CHEMISTRY		
HS-PS3-4 Energy		
HS-PS3-4: 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).		
Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.		
Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.		
Evidence Statements: HS-PS3-4		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
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.	**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. 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). **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.	**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.
Connections to other DCIs in this grade-band: HS.ESS2.A		
Articulation of DCIs across grade-bands: MS.PS3.B		
NJSLS- ELA: RST.11-12.1, WHST.9-12.7, WHST.11-12.8		
NJSLS- Math: MP.2, MP.4		

5E Model	
HS-PS3-4: 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).	
Engage Anticipatory Set	Conduction: The Effect of Wall Thickness on Heat Conduction Using this interactive model, students will compare the flow of heat through materials of differing thicknesses. https://concord.org/stem-resources/conduction-effect-wall-thickness-heat-conduction
	Hands on Activity: To Heat or Not to Heat https://www.teachengineering.org/view_activity.php?url=collection/wsu_/activities/wsu_heat_activity/wsu_heat_activity.xml Energy Forms and Changes https://phet.colorado.edu/en/simulation/legacy/energy-forms-and-changes

Exploration Student Inquiry	In this online simulation, students will explore how heating and cooling iron, brick, and water adds or removes energy. They will see how energy is transferred between objects, build their own system with energy sources, changers, and users and track and visualize how energy flows and changes through your system. Heat, Temperature and Calorimetry In this lesson, students will differentiate between heat energy and temperature and apply this knowledge to calorimetry. http://betterlesson.com/lesson/640677/heat-temperature-and-calorimetry Calorimetry Lab In this lesson, students will track energy changes in an open calorimeter when mixing water of different temperatures. http://betterlesson.com/lesson/640678/calorimetry-lab
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (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. 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). 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.
Elaboration Extension Activity	Soda Can Calorimeter This activity will introduce the concept of calorimetry and investigate the caloric content of snack foods https://www.flinnsci.com/media/510570/soda_can.pdf Additional Activities http://www.ck12.org/ngss/high-school-physical-sciences/energy
Evaluation Assessment Tasks	Assessment Task A: Throughout the exploration activities, teachers should assess students' planning of their investigations. Assessment Task B: Calorimetry Lab: Analysis Questions