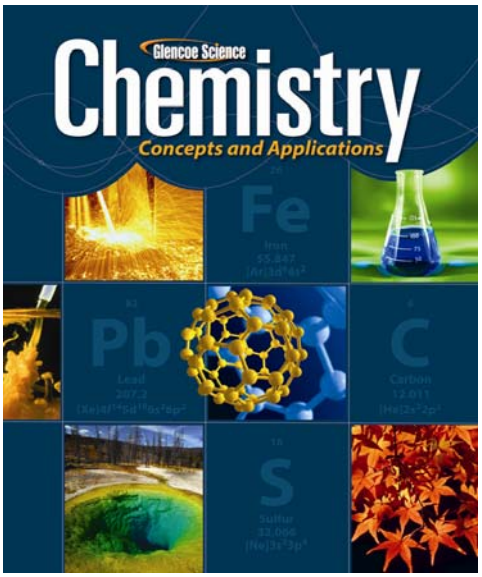

Chemistry

Concepts and Applications

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STANDARDS	PAGE REFERENCES
Chemistry I: Embedded Inquiry	
Conceptual Strand *Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.*	
Guiding Question *What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?*	
Course Level Expectations	
CLE 3221.Inq.1 Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted.	**Student Edition:** *Expanding the Model of the Atom* 228-229 *Figure 2.5* 57 *Figure 2.10* 63 *Figure 7.1* 228 *Hypotheses, Theories, and Laws* 57 *Nuclear Fission* 757 *Physics Connection* 230 *The Discovery of Atomic Structure* 59-63
CLE 3221.Inq.2 Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.	**Student Edition:** *Inquiry Extension* 327 *Skill Review* 580 #43

STANDARDS	PAGE REFERENCES
CLE 3221.Inq.3 Use appropriate tools and technology to collect precise and accurate data.	**Student Edition:** *CHEMLAB* 36-37, 98-99, 170-171, 360-361, 674-675, 720-721 *Mini Lab* 418, 708
CLE 3221.Inq.4 Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.	**Student Edition:** *CHEMLAB* 19, 37, 55, 99, 171, 235, 361, 507, 545, 675, 721 *Mini Lab* 164, 203, 373, 418, 504, 533, 687
CLE 3221.Inq.5 Compare experimental evidence and conclusions with those drawn by others.	**Student Edition:** *CHEMLAB* 55 *Mini Lab* 232, 770
CLE 3221.Inq.6 Communicate and defend scientific findings.	**Student Edition:** *CHEMLAB* 37, 267, 721 *Mini Lab* 232, 341, 482, 504, 687 *Removing Electroplating* 876
Checks for Understanding	
3221.Inq.1 Trace the historical development of a scientific principle or theory.	**Student Edition:** *Expanding the Model of the Atom* 228-229 *History Connection* 56 *Physics Connection* 230 *The Discovery of the Atomic Structure* 59-63 *The Kinetic Theory of Matter* 339-341 *The Search for a Periodic Table* 84-89
3221.Inq.2 Identify an answerable question and formulate a hypothesis to guide a scientific investigation.	**Student Edition:** *Discuss the Technology* 388, 425, 471, 485, 608 *Inquiry Extension* 651 *Launch Lab* 479
3221.Inq.3 Design a simple experiment including appropriate controls.	**Student Edition:** *Discuss the Technology* 325 *Inquiry Extensions* 171, 267, 327, 749 *Launch Lab* 479 *Think Critically* 183 #34, 333 #26, 661 #26, 699 #37, 775 #38
3221.Inq.4 Perform and understand laboratory procedures directed at testing hypothesis.	**Student Edition:** *CHEMLAB* 134-135 *Mini Lab* 418
3221.Inq.5 Select appropriate tools and technology to collect precise and accurate quantitative and qualitative data.	**Student Edition:** *CHEMLAB* 54-55, 98-99, 170-171, 360-361, 506-507, 674-675, 720-721 *Mini Lab* 75, 418, 504, 708

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STANDARDS	PAGE REFERENCES
3221.Inq.6 Correctly read a thermometer, balance, metric ruler, graduated cylinder, pipette, and burette.	**Student Edition:** *CHEMLAB* 36-37, 54-55, 170-171, 234-235, 360-361, 422-423, 674-675, 720-721 *Measuring Capillarity* 874 *Mini Lab* 408, 418, 708
3221.Inq.7 Record observations and/or data using correct scientific units and significant figures.	**Student Edition:** *CHEMLAB* 36-37, 54-55, 360-361, 422-423, 674- 675, 720-721
3221.Inq.8 Export data into the appropriate form of data presentation (e.g., equation, table, graph, or diagram).	**Student Edition:** *CHEMLAB* 37, 99, 361, 675, 749 *Mini Lab* 218, 384, 770
3221.Inq.9 Translate data into the correct units and dimension using conversion factors and scientific notation**.**	**Student Edition:** *CHEMLAB* 37 *Comparing Orbital Sizes* 871 *Measuring Moles of Sugar* 873
3221.Inq.10 Analyze information in a table, graph or diagram (e.g., compute the mean of a series of values or determine the slope of a line).	**Student Edition:** *CHEMLAB* 19, 37, 99, 171, 267, 361, 423, 675, 721, 749 *Mini Lab* 770
3221.Inq.11 If accepted values are known, calculate the percent error for an experiment.	The following reference can be used to introduce this objective. **Student Edition:** *CHEMLAB* 55 (Apply and Assess)
3221.Inq.12 Determine the accuracy and precision of experimental results.	**Student Edition:** *CHEMLAB* 55, 721 *Mini Lab* 408
3221.Inq.13 Analyze experimental results and identify possible sources of bias or experimental error.	**Student Edition:** *CHEMLAB* 55, 205, 361, 423, 721 *Testing for Ammonia* 875
3221.Inq.14 Recognize, analyze, and evaluate alternative explanations for the same set of observations.	**Student Edition:** *CHEMLAB* 507
3221.Inq.15 Design a model based on the correct hypothesis that can be used for further investigation.	**Student Edition:** *CHEMLAB* 457 *Inquiry Extension* 361, 545, 721, 749

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STANDARDS	PAGE REFERENCES
State Performance Indicators	
SPI 3221 Inq.1 Select a description or scenario that reevaluates and/or extends a scientific finding.	**Student Edition:** 759-760 *Biology Connections* 766 *Chemistry and Technology* 106-107, 236-237, 388, 574, 750-751 *Everyday Chemistry* 351, 711 *Figure 21.15* 759 *Medical Uses of Radioisotopes* 763
SPI 3221 Inq.2 Analyze the components of a properly designed scientific investigation.	**Student Edition:** *CHEMLAB* 327, 457, 675 *Inquiry Extension* 37, 55, 457
SPI 3221 Inq.3 Determine appropriate tools to gather precise and accurate data.	**Student Edition:** *CHEMLAB* 54-55, 98-99, 170-171, 360-361, 506-507, 674-675, 720-721 *Mini Lab* 75, 418, 504, 708
SPI 3221 Inq.4 Evaluate the accuracy and precision of data.	**Student Edition:** *CHEMLAB* 55, 721 *Mini Lab* 408
SPI 3221 Inq.5 Defend a conclusion based on scientific evidence.	**Student Edition:** *CHEMLAB* 235, 267, 387 *Mini Lab* 96, 260, 443, 645, 758 *Modeling Fusion* 878
SPI 3221 Inq.6 Determine why a conclusion is free of bias.	The following reference can be used to introduce this topic through classroom discussion. **Student Edition:** *Figure 2.5* 57
SPI 3221 Inq.7 Compare conclusions that offer different, but acceptable explanations for the same set of experimental data.	**Student Edition:** *CHEMLAB* 18-19 *Mini Lab* 504

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STANDARDS	PAGE REFERENCES
Chemistry I: Embedded Technology and Engineering	
Conceptual Strand *Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.*	
Guiding Question *How do science concepts, engineering skills, and applications of technology improve the quality of life?*	
Course Level Expectations	
CLE 3221.T/E.1 Explore the impact of technology on social, political, and economic systems.	**Student Edition:** *Chemistry and Society* 29, 58, 144, 447, 495, 537 *Chemistry and Technology* 214-215, 388 *Everyday Chemistry* 351, 417, 505 *History Connections* 56, 305
CLE 3221.T/E.2 Differentiate among elements of the engineering design cycle: design constraints, model building, testing, evaluating, modifying, and retesting.	
CLE 3221.T/E.3 Explain the relationship between the properties of a material and the use of the material in the application of a technology.	**Student Edition:** *Chemistry and Technology* 106-107, 286-289, 470-471, 606-608 *Everyday Chemistry* 611 *Figure 3.17* 104-105 *How It Works* 282 *Semiconductors and Their Uses* 109-111
CLE 3221.T/E.4 Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.	**Student Edition:** 728 *Biology Connection* 201, 766 *Chemistry and Technology* 724-725 *Earth Science Connection* 723 *Everyday Chemistry* 711 *Physics Connection* 566
Checks for Understanding	
3221.1 Select appropriate tools to conduct a scientific inquiry.	**Student Edition:** *CHEMLAB* 54-55, 98-99, 170-171, 360-361, 506-507, 674-675, 720-721 *Mini Lab* 75, 418, 504, 708
3221.2 Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.	

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STANDARDS	PAGE REFERENCES
3221.3 Explore how the unintended consequences of new technologies can impact human and non-human communities.	**Student Edition:** 772-773 *Chemistry and Society* 58, 495, 657 *Chemistry and Technology* 424-425 *Figure 18.15* 641 *Problems Associated with Radioactivity* 768-770 *Writing in Chemistry* 550 #68
3221.4 Present research on current bioengineering technologies that advance health and contribute to improvements in our daily lives.	**Student Edition:** 767 *Biology Connection* 278, 766 *Chemistry and Society* 144, 537 *Figure 21.21* 764 *How It Works* 595 *Medical Uses of Radioisotopes* 763 *Writing in Chemistry* 550 #68
3221.5 Design a series of multi-view drawings that can be used by other students to construct an adaptive design and test its effectiveness.	
State Performance Indicators	
SPI 3221.T/E.1 Distinguish among tools and procedures best suited to conduct a specified scientific inquiry.	**Student Edition:** *CHEMLAB* 54-55, 98-99, 170-171, 360-361, 506-507, 674-675, 720-721 *Mini Lab* 75, 418, 504, 708
SPI 3221.T/E.2 Evaluate a protocol to determine the degree to which an engineering design process was successfully applied.	
SPI 3221.T/E.3 Evaluate the overall benefit to cost ratio of a new technology.	**Student Edition:** *Discuss the Technology* 485, 725 *Energy Economics* 719
SPI 3221.T/E.4 Use design principles to determine if a new technology will improve the quality of life for an intended audience.	

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STANDARDS	PAGE REFERENCES
Chemistry I: Embedded Mathematics	
Conceptual Strand *Science applies mathematics to investigate questions, solve problems, and communicate findings.*	
Guiding Question *What mathematical skills and understandings are needed to successfully investigate chemistry?*	
Course Level Expectations	
CLE 3221.Math.1 Understand the mathematical principles associated with the science of chemistry.	**Student Edition:** 347-348, 380-381, 408, 461, 541 *Calorimetry* 715 *CHEMLAB* 387 *Determining Chemical Formulas* 426-427 *Determining Mass Percent* 421 *Example Problem* 393, 755 *Figure 12.8* 413 *Ideal Gas Laws* 418-419 *Theoretical Yield and Actual Yield* 420 *The pH Scale* 501
CLE 3221.Math.2 Utilize appropriate mathematical equations and processes to solve chemistry problems.	**Student Edition:** 348 *CHEMLAB* 721 *Example Problems* 384-385, 391, 393, 409-410, 416, 419, 542, 716 *Mini Lab* 373 *Practice Problems* 385, 391, 410, 416, 419, 542, 716
Checks for Understanding	
3221.Math.1 Use a variety of appropriate notations (e.g., exponential, functional, square root).	**Student Edition:** *Example Problem* 542 *Practice Problems* 502, 542 *Supplemental Practice* 832 #25-26, 833 #27-#33
3221.Math.2 Select and apply appropriate methods for computing with real numbers and evaluate the reasonableness of the results.	**Student Edition:** 348 *CHEMLAB* 721 *Example Problems* 384-385, 393, 409-410, 414, 416, 419, 462-463, 716, 755 *Practice Problems* 385, 415, 462-463

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STANDARDS	PAGE REFERENCES
3221.Math.3 Apply algebraic properties, formulas, and relationships to perform operations on real-world problems (e.g., solve for density, determine the concentration of a solution in a variety of units: ppm, ppb, molarity, molality, and percent composition) calculate heats of reactions and phase changes, and manipulate gas law equations.	**Student Edition:** *CHEMLAB* 36-37, 423, 748-749 *Example Problems* 384-385, 391, 393, 414, 416, 462-463, 542, 716, 755 *Figure 1.23* 35 *Practice Problems* 385, 391, 415, 462-463, 542, 716
3221.Math.4 Interpret rates of change from graphical and numerical data (e.g., phase diagrams, solubility graphs, colligative properties, nuclear decay or half-life).	**Student Edition:** *Chemical Handbook* 802-804 *CHEMLAB* 748-749 *Figure 10.23* 362 *Figure 10.24* 363 *Figure 11.8* 381 *Figure 11.13* 390 *Figure 13.6* 440 *Figure 13.21* 459 *Figure 20.4* 709 *Figure 21.8* 752
3221.Math.5 Analyze graphs to describe the behavior of functions (e.g., concentration of a solution, phase diagrams, solubility graphs, colligative properties, nuclear decay half-life).	**Student Edition:** *Chemistry Handbook* 802-804 *CHEMLAB* 748-749 *Figure 10.23* 362 *Figure 10.24* 363 *Figure 11.8* 381 *Figure 11.13* 390 *Figure 13.21* 459 *Figure 20.5* 710 *Figure 21.8* 752 *Launch Lab* 255 *Mini Lab* 260 *Supplemental Practice* 827 #3, 828 #13, 842 #4
3221.Math.6 Model real-world phenomena using functions and graphs.	**Student Edition:** *CHEMLAB* 748-749 *Figure 10.16* 350 *Figure 10.23* 362 *Figure 10.24* 363 *Figure 11.8* 381 *Figure 11.13* 390 *Figure 13.21* 459 *Figure 21.25* 768 *Launch Lab* 255

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STANDARDS	PAGE REFERENCES
3221.Math.7 Apply and interpret algebraic properties in symbolic manipulation (e.g., density, concentration of a solution, chemical equations, effect of volume, temperature or pressure on behavior of a gas, percent composition of elements in a compound, molar mass, number of moles, and molar volume, amount of products or reactants given mole, molarity, volume at STP or mass amounts, heat loss or gain using mass, temperature change and specific heat, and half-life of an isotope)	**Student Edition:** 461 *CHEMLAB* 748-749 *Example Problem* 747 *Figure 11.7* 380 *Figure 11.12* 389 *Figure 12.8* 413 *Figure 20.6* 710 *Ideal Gas Law* 418-419 *Practice Problems* 747 *Radioactive Decay* 743 *Theoretical Yield and Actual Yield* 420
3221.Math.8 Apply and communicate measurement units, concepts and relationships in algebraic problem-solving situations.	**Student Edition:** 348 *CHEMLAB* 423 *Example Problems* 393, 414, 416, 419, 462-463, 542 *Practice Problems* 415-416, 419, 462-463, 542
3221.Math.9 Select appropriate units, scales, and measurement tools for problem situations involving proportional reasoning and dimensional analysis.	**Student Edition:** *Example Problems* 384-385, 393, 414, 416, 462-463, 542, 755, 799 *Practice Problems* 385, 415-416, 462-463, 542, 755, 799
3221.Math.10 Select, construct, and analyze appropriate graphical representations for a data set.	**Student Edition:** *CHEMLAB* 360-361, 674-675, 748-749 *Launch Lab* 255
3221.Math.11 Identify and solve different types of stoichiometry problems (e.g., volume at STP to mass, moles to mass, molarity).	**Student Edition:** *Example Problem* 377, 379, 414, 416, 542 *Practice Problems* 379, 415-416, 542 *Supplemental Practice* 832-833 #25-#30, #35 *Understand Concepts* 548 #37-38
3221.Math.12 Calculate the amount of product expected in a lab experience and determine percent yield.	**Student Edition:** *Problem Solving* 432 #61 *Section 12.2* 428 #20 *Supplemental Practice* 827 #40
3221.Math.13 Convert among the quantities of a substance: mass, number of moles, number of particles, molar volume at STP.	**Student Edition:** *Example Problem* 414, 416 *Practice Problems* 415-416 *Skill Review* 432 #59 *Understand Concepts* 430 #35

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STANDARDS	PAGE REFERENCES
State Performance Indicators	
SPI 3221.Math.1 Use real numbers to represent real-world applications (e.g., slope, rate of change, probability, and proportionality).	**Student Edition:** 381 *Chemistry Handbook* 802-803 *CHEMLAB* 387 *Figure 11.8* 381 *Figure 11.13* 390 *Launch Lab* 255
SPI 3221.Math.2 Perform operations on algebraic expressions and informally justify the procedures chosen.	**Student Edition:** *CHEMLAB* 387 *Example Problem* 384-385, 391, 393, 419 *Figure 12.8 413* *Ideal Gas Law* 418-419 *Inquiry Extension* 387 *Theoretical Yield and Actual Yield* 420 *Determining Mass Percents* 421
SPI 3221.Math.3 Interpret graphs that depict real-world phenomena.	**Student Edition:** *Chemistry Handbook* 802-804 *CHEMLAB* 748-749 *Figure 10.23* 362 *Figure 10.24* 363 *Figure 11.8* 381 *Figure 11.13* 390 *Figure 13.21* 459 *Figure 20.5* 710 *Figure 21.8* 752 *Launch Lab* 255 *Mini Lab* 260 *Supplemental Practice* 827 #3, 828 #13, 842 #4
SPI 3221.Math.4 Apply measurement unit relationships including Avogadro's number, molarity, molality, volume, and mass to balance chemical equations.	**Student Edition:** *Chemistry Online* 415 *CHEMLAB* 422-423 *Example Problem* 414 *Figure 12.8* 413 *Practice Problems* 415 *Section 12.2 Assessment* 428 #18 *Supplemental Practice* 826 #27
SPI 3221.Math.5 Use concepts of mass, length, area, and volume to estimate and solve real-world problems.	**Student Edition:** *CHEMLAB* 386-387 *Comparing Orbital Sizes* 871 *Launch Lab* 403

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STANDARDS	PAGE REFERENCES
Chemistry I: Standard 1 – Atomic Structure	
Conceptual Strand 1 *Atomic theory is the foundation for understanding the interactions and changes in matter.*	
Guiding Question 1 *How does the structure of matter determine its chemical and physical properties?*	
Course Level Expectations	
CLE 3221.1.1 Compare and contrast historical models of the atom.	**Student Edition:** *Apply Concepts* 251 #26 *Cumulative Review* 252 #36 *Early Ideas About Matter* 50-51 *Expanding the Model of the Atom* 228-229 *Figure 7.1* 228 *The Discovery of Atomic Structure* 59-63
CLE 3221.1.2 Analyze the organization of the modern periodic table.	**Student Edition:** *Figure 8.2 & 8.3* 257 *Figure 8.6* 259 *Launch Lab* 255 *Mini Lab* 260 *Patterns of Behavior of Main Group Elements* 256-261 *Section 8.1 Assessment* 279 #1-2 *Understand Concepts* 295 #16
CLE 3221.1.3 Describe the atom in terms of its composition and electron characteristics.	**Student Edition:** 59, 229, 233 *Atomic Numbers* 64 *Electron Distribution in Energy Level* 238-240 *Figure 7.2 & 7.3* 229 *Figure 7.5* 231
Checks for Understanding	
3221.1.1 Identify the contributions of the major atomic theorists: Neils Bohr, James Chadwick, John Dalton, Max Planck, Ernest Rutherford, and J.J. Thomson.	**Student Edition:** *Expanding the Model of the Atom* 228-229 *Figure 7.1* 228 *Physics Connections* 230 *The Discovery of Atomic Structure* 59-63

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STANDARDS	PAGE REFERENCES
3221.1.2 Compare the Bohr model and the quantum mechanical electron-cloud models of the atom.	**Student Edition:** *Electron Distribution in Energy Levels* 238-240 *Expanding the Model of the Atom* 228-229, 231 *Figure 7.1* 228 *Figure 7.8 & 7.9* 239 *Figure 7.10* 240 *Figure 7.15* 249
3221.1.3 Draw Bohr models of the first 18 elements.	**Student Edition:** Using Reference Table 846-847 and the diagram of Bohr's Model (Figure 7.1 page 228), this could be introduced in the classroom.
3221.1.4 Interpret a Bohr model of an electron moving between its ground and excited states in terms of the absorption or emission of energy.	**Student Edition:** *Expanding the Model of the Atom* 228 *Physics Connection* 230
3221.1.5 Use the periodic table to identify an element as a metal, nonmetal, or metalloid.	**Student Edition:** 101-103 *The Main Group Metals and Non Metals* 261, 264, 268-269, 271, 274, 276, 279
3221.1.6 Apply the periodic table to determine the number of protons and electrons in a neutral atom.	**Student Edition:** *Atomic Numbers* 64 *Figure 3.10* 96 *Periods and Groups* 94, 96-97 *Relationship of the Periodic Table to the Atomic Structure* 93
3221.1.7 Determine the number of protons and neutrons for a particular isotope of an element.	**Student Edition:** 60 *Atomic Numbers* 64 *Figure 2.7* 60 *Figure 2.11* 64 *Figure 2.13* 66 *Mini Lab* 61
3221.1.8 Explain the formation of anions and cations, and predict the charge of an ion usually formed by the main-group elements.	**Student Edition:** 259-261 *Figure 5.4* 155 *Figure 8.5* 258 *Figure 8.6* 259 *Figure 8.7* 261 *Table 5.1* 155

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STANDARDS	PAGE REFERENCES
3221.1.9 Sequence selected atoms from the main-group elements based on their atomic or ionic radii.	**Student Edition:** *CHEMLAB* 266-267 *Figure 8.2 & 8.3* 257 *Figure 8.6* 259 *Mini Lab* 260 *Section 8.1 Assessment* 279 #1 *Supplemental Practice* 818 #1-#2
3221.1.10 Sequence selected atoms from the main-group elements based on first ionization energy, electron affinity or electronegativity.	**Student Edition:** 302-303 *Concepts in Motion* 302 *Figure 9.2* 302 *Figure 9.5* 304 *Ionic Character* 303-304 *Section 9.1 Assessment* 312 #4 *Supplemental Practice* 819 #2
3221.1.11 Determine an atom's Lewis electron-dot structure or number of valence electrons from an element's atomic number or position in the periodic table.	**Student Edition:** 76-77 *Figure 2.24* 77 *Section 2.2 Assessment* 77 #8 *Supplemental Practice* 809 #10 *Understand Concepts* 79 #20
3221.1.12 Represent an atom's electron arrangement in terms of orbital notation, electron configuration notation, and electron-dot notation.	**Student Edition:** 323 *Apply Concepts* 251 #29 *Building Electron Configurations* 242-245 *Concepts in Motion* 243 *Figure 7.12* 242 *Figure 7.13* 245 *Section 7.2 Assessment* 249 #6-7, #11 *Table 7.2* 243 *Table 7.3* 244
3221.1.13 Compare s and p orbitals in terms of their shape, and order the s, p, d and f orbitals in terms of energy and number of possible electrons.	**Student Edition:** *Electron Distribution in Energy Levels* 238-240 *Figure 7.9* 239 *Figure 7.10* 240 *Section 7.1 Assessment* 240 #1-3 *Table 7.1* 238

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STANDARDS	PAGE REFERENCES
State Performance Indicators	
SPI 3221.1.1 Compare and contrast the major models of the atom (e.g., Democritus, Thomson, Rutherford, Bohr, and the quantum mechanical model).	**Student Edition:** *Electron Distribution in Energy Levels* 238-240 *Expanding the Model of the Atom* 228-229 *Figure 7.1* 228 *Figure 7.8 & 7.9* 239 *Figure 7.10* 240 *Figure 7.15* 249 *Physics Connections* 230 *The Discovery of Atomic Structure* 59-63
SPI 3221.1.2 Interpret the periodic table to describe an element's atomic makeup.	**Student Edition:** *Atomic Numbers* 64 *Figure 3.10* 96 *Periods and Groups* 94, 96-97 *Relationship of the Periodic Table to the Atomic Structure* 93 *The Main Group Metals and Non Metals* 261, 264, 268-269, 271, 274, 276, 279
SPI 3221.1.3 Describe the trends found in the periodic table with respect to atomic size, ionization energy, electron affinity or electronegativity.	**Student Edition:** 302-303 *CHEMLAB* 266-267 *Concepts in Motion* 302 *Figure 8.2 & 8.3* 257 *Figure 8.6* 259 *Figure 9.2* 302 *Figure 9.4* 303 *Ionic Character* 303 *Mini Lab* 260 *Section 8.1 Assessment* 279 #1 *Section 9.1 Assessment* 312 #4
SPI 3221.1.4 Determine the Lewis electron-dot structure or number of valence electrons for an atom of any main-group element, given its atomic number or its position in the periodic table.	**Student Edition:** 76-77 *Figure 2.24* 77 *Section 2.2 Assessment* 77 #8 *Supplemental Practice* 809 #10 *Understand Concepts* 79 #20

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STANDARDS	PAGE REFERENCES
SPI 3221.1.5 Represent an electron's location in the quantum mechanical model of an atom in terms of the shape of electron clouds (s and p orbitals in particular), relative energies of orbitals, and the number of electrons possible in the s, p, d and f orbitals.	**Student Edition:** 323 *Apply Concepts* 251 #29 *Building Electron Configurations* 242-245 *Concepts in Motion* 243 *Electron Distribution in Energy Levels* 238-240 *Figure 7.9* 239 *Figure 7.10* 240 *Figure 7.12* 242 *Figure 7.13* 245 *Section 7.1 Assessment* 240 #1-#3 *Section 7.2 Assessment* 249 #6-#7, #11 *Table 7.1* 238 *Table 7.2* 243 *Table 7.3* 244
Chemistry I: Standard 2 – Matter and Energy	
Conceptual Strand 2 *The properties of matter determine how it interacts with energy.*	
Guiding Question 2 *What is the relationship between matter and energy?*	
Course Level Expectations	
CLE 3221.2.1 Investigate the characteristic properties of matter.	**Student Edition:** *A Picture of Matter* 4-7 *Chemical Properties and Changes* 38 *Chemistry and Technology* 106-107 *Figure 1.2* 5 *Figure 1.24* 39 *Figure 3.17* 104-105 *Launch Lab* 3 *Physical Properties* 32-34 *Semiconductors and Their Uses* 109-111 *Writing in Chemistry* 366 #39
CLE 3221.2.2 Explore the interactions between matter and energy.	**Student Edition:** 193-194, 196-197 *Example Problem* 198 *Mini Lab* 194 *Section 11.2 Assessment* 396 #28 *Temperature and Kinetic Energy* 346-347 *The Kinetic Theory of Matter* 339-341

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STANDARDS	PAGE REFERENCES
CLE 3221.2.3 Apply the kinetic molecular theory to describe solids, liquids, and gases.	**Student Edition:** *Figure 10.6* 342 *Figure 10.7* 343 *Section 10.1 Assessment* 345 #1-#2 *States of Matter* 338-339 *The Kinetic Theory of Matter* 339-343
CLE 3221.2.4 Investigate characteristics associated with the gaseous state.	**Student Edition:** 33, 339-341 *Defining Gas Pressure* 370-373 *Figure 10.14* 349 *Launch Lab* 369 *Mass and Speed of Particles* 348-349 *Mini Lab* 373
CLE 3221.2.5 Discuss phase diagrams of one-component systems.	**Student Edition:** *Figure 10.23* 362 *Figure 10.24* 363 *Heat of Fusion* 362-363 *Skill Review* 366 #37
Checks for Understanding	
3221.2.1 Identify a material as an element, compound or mixture; identify a mixture as homogeneous or heterogeneous; and/or identify a mixture as a solution, colloid or suspension.	**Student Edition:** 15-16, 20-23, 28, 472 *Chemistry and Technology* 470-471 *CHEMLAB* 18-19, 456-457 *Figure 1.12* 16 *Figure 1.15* 24 *Launch Lab* 151 *Section 1.1 Assessment* 31 #2, #5 *Substances: Pure Matter* 24-25 *Table 1.3* 30
3221.2.2 Identify the solute and solvent composition of a solid, liquid or gaseous solution.	**Student Edition:** 23, 454 *Water: The Universal Solvent* 450
3221.2.3 Express the concentration of a solution in units of ppm, ppb, molarity, molality, and percent composition.	**Student Edition:** 458, 460-461 *Chemistry Online* 463 *Example Problem* 463 *Practice Problems* 463 *Section 13.2 Assessment* 473 #17 *Supplemental Practice* 829 #19-20

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STANDARDS	PAGE REFERENCES
3221.2.4 Describe how to prepare solutions of given concentrations expressed in units of ppm, ppb, molarity, molality, and percent composition.	**Student Edition:** 461 *Example Problem* 462 *Supplemental Practice* 829 #15-18
3221.2.5 Investigate factors that affect the rate of solution.	**Student Edition:** *Solution Concentration* 458-461 *Solutions of Gases in Water* 469 *Supplemental Practice* 829 #27
3221.2.6 Describe how to prepare a specific dilution from a solution of known molarity.	The following references can be used to introduce molarity and dilution through classroom discussion. **Student Edition:** 460-461
3221.2.7 Determine the colligative properties of a solution based on the molality and freezing point or boiling points of the solvent.	**Student Edition:** *Figure 13.25* 464 *Properties and Applications of Solutions* 464-465
3221.2.8 Use a solubility graph, composition of a solution and temperature to determine if a solution is saturated, unsaturated or supersaturated.	Solution concentration is discussed in the following references. **Student Edition:** 458-459
3221.2.9 Classify properties and changes in matter as physical, chemical, or nuclear.	**Student Edition:** *Chemical Properties and Changes* 38, 40-41 *Figure 1.24* 39 *Physical Properties* 32-34 *Radioactive Decay* 743, 745-746 *Section 1.2 Assessment* 42 #6 *Skill Review* 46 #55 *Understand Concepts* 44 #27
3221.10 Use calorimetry to: identify unknown substances through specific heat, determine the heat changes in physical and chemical changes, determine the mass of an object, and determine the change in temperature of a material.	**Student Edition:** *CHEMLAB* 720-721

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STANDARDS	PAGE REFERENCES
3221.2.11 Perform calculations on heat of solvation, heat of reaction, and heat of formation, and heat of phase change.	**Student Edition:** 708 *Calorimetry* 715 *CHEMLAB* 720-721 *Example Problem* 716 *Figure 20.4* 709 *Figure 20.5* 710 *Practice Problems* 716 *Supplemental Practice* 841 #4-#5
3221.2.12 Use particle spacing diagrams to identify solids, liquids, or gases.	**Student Edition:** *Figure 10.6* 342 *Figure 10.7 & Figure 10.8* 343 *Figure 10.13* 349
3221.2.13 Distinguish among the solid, liquid, and gaseous states of a substance in terms of the relative kinetic energy of its particles.	**Student Edition:** *CHEMLAB* 360-361 *Figure 11.14* 390 *Section 10.1 Assessment* 345 #1-#2 *The Kinetic Theory of Matter* 339-343
3221.2.14 Use a phase diagram to correlate changes in temperature and energy with phases of matter.	**Student Edition:** *CHEMLAB* 360-361 *Heat of Fusion* 362-363 *Figure 10.23* 362 *Figure 10.24* 363 *Section 10.1 Assessment* 345 #4
3221.2.15 Graph and interpret the results of experiments that explore relationships among pressure, temperature, and volume of gases.	**Student Edition:** *CHEMLAB* 386-387 *Inquiry Extension* 387 *Think Critically* 399 #58
3221.2.16 Solve gas law problems.	**Student Edition:** *Apply Concepts* 398-399 #40-#51 *Example Problems* 384, 385, 391, 393 *Practice Problems* 385, 391, 394 *Problem Solving* 400 #70-#72 *Supplemental Practice* 822-823 #9-#18, #21-#27

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STANDARDS	PAGE REFERENCES
State Performance Indicators	
SPI 3221.2.1 Distinguish among elements, compounds, solutions, colloids, and suspensions.	**Student Edition:** 23-25, 28, 472 *Binary Ionic Compounds* 152-153 *Chemistry and Technology* 470-471 *CHEMLAB* 18-19, 456-457 *Figure 1.15* 24 *Launch Lab* 151 *Section 1.1 Assessment* 31 #5 *Table 1.3* 30
SPI 3221.2.2 Identify properties of a solution: solute and solvent in a solid, liquid or gaseous solution; procedure to make or determine the concentration of a solution in units of ppm, ppb, molarity, molality, percent composition, factors that affect the rate of solution, and colligative properties.	**Student Edition:** 23, 454, 458, 460-461 *Chemistry Online* 463 *Example Problem* 462-463 *Practice Problems* 463 *Section 13.2 Assessment* 473 #17 *Solution Concentration* 458-461 *Solutions of Gases in Water* 469 *Supplemental Practice* 829 #15-20, #27 *Water: The Universal Solvent* 450
SPI 3221.2.3 Classify a solution as saturated, unsaturated or supersaturated, based on its composition and temperature and a solubility graph.	The following references discuss solution concentration. **Student Edition:** 458-459
SPI 3221.2.4 Classify a property of change in matter as physical, chemical, or nuclear.	**Student Edition:** *Chemical Properties and Changes* 38, 40-41 *Figure 1.24* 39 *Physical Properties* 32-34 *Radioactive Decay* 743, 745-746 *Section 1.2 Assessment* 42 #6 *Skill Review* 46 #55 *Understand Concepts* 44 #27

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SPI 3221.2.5 Compare and contrast heat and temperature changes in chemical and physical processes.	**Student Edition:** 193-194, 362-363 *Changes of State* 350, 354-356 *CHEMLAB* 360-361 *Heat and Chemical Reactions* 707-710 *Figure 10.23* 362 *Figure 10.24* 363 *Figure 20.4* 709 *Figure 20.5 & Figure 20.6* 710 *Section 10.2 Assessment* 363 #1
SPI 3221.2.6 Investigate similarities and differences among solids, liquids and gases in terms of energy and particle spacing.	**Student Edition:** *CHEMLAB* 360-361 *Figure 10.6* 342 *Figure 10.7 & Figure 10.8* 343 *Figure 10.13* 349 *Figure 11.14* 390 *Section 10.1 Assessment* 345 #1-#2 *The Kinetic Theory of Matter* 339-343
SPI 3221.2.7 Predict how changes in volume, temperature, and pressure affect the behavior of a gas.	**Student Edition:** *Boyle's Law: Pressure and Volume* 380-381 *Charles's Law: Temperature and Volume* 389-390 *CHEMLAB* 386-387 *Figure 11.3* 372 *Inquiry Extension* 387 *Launch Lab* 369 *Mini Lab* 384 *Think Critically* 399 #58

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STANDARDS	PAGE REFERENCES
Chemistry I: Standard 3 – Interactions of Matter	
Conceptual Strand 3 *Interactions between matter generate substances with new physical and chemical properties*.	
Guiding Question 3 *What types of interactions between matter generate new substances?*	
Course Level Expectations	
CLE 3221.3.1 Investigate chemical bonding.	**Student Edition:** 670 *A Model of Bonding* 300-301 *Bonding in Metals* 311-312 *Covalent Character* 306-307 *Electronegativity: An Attraction for Electrons* 301-303 *Figure 9.1* 301 *Ionic Character* 303-304 *Polar Covalent Bonds* 307-309
CLE 3221.3.2 Analyze chemical and nuclear reactions.	**Student Edition:** *Chemical Reactions* 188 *Concepts in Motion* 742 *Figure 1.25* 40 *Mini Lab* 194 *Nuclear Fission* 757 *Nuclear Fusion* 760-761 *Nuclear Notation* 742 *Supplemental Practice* 843 #7 *Table 21.1* 742
CLE 3221.3.3 Explore the mathematics of chemical formulas and equations.	**Student Edition:** *Balanced Chemical Equations* 196-197 *Determining Chemical Formulas* 426-428 *Example Problems* 156, 159, 198-199 *Practice Problems* 156, 160, 199 *Section 12.2 Assessment* 428 #22
CLE 3221.3.4 Explain the law of conservation of mass/energy.	**Student Edition:** 40, 51, 196-197, 707 *CHEMLAB* 54-55 *Figure 1.25* 40 *Figure 2.2* 51 *Figure 2.4* 53 *Inquiry Extension* 55

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Checks for Understanding	
3221. 3.1 Determine the type of chemical bond that occurs in a chemical compound.	**Student Edition:** 131-132, 136-139, 141, 143, 145 *Bonding in Metals* 311-312 *CHEMLAB* 134-135 *Figure 4.17* 131 *Figure 4.20* 137 *Figure 4.22* 139 *Figure 9.11* 311 *Section 4.2 Assessment* 145 #6
3221.3.2 Differentiate between ionic and covalent bond models.	**Student Edition:** *A Model of Bonding* 300-301 *Covalent Character* 306-307 *Figure 9.1* 301 *Figure 9.7* 307 *Ionic Character* 303-304 *Polar Covalent Bonds* 307-309 *Practice Problems* 310 *Section 9.1 Assessment* 312 #3 *Table 9.1* 300 *Understand Concepts* 183 #20, #23
3221.3.3 Identify the chemical formulas of common chemical compounds.	**Student Edition:** 155, 179, 427-428 *Example Problem* 156, 159 *Practice Problems* 156, 160, 163, 179 *Section 5.1 Assessment* 167 #8, #12 *Section 5.2 Assessment* 181 #18 *Supplemental Practice* 811 #6, 812 #7, 813 #11-#12, #14, #16, #19
3221.3.4 Employ a table of polyvalent cations and polyatomic ions to name and describe the chemical formula of ionic compounds.	**Student Edition:** *Chemistry Online* 157 *Example Problem* 156, 159 *Practice Problems* 156, 160, 163 *Section 5.1 Assessment* 167 #8 *Supplemental Practice* 813 #11-12, #14, #19

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3221.3.5 Convert percent composition information into the empirical or molecular formula of a compound.	**Student Edition:** *Apply Concepts* 431 #48 *Determining Chemical Formulas* 426-427 *Section 12.2 Assessment* 428 #22 *Understand Concepts* 430 #41
3221.3.6 Apply information about the molar mass, number of moles, and molar volume to the number of particles of the substance.	**Student Edition:** 408 *Chemistry Online* 415 *Concepts in Motion* 407 *Example Problem* 409-410, 414, 416 *Figure 12.6* 407 *Figure 12.8* 413 *Practice Problems* 410, 415-416 *Think Critically* 431 #53 *Understand Concepts* 430 #35
3221.3.7 Balance an equation for a chemical reaction.	**Student Edition:** *Balanced Chemical Equation* 196-197 *CHEMLAB* 205 *Example Problem* 198-199 *Mini Lab* 203 *Practice Problems* 199 *Section 6.1 Assessment* 199 #6, #9 *Supplemental Practice* 815 #4-5, #11-#13 *Understand Concepts* 223 #24
3221.3.8 Classify a chemical reaction as composition, decomposition, single replacement, double replacement, and combustion.	**Student Edition:** *Apply Concepts* 223 #25 *Major Classes of Reactions* 202-203, 206 *Problem Solving* 224 #42 *Section 6.2 Assessment* 207 #12 *Supplemental Practice* 815 #8-9, #11-#13 *Table 6.1* 207
3221.3.9 Use activity series or solubility product table information to predict the products of a chemical reaction.	**Student Edition:** *CHEMLAB* 456-457

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3221.3.10 Predict the products of a neutralization reaction involving inorganic acids and bases.	**Student Edition:** *Apply Concepts* 549 #47 *Example Problem* 521, 524, 529 *Practice Problems* 521, 524, 529 *Section 15.1 Assessment* 530 #11, #14 *Supplemental Practice* 831 #1-6, 832 #17 *Types of Acid-Base Reactions* 516-517 *Understand Concepts* 548 #26
3221.3.11 Interpret a chemical equation to determine molar ratios.	**Student Edition:** *Example Problem* 414, 416 *Practice Problems* 415, 416 *Section 12.2 Assessment* 428 #1 *Supplemental Practice* 824 #35
3221.3.12 Convert between the following quantities of a substance: mass, number of moles, number of particles, and molar volume at STP.	**Student Edition:** *Example Problem* 410, 414, 416 *Figure 12.8* 413 *Practice Problems* 410, 415-416 *Skill Review* 432 #59 *Supplemental Practice* 824-825 #1-#10
3221.3.13 Solve different types of stoichiometry problems (e.g., volume at STP to mass, moles to mass, molarity,).	**Student Edition:** *Example Problem* 377, 379, 414, 416, 542 *Practice Problems* 379, 415-416, 542 *Supplemental Practice* 832-833 #25-#30, #35 *Understand Concepts* 548 #37-38
3221.3.14 Determine the amount of expected product in a lab activity and calculate percent yield.	**Student Edition:** *Problem Solving* 432 #61 *Section 12.2* 428 #20 *Supplemental Practice* 827 #40
3221.3.15 Calculate the amount of heat lost or gained by a substance based on its mass, change in temperature, and specific heat during physical and chemical processes.	**Student Edition:** 708 *Calorimetry* 715 *CHEMLAB* 720-721 *Example Problem* 716 *Figure 20.4* 709 *Figure 20.5* 710 *Practice Problems* 716 *Supplemental Practice* 841 #4-#5

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3221.3.16 Research applications of thermal changes in nuclear reactions.	**Student Edition:** *Figure 21.15* 759 *Figure 21.30* 773 *Section 21.2 Assessment* 762 #13 *Writing in Chemistry* 776 #44
3221.3.17 Identify a substance as an acid or base according to its formula.	**Student Edition:** *A Broader Definition of Acids and Bases* 526-527 *Other Acids and Bases: Anhydrides* 493-494 *Section 15.1 Assessment* 530 #13 *Submicroscopic Behavior of Acids* 483-484, 486 *Submicroscopic Behavior of Bases* 489 *Supplemental Practice* 830 #5-#6
3221.3.18 Investigate the acidity/basicity of substances with various indicators.	**Student Edition:** *CHEMLAB* 506-507 *Figure 14.2* 504 *Inquiry Extension* 507 *Mini Lab* 504, 518 *Section 14.2 Assessment* 508 #12 *Skill Review* 512 #53 *Testing for Acid Rain* 874
3221.3.19 Write the nuclear equation involving alpha or beta particles based on the mass number of the parent isotope and complete symbols for alpha or beta emissions.	**Student Edition:** *Example Problem* 747 *Figure 21.5* 743 *Practice Problems* 747 *Problem Solving* 776 #50 *Radioactive Decay* 743, 745 *Supplemental Practice* 842 #1
3221.3.20 Determine the half-life of an isotope by examining a graph or with an appropriate equation.	**Student Edition:** *CHEMLAB* 748-749
3221.3.21 Write a balanced nuclear equation to compare nuclear fusion and fission.	**Student Edition:** 757, 761 *Section 21.2 Assessment* 762 #1
3221.3.22 Describe the benefits and hazards of nuclear energy.	**Student Edition:** 759-760, 772-773 *Figure 21.17* 760 *Section 21.2 Assessment* 762 #13 *Supplemental Practice* 843 #9

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State Performance Indicators	
SPI 3221.3.1 Analyze ionic and covalent compounds in terms of how they form, names, chemical formulas, percent composition, and molar masses.	**Student Edition:** *A Model of Bonding* 300-301 *Chemistry Online* 157 *Concepts in Motion* 407 *Covalent Character* 306-307 *Determining Chemical Formulas* 426-428 *Example Problem* 156, 159, 409-410, 414, 416 *Figure 9.1* 301 *Figure 9.7* 307 *Figure 12.8* 413 *Ionic Character* 303-304 *Polar Covalent Bonds* 307-309 *Supplemental Practice* 811 #6, 812 #7, 813 #11-#12, #14, #16, #19 *Table 9.1* 300 *Think Critically* 431 #53
SPI 3221.3.2 Identify the reactants, products, and types of different types of chemical reactions (composition, decomposition, double replacement, single replacement, combustion).	**Student Edition:** *Apply Concepts* 223 #25 *Major Classes of Reactions* 202-203, 206 *Problem Solving* 224 #42 *Section 6.2 Assessment* 207 #12 *Supplemental Practice* 815 #8-9, #11-#13 *Table 6.1* 207
SPI 3221.3.3 Predict the products of a chemical reaction.	**Student Edition:** *Example Problem* 524 *Launch Lab* 553 *Practice Problems* 524 *Supplemental Practice* 832 #17
SPI 3221.3.4 Balance a chemical equation to determine molar ratios.	**Student Edition:** *Section 12.2 Assessment* 428 #1
SPI 3221.3.5 Convert among the following quantities of a substance: mass, number of moles, number of particles, molar volume at STP.	**Student Edition:** *Example Problem* 414, 416 *Practice Problems* 415-416 *Skill Review* 432 #59 *Understand Concepts* 430 #35

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SPI 3221.3.6 Identify and solve stoichiometry problems: volume at STP to mass, moles to mass, and molarity.	**Student Edition:** *Example Problem* 377, 379, 414, 416, 542 *Practice Problems* 379, 415-416, 542 *Supplemental Practice* 832-833 #25-#30, #35 *Understand Concepts* 548 #37-38
SPI 3221.3.7 Classify substances as acids or bases based on their formulas and how they react with various indicators.	**Student Edition:** *A Broader Definition of Acids and Bases* 526-527 *CHEMLAB* 506-507 *Figure 14.2* 504 *Inquiry Extension* 507 *Mini Lab* 504, 518 *Section 14.2 Assessment* 508 #12 *Skill Review* 512 #53 *Other Acids and Bases: Anhydrides* 493-494 *Section 15.1 Assessment* 530 #13 *Submicroscopic Behavior of Acids* 483-484, 486 *Submicroscopic Behavior of Bases* 489 *Supplemental Practice* 830 #4-#6 *Testing for Acid Rain* 874
SPI 3221.3.8 Describe radioactive decay through a balanced nuclear equation and through an analysis of the half-life concept.	**Student Edition:** 757, 761 *CHEMLAB* 748-749 *Example Problem* 747 *Figure 21.5* 743 *Figure 21.8* 752 *Practice Problems* 747 *Radioactive Decay* 743, 745 *Supplemental Practice* 842 #1, #4
SPI 3221.3.9 Compare and contrast nuclear fission and fusion.	**Student Edition:** *Figure 21.13* 757 *Figure 21.14* 758 *Figure 21.18* 761 *Nuclear Fission* 757-759 *Nuclear Fusion* 760-761 *Section 21.2 Assessment* 762 #10

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SPI 3221.3.10 Relate the law of conservation of mass/energy to thermal changes that occur during physical, chemical or nuclear processes.	**Student Edition:** 193, 196-197, 707-710, 757 *Example Problem* 198 *Figure 6.5* 193 *Figure 20.3* 707 *Figure 21.18* 761 *Section 20.2 Assessment* 728 #11

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