, product formation, and energy.	Chm.2.2.1 Explain the energy content of a chemical reaction.	2.2.1 Given the energy diagram below, which statement describes the forward reaction?  a. It is an exothermic reaction with an energy change of 160 kJ. b. It is an exothermic reaction with an energy change of 80 kJ. c. It is an endothermic reaction with an energy change of 160 kJ. **d. It is an endothermic reaction with an energy change of 80 kJ.** 2.2.1 What type of reaction is represented by the energy diagram below?  Label the location of the energy of reactants, energy of the products, activation energy, and enthalpy (heat of reaction.) If a catalyst were added to this reaction, what quantities

		would change? Justify your reasoning.
	Chm.2.2.2 Analyze the evidence of chemical change.	2.2.2 A student mixes two chemicals in a test tube. The test tube turns hot and bubbles appear. What indicators of chemical reaction is the student observing? a. Change in color and formation of precipitate. b. Change in color and formation of gas. c. Change in temperature and formation of precipitate. **d. Change in temperature and formation of gas.** 2.2.2 Select the indicators of chemical reactions that would help you distinguish between these two reactions. Write a balanced chemical equation for each reaction (include phases). Identify the type of reaction. 1. Sodium metal dropped into a beaker of water. 2. Silver nitrate is added to sodium chloride.
	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).	2.2.3 Consider this combustion reaction equation: $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$ When the equation is balanced, what will be the coefficient of O_2? a. 1 b. 7 c. 10 **d. 13** 2.2.3 10.3 grams of sodium hydrogen carbonate reacts with an excess of hydrochloric acid. A white crystalline substance is produced and the mass of the product is 7.59 g. 1. What type of reaction occurred? 2. Write the balanced chemical equation for this reaction. 3. What is the identity of the white crystalline product? 4. Based on the data from the reaction, determine the molar ratio between the given reactant and product.

	Chm.2.2.4 Analyze the stoichiometric relationships inherent in a chemical reaction.	2.2.4 Given the balanced chemical equation the reaction, $P_4 + 5O_2 \rightarrow P_4O_{10}$ What mass of oxygen is needed to completely react with 7.75 g P_4? a. 2.00 grams b. 5.00grams **c. 10.00 grams** d. 40.00 grams
		2.2.4 A 70.0 g sample of limestone consists of a large percentage of calcium carbonate. The sample reacts with an excess of hydrochloric acid and 14.0 L of carbon dioxide is generated at STP. What is the percentage of calcium carbonate in the limestone? Write the balanced chemical equation for this reaction.
	Chm.2.2.5 Analyze quantitatively the composition of a substance (empirical formula, molecular formula, percent composition, and hydrates).	2.2.5 A compound consisting of 56.38% phosphorus and 43.62% oxygen has a molecular mass of 220 g/mole. What is the molecular formula of this compound? a. PO b. PO_2 c. P_2O_3 **d. P_4O_6**
		2.2.5 A 10.10 g sample of barium chloride hydrate is heated in crucible. After all of the water is driven off, 8.50 g of the anhydrous barium chloride remains in the crucible. What is the formula of the hydrate?

Interactions of Matter and Energy		
Essential Standards	**Clarifying Objectives**	**Assessment Examples**
Chm.3.1 Understand the factors affecting rate of reaction and chemical equilibrium.	Chm.3.1.1Explain the factors that affect the rate of a reaction (temperature, concentration, particle size and presence of a catalyst).	3.1.1 Write a letter to a fellow scientist who missed the lecture on how these factors affect the rate of a chemical reaction. Give examples of each. 3.1.1 When a set amount of marble chips ($CaCO_3$) is added to a small amount of dilute hydrochloric acid, a reaction occurs. What should be done to decrease the rate of reaction the next time the experiment is performed? a. Use more acid. b. Stir. **c. Use larger marble chips.** d. Add heat.
	Chm.3.1.2 Explain the conditions of a system at equilibrium.	3.1.2 Make a "How-To" reference poster for laboratory workers to use in determining if a system is at equilibrium. 3.1.2 A scientist observes a chemical reaction as it takes place. How can the scientist so in order to tell if the reaction has achieved equilibrium? **a. Measure concentrations of products and reactants over time.** b. Monitor the temperature of the reaction over time. c. Measure the pH of the solution over time. d. Wait for the formation of a precipitate.
	Chm.3.1.3 Infer the shift in equilibrium when a stress is applied to a chemical system (Le Chatelier's Principle).	3.1.3 Given different equilibrium equations, determine the shift in equilibrium and the effects for a variety of changes (concentration of reactant or product, change in temperature, change in pressure, addition of a catalyst). 3.1.3 For the reaction $2SO_2(g) + O_2(g) \rightleftarrows 2SO_3(g) + \text{heat}$ Which action will increase the concentration of SO_3? a. removing SO_2 b. increasing the temperature **c. increasing the pressure** d. adding a catalyst

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<tr>
<td>Chm.3.2 Understand solutions and the solution process.</td>
<td>Chm.3.2.1 Classify substances using the hydronium and hydroxide ion concentrations.</td>
<td>3.2.1 Based on hydroxide ion concentration, which unknown substance would be an acid?
a. Substance A, $[OH^-] = 1.0 \times 10^{-2}M$
b. Substance B, $[OH^-] = 1.0 \times 10^{-4}M$
c. Substance C, $[OH^-] = 1.0 \times 10^{-6}M$
d. Substance D, $[OH^-] = 1.0 \times 10^{-8}M$

3.2.1 Given a list of substances and their hydronium ion concentrations, classify them as acidic, basic, or neutral.</td>
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<td>Chm.3.2.2 Summarize the properties of acids and bases.</td>
<td>3.2.2 Given the data table below, which substance is an acid?
<table><tr><th></th><th colspan="4">Substance</th></tr><tr><th></th><th>W</th><th>X</th><th>Y</th><th>Z</th></tr><tr><td>Tastes bitter</td><td>?</td><td>Yes</td><td>Yes</td><td>No</td></tr><tr><td>Tastes sour</td><td>No</td><td>No</td><td>?</td><td>Yes</td></tr><tr><td>Feels slippery</td><td>No</td><td>Yes</td><td>Yes</td><td>?</td></tr><tr><td>Turns litmus blue</td><td>Yes</td><td>Yes</td><td>Yes</td><td>?</td></tr><tr><td>Turns litmus red</td><td>?</td><td>No</td><td>No</td><td>Yes</td></tr></table>a. Substance W
b. Substance X
c. Substance Y
d. Substance Z

3.2.2 Make trading cards (like baseball cards) for three “people”: Anthony A. Acid, Betty B. Base, and I.M. Neutral. List stats (properties) and other pertinent info (such as interactions, concentration ranges, pH’s, etc.) on the back.</td>
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<td>Chm.3.2.3 Infer the quantitative nature of a solution (molarity, dilution, and titration with a 1:1 molar ratio).</td>
<td>3.2.3 What volume of 0.200M HCl will neutralize 10.0mL of 0.400M KOH?
a. 40.0mL
b. 20.0mL
c. 8.00mL
d. 5.00mL

3.2.3 25.0 mL of 12.0 M H_2SO_4 is diluted to a total volume of 1.00L. What is the concentration of the newly diluted</td>
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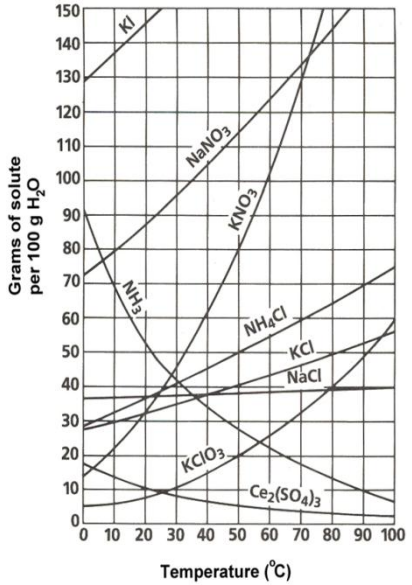
	Chm.3.2.4 Summarize the properties of solutions.	solution? Justify your answer. 3.2.4 Heat is added to a solution to **a. increase the solubility of a solid solute.** b. increase the solubility of a gas solute. c. increase the miscibility of the solution d. increase the degree of saturation of the solution. 3.2.4 Make a PowerPoint presentation of at least 8 slides to illustrate these general properties of solutions: solubility, miscibility, concentration and degree of saturation.
	Chm.3.2.5 Interpret solubility diagrams.	 3.2.5 How many grams of KCl are required to make a saturated solution in 50.0 g of water at 80°C? **a. 25.0 g** b. 50.0 g c. 100. g d. 150. g

		3.2.5 Why does the solubility of NH_3 decrease as the temperature increases? Explain this on a molecular level.
	Chm.3.2.6 Explain the solution process.	3.2.6 When considering the energetics of the solution process, which process is *always* exothermic? a. Solute particles separate from one another. b. Solvent particles separate from one another. **c. Solute and solvent particles form attractions for one another.** d. Solution formation as a whole is always endothermic. 3.2.6 Develop and make an illustrated storyboard for a three-minute short film that explains how solutions form on a particulate level. Use minimum of 6 vignettes.