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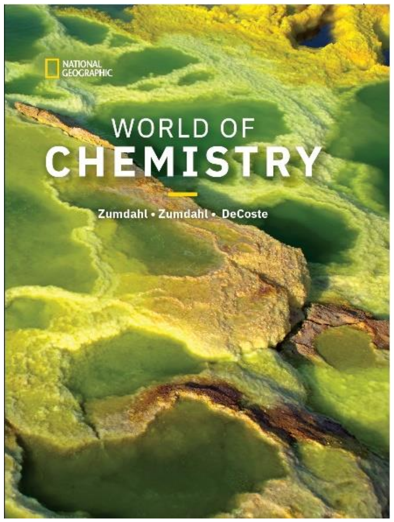

Correlation of

World of Chemistry, 4/E,
by Steven S. Zumdahl/ Susan A. Zumdahl, © 2021,
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to

Indiana Academic Science Standards
Chemistry

Correlation to the Indiana Academic Science Standards, Chemistry
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Standards	Where Addressed
High School	
Chemistry	
HS-PS1 Matter and Its Interactions	
HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.	124-133
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	
▪ Use a model to predict the relationships between systems or between components of a system.	4-9, 13, 18-20, 393-397, 428-434, 465, 667, 703-722
Disciplinary Core Ideas	
PS1.A: Structure and Properties of Matter	
▪ Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.	116-141
▪ The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.	124-144
Crosscutting Concepts	
CC.1: Patterns	
▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	10-12, 18-19, 296, 324, 426

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Standards	Where Addressed
HS-PS1-2 Matter and its Interactions	
HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.	10-17, 100-101, 149, 183, 228, 253,336, 423
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, and peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	116-123, 690, 706
Disciplinary Core Ideas	
PS1.A: Structure and Properties of Matter	
▪ The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.	124-144
PS1.B: Chemical Reactions	
▪ The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	254-286
Crosscutting Concepts	
CC.1: Patterns	
▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	10-12, 18-19, 296, 324, 426

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Standards	Where Addressed
HS-PS1-3 Matter and its Interactions	
HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.	10-17, 100-101, 149, 183, 228, 253,293, 336, 423
Science and Engineering Practices	
SEP.3: Planning and Carrying Out Investigations Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.	
▪ Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	10-15, 58, 100, 116, 149, 183, 228, 293
Disciplinary Core Ideas	
PS1.A: Structure and Properties of Matter	
▪ The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.	424-434
Crosscutting Concepts	
CC.1: Patterns	
▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	10-12, 18-19, 296, 324, 426
HS-PS1-4 Matter and its Interactions	
HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.	6-12, 428-434
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
▪ Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	4-9, 13, 18-20, 365-369, 393-397, 428-434, 465, 667, 703-722

Standards	Where Addressed
Disciplinary Core Ideas	
PS1.A: Structure and Properties of Matter	
▪ A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.	428-434
PS1.B: Chemical Reactions	
▪ Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	342-370, 428-434
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	346-354
HS-PS1-5 Matter and its Interactions	
HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.	630-635
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	10-20, 630-635
Disciplinary Core Ideas	
PS1.B: Chemical Reactions	
▪ Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	630-635

Standards	Where Addressed
Crosscutting Concepts	
CC.1: Patterns	
▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	12, 18-19, 296, 324, 426
HS-PS1-6 Matter and its Interactions	
HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.	17-19, 646-659
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	13-19, 22, 71, 232
Disciplinary Core Ideas	
PS1.B: Chemical Reactions	
▪ In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.	646-659
ETS1.C: Optimizing the Design Solution	
▪ Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. *(secondary)*	646-648
Crosscutting Concepts	
CC.7: Stability and Change	
▪ Much of science deals with constructing explanations of how things change and how they remain stable.	13-20, 435-432, 710-720

Standards	Where Addressed
HS-PS1-7 Matter and its Interactions	
HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	129-133, 296-326
Science and Engineering Practices	
SEP.5: Using Mathematics and Computational Thinking Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Use mathematical representations of phenomena to support claims.	129-133, 296-326
Disciplinary Core Ideas	
PS1.B: Chemical Reactions	
▪ The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	129-133, 296-326
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ The total amount of energy and matter in closed systems is conserved.	131, 342-350
Connections to Nature of Science	
Knowledge Assumes an Order and Consistency in Natural Systems	
▪ Science assumes the universe is a vast single system in which basic laws are consistent.	8, 13, 369

Standards	Where Addressed
HS-PS1-8 Matter and its Interactions	
Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.	704-726
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
▪ Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	4-9, 13, 18-20, 365-369, 393-397, 428-434, 465, 667, 703-722
Disciplinary Core Ideas	
PS1.C: Nuclear Processes	
▪ Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process.	704-735
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.	704-735

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Standards	Where Addressed
HS-PS1-9 Matter and its Interactions	
HS-PS1-9.[*] Use mathematical representations to describe the composition and properties of individual solutions and solutions involved in chemical reactions.	557-579
Science and Engineering Practices	
SEP.5: Using Mathematics and Computational Thinking Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Use mathematical representations of phenomena to support claims.	129-133, 296-326
Disciplinary Core Ideas	
PS1.B: Chemical Reactions	
▪ The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	129-133, 296-326
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ The total amount of energy and matter in closed systems is conserved.	131, 342-350
Connections to Nature of Science	
Scientific Knowledge Assumes an Order and Consistency in Natural Systems	
▪ Science assumes the universe is a vast single system in which basic laws are consistent.	8, 13, 369

[*] Denotes Indiana Specific Standards

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Standards	Where Addressed
HS-PS1-10 Matter and its Interactions	
HS-PS1-10.[*] Analyze data to support the claim that the combined gas law describes the relationships among volume, pressure and temperature for a sample of an ideal gas.	487-496
Science and Engineering Practices	
SEP.5: Using Mathematics and Computational Thinkin Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Use mathematical representations of phenomena to support claims.	475-500, 603-616
Disciplinary Core Ideas	
PS1.A: Structure and Properties of Matter	
▪ A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.	428-434
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	346-354
CC.1: Patterns	
▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	10-12, 18-19, 296, 324, 426

[*] Denotes Indiana Specific Standards

Standards	Where Addressed
HS-PS3-1 Energy	
HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.	343-350, 355-359
Science and Engineering Practices	
SEP.5: Using Mathematics and Computational Thinking Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials, and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Create a computational model or simulation of a phenomenon, designed device, process, or system.	11-19, 345-350, 365, 368
Disciplinary Core Ideas	
PS3.A: Definitions of Energy	
▪ Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.	342-370
PS3.B: Conservation of Energy and Energy Transfer	
▪ Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.	342-356
▪ Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.	342-343
▪ Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.	342-354
▪ The availability of energy limits what can occur in any system.	343, 345, 355-359, 360-362, 366-370

Standards	Where Addressed
Crosscutting Concepts	
CC.4: Systems and System Models	
▪ Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.	15, 116-123, 365
Connections to Nature of Science	
Scientific Knowledge Assumes an Order and Consistency in Natural Systems	
▪ Science assumes the universe is a vast single system in which basic laws are consistent.	8, 13, 369
HS-PS3-2 Energy	
HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).	342-370
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
▪ Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.	4-9, 13, 18-20, 365-369, 393-397, 428-434, 465, 667, 703-722
Disciplinary Core Ideas	
PS3.A: Definitions of Energy	
▪ Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.	342-370
▪ At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.	342-347

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Standards	Where Addressed
▪ These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases, the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.	345-368
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.	342-354
HS-PS3-3 Energy	
HS-PS3-3. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).	355-362
Science and Engineering Practices	
SEP.3: Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.	
▪ Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	356, 368, 376
Disciplinary Core Ideas	
PS3.B: Conservation of Energy and Energy Transfer	
▪ Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.	342-354
▪ Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).	368-369

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Standards	Where Addressed
PS3.D: Energy in Chemical Processes	
▪ Although energy cannot be destroyed, it can be converted to less useful forms — for example, to thermal energy in the surrounding environment.	368-369
Crosscutting Concepts	
CC.4: Systems and System Models	
▪ When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.	13-14, 17-19