Science-Chemistry
Units of Instruction
2022-2023

BOONE COUNTY SCHOOLS

ACHIEVING EXCELLENCE TOGETHER

Curriculum Revision Rationale

For the 2022-23 school year and forward, the science curriculum has been redesigned to reflect current best practice in science. Teachers re-visited the *Framework for K-12 Science Education*, from which the *Next Generation Science Standards (NGSS)* were derived. Per the K-12 framework, "***The overarching goal of our framework for K-12 science education is to ensure that by the end of 12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology***." Within the framework, there are core ideas with essential and supporting questions that guide what students should be learning and doing. The following units/core idea "placemats" are designed around those.

In the pages below, there is a "year at-a-glance" summary page of the units/core ideas with priority and supporting standards, order, and pacing. The pacing for block schedule schools is listed first, with the pacing for traditional schedule schools listed below. Following that, are 1-2 page unit/core idea "placemats". Teachers were presented with the core ideas and the essential and supporting questions, and asked to brainstorm possible phenomena. Then, they were presented with the performance expectations that aligned with each core idea, and worked on aligning those components. Finally, the science practices within those performance expectations were identified. Each placemat contains a core idea with essential and supporting questions, sample (not required) anchoring phenomena, priority and supporting standards. Anchoring phenomena are phenomena that are used to design units of instruction. This document explains what makes good anchor phenomena-Qualities of a Good Anchor Phenomenon for a Coherent Sequence of Science Lessons. As teachers use various phenomena to design units over the next year, we hope to add more examples, and possibly example units, for the next school year.

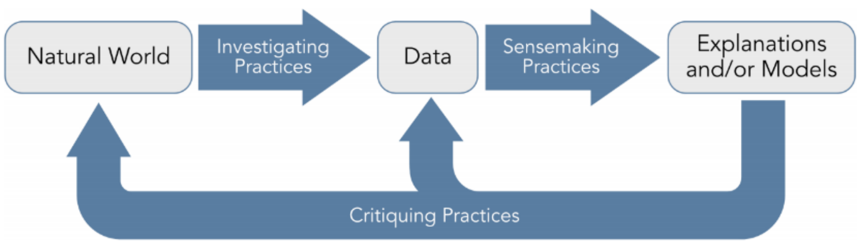
In this newly revised curriculum, there has been a change in priority and supporting standards. Per the front matter of the topic arrangement of the *NGSS*, which is the current arrangement of our *Kentucky Academic Standards,* students are expected to demonstrate proficiency in using the scientific practices, and to use the practices to demonstrate understanding of the core ideas. When re-evaluating the criteria for priority standards, it was determined that the science practices will be given priority, with the performance expectations as supporting. Units of instruction can then be designed with the core ideas, essential & supporting questions, and phenomena in mind. The expectation is that schools are designing units around the core ideas within the same time frame, per the pacing listed within the document.

Chemistry

Unit 1 **Core Idea:** Energy	**Unit 2** **Core Idea:** Structure & Properties of Matter	**Unit 3** **Core Idea:** Chemical Reactions
Developing and Using Models **Planning and Carrying Out Investigations** **Using Mathematics and Computational Thinking** **Constructing Explanations and Designing Solutions** HS-PS3-1 HS-PS3-3 HS-PS3-4 **3 weeks** **6 weeks**	**Developing and Using Models** **Planning and Carrying Out Investigations** HS-PS1-1 HS-PS1-3 HS-PS1-8 **10 weeks** **20 weeks**	**Developing and Using Models** **Using Mathematics and Computational Thinking** **Constructing Explanations and Designing Solutions** HS-PS1-2 HS-PS1-4 HS-PS1-5 HS-PS1-6 HS-PS1-7 **5 weeks** **10 weeks**

Energy (Block: 3 weeks/Traditional: 6 weeks)

Unit 1/Core Idea: Energy Essential Question: How is energy transferred and conserved?
Supporting Questions: ● What is energy? ● What is meant by conservation of energy? How is energy transferred between objects or systems? ● How are forces related to energy? ● How do food and fuel provide energy? If energy is conserved, why do people say it is produced or used?



	Investigating Practices	Sensemaking Practices	Critiquing Practices
	1. Asking questions	2. Developing and using models	7. Engaging in argument from evidence
Science Practices	3. Planning and carrying out investigations	4. Analyzing and interpreting data	8. Obtaining, evaluating, and communication information
	5. Using mathematical and computational thinking	6. Constructing explanations	

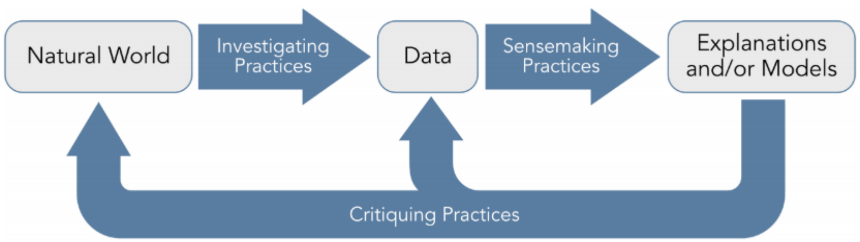
Priority (Practices):	Supporting (Performance Expectations):
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2),(HS-PS3-5) **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. (HS-PS3-4) **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. (HS-PS3-1) **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. Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence,prioritized criteria, and trade off considerations. (HS-PS3-3)	**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. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.] **HS-PS3-3.** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.] **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.]

Structure & Properties of Matter (Block: 10 weeks/Traditional: 20 weeks)

Unit 2/Core Idea: Structure & Properties of Matter
Essential Question: How can one explain the structure and properties of matter?

Supporting Questions:

- How do particles combine to form the variety of matter one observes?
- What forces hold nuclei together and mediate nuclear processes?



	Investigating Practices	Sensemaking Practices	Critiquing Practices
Science Practices	1. Asking questions	2. Developing and using models	7. Engaging in argument from evidence
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Priority (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. Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-8) Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

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. (HS-PS1-3)

Supporting (Performance Expectations):

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. [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]

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. [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, and not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.]

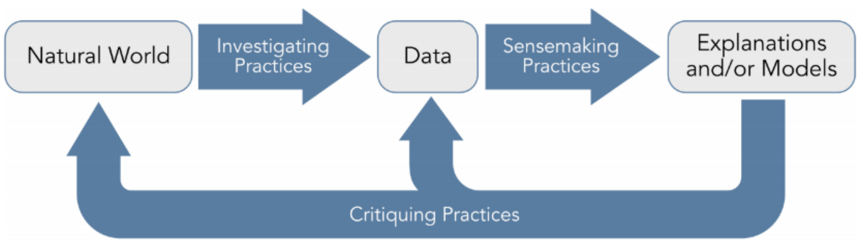
HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.]

Chemical Reactions (Block: 5 weeks/Traditional: 10 weeks)

Unit 3/Core Idea: Chemical Reactions
Essential Questions: How can one explain the interactions of matter?

Supporting Questions:

- How do substances combine or change (react) to make new substances?
- How does one characterize and explain these reactions and predictions about them?



	Investigating Practices	Sensemaking Practices	Critiquing Practices
Science Practices	1. Asking questions	2. Developing and using models	7. Engaging in argument from evidence
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Priority (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. Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4)

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. (HS-PS1-7)

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. (HS-PS1-5) 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) Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.

Supporting (Performance Expectations):

HS-PS1-2. **Construct and revise an explanation for the outcome of a simple chemical reaction based on t**he outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]

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. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]

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. [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.]

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.* [Clarification Statement: Emphasis is on

(HS-PS1-6)	the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.] **HS-PS1-7.** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include complex chemical reactions.]