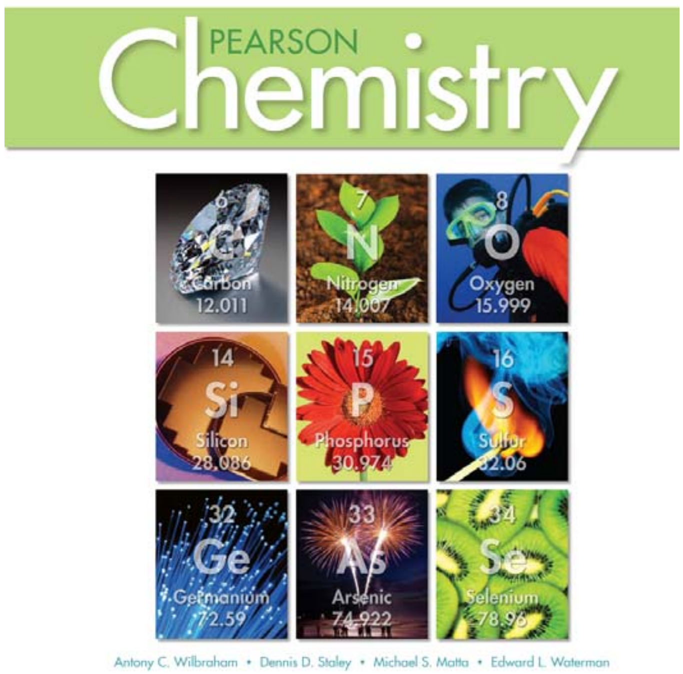
A Correlation of

Pearson
Chemistry
© 2012



To the

Michigan
High School Content Standards and Expectations

INTRODUCTION

This document demonstrates how ***Pearson Chemistry* ©2012** meets the Michigan High School Content Standards and Expectations. Correlation page references are to the Student and Teacher's Editions and are cited at the page level.

Pearson Chemistry combines proven and tested content with cutting-edge digital support and hands-on learning opportunities. This program provides you with everything you need to engage and motivate your students, as well as the tools to support the varied types of learners in your classroom.

Built on Grant Wiggins' *Understanding by Design* framework, this learning model connects curriculum, instruction, and assessment to the "Big Ideas" of chemistry that develops deep understanding.

Pearson Chemistry provides all of the problem-solving and math support that students need to be successful in the course, with ample opportunity for practice both in the Student Edition and in the program's digital resources.

Pearson Chemistry helps you meet the unique learning styles of each student in your classroom with a variety of resources. A variety of assessment opportunities helps you monitor student progress ensure student success on high-stakes tests.

Pearsonchem.com integrates key concepts from the text and brings them alive online with complete Student and Teacher eTexts, animations, virtual labs, tutorials, practice problems, and a comprehensive teacher center. Digital references are referenced at point-of-use in the textbook. PearsonChem.com also offers valuable tools you can use to monitor student's progress through your course.

Pearson Chemistry ©2012
to the
Michigan High School Content Standards and Expectations

Table of Contents

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
STANDARD C1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS	
Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.	
C1.1 Scientific Inquiry	
Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.	
C1.1A Generate new questions that can be investigated in the laboratory or field.	**SE/TE:** 17, 51, 92, 149, 200, 208, 254, 324, 374, 399, 435, 475, 508, 545, 583, 635, 670, 717, 752, 787, 828, 849, 887
C1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.	**SE/TE:** 64-72, 92, 93, 95-96, 98, 99, 120, 156, 190, 208, 238, 254, 399, 467, 545, 571, 752, 849
C1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).	**SE/TE:** 17, 39, 51, 72, 92, 142, 149, 200, 207, 208, 238, 254, 279, 295, 324, 328, 354, 355, 374, 399, 404, 435, 437, 467, 475, 491, 508, 519, 545, 571, 583, 600, 635, 662, 670, 671, 681, 699, 717, 744, 750, 752, 787, 818, 828, 849, 887, 896
C1.1D Identify patterns in data and relate them to theoretical models.	**SE/TE:** 887
C1.1E Describe a reason for a given conclusion using evidence from an investigation.	**SE/TE:** 17, 39, 51, 142, 200, 207, 279, 354, 355, 374, 435, 437, 475, 491, 508, 519, 583, 600, 635, 670, 671, 681, 699, 717, 744, 750, 752, 896

Pearson Chemistry ©2012
to the
Michigan High School Content Standards and Expectations

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
C1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.	**SE/TE:** 208, 254, 437, 475, 519, 635
C1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 17, 39, 51, 72, 92, 142, 149, 200, 207, 208, 238, 254, 279, 295, 324, 328, 354, 355, 374, 399, 404, 435, 437, 467, 475, 491, 508, 519, 545, 571, 583, 600, 635, 662, 670, 671, 681, 699, 717, 744, 750, 752, 787, 818, 828, 849, 887, 896
C1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.	**SE/TE:** 17, 39, 51, 72, 92, 142, 149, 184, 200, 207, 208, 238, 254, 279, 295, 324, 328, 354, 355, 374, 399, 404, 435, 437, 467, 475, 491, 508, 519, 545, 571, 583, 600, 635, 662, 670, 671, 681, 699, 717, 744, 750, 752, 787, 818, 828, 849, 887, 896
C1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 104, 107, 433, 859-861, 897, R17
C1.2 Scientific Reflection and Social Implications	
The integrity of the scientific process depends on scientists and citizens understanding and respecting the "Nature of Science." Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.	
C1.2A Critique whether or not specific questions can be answered through scientific investigations.	**SE/TE:** 17, 39, 51, 72, 92, 142, 149, 184, 200, 207, 208, 238, 254, 279, 295, 324, 328, 354, 355, 374, 399, 404, 435, 437, 467, 475, 491, 508, 519, 545, 571, 583, 600, 635, 662, 670, 671, 681, 699, 717, 744, 750, 752, 787, 818, 828, 849, 887, 896
C1.2B Identify and critique arguments about personal or societal issues based on scientific evidence.	**SE/TE:** 1, 7-11, 27, 28, 30, 110-111, 502-503, 602-603, 784, 867, 892-893

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
C1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.	**TE only:** 110, 368, 397, 576-577, 744, 784, R2, R3, R4, R8, R12, R16, R19, R23, R27, R21, R32
C1.2D Evaluate scientific explanations in a peer review process or discussion format.	**SE/TE:** 18-19
C1.2E Evaluate the future career and occupational prospects of science fields.	**SE/TE:** 2-3, 5, 6, 27, 28-29, 31, 284, 455, 463, 467, 620, 663, 774, 853
C1.2f Critique solutions to problems, given criteria and scientific constraints.	*Opportunities to address this standard can be found on the following pages:* **TE only:** 52, 576, 663, 744, 784
C1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions.	**TE only:** 52, 351, 368, 397, 744, 784
C1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.	**SE/TE:** 16-17, 19, 27, 28, 30, 31, 124
C1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.	**SE/TE:** 102-104, 105-109, 121, 122-124, 128-132, 133, 138-139, 142-143, 145, 147-148, 150, 151, 154-155, 156, 160-162, 289-290, 294, 320, 646, 649, 651-652, 736, 876
C1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.	**TE only:** 52, 110, 111, 351, 368, 397, 744, R4, R5, R6, R11-R12, R16-R17, R18, R19, R20, R21, R22, R23, R24, R31, R33, R35, R38-R39, R40
C1.2k Analyze how science and society interact from a historical, political, economic, or social perspective.	*This standard is met throughout the text. Please see the following examples:* **SE/TE:** 7-11, 12-13, 14-15, 19, 27, 28-30, 52-53, 83, 101, 102-104, 105-109, 110-111, 121, 122-124, 126-127, 133, 138, 146, 155, 163, 183, 189, 193, 211-212, 217, 218, 239, 270, 305, 334-335, 355, 368, 397, 440-441, 455, 476-477, 502-503, 532-533, 576-577, 602-603, 681, 700, 716, 736, 774, 782-786, 803, 821, 853, 859-861, 867, 888-890, 892-893, 894-897, R2-R41

Pearson Chemistry ©2012
to the
Michigan High School Content Standards and Expectations

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
STANDARD C2: FORMS OF ENERGY	
Students recognize the many forms of energy and understand that energy is central to predicting and explaining how and why chemical reactions occur. The chemical topics of bonding, gas behavior, kinetics, enthalpy, entropy, free energy, and nuclear stability are addressed in this standard. *Chemistry students relate temperature to the average kinetic energy of the molecules and use the kinetic molecular theory to describe and explain the behavior of gases and the rates of chemical reactions. They understand nuclear stability in terms of reaching a state of minimum potential energy.*	
P2.p1 Potential Energy *(prerequisite)*	
Three forms of potential energy are gravitational, elastic, and chemical. Objects can have elastic potential energy due to their compression or chemical potential energy due to the arrangement of the atoms. *(prerequisite)*	
P2.p1A Describe energy changes associated with changes of state in terms of the arrangement and order of the atoms (molecules) in each state. *(prerequisite)*	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 36-37, 420-421, 425, 431, 442
P2.p1B Use the positions and arrangements of atoms and molecules in solid, liquid, and gas state to explain the need for an input of energy for melting and boiling and a release of energy in condensation and freezing. *(prerequisite)*	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 36-37, 420-421, 425, 431, 442
C2.1x Chemical Potential Energy	
Potential energy is stored whenever work must be done to change the distance between two objects. The attraction between the two objects may be gravitational, electrostatic, magnetic, or strong force. Chemical potential energy is the result of electrostatic attractions between atoms.	
C2.1a Explain the changes in potential energy (due to electrostatic interactions) as a chemical bond forms and use this to explain why bond breaking always requires energy.	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 556
C2.1b Describe energy changes associated with chemical reactions in terms of bonds broken and formed (including intermolecular forces).	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 556
C2.1c Compare qualitatively the energy changes associated with melting various types of solids in terms of the types of forces between the particles in the solid.	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 431

Michigan High School Content Expectations Standards	**Pearson Chemistry © 2012**
C2.2 Molecules in Motion	
Molecules that compose matter are in constant motion (translational, rotational, vibrational). Energy may be transferred from one object to another during collisions between molecules.	
C2.2A Describe conduction in terms of molecules bumping into each other to transfer energy. Explain why there is better conduction in solids and liquids than gases.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 36-37, 420-421, 425, 431, 442
C2.2B Describe the various states of matter in terms of the motion and arrangement of the molecules (atoms) making up the substance.	**SE/TE:** 36-37, 55-57, 59, 420-421, 424, 425, 430, 431-434, 442, 443, 445, 447
C2.2x Molecular Entropy	
As temperature increases, the average kinetic energy and the entropy of the molecules in a sample increases.	
C2.2c Explain changes in pressure, volume, and temperature for gases using the kinetic molecular model.	**SE/TE:** 421-422, 424, 442, 443-445, 450-454, 478, 480-483, 485
C2.2d Explain convection and the difference in transfer of thermal energy for solids, liquids, and gases using evidence that molecules are in constant motion.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 36-37, 420-421, 425, 431
C2.2e Compare the entropy of solids, liquids, and gases.	**SE/TE:** 630-631, 639, 643, 688
C2.2f Compare the average kinetic energy of the molecules in a metal object and a wood object at room temperature.	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 431
C2.3x Breaking Chemical Bonds	
For molecules to react, they must collide with enough energy (activation energy) to break old chemical bonds before their atoms can be rearranged to form new substances.	
C2.3a Explain how the rate of a given chemical reaction is dependent on the temperature and the activation energy.	**SE/TE:** 596-598, 601, 636, 638, 643
C2.3b Draw and analyze a diagram to show the activation energy for an exothermic reaction that is very slow at room temperature.	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 597

Michigan High School Content Expectations Standards	**Pearson Chemistry © 2012**
C2.4x Electron Movement	
For each element, the arrangement of electrons surrounding the nucleus is unique. These electrons are found in different energy levels and can only move from a lower energy level (closer to nucleus) to a higher energy level (farther from nucleus) by absorbing energy in discrete packets. The energy content of the packets is directly proportional to the frequency of the radiation. These electron transitions will produce unique absorption spectra for each element. When the electron returns from an excited (high energy state) to a lower energy state, energy is emitted in only certain wavelengths of light, producing an emission spectra.	
C2.4a Describe energy changes in flame tests of common elements in terms of the (characteristic) electron transitions.	**SE/TE:** 142, 148, R8
C2.4b Contrast the mechanism of energy changes and the appearance of absorption and emission spectra.	**SE/TE:** 140, 142-145, 149, 150, 151, 152-156
C2.4c Explain why an atom can absorb only certain wavelengths of light.	**SE/TE:** 140, 144-145, 148, 150, 153
C2.4d Compare various wavelengths of light (visible and nonvisible) in terms of frequency and relative energy.	**SE/TE:** 138-139, 141, 148, 149, 151, 151, 152-155, 157, 260, 416, 446, R53
C2.5x Nuclear Stability	
Nuclear stability is related to a decrease in potential energy when the nucleus forms from protons and neutrons. If the neutron/proton ratio is unstable, the element will undergo radioactive decay. The rate of decay is characteristic of each isotope; the time for half the parent nuclei to decay is called the half-life. Comparison of the parent/daughter nuclei can be used to determine the age of a sample. Heavier elements are formed from the fusion of lighter elements in the stars.	
C2.5a Determine the age of materials using the ratio of stable and unstable isotopes of a particular type.	**SE/TE:** 882-883, 898, 899, 901-903
C2.r5b Illustrate how elements can change in nuclear reactions using balanced equations. *(recommended)*	**SE/TE:** 885-886, 900-902, 905, R72
C2.r5c Describe the potential energy changes as two protons approach each other. *(recommended)*	*The opportunity to address this standard may be found on the following page:* **SE/TE:** 107
C2.r5d Describe how and where all the elements on earth were formed. *(recommended)*	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 891

Michigan High School Content Expectations Standards	**Pearson Chemistry © 2012**
STANDARD C3: ENERGY TRANSFER AND CONSERVATION	
Students apply the First and Second Laws of Thermodynamics to explain and predict most chemical phenomena. *Chemistry students use the term enthalpy to describe the transfer of energy between reactants and products in simple calorimetry experiments performed in class and will recognize Hess's Law as an application of the conservation of energy.* *Students understand the tremendous energy released in nuclear reactions is a result of small amounts of matter being converted to energy.*	
P3.p1 Conservation of Energy *(prerequisite)*	
When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. *(prerequisite)*	
P3.p1A Explain that the amount of energy necessary to heat a substance will be the same as the amount of energy released when the substance is cooled to the original temperature. *(prerequisite)*	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 557
C3.1x Hess's Law	
For chemical reactions where the state and amounts of reactants and products are known, the amount of energy transferred will be the same regardless of the chemical pathway. This relationship is called Hess's law.	
C3.1a Calculate the ΔH for a given reaction using Hess's Law.	**SE/TE:** 578-579, 582, 584, 585, 586-589, 591, 758, 872, R65-R66
C3.1b Draw enthalpy diagrams for exothermic and endothermic reactions.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 562-568, 569-575, 578-582
C3.1c Calculate the ΔH for a chemical reaction using simple coffee cup calorimetry.	**SE/TE:** 562-564, 584, 585
C3.1d Calculate the amount of heat produced for a given mass of reactant from a balanced chemical equation.	**SE/TE:** 568, 588, 758, R65
P3.p2 Energy Transfer *(prerequisite)*	
Nuclear reactions take place in the sun. In plants, light from the sun is transferred to oxygen and carbon compounds, which, in combination, have chemical potential energy (photosynthesis). *(prerequisite)*	
P3.p2A Trace (or diagram) energy transfers involving various types of energy including nuclear, chemical, electrical, sound, and light. *(prerequisite)*	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 556, 745-746, 839

Michigan High School Content Expectations Standards	**Pearson Chemistry © 2012**
C3.2x Enthalpy	
Chemical reactions involve breaking bonds in reactants (endothermic) and forming new bonds in the products (exothermic). The enthalpy change for a chemical reaction will depend on the relative strengths of the bonds in the reactants and products.	
C3.2a Describe the energy changes in photosynthesis and in the combustion of sugar in terms of bond breaking and bond making.	**SE/TE:** 839-840, 869, R72
C3.2b Describe the relative strength of single, double, and triple covalent bonds between nitrogen atoms.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 230-231, 236-238
C3.3 Heating Impacts	
Heating increases the kinetic (translational, rotational, and vibrational) energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic (translational) energy of the atoms, molecules, or ions increases, the temperature of the matter increases. Heating a sample of a crystalline solid increases the kinetic (vibrational) energy of the atoms, molecules, or ions. When the kinetic (vibrational) energy becomes great enough, the crystalline structure breaks down, and the solid melts.	
C3.3A Describe how heat is conducted in a solid.	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 431
C3.3B Describe melting on a molecular level.	**SE/TE:** 431
C3.3x Bond Energy	
Chemical bonds possess potential (vibrational and rotational) energy.	
C3.3c Explain why it is necessary for a molecule to absorb energy in order to break a chemical bond.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 236-237
C3.4 Endothermic and Exothermic Reactions	
Chemical interactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic).	
C3.4A Use the terms endothermic and exothermic correctly to describe chemical reactions in the laboratory.	**SE/TE:** 557-558, 586, 642, R65
C3.4B Explain why chemical reactions will either release or absorb energy.	**SE/TE:** 557-558

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
C3.4x Enthalpy and Entropy	
All chemical reactions involve rearrangement of the atoms. In an exothermic reaction, the products have less energy than the reactants. There are two natural driving forces: (1) toward minimum energy (enthalpy) and (2) toward maximum disorder (entropy).	
C3.4c Write chemical equations including the heat term as a part of equation or using ΔH notation.	**SE/TE:** 565-566, 568
C3.4d Draw enthalpy diagrams for reactants and products in endothermic and exothermic reactions.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 565-567
C3.4e Predict if a chemical reaction is spontaneous given the enthalpy (ΔH) and entropy (ΔS) changes for the reaction using Gibb's Free Energy, $\Delta G = \Delta H - T\Delta S$ (Note: mathematical computation of ΔG is not required.)	**SE/TE:** 634, 636
C3.4f Explain why some endothermic reactions are spontaneous at room temperature.	**SE/TE:** 627-634, 635, 636, 638-639
C3.4g Explain why gases are less soluble in warm water than cold water.	**SE/TE:** 521-524, 546, 549-550
C3.5x Mass Defect	
Nuclear reactions involve energy changes many times the magnitude of chemical changes. In chemical reactions matter is conserved, but in nuclear reactions a small loss in mass (mass defect) will account for the tremendous release of energy. The energy released in nuclear reactions can be calculated from the mass defect using $E = mc^2$.	
C3.5a Explain why matter is not conserved in nuclear reactions.	**SE/TE:** 876-879
STANDARD C4: PROPERTIES OF MATTER	
Compounds, elements, and mixtures are categories used to organize matter. Students organize materials into these categories based on their chemical and physical behavior. Students understand the structure of the atom to make predictions about the physical and chemical properties of various elements and the types of compounds those elements will form. An understanding of the organization the Periodic Table in terms of the outer electron configuration is one of the most important tools for the chemist and student to use in prediction and explanation of the structure and behavior of atoms.	
P4.p1 Kinetic Molecular Theory *(prerequisite)*	
Properties of solids, liquids, and gases are explained by a model of matter that is composed of tiny particles in motion. *(prerequisite)*	
P4.p1A For a substance that can exist in all three phases, describe the relative motion of the particles in each of the phases. *(prerequisite)*	**SE/TE:** 420-421, 424, 425, 430, 431, 434, 442, 443, 447, 484

Michigan High School Content Expectations Standards	**Pearson Chemistry © 2012**
P4.p1B For a substance that can exist in all three phases, make a drawing that shows the arrangement and relative spacing of the particles in each of the phases. *(prerequisite)*	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 36-37
P4.p1C For a simple compound, present a drawing that shows the number of particles in the system does not change as a result of a phase change. *(prerequisite)*	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 36-37
P4.p2 Elements, Compounds, and Mixtures *(prerequisite)*	
Elements are a class of substances composed of a single kind of atom. Compounds are composed of two or more different elements chemically combined. Mixtures are composed of two or more different elements and/or compounds physically combined. Each element and compound has physical and chemical properties, such as boiling point, density, color, and conductivity, which are independent of the amount of the sample. *(prerequisite)*	
P4.p2A Distinguish between an element, compound, or mixture based on drawings or formulae. *(prerequisite)*	**SE/TE:** 45-47, 54, 55
P4.p2B Identify a pure substance (element or compound) based on unique chemical and physical properties. *(prerequisite)*	**SE/TE:** 35, 54, 56
P4.p2C Separate mixtures based on the differences in physical properties of the individual components. *(prerequisite)*	**SE/TE:** 39, 41, 54, 55, 57, 190, 437
P4.p2D Recognize that the properties of a compound differ from those of its individual elements. *(prerequisite)*	**SE/TE:** 43
C4.1x Molecular and Empirical Formulae	
Compounds have a fixed percent elemental composition. For a compound, the empirical formula can be calculated from the percent composition or the mass of each element. To determine the molecular formula from the empirical formula, the molar mass of the substance must also be known.	
C4.1a Calculate the percent by weight of each element in a compound based on the compound formula.	**SE/TE:** 327, 333, 336, 337, 338-339, 343, 446, 484, R56
C4.1b Calculate the empirical formula of a compound based on the percent by weight of each element in the compound.	**SE/TE:** 330-331, 333, 336, 340, R57

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
C4.1c Use the empirical formula and molecular weight of a compound to determine the molecular formula.	**SE/TE:** 332-333, 336, 339, 484, R57
C4.2 Nomenclature	
All compounds have unique names that are determined systematically.	
C4.2A Name simple binary compounds using their formulae.	**SE/TE:** 274-275, 279, 280-283, 292-294, 295, 296, 297, 298-300, 303, R54-R55
C4.2B Given the name, write the formula of simple binary compounds.	**SE/TE:** 272-273, 279, 283, 293-294, 295, 296, 297, 298-301, R54-R55
C4.2x Nomenclature	
All molecular and ionic compounds have unique names that are determined systematically.	
C4.2c Given a formula, name the compound.	**SE/TE:** 268-269, 278-279, 285-288, 292-294, 295, 296, 297, 298-299, 303, 342, 380, 416, 484, 642, R54-R55
C4.2d Given the name, write the formula of ionic and molecular compounds.	**SE/TE:** 276-277, 279, 285-288, 293-294, 296, 297, 298-301, 303, 342, 380, 416, 446, R54-R55
C4.2e Given the formula for a simple hydrocarbon, draw and name the isomers.	**SE/TE:** 775-778, 788, 790, 795
C4.3 Properties of Substances	
Differences in the physical and chemical properties of substances are explained by the arrangement of the atoms, ions, or molecules of the substances and by the strength of the forces of attraction between the atoms, ions, or molecules.	
C4.3A Recognize that substances that are solid at room temperature have stronger attractive forces than liquids at room temperature, which have stronger attractive forces than gases at room temperature.	**SE/TE:** 252-253, 257, 425, 430, 431, 442, 443
C4.3B Recognize that solids have a more ordered, regular arrangement of their particles than liquids and that liquids are more ordered than gases.	**SE/TE:** 36-37, 55-56, 59, 204-205, 216-217, 420, 425, 430, 431, 434, 442, 443, 447

Michigan High School Content Expectations Standards		**Pearson Chemistry © 2012**
C4.3x Solids		
Solids can be classified as metallic, ionic, covalent, or network covalent. These different types of solids have different properties that depend on the particles and forces found in the solid.		
C4.3c	Compare the relative strengths of forces between molecules based on the melting point and boiling point of the substances.	**SE / TE:** 252, 257, 431, 434, 443
C4.3d	Compare the strength of the forces of attraction between molecules of different elements. (For example, at room temperature, chlorine is a gas and iodine is a solid.)	**SE / TE:** 251
C4.3e	Predict whether the forces of attraction in a solid are primarily metallic, covalent, network covalent, or ionic based upon the elements' location on the periodic table.	*Opportunities to address this standard can be found on the following pages:* **SE / TE:** 201-202, 209-210, 226-234, 431
C4.3f	Identify the elements necessary for hydrogen bonding (N, O, F).	**SE / TE:** 251
C4.3g	Given the structural formula of a compound, indicate all the intermolecular forces present (dispersion, dipolar, hydrogen bonding).	*Opportunities to address this standard can be found on the following pages:* **SE / TE:** 250-251
C4.3h	Explain properties of various solids such as malleability, conductivity, and melting point in terms of the solid's structure and bonding.	**SE / TE:** 204, 206-207, 209-212, 213, 214-217
C4.3i	Explain why ionic solids have higher melting points than covalent solids. (For example, NaF has a melting point of 995°C, while water has a melting point of 0° C.)	**SE / TE:** 225, 256, 431
C4.4x Molecular Polarity		
The forces between molecules depend on the net polarity of the molecule as determined by shape of the molecule and the polarity of the bonds.		
C4.4a	Explain why at room temperature different compounds can exist in different phases.	**SE / TE:** 252-253, 256

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
C4.4b Identify if a molecule is polar or nonpolar given a structural formula for the compound.	**SE/TE:** 247-250, 257, 261
C4.5x Ideal Gas Law	
The forces in gases are explained by the ideal gas law.	
C4.5a Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-volume relationship in gases.	**SE/TE:** 456-457, 463, 478, 480, 642, R62
C4.5b Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-temperature relationship in gases.	**SE/TE:** 460-461, 463, 478, 480, 482, 485, 514, 642, 834, R62-R63
C4.5c Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the temperature-volume relationship in gases.	**SE/TE:** 458-459, 463, 478, 480, 482, 485, 590, 642, 758, R62-R63
C4.6x Moles	
The mole is the standard unit for counting atomic and molecular particles in terms of common mass units.	
C4.6a Calculate the number of moles of any compound or element given the mass of the substance.	**SE/TE:** 317, 319, 323, 324, 336, 338, 380, 416, 446, R56
C4.6b Calculate the number of particles of any compound or element given the mass of the substance.	**SE/TE:** 339, 341
C4.7x Solutions	
The physical properties of a solution are determined by the concentration of solute.	
C4.7a Investigate the difference in the boiling point or freezing point of pure water and a salt solution.	**SE/TE:** 536-537, 540-544, 546, 548-549, 553
C4.7b Compare the density of pure water to that of a sugar solution.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 80-81

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
C4.8 Atomic Structure	
Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.	
C4.8A Identify the location, relative mass, and charge for electrons, protons, and neutrons.	**SE/TE:** 105-109, 121, 122-124, 125, 129-130, 150, 152, 157, 260, 302, 590
C4.8B Describe the atom as mostly empty space with an extremely small, dense nucleus consisting of the protons and neutrons and an electron cloud surrounding the nucleus.	**SE/TE:** 107-109, 121, 122-124, 302
C4.8C Recognize that protons repel each other and that a strong force needs to be present to keep the nucleus intact.	*Opportunities to address this standard can be found on the following page:* **SE/TE:** 107
C4.8D Give the number of electrons and protons present if the fluoride ion has a -1 charge.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 176, 198-199
C4.8x Electron Configuration	
Electrons are arranged in main energy levels with sublevels that specify particular shapes and geometry. Orbitals represent a region of space in which an electron may be found with a high level of probability. Each defined orbital can hold two electrons, each with a specific spin orientation. The specific assignment of an electron to an orbital is determined by a set of 4 quantum numbers. Each element and, therefore, each position in the periodic table is defined by a unique set of quantum numbers.	
C4.8e Write the complete electron configuration of elements in the first four rows of the periodic table.	**SE/TE:** 134-137, 150, 152-153, 157, 170-173, 186, 218, 260, 302, 342, 642, R44, R53
C4.8f Write kernel structures for main group elements.	**SE/TE:** 195-199, 203, 214-215, 416, 552
C4.8g Predict oxidation states and bonding capacity for main group elements using their electron structure.	**SE/TE:** 201-203, 207, 214, 226-231, 256, 701-706, 719, 720-721, 723, R37, R42-R43
C4.8h Describe the shape and orientation of *s* and *p* orbitals.	**SE/TE:** 131, 150, 152, 157
C4.8i Describe the fact that the electron location cannot be exactly determined at any given time.	**SE/TE:** 130-132, 150

Pearson Chemistry ©2012
to the
Michigan High School Content Standards and Expectations

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
C4.9 Periodic Table	
In the periodic table, elements are arranged in order of increasing number of protons (called the atomic number). Vertical groups in the periodic table (families) have similar physical and chemical properties due to the same outer electron structures.	
C4.9A Identify elements with similar chemical and physical properties using the periodic table.	**SE/TE:** 164-166, 167-173, 185, 187, 218, 342, R2-R3, R6-R7, R10-R11, R14-R15, R20-R21, R24-R25, R28-R29, R32, R36-R37
C4.9x Electron Energy Levels	
The rows in the periodic table represent the main electron energy levels of the atom. Within each main energy level are sublevels that represent an orbital shape and orientation.	
C4.9b Identify metals, non-metals, and metalloids using the periodic table.	**SE/TE:** 164-166, 185, 191, 484, R2, R6, R10, R14, R20, R24, R28, R36
C4.9c Predict general trends in atomic radius, first ionization energy, and electronegativity of the elements using the periodic table.	**SE/TE:** 174-175, 177-182, 185, 186-189, 191, 260, 302, 342, 380, 416, 446, 590, R3, R7, R11, R14, R21, R25, R29, R32, R53-R54
C4.10 Neutral Atoms, Ions, and Isotopes	
A neutral atom of any element will contain the same number of protons and electrons. Ions are charged particles with an unequal number of protons and electrons. Isotopes are atoms of the same element with different numbers of neutrons and essentially the same chemical and physical properties.	
C4.10A List the number of protons, neutrons, and electrons for any given ion or isotope.	**SE/TE:** 114-115, 119, 122, 125, 156, 176, 190, 194-199, 218, 342, 380, 416, R52
C4.10B Recognize that an element always contains the same number of protons.	**SE/TE:** 112-115, 121, 122
C4.10x Average Atomic Mass	
The atomic mass listed on the periodic table is an average mass for all the different isotopes that exist, taking into account the percent and mass of each different isotope.	
C4.10c Calculate the average atomic mass of an element given the percent abundance and mass of the individual isotopes.	**SE/TE:** 116-119, 120, 121, 122-123, 552, R53
C4.10d Predict which isotope will have the greatest abundance given the possible isotopes for an element and the average atomic mass in the periodic table.	**SE/TE:** 118-119

Pearson Chemistry ©2012
to the
Michigan High School Content Standards and Expectations

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
C4.10e Write the symbol for an isotope, $^{A}_{Z}X$, where *Z* is the atomic number, *A* is the mass number, and *X* is the symbol for the element.	**SE/TE:** 115, 125
STANDARD C5: CHANGES IN MATTER	
Students will analyze a chemical change phenomenon from the point of view of what is the same and what is not the same.	
P5.p1 Conservation of Matter *(prerequisite)*	
Changes of state are explained by a model of matter composed of tiny particles that are in motion. When substances undergo changes of state, neither atoms nor molecules themselves are changed in structure. Mass is conserved when substances undergo changes of state. *(prerequisite)*	
P5.p1A Draw a picture of the particles of an element or compound as a solid, liquid, and gas. *(prerequisite)*	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 36-37
C5.r1x Rates of Reactions *(recommended)*	
The rate of a chemical reaction will depend upon (1) concentration of reacting species, (2) temperature of reaction, (3) pressure if reactants are gases, and (4) nature of the reactants. A model of matter composed of tiny particles that are in constant motion is used to explain rates of chemical reactions. *(recommended)*	
C5.r1a Predict how the rate of a chemical reaction will be influenced by changes in concentration, and temperature, pressure. *(recommended)*	**SE/TE:** 598, 638-639, R66
C5.r1b Explain how the rate of a reaction will depend on concentration, temperature, pressure, and nature of reactant. *(recommended)*	**SE/TE:** 598, 601, 638-639, 643, 794, R66
C5.2 Chemical Changes	
Chemical changes can occur when two substances, elements, or compounds interact and produce one or more different substances whose physical and chemical properties are different from the interacting substances. When substances undergo chemical change, the number of atoms in the reactants is the same as the number of atoms in the products. This can be shown through simple balancing of chemical equations. Mass is conserved when substances undergo chemical change. The total mass of the interacting substances (reactants) is the same as the total mass of the substances produced (products).	
C5.2A Balance simple chemical equations applying the conservation of matter.	**SE/TE:** 349-354, 359, 361, 363, 365, 367, 370-371, 373, 374, 375, 376, 377-379, 381, 388-389, 399, 404, 416, 446, 484, 514, 642, 758, 904, R57-R58
C5.2B Distinguish between chemical and physical changes in terms of the properties of the reactants and products.	**SE/TE:** 32-33, 37, 42-43, 48-50, 51, 54, 55-58, 59, 342, 356-367, 371-373, 375, 377, 379, R51

Michigan High School Content Expectations Standards	**Pearson Chemistry © 2012**
C5.2C Draw pictures to distinguish the relationships between atoms in physical and chemical changes.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 37, 42-43, 48-50
C5.2x Balancing Equations	
A balanced chemical equation will allow one to predict the amount of product formed.	
C5.2d Calculate the mass of a particular compound formed from the masses of starting materials.	**SE/TE:** 387-389, 391-393, 398, 399, 409, 411, 413, 415, 446, 514, 590, 642, R59-R61
C5.2e Identify the limiting reagent when given the masses of more than one reactant.	**SE/TE:** 400-403, 409, 410, 412, 414, 446, 514, R61
C5.2f Predict volumes of product gases using initial volumes of gases at the same temperature and pressure.	**SE/TE:** 387, 394, 396, 398, 409, 514
C5.2g Calculate the number of atoms present in a given mass of element.	**SE/TE:** 339
C5.3x Equilibrium	
Most chemical reactions reach a state of dynamic equilibrium where the rates of the forward and reverse reactions are equal.	
C5.3a Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).	**SE/TE:** 612-615, 620, 636, 638-641, 643, 794, 834, 688, R66
C5.3b Predict shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).	**SE/TE:** 612-615, 620, 636, 638-641, 688, 794, 834, R66
C5.3c Predict the extent reactants are converted to products using the value of the equilibrium constant.	**SE/TE:** 616-620, 636, 637, 638-639, 758, R67
C5.4 Phase Change/Diagrams	
Changes of state require a transfer of energy. Water has unusually high-energy changes associated with its changes of state.	
C5.4A Compare the energy required to raise the temperature of one gram of aluminum and one gram of water the same number of degrees.	**SE/TE:** 559

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
C5.4B Measure, plot, and interpret the graph of the temperature versus time of an ice-water mixture, under slow heating, through melting and boiling.	**SE/TE:** 572
C5.4x Changes of State	
All changes of state require energy. Changes in state that require energy involve breaking forces holding the particles together. The amount of energy will depend on the type of forces.	
C5.4c Explain why both the melting point and boiling points for water are significantly higher than other small molecules of comparable mass (e.g., ammonia and methane).	**SE/TE:** 488-489, 491, 493, 509, 510
C5.4d Explain why freezing is an exothermic change of state.	**SE/TE:** 589
C5.4e Compare the melting point of covalent compounds based on the strength of IMFs (intermolecular forces).	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 250-251, 431
C5.5 Chemical Bonds — Trends	
An atom's electron configuration, particularly of the outermost electrons, determines how the atom can interact with other atoms. The interactions between atoms that hold them together in molecules or between oppositely charged ions are called chemical bonds.	
C5.5A Predict if the bonding between two atoms of different elements will be primarily ionic or covalent.	**SE/TE:** 201-203, 213, 214-215, 226, 256, 260, 302, 904
C5.4B Predict the formula for binary compounds of main group elements.	**SE/TE:** 202-203, 207, 213, 216
C5.5x Chemical Bonds	
Chemical bonds can be classified as ionic, covalent, and metallic. The properties of a compound depend on the types of bonds holding the atoms together.	
C5.5c Draw Lewis structures for simple compounds.	**SE/TE:** 226-238, 256-259, 261, 302, 342, 514, R54
C5.5d Compare the relative melting point, electrical and thermal conductivity and hardness for ionic, metallic, and covalent compounds.	**SE/TE:** 204, 206-207, 209-210, 212, 213, 214-217, 224-225, 256, 261
C5.5e Relate the melting point, hardness, and electrical and thermal conductivity of a substance to its structure.	**SE/TE:** 204, 206-207, 209-210, 212, 213, 214-217, 224-225, 256

Michigan High School Content Expectations Standards	Pearson Chemistry © 2012
C5.6x Reduction / Oxidation Reactions	
Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve electron transfer are known as oxidation/reduction (or "redox").	
C5.6a Balance half-reactions and describe them as oxidations or reductions.	**SE / TE:** 712-715, 718, 719, 720-723, 725, R68
C5.6b Predict single replacement reactions.	**SE / TE:** 360-361, 366, 377
C5.6c Explain oxidation occurring when two different metals are in contact.	**SE / TE:** 728-729, 736, 872, R69
C5.6d Calculate the voltage for spontaneous redox reactions from the standard reduction potentials.	**SE / TE:** 738-741, 743, 753, 754-757, 759, R69
C5.6e Identify the reactions occurring at the anode and cathode in an electrochemical cell.	**SE / TE:** 730-732, 755-757, 759, 794, 834, 872, R69
C5.7 Acids and Bases	
Acids and bases are important classes of chemicals that are recognized by easily observed properties in the laboratory. Acids and bases will neutralize each other. Acid formulas usually begin with hydrogen, and base formulas are a metal with a hydroxide ion. As the pH decreases, a solution becomes more acidic. A difference of one pH unit is a factor of 10 in hydrogen ion concentration.	
C5.7A Recognize formulas for common inorganic acids, carboxylic acids, and bases formed from families I and II.	**SE / TE:** 285-288, 298-300, 647-649
C5.7B Predict products of an acid-base neutralization.	**SE / TE:** 672-675, 682, 684-685, 689, R67
C5.7C Describe tests that can be used to distinguish an acid from a base.	**SE / TE:** 660-662, 682, 686
C5.7D Classify various solutions as acidic or basic, given their pH.	**SE / TE:** 656, 682
C5.7E Explain why lakes with limestone or calcium carbonate experience less adverse effects from acid rain than lakes with granite beds.	*Opportunities to address this standard can be found on the following page:* **SE / TE:** 671

Michigan High School Content Expectations Standards	**Pearson Chemistry © 2012**
C5.7x Brønsted-Lowry	
Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve proton transfer are known as acid/base reactions.	
C5.7f Write balanced chemical equations for reactions between acids and bases and perform calculations with balanced equations.	**SE/TE:** 672-673, 675, 683, 684-685, 687, 689, 758, 794, R67
C5.7g Calculate the pH from the hydronium ion or hydroxide ion concentration.	**SE/TE:** 656-657, 659, 662, 682, 684-685, 689, 724, 758, 794, 872, R67
C5.7h Explain why sulfur oxides and nitrogen oxides contribute to acid rain.	*Opportunities to address this standard can be found on the following pages:* **SE/TE:** 671, R23
C5.r7i Identify the Brønsted-Lowry conjugate acid-base pairs in an equation. *(recommended)*	**SE/TE:** 650, 652, 724
C5.8 Carbon Chemistry	
The chemistry of carbon is important. Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.	
C5.8A Draw structural formulas for up to ten carbon chains of simple hydrocarbons.	**SE/TE:** 763, 766-768, 771, 772, 789, 790-793, 795, 834, 904, R97
C5.8B Draw isomers for simple hydrocarbons.	**SE/TE:** 775-778, 790, 795
C5.8C Recognize that proteins, starches, and other large biological molecules are polymers.	**SE/TE:** 841-843, 844-848, 850-852, 854-855, 868, 869-871, 873