## Carter County NGSS Science Curriculum

Unit Title/Topic:		Grade:		Time:		
Chemical Reactions		9th		6 weeks		
Performance Expectations: Students who demonstrate understanding HS-PS1-2. Construct and revise an explanation outermost electron states of atoms, trends in the periodic [Clarification Statement: Examples of chemical reaction of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical HS-PS1-4. Develop a model to illustrate that this depends upon the changes in total bond energy system that affects the energy change. Examples of models of showing the relative energies of reactants and products, and representations showing calculating the total bond energy changes during a chemical reaction from the I HS-PS1-5. Apply scientific principles and evided temperature or concentration of the reacting particular Statement: Emphasis is on student reasoning that for Boundary: Assessment is limited to simple reactions in which there are only two qualitative relationships between rate and temperature.] HS-PS1-6. Refine the design of a chemical systemic increased amounts of products at equilibrium.* [Clarification refining designs of chemical reaction systems, including descri- what happens at the molecular level. Examples of designs could include dir- removing products.] [Assessment Boundary: Assessment is limited to specifying the char- equilibrium constants and concentrations.] HS-PS1-7. Use mathematical representations to during a chemical reaction. [Clarification Statemer relationships between masses of atoms in the reactants and the pr using the mole as the conversion from the atomic to the macroscopic scales, memorization and rote application of problem-solving techniques.] [Assessment application and rote application and rote	g can: table, and ions could in mical reactive e release y. [Clarifical could include g energy is co- bond energing ence to pro- articles on cuses on the ro reactants stem by sp on Statemer riptions of t fferent way ange in only to support ent: Emphasis roducts, and . Emphasis i nent Bounda	utcome of a simple chemi knowledge of the pattern clude the reaction of sodium ons involving main group ele or absorption of energy fr tion Statement: Emphasis is e molecular-level drawings a conserved.] [Assessment Bou es of reactants and products vide an explanation about the rate at which a reaction e number and energy of collis ; evidence from temperature ecifying a change in conc tt: Emphasis is on the applica- he connection between chan s to increase product format r one variable at a time. Asse the claim that atoms, and is is on using mathematical if the translation of these rela- s on assessing students' use ary: Assessment does not increase	ical real is of cl ments om and co on the and dial indary: i.] it the econocci sions b c, conce ditions b c,	action based on the hemical properties. thorine, of carbon and oxygen, or and combustion reactions.] chemical reaction system idea that a chemical reaction is a grams of reactions, graphs Assessment does not include effects of changing the curs. [Clarification etween molecules.] [Assessment entration, and rate data; and that would produce f Le Chatlier's Principle and on ade at the macroscopic level and luding adding reactants or t does not include calculating effore mass, are conserved to communicate the proportional ips to the macroscopic scale thematical thinking and not on pomplex chemical reactions.]		
Learning Targets/I Cans:						
I can balance simple chemical reactions.						
I can create molecular-level drawings and diagrams of reactions.						
I can relate temperature changes to t	I can relate temperature changes to the number of collisions between particles.					
I can explain the multiple variables that affect reaction rates.						
Science and Engineering Practices 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.	Disciplin PS1.A: Stru Matter • The peri- horizontally number of p and places those with s columns. The repeating participation of the columns. The repeating participation of the repeating participation of the columns. The repeating participation of the repeating participation of the columns. The repeating participation of the repeating participation of the repeating participation of the columns. The repeating participation of the repeating participation of the columns. The repeating participation of the repeating partici	ary Core Ideas inclure and Properties of odic table orders elements by the irotons in the atom's nucleus imilar chemical properties in e atterns of this table reflect	Cros Patter • Diff each o studiec causali (HS-PS Energy • The in	scutting Concepts ns ferent patterns may be observed at f the scales at which a system is d and can provide evidence for ity in explanations of phenomena. 51-2),(HS-PS1-5) y and Matter e total amount of energy and matter		
the	patterns of	outer	closed	systems is conserved. (HS-PS1-7)		

<ul> <li>components of a system. (HS-PS1-4)</li> <li>Using Mathematics and Computational Thinking Mathematics and Computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking at range of linear and nonlinear functions, including trigonometric find energy is minimized. A sable moment is also addressed by HS-PS1-1.</li> <li>Stable forms of matter are those in what provide at least the molecule has less energy than the same separated; one must provide at least the molecule apart. (HS-PS1-4)</li> <li>Stable forms of matter are those in what provide at least the molecule apart. (HS-PS1-4)</li> <li>Stable form support of the stable form support of the mature persentations of phenomena to support of the multiple and independent student generated</li> <li>Apply scientific principles and evidence to provide an meany stable form a variety of molecules multiple soft molecules and the reverse reaction and the reverse reaction. (HS-PS1-2), (HS-PS1-7)</li> <li>The fact that atoms are conserved, mark stable widence obtained from a variety of sources (Including student-generated sources for white set as builton to a complex real-world provide an meany stable form a variety of sources (Including student-generated sources for white provide criteria, and tradeoff considerations. (HS-PS1-2), (HS-PS1-7), (HS-PS1-7), (HS-PS1-7), (HS-PS1-7), (HS-PS1-7), (HS-PS1-7), (HS-PS1-7), (HS-PS1-1-7), (HS-PS1-1-7), (HS-PS1-1-7), (HS-PS1-1-7), (HS-PS1-1-7)</li></ul>	relationships between systems or between	electron states. (HS-PS1-2) (Note: This	<ul> <li>Changes of energy and matter in a</li> </ul>
<ul> <li>system. (HS-PS1-4)</li> <li>Using Mathematical and computational Thinking at Mathematical and computational thinking at Manapetc. field energy is minimized. A stable forms of nature are those in which the detectio:</li> <li>arange of linear and nonlinear functions including trigonometric</li> <li>functions, exponentials and logarithms, and computational tools to analyze, represent, and model data.</li> <li>Simple computational simulations are created and used based on mathematical models of basic assumptions.</li> <li>Use mathematical and constructing trajenamical expensions and designing solutions of the collisions of molecules. And the collisions of molecules, with constructing explanations and designing solutions on K-8 experiences and progresses to explanations and designing solutions on K-8 experiences and progresses to explanations and designing solutions on K-8 experiences and progresses to explanations and designing solution: a nere solution to phenomena na solve design multiple and independent studengenerated</li> <li>A phyl scientific principles and evidence to provide an molecules and the reverse reaction and the reverse reaction</li></ul>	components of a	Disciplinary Core	system
<ul> <li>Using Marhemitates and Computational Thinking Mathemitatical 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.</li> <li>Simple computational simulations are created and model data.</li> <li>Binple computational simulations are created and mathematical models of basic assumptions.</li> <li>Use mathematical representations of phenomena to support daims. (HS-PS1-7)</li> <li>Construct and revises an explanation based on revising automs, models, theories, a construct and revises an explanation based valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, review) and the assumption that theories sources of evidence cobtained from a variety of sources (including students' own investigations, models, theories, review) and the assumption that theories sources of evidence cobtained from a variety of sources (including students' own investigations, models, theories, review) and the assumption that theories sources of evidence cobtained from a variety of sources (including students' own investigations, models, theories, review) and the assumption that theories sources (review) and the assumption that theories review reaction reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, review) and will continue to do so in the future. (HS- Solition receives reaction review; rand will continue to do so in the future. (HS- Solition review; rand will continue to do so in the future. Solition review; rand will continue to do so in the future. Solition review; rand will continue to do so in the future. Solition review; rand will continue to do so in the future. Solition review; rand will continue to do so in the future. Solition review; rand will con</li></ul>	system. (HS-PS1-4)	Idea is also addressed by HS-PS1-1 )	can be described in terms of energy and
<ul> <li>Mathematical and computational thinking at the p-12 level builds</li> <li>P-12 b</li></ul>	Using Mathematics and Computational Thinking	<ul> <li>Stable forms of matter are those in</li> </ul>	matter flows into, out of, and within that
<ul> <li>g-12 level builds</li> <li>Min diseactor.</li> <li>g-12 level builds</li> <li>Min diseactor.</li> <li>Min diseactor.&lt;</li></ul>	Mathematical and computational thinking at the	which the electric	system. (HS-PS1-4)
<ul> <li>an end analysis,</li> <li>arange of linear and nonlinear functions including</li> <li>computational simulations are created and</li> <li>used based on mathematical models of basic assumptions.</li> <li>Use mathematical representations of phenomena to support</li> <li>constructing explanations and designing solutions</li> <li>for studentg explanations and designing solutions</li> <li>for succes of evidence consistent with scientific diversities and the repry. (HSPS1-9)</li> <li>In many situations, a dynamic and consistency in the set of molecules</li> <li>principles, and theories.</li> <li>Apply scientific principles and evidence to provide an explanation based on valid and relations of phenomena and solve design problems, taking into account possible unanticipated effects. (HSP S1-5)</li> <li>In many situations, expendent based on sale with the discuss</li> <li>present. (HS-PS1-2).(HS-PS1-2).(HS-PS1-7)</li> <li>ETS1.C: Optimizing the Design solution a farming the provide criteria, and tradeoff considerations. (HS-PS1-7).(HS-PS1-7).</li> <li>ETS1.C: Optimizing the Design solution a complex real-world problem, based on scientific throweldge, student-generated sources of evidence. The fart that atoms are conserved, to simple romes that can be approached systematically, and decisions</li> <li>constru</li></ul>	9–12 level builds	and magnetic field energy is minimized	Stability and Change
A state 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 mathematical models of basic assumptions. • Use mathematical representations of phenoment to support claims. (HS-PS1-7) Constructing explanations and designing solutions on K-3 experiences and progresses to explanations of designs sources of evidence consistent with scientific rideas, principles, and theories. • Apply scientific principles and evidence to provide an explanations of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5) • Constructing explanations and designing solutions on K-3 experiences and progresses to explanations of designs explanations of phenomena and solve design problems, taking into account possible unanticipated effects. HS-S1-5) • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including student's owning estimation, and tradeoff considerations, HS-S1-2) • Refine a solution to a complex real-world problem, based on cientific Knowledge, student-generated sources of widence, (including student's owning estimations, models, theories, imple needed. (secondary to HS-PS1-7) • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including realiable evidence obtained from a variety of sources (including student's ownies, student's	on K–8 and progresses to using algebraic thinking	A dable	<ul> <li>Much of science deals with constructing</li> </ul>
<ul> <li>Transport of timesr and nonlinear functions including trigonometric frameworks of a toms to factors, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and noted that.</li> <li>Simple computational simulations are created and used based on moteoute apart. (HS-FS1-4)</li> <li>PS1.8: Chemical Reactions</li> <li>Use mathematical models of basic assumptions.</li> <li>Use mathematical representations of phenomena to support claims. (HS-FS1-7)</li> <li>Demail provide at least this interve of a consistence with scientific tideas, (HS-FS1-7)</li> <li>In many situations, and designing solutions to a scipper set least this tare matched by changes in kinetic energy. (HSFS1-5)</li> <li>In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction and the reverse</li></ul>	and analysis.	A SIDDLE	explanations of how things change and
<ul> <li>be do addits</li> <li>computational tools</li> <li>constructional simulations are created and used based on</li> <li>anathematical models of basic assumptions.</li> <li>Jse mathematical representations of phenomena to support</li> <li>constructing explanations and designing Solutions</li> <li>constructing explanation based on availet of sources (including students' own investigations, models, theories, simulations, evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, students' own investigations, models, theories, simulations, explanation and tradeoff considerations.</li> <li>construct and revise an explanation based on solution to a complex real-word problem, based on socientific priority of certain criteria over diversions (HS-PS1-2)</li> <li>enting any need to be broken down into stigations, models, theories, simulations, evidence, (iscondary to HS-PS1-7)</li> <li>enting asolutin to a complex real-word problem, based on</li></ul>	a range of linear and nonlinear functions including	molecule has less energy than the same	how they remain stable (HS-PS1-6)
<ul> <li>Separated, one must provide at least this computational tools</li> <li>Grantactine, exponentials and logarithms, and computational tools</li> <li>Grantactine, exponentials to analyze, represent, and model data.</li> <li>Simple computational simulations are created and used based on mathematical models of basic assumptions.</li> <li>Use mathematical representations of phenomena to support claims, (HS-PS1-7)</li> <li>Constructing explanations and designing solutions on 6-8 experiences and progresses to explanation and designs</li> <li>That are supported by multiple and independent studentgenerated sources of evidence consistent with scientific ideas, principles, and theories.</li> <li>Apply scientific principles and evidence to provide an explanation sade of explanation sade of explanation sade designs solutions of phenomena and solve design problems, taking students/own investigations, models, theories, peer review) and the assumption that theories and leaves that account growing at what describe the natural world operate today as that describe the natural world operate today as that describe.</li> <li>Refine a solution to a complex real-world problem, based on scientific Knowledge, student-generated sources of evidence, student-generated sources of evidence orbained from a variety of molecules present. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific Knowledge, student-generated sources of evidence, student-generated sources of evidence, student-generated sources of evidence, student-generated sources of evidence, student-generated sources of evidence formics, thereids, may be needed. (secondary to HS-PS1-6)</li> <li>Chase as a stat and tradeoff considerations.</li> <li>(HS-PS1-6)</li> </ul>	trigonometric	set or atoms	
<ul> <li>Computational tools</li> <li>Computational tools</li> <li>Constructing explanations and designing Solutions</li> <li>Constructing explanations and designing Solutions</li> <li>Constructing explanations and designs</li> <li>Constructing explanations and designs</li> <li>Construct and revise an explanation based on ralid and reliable evidence obtained from a variety of sources of evidence consistent furtheres</li> <li>Construct and revise an explanation based on ralid and reliable evidence solution to somplex real-world problem, based on scientific thrends, there is situations, models, theories, simulations, models, theories, simulations, so the explanation and there is construct and revise an explanation based on valid and reliable evidence solution to a complex real-world problem, based on scientific thrends, theories, thereful and will continue to do so in the furture. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific criteria, and tradeoff considerations. (HS-PS1-6)</li> </ul>	functions exponentials and logarithms and	separated; one must provide at least this	Connections to Nature of Science
<ul> <li>Computational boxis</li> <li>Constructing explanations and Designing Solutions</li> <li>The are supported by multiple and independent</li> <li>Surces of evidence consistent with scientific ideas,</li> <li>Apply scientific principles and theories.</li> <li>Apply scientific principles and theories.</li> <li>Construct and revise an explanation based on aild and</li> <li>Construct and revise an explanation based on aild and</li> <li>Construct and revise an explanation based on aild and</li> <li>Construct and revise an explanation based on suiters</li> <li>Construct and revise an explanation based on reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, effects. (HS-PS1-2)</li> <li>Construct and revise an explanation based on scientific review.) and the assumption that theories and laws that</li> <li>Cerrific as solution to a complex real-world problem, based on scientific cirefica, and tradeoff considerations.</li> <li>Kerine a solution to a complex real-world proinciples, student-generated sources of evidence, student-generated sources of evidence of the class of the class</li></ul>	computational tools	energy in	Scientific Knowledge Assumes an Order
<ul> <li>Substrational simulations are created and sumption at support computational simulations are created and mathematical representations of phenomena to support claims. (HS-PS1-7)</li> <li>Constructing Explanations and Designing Solutions of molecules and the rearrangements of aconsequent changes in the sum of all bond energies in the set of molecules and the sum of all bond energies in the set of molecules and the sum of all bond energies in the set of molecules and the sum of all bond energies in the set of molecules and the sum of all bond energies in the set of molecules and the sum of all bond energies in the set of molecules and the sum of all bond energies in the set of molecules and the sum of all bond energies in the set of molecules and the sum of all bond energies in the set of molecules and the reverse reaction molecules of the clements of active bots in the sum of all bond energies of the clements of atoms into account possible unanticipated effects. (HS-PS1-5)</li> <li>Construct and revise an explanation based on all and multiple evidence obtained from a variety of sources (including students' own investigations, models, theories, secientitic knowledge, student-generated sources of evidence, student-generated sources of evidence obtained from a variety of sources (including students') and tradeoff considerations. (HS-PS1-6)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, student-generated sources of evidence, student-generated sources of evidence, student-generated sources of evidence considerations, bet and will continue to do so in the future</li></ul>	for statistical analysis to analyze, represent, and	order to take the molecule apart. (HS-	and Consistency in Natural Systems
<ul> <li>PSI-B: Chemical reductions</li> <li>Simple computational simulations are created and used based on mathematical models of basic assumptions.</li> <li>Use mathematical representations of phenomena to support claims, (HS-PS1-7)</li> <li>Constructing explanations and Designing Solutions</li> <li>Constructing explanations and Designing Solutions on K-8 experiences and progresses to explanations and designs solutions on K-8 experiences and progresses to explanations and designs for the collisions of molecules, with consequent changes in the set of molecules and the rearrangements of atoms into new molecules, with consequent changes in the set of molecules for the collisions of molecules with at are matched by changes in kinetic energy. (HSPS1-5)</li> <li>In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reactions. (HS-PS1-7)</li> <li>TETS I.C. Optimizing the Design Solutions and Designing Solutions, peer review) and the assumption that theories and aws that describe and any need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS1-6)</li> <li>Solution Arabee on solution to a complex real-word problem, based on scientific Knewledge, student-ge</li></ul>	model data	PS1-4)	<ul> <li>Science assumes the universe is a vast</li> </ul>
<ul> <li>Chemical processes, their rates, and whether or not emerges is stored or role assess, their rates, and whether or not emerges is stored or role assess, their rates, and whether or not emerges is stored or role assess. Their rates, and whether or not emerges is stored or released can be understood in terms of the collisions of molecules and the collisions of molecules, with consequent changes in the sum of all bond energies in the set of molecules and the assess to explanations and designs that are supported by multiple and independent studentgenerated sources of evidence consistent with scientific ideas, principles, and theories.</li> <li>Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (H5-PS1-5)</li> <li>In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction. (HS-PS1-5)</li> <li>To construct and revise an explanation based on soin the future. (HS-PS1-2)</li> <li>Crietia may need to be broken down into simple rones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS1-6)</li> </ul>	Simple computational simulations are created and	PS1.B: Chemical Reactions	single system in which basic laws are
<ul> <li>Winter or not</li> <li>Provide an ensure of the collisions of molecules and the rearrangements of all bond energies in the set of molecules</li> <li>Mathematical models of provide an evidence to provide an evidence consistent with scientific ideas, principles, and theories.</li> <li>Apply scientific principles and evidence to provide an explanation as and object estimation of phenomena and solve design problems, taking intra account possible unanticipated effects. (HS-FS1-5)</li> <li>Construct and revise an explanation based on valid and</li> <li>Construct and revise an explanation based on valid and set estimates and will continue to do so in the future. (HS-FS1-5)</li> <li>Refine a solution to a complex real-wordd problem, based on scientific drains, (HS-FS1-2)</li> <li>Refine a solution to a complex real-wordd problem, based on scientific criteria, and tradeoff considerations. (HS-FS1-6)</li> <li>Winter or not</li> </ul>	used based on	<ul> <li>Chemical processes, their rates, and</li> </ul>	consistent (HS-PS1-7)
<ul> <li>Use mathematical representations of phenomena to support claims. (HS-PS1-7)</li> <li>Constructing explanations and designing solutions in 9-12 builds</li> <li>On K-8 experiences and progresses to explanations and designs</li> <li>that are supported by multiple and independent studentgenerated</li> <li>sources of evidence consistent with scientific ideas, principles, and theories.</li> <li>Apply scientific principles and evidence to provide an explanation of phenomena and solve design into account possible unanticipated effects. (HS-PS1-5)</li> <li>Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and will continue to do so in the future. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, otsidence charactions, (HS-PS1-6)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, HS-PS1-6)</li> </ul>	mathematical models of basic accumptions	whether or not	
<ul> <li>Use mature interns</li> <li>understood in terms</li> <li>of the collisions of molecules and the revaragements of atoms into new molecules, with consequent changes in the set of molecules and the revaragements of atoms into new molecules, with consequent changes in the set of molecules with at are matched by changes in the set of molecules for the sum of all bond energies in the set of molecules and the reverse reaction reverse reaction and the reverse reverse reaction reverse revere</li></ul>	Indulematical models of basic assumptions.	energy is stored or released can be	
<ul> <li>International the Second transmitter of the collisions of molecules and the rearrangements of atoms into new molecules, with a constructing explanations and designs that are supported by multiple and independent studentgenerated supported by multiple and independent studentgenerated supported by multiple and independent studentgenerated sources of evidence consistent with scientific rinciples, and theories.</li> <li>Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)</li> <li>Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, eerrer work) and the assumption that theories an laws that describe the natural world operate today as they first-21.</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student conservent to a soin the future. (HS-PS1-6)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student considerations. (HS-PS1-6)</li> </ul>	- Ose mathematical representations of	understood in terms	
<ul> <li>Claims (15-75)</li> <li>Problems, taking</li> <li>reliable evidence obtained from a variety of sources of evidence, sources of</li></ul>	claims (HS-DS1-7)	of the collisions of molecules and the	
Constructing explanations and designing solutions in 9–12 builds on K-8 expriences and progresses to explanations and designs that are supported by multiple and independent studentyenerated sources of evidence consistent with scientific ideas, a Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS- PS1-5)atom situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction molecules• Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS- PS1-5)• In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction molecules• Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, 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. (HS- PS1-2)• Criteria may need to be broken down into scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)• Criteria may need to HS-PS1-6)	Constructing Explanations and Designing Solutions	rearrangements of	
<ul> <li>Consequent changes in the set of molecules</li> <li>Consequent provise of all types of molecules</li> <li>Construct and revise an explanation based on sources (including</li> <li>Construct and revise an explanation based on scientific the molecules present. (HS-PS1-2) (HS-PS1-7)</li> <li>ETS1.C: Optimizing the Design</li> <li>Contract may need to be broken down intervity of sources of evidence, student generated sources of evidence, student generated sources of evidence, student generated sources of evidence intervity of sources (including generated sources of evidence, stud</li></ul>	Constructing explanations and designing solutions	atoms into new molecules, with	
<ul> <li>the sum of all bond energies in the set of explanations and designs</li> <li>that are supported by multiple and independent studentgenerated</li> <li>sources of evidence consistent with scientific ideas, principles, and theories.</li> <li>Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking</li> <li>into account possible unanticipated effects. (HS-PS1-5)</li> <li>Construct and revise an explanation based on valid and</li> <li>Construct and revise an explanation based on valid and</li> <li>reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, 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. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> </ul>	in 9–12 builds	consequent changes in	
<ul> <li>molecules</li> <li>molecules</li> <li>molecules</li> <li>mary situations, and designs</li> <li>that are supported by multiple and independent</li> <li>studentgenerated</li> <li>sources of evidence consistent with scientific</li> <li>ideas,</li> <li>Apply scientific principles and evidence to</li> <li>problems, taking</li> <li>robalems, taking<th>on K—8 experiences and progresses to</th><th>the sum of all bond energies in the set of</th><th></th></li></ul>	on K—8 experiences and progresses to	the sum of all bond energies in the set of	
<ul> <li>that are supported by multiple and independent studentgenerated</li> <li>sources of evidence consistent with scientific ideas,</li> <li>principles, and theories.</li> <li>Apply scientific principles and evidence to provide an</li> <li>explanation of phenomena and solve design problems, taking</li> <li>into account possible unanticipated effects. (HS- PS1-5)</li> <li>Construct and revise an explanation based on valid and</li> <li>reliable evidence obtained from a variety of sources (including</li> <li>students' own investigations, models, theories, simulations,</li> <li>peer review) and the assumption that theories and describe the natural world operate today as they did in the past and will continue to do so in the future. (HS- PS1-2)</li> <li>Refine a solution to a complex real-world problemb, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.</li> <li>(HS-PS1-6)</li> </ul>	explanations and designs	molecules	
<ul> <li>and the supported by mittight and independent student generated</li> <li>sources of evidence consistent with scientific ideas,</li> <li>Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)</li> <li>Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, 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. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> </ul>	that are supported by multiple and independent	that are matched by changes in kinetic	
<ul> <li>4),(15-PS1-5)</li> <li>4),(15-PS1-5)</li> <li>4),(15-PS1-5)</li> <li>4),(15-PS1-5)</li> <li>4),(15-PS1-5)</li> <li>5)</li> <li>Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the pear sand will continue to do so in the future. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.</li> <li>HS-PS1-6)</li> <li>Thany situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction and the section to a complex real-world problem, based on scientific knowledge, student-generated sources of the cleaners.</li> <li>HS-PS1-6)</li> <li>Tho many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction and the serves reaction and the reverse reaction and the serves reaction and the reverse reaction and the serves reaction and the serves reaction and the serves reaction and the reverse reaction and the serves reaction and the serves reaction and the serves reaction and the reverse reaction and the serves reaction and</li></ul>	studentgenerated	energy. (HSPS1-	
<ul> <li>In many situations, a dynamic and conditions, a dynamic and the reverse reaction and the determines the numbers of all types of molecules present. (HS-PS1-6)</li> <li>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 and reactions. (HS-PS1-2). (HS-PS1-7)</li> <li>ETS1-2)</li> <li>The fact that atoms are do be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (secondary to HS-PS1-6)</li> </ul>	sources of evidence consistent with scientific	4),(HS-PS1-5)	
<ul> <li>Condition-dependent</li> <li>Conditi</li></ul>	ideas	<ul> <li>In many situations, a dynamic and</li> </ul>	
<ul> <li>Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking</li> <li>into account possible unanticipated effects. (HS-PS1-5)</li> <li>Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, 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. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> </ul>	nrinciples and theories	condition-dependent	
<ul> <li>reverse reaction</li> <li>reverse reaction</li> <li>reverse reaction</li> <li>determines the numbers of all types of molecules</li> <li>reverse reaction</li> <li>determines the numbers of all types of molecules</li> <li>reverse reaction</li> <li>reverse reaction</li> <li>determines the numbers of all types of molecules</li> <li>reverse reaction</li> <li>reverse reaction</li> <li>determines the numbers of all types of molecules</li> <li>reverse reaction</li> <li>reverse reaction</li> <li>determines the numbers of all types of molecules</li> <li>reverse reaction</li> <li>reactions. (HS-PS1-2), (HS-PS1-7)</li> <li>restincing reactions (HS-PS1-2), (HS-PS1-7)</li> <li>restincing reactions. (HS-PS1-2)</li> <li>reverse reactions (HS-PS1-2), (HS-PS1-7)</li> <li>reverse reactions (HS-PS1-2)</li> <li>reverse reactions (HS-PS1-2)</li> <li>reverse reactions (HS-PS1-2)</li> <li>reverse reactions (HS-PS1-2)</li> <li>reactions (HS-PS1-2)</li> <li>reactions (HS-PS1-2)</li> <li>reverse reactions (HS-PS1-2)</li> <li>reactions (HS-PS1-2)</li> <li>reverse reactions (HS-PS1-2)</li> <li>reverse reactions (HS-PS1</li></ul>	<ul> <li>Apply scientific principles and evidence to</li> </ul>	balance between a reaction and the	
<ul> <li>explanation of phenomena and solve design problems, taking</li> <li>into account possible unanticipated effects. (HS- PS1-5)</li> <li>Construct and revise an explanation based on valid and</li> <li>reliable evidence obtained from a variety of sources (including</li> <li>students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that</li> <li>describe the natural world operate today as they did in the past and will continue to do so in the future. (HS- PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.</li> <li>(HS-PS1-6)</li> <li>Uter finites of all types of ant decisions and types of molecules</li> <li>Definition of a log of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)</li> <li>ETS1.C: Optimizing the Design Solution</li> <li>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 (tradeoffs) may be needed. (secondary to HS-PS1- 6)</li> </ul>	provide an	determines the numbers of all types of	
<ul> <li>problems, taking</li> <li>problems, taking</li> <li>into account possible unanticipated effects. (HS-PS1-5)</li> <li>Construct and revise an explanation based on valid and</li> <li>reliable evidence obtained from a variety of sources (including</li> <li>students' own investigations, models, theories, simulations,</li> <li>peer review) and the assumption that theories and laws that</li> <li>describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> </ul>	explanation of phenomena and solve design	meloculos	
<ul> <li>into account possible unanticipated effects. (HS-PS1-5)</li> <li>Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, 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. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> <li>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. (HS-PS1-2), (HS-PS1-7)</li> <li>ETS1.C: Optimizing the Design Solution</li> <li>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 (tradeoffs) may be needed. (secondary to HS-PS1-6)</li> </ul>	problems, taking	procent (US DS1 6)	
<ul> <li>PS1-5)</li> <li>Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, 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. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> <li>The dual dations are conserved, the transmission of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)</li> <li>ETS1.C: Optimizing the Design Solution</li> <li>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 (tradeoffs) may be needed. (secondary to HS-PS1-6)</li> </ul>	into account possible unanticipated effects. (HS-	<ul> <li>The fact that atoms are conserved</li> </ul>	
<ul> <li>Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, 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. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> </ul>	PS1-5)	- The fact that atoms are conserved,	
valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, 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. (HS- PS1-2) • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	<ul> <li>Construct and revise an explanation based on</li> </ul>	knowledge of the chemical properties of	
reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, 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. (HS- PS1-2) • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	valid and	the elements	
sources (including students' own investigations, models, theories, simulations, 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. (HS- PS1-2) • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	reliable evidence obtained from a variety of	involved, can be used to describe and	
<ul> <li>students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that</li> <li>describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> <li>Patting a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> </ul>	sources (including	predict chemical	
simulations, 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. (HS- PS1-2) • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	students' own investigations, models, theories,	reactions (HS-PS1-2) (HS-PS1-7)	
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. (HS- PS1-2) Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	simulations,	ETS1.C: Optimizing the Design	
laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS- PS1-2)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 (tradeoffs) may be needed. (secondary to HS-PS1- 6)Image: Second systematically and tradeoff considerations. (HS-PS1-6)- 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 (tradeoffs) may be needed. (secondary to HS-PS1- 6)	peer review) and the assumption that theories and	Solution	
describe the natural world operate today as they did in the past and will continue to do so in the future. (HS- PS1-2) • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	laws that	<ul> <li>Criteria may need to be broken down</li> </ul>	
did in the past and will continue to do so in the future. (HS- PS1-2) • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	describe the natural world operate today as they	into simpler ones	
<ul> <li>past and will continue to do so in the future. (HS-PS1-2)</li> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> </ul>	did in the	that can be approached systematically,	
PS1-2)       about the priority of certain criteria over others (tradeoffs)         Problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)       about the priority of certain criteria over others (tradeoffs)	past and will continue to do so in the future. (HS-	and decisions	
<ul> <li>Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)</li> <li>others (tradeoffs) may be needed. (secondary to HS-PS1- 6)</li> </ul>	PS1-2)	about the priority of certain criteria over	
problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	<ul> <li>Refine a solution to a complex real-world</li> </ul>	others (tradeoffs)	
scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	problem, based on	may be needed. (secondary to HS-PS1-	
of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)	scientific knowledge, student-generated sources	6)	
prioritized criteria, and tradeoff considerations. (HS-PS1-6)	of evidence,		
(HS-PS1-6)	prioritized criteria, and tradeoff considerations.		
	(HS-PS1-6)		

## **Critical Content Vocabulary:**

Chemical reactions Endothermic reactions Exothermic reactions

## **Resources:**