The *Kentucky Academic Standards for Science: An Overview*

Facilitator’s Guide

Summer 2023

Contents:

Module Overview:

The *Kentucky Academic Standards for Science: An Overview* Module, developed by the Kentucky Department of Education (KDE), contains the materials to be used in work sessions at the district, school, or department level. This module is intended to support the implementation of the *Kentucky Academic Standards (KAS) for Science* in classrooms across the state.

The duration and scope may be customized to accommodate local needs and conditions. However, participants should engage in all sessions to gain an understanding of the complexity and rigor of the *KAS for Science*.

Materials:

KDE developed materials that are part of this module:

- *The KAS for Science: An Overview Facilitator's Guide*
- *The KAS for Science: An Overview* slide presentation

These materials are available at KYStandards.

Materials also needed for this module:

- Appendix E: *Disciplinary Core Idea Progressions in the Next Generation Science Standards*
- Appendix F: *Science and Engineering Practices in the Next Generation Science Standards*
- Appendix G: *Crosscutting Concepts in the Next Generation Science Standards*
- Appendix I: *Engineering Design in the Next Generation Science Standards*

Goals:

The goals of The *KAS for Science: An Overview* Module are for districts or schools to:

- Build a shared understanding of the architecture and components of the *KAS for Science.*

- Strengthen the understanding of the three dimensions of science and recognize how they work together to support highly effective science teaching and learning.
- Identify and prioritize areas where future professional learning will be needed for successful implementation of the *KAS for Science* and develop a plan to address those areas.

At the completion of this module, participants will be able to develop an argument as to how instruction of the *KAS for Science* is the same/different as is generally observed during science instruction.

Intended Audiences:

Participants

Module participants are district teams that may include, but are not limited to, district leadership, school administrators, instructional specialists/coaches, intervention specialists, department chairs, special educators and active or pre-service classroom teachers.

Facilitators

Module session facilitators may include, but are not limited to, district leadership, school administrators, instructional specialists/coaches, intervention specialists, department chairs, special educators, classroom teachers and higher education faculty.

Using This Facilitator's Guide:

This facilitator's guide provides suggestions for structuring each section of this module, recommended learning experiences to prompt meaningful discourse of the *KAS for Science* and guidance on talking points to use with the provided presentation.

As you work through the module, learning experiences will be provided to aid in developing, or reinforcing, participant knowledge of the *KAS for Science.* Facilitators may need to revise specific tasks to meet the participant needs or to be respectful of work-session time limits.

Setup for Success

This module begins with a "Setup for Success" intentionally embedded to promote an environment of trust between facilitators and participants and among the participants themselves. Throughout the module, participants will be expected to collaborate in a variety of ways. Using the "Setup for Success" will be critical for participants to actively participate and accept collective responsibility for the successful attainment of module goals. Facilitators should feel free to adapt these activities to fit the size of the audience and the space of the work session, but they should be mindful that the Setup for Success activities are not randomly chosen ‘icebreaker’ activities; they have been intentionally chosen within the purpose and scope of the entire module.

Planning Ahead:

- Determine which stakeholders to invite as participants. In the invitation, describe how the work session will benefit them.
- A few days before the meeting, you may want to remind participants to bring their documents to the meeting (see below for Participant Documents Needed).
- Reserve adequate space and equipment. Tables should be set up to support small-group discussion.
- Access to the internet for the facilitator will be necessary for video access within this module.
- Access to the Internet for participants is helpful but may not be necessary, depending on how participants plan to engage with the *KAS for Science.*

Preparation:

Participant Documents Needed:

Ask participants to choose how they will feel most comfortable engaging with the *KAS for Science*, either:

- A device with access to the *KAS for Science*
- A hard copy of the *KAS for Science* (at least one per team)

Facilitator Work Session Supplies Needed:

These items will be needed with this module.

- Computer with access to the *KAS for Science: An Overview* slide presentation
- Technology with projection capability, including a speaker system
- Copies of session handouts
- Paper or journal to record responses to thought questions/reflections
- Issues Bin

- The Issues Bin can be used by participants to note ideas, questions, or issues constructively while the other attendees continue to focus on an activity or lesson. You might use a poster or you may prefer to have a digital Issues Bin where participants can access a Google document to post questions.
- Poster paper (optional unless otherwise indicated)
- Self-Sticking Notes (optional unless otherwise indicated)
- Colored markers (optional unless otherwise indicated)

Work Session Consideration:

Building a Community

Building a community is important for any group that will work together, especially if participants have not collaborated before. The concept is the same as building a safe, respectful, productive classroom climate. Incorporating community-building into each session builds trust, shows participants that they are valuable as individuals and engages them in the learning process. The goal is a professional learning network where participants can be supported. Community-building can be as simple as allowing participants to introduce themselves and their role in the school/district. Additional methods are developing or refining group norms, allowing for questions and/or the sharing of answers to reflection questions or individual discovery task items. Again, time allotted for community-building will allow participants to have a voice and be engaged as active contributors and learners.

Module 1: The Kentucky Academic Standards (KAS) for Science: An Overview

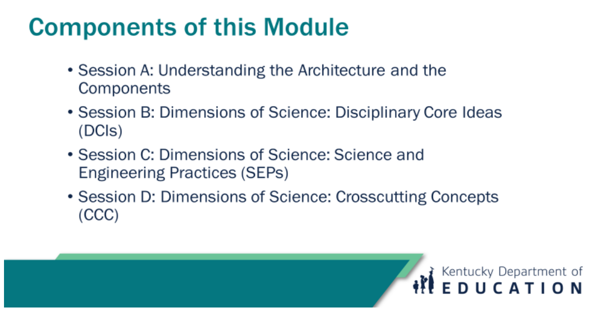
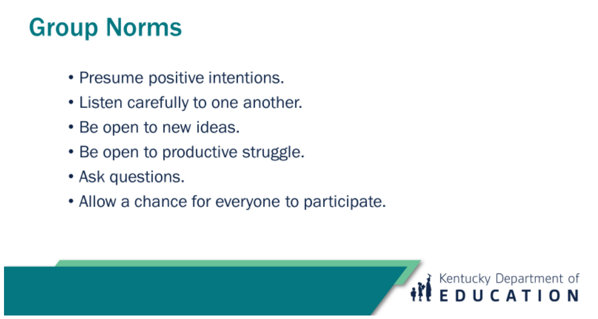
Preparation for Session A: Understanding the Architecture and the Components

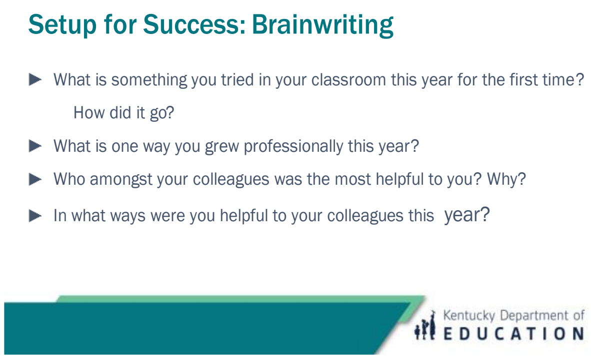
Posters to Make Ahead of Time:

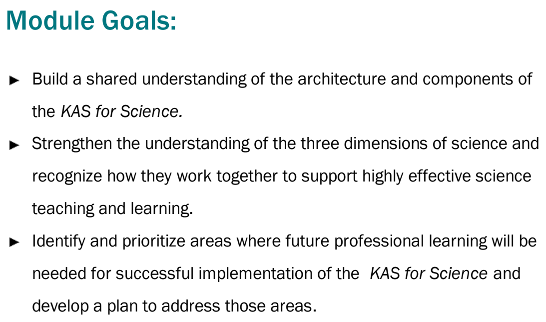
- Issues Bin Poster: Poster can just be labeled “Issues Bin”. The Issues Bins can be used by the participant to note ideas, questions, or issues constructively while the class continues to focus on an activity or lesson. You may use a poster or a digital Issues Bin where participants can access a Google document.

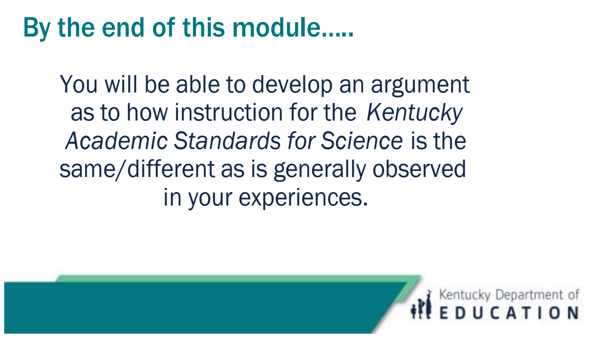
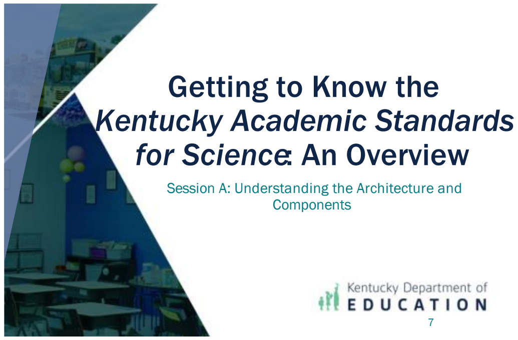
- Setup for Success: Brainwriting - Prepare four posters with one of the following questions written per poster:
    - What is something you tried in your classroom this year for the first time? How did it go?
    - What is one way you grew professionally this year?
    - Who amongst your colleagues was the most helpful to you? Why?
    - In what ways were you helpful to your colleagues this year?

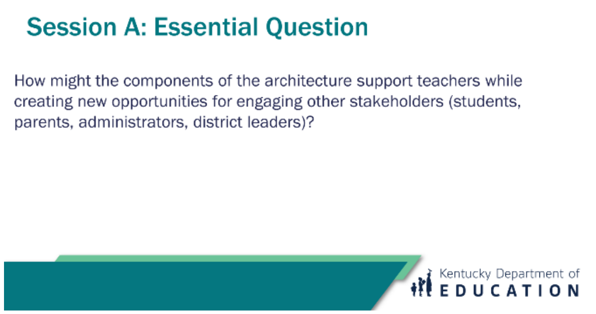
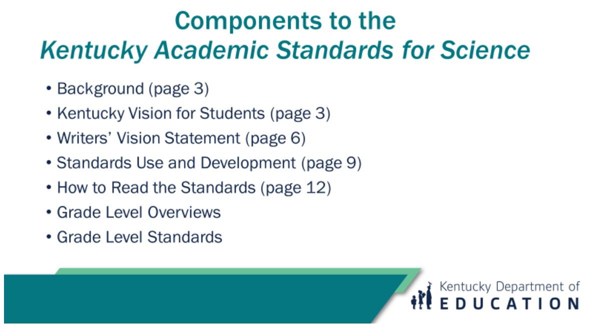
Session A: Understanding the Architecture and the Components

Facilitator Notes	Accompanying Slide(s)
Officially welcome the participants. Introduce yourself (if necessary). **Explain:** “This module is intended to provide an overview, or reinforce your understanding of, the *KAS for Science.”*	**Slide 1**  Getting to Know the *Kentucky Academic Standards for Science* An Overview Kentucky Department of EDUCATION
Facilitator Notes: *This slide shows the content incorporated within this module.*	**Slide 2**  Components of this Module • Session A: Understanding the Architecture and the Components • Session B: Dimensions of Science: Disciplinary Core Ideas (DCIs) • Session C: Dimensions of Science: Science and Engineering Practices (SEPs) • Session D: Dimensions of Science: Crosscutting Concepts (CCC) Kentucky Department of EDUCATION
Explain: “Group norms can help to create a safe space where participants feel comfortable sharing their ideas and experiences. This slide is a starter. Take a moment to read the norms.” *Facilitator Notes:* *After people are finished, ask if anyone would like to revise, edit or add any norms to the list. If so, make changes on the slide; if not, move on to your discussion of the Issues Bin.* **Explain:**	**Slide 3**  Group Norms • Presume positive intentions. • Listen carefully to one another. • Be open to new ideas. • Be open to productive struggle. • Ask questions. • Allow a chance for everyone to participate. Kentucky Department of EDUCATION

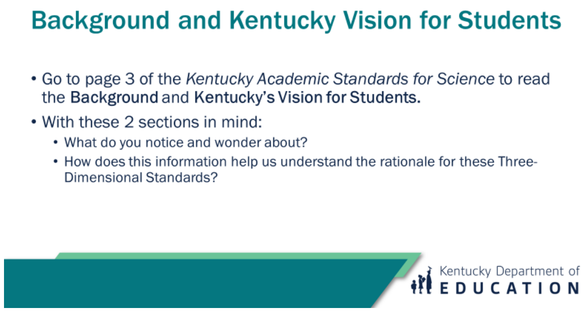
Facilitator Notes	Accompanying Slide(s)
“I realize you may not want to pose every question to the whole group, or we may not have time in the session to get to every question. Therefore, I want us to have a place for to address those issues, questions, or ideas.” *Facilitator Notes:* *Introduce participants to the Issues Bin. The Issues bin can be used by the participant to note ideas, questions, or issues constructively while the other attendees continue to focus on an activity or lesson. You may use a poster or a digital parking lot where participants can access a Google document. The purpose of the Issues Bin is to provide participants with a safe way of asking questions or suggesting ideas. Participants should feel free to add to the Issues Bin throughout the module.* *Remember that you may not know answers to all the questions, and that is okay. Some issues may be addressed in future sections of this module. If the question is pressing and doesn’t appear to be addressed in this module, talk to your district team and determine who would be the best person to contact at the KDE. You may also e-mail questions or feedback to KDEScience@education.ky.gov*	
Setup for Success: Brainwriting **Explain:** The process of aligning classroom instruction to the *KAS for Science* will be at the center of the continuous improvement we strive for within our teaching practice. Before you can know where you are going, let’s consider where you’ve been. We are going to begin with that today.” *The goal of this activity is for educators to understand that cultivating something better within our classroom doesn’t mean forgetting or taking value away from the progress made up until this point. To engage in “Brainwriting,” participants will answer three of the four questions from the slide on self-sticking notes (one note per question) and then stick them to the appropriate poster.*	**Slide 4**  Setup for Success: Brainwriting ▶ What is something you tried in your classroom this year for the first time? How did it go? ▶ What is one way you grew professionally this year? ▶ Who amongst your colleagues was the most helpful to you? Why? ▶ In what ways were you helpful to your colleagues this year? Kentucky Department of EDUCATION

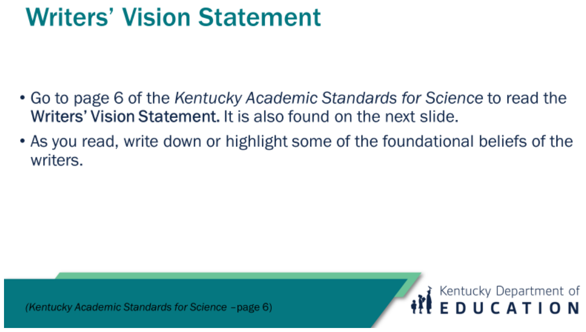
Facilitator Notes	Accompanying Slide(s)
Have participants do a quick "gallery walk" to see the responses of others to the questions. Facilitate discussion of the responses (if needed). **Explain:** As we progress throughout this module, we hope you will embrace the opportunity to grow professionally and consider how you can work with your colleagues to help one another maximize current successes and continuously improve the classroom experience for students. *Facilitator Note:* *Letting participants choose which three questions to answer gives them choice while also allowing new educators to focus on the last three questions.*	
Explain: "Throughout this module, the goals are for you to: ● Build a shared understanding of the architecture and components of the *KAS for Science.* ● Strengthen the understanding of the three dimensions of science and recognize how they work together to support highly effective science teaching and learning. ● Identify and prioritize areas where future professional learning will be needed for successful implementation of the *KAS for Science* and develop a plan to address those areas."	**Slide 5**  **Module Goals:** ► Build a shared understanding of the architecture and components of the *KAS for Science.* ► Strengthen the understanding of the three dimensions of science and recognize how they work together to support highly effective science teaching and learning. ► Identify and prioritize areas where future professional learning will be needed for successful implementation of the *KAS for Science* and develop a plan to address those areas.

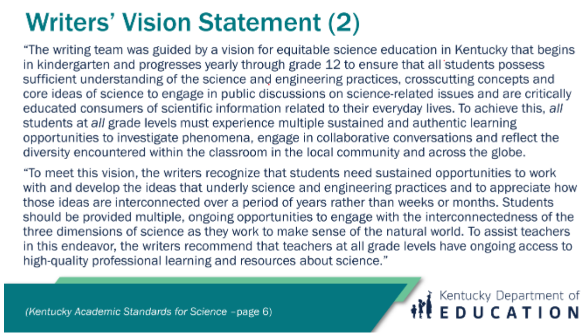
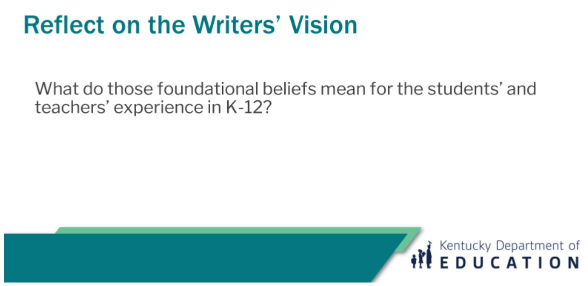
Facilitator Notes	Accompanying Slide(s)
Facilitator Note: *Let participants know that at the completion of all four sessions within this module, they will be asked to develop an "elevator speech" around this statement.*	**Slide 6**  By the end of this module..... You will be able to develop an argument as to how instruction for the *Kentucky Academic Standards for Science* is the same/different as is generally observed in your experiences. Kentucky Department of EDUCATION
Explain: "Today, we will look at the architecture and components of the standards to build a shared understanding of the *KAS for Science*. Outside of revisions to the science standards themselves, one of the major changes you'll note is with the architecture of the document and inclusion of various components to support stakeholders. Remember, for the revision team, determining these changes meant considering: ● Clear and succinct components that educators will find useful as they plan and design instruction. ● Clear and succinct components that other stakeholders will find useful in supporting the work happening within Kentucky classrooms. ● Components that come together to create a cohesive structure within the *KAS for Science*."	**Slide 7**  Getting to Know the *Kentucky Academic Standards for Science*: An Overview Session A: Understanding the Architecture and Components Kentucky Department of EDUCATION 7
Explain: "Remember, one charge of KRS 158.6453 is for the standards to "communicate expectations more clearly and concisely to teachers, parents, students and citizens." Let's consider how elements of the architecture relate to that statement. As we examine each of the components of the *KAS for Science*, please consider how the new components may support teachers and create new opportunities to engage other stakeholders."	**Slide 8**

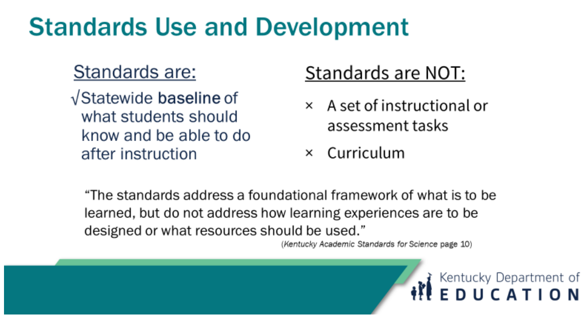
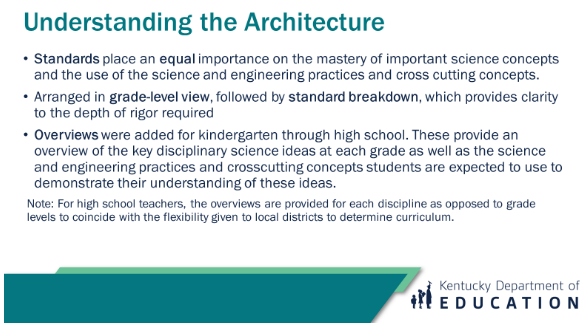
Facilitator Notes	Accompanying Slide(s)
Facilitator Note: *Have the participants record this question on their paper/journal and explain that we will come back to this question at the end of the session. As they think of responses throughout the session, they may choose to record them as they go.*	 Session A: Essential Question How might the components of the architecture support teachers while creating new opportunities for engaging other stakeholders (students, parents, administrators, district leaders)? Kentucky Department of EDUCATION
Explain: “These are the key components provided to support the KAS for Science. Take some independent time to browse through the standards document, focusing on the components listed on the slide. We will look at each of these components more intentionally as we progress through this session.”	**Slide 9**  Components to the *Kentucky Academic Standards for Science* • Background (page 3) • Kentucky Vision for Students (page 3) • Writers’ Vision Statement (page 6) • Standards Use and Development (page 9) • How to Read the Standards (page 12) • Grade Level Overviews • Grade Level Standards Kentucky Department of EDUCATION
Explain: On page 3, you will see the Background and Kentucky’s Vision for Students. Take a moment to read through those 2 sections with these questions in mind: 1. What do you notice and wonder about? 2. How might this information help us understand the rationale for these Three-Dimensional Standards?”	**Slide 10**

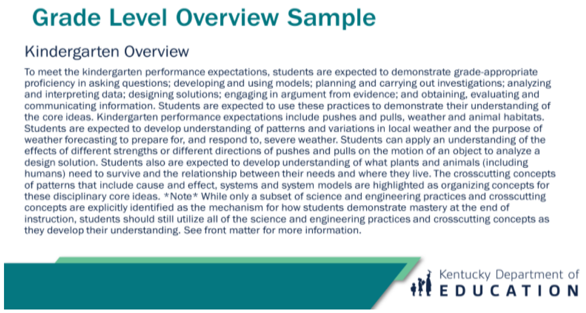
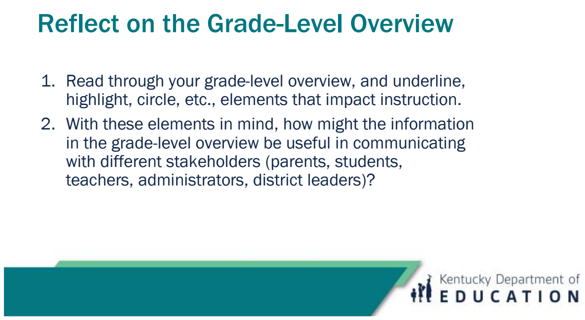
Facilitator Notes	Accompanying Slide(s)

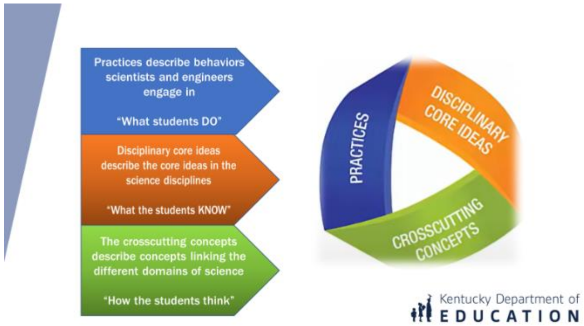
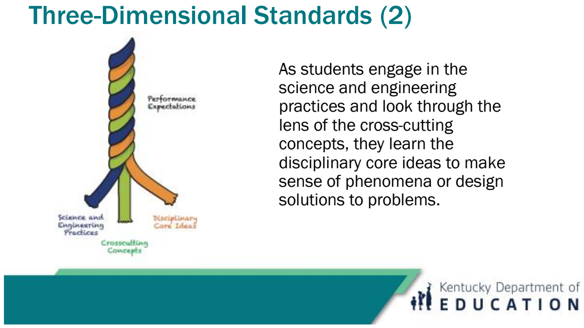
Facilitator Notes:
Have the participants draw a t-chart. On the left side, have them write what they notice and on the right side, have them write wonderings.
 	
Example below:
 	
Notice
Wonderings
 	
Have the participants share out in their table groups and keep track of what is shared in the group by adding a +1 to similar ideas and recording the different responses of others in a different color.
	Background and Kentucky Vision for Students
	• Go to page 3 of the *Kentucky Academic Standards for Science* to read the **Background** and **Kentucky's Vision for Students.**
	• With these 2 sections in mind:
	  • What do you notice and wonder about?
	  • How does this information help us understand the rationale for these Three-Dimensional Standards?
	Kentucky Department of EDUCATION

Explain: "The Writers' Vision is stated on page 6 of the *Kentucky Academic Standards for Science*. The Writers' Vision aligns with KRS 158.6453 requirements and public feedback." Please use this silent time to closely read the Writers' Vision. As you read, write down or highlight the foundational beliefs of the writers.	**Slide 11** Writers' Vision Statement • Go to page 6 of the *Kentucky Academic Standards for Science* to read the **Writers' Vision Statement.** It is also found on the next slide. • As you read, write down or highlight some of the foundational beliefs of the writers. *(Kentucky Academic Standards for Science –page 6)* Kentucky Department of EDUCATION
Facilitator Notes: *Once participants are finished reading and identifying the foundational beliefs, have a quick conversation around those foundational beliefs.* *Some foundational beliefs to pull out are:* • *Receive equitable science education.* • *Experience science learning beginning in kindergarten.*	**Slide 12**

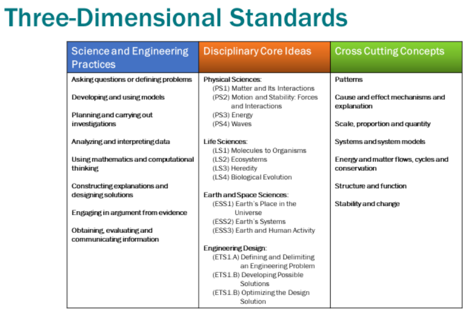
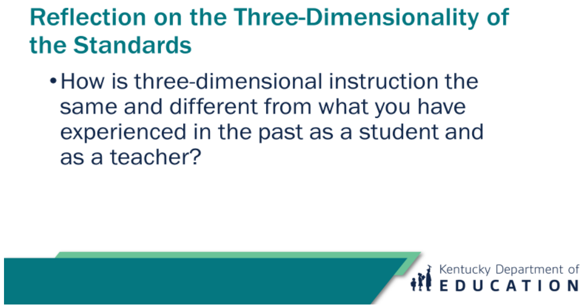
Facilitator Notes	Accompanying Slide(s)
• *Learning progresses yearly.* • *Possess sufficient understanding of the science and engineering practices, crosscutting concepts and core ideas of science.* • *Able to engage in public discussions on science-related issues.* • *Become critical educated consumers of scientific information related to their everyday lives.* • *Experience multiple sustained and authentic learning opportunities.* • *Investigate phenomena.* • *Engage in collaborative conversations.* • *Reflect the diversity encountered within the classroom in the local community and across the globe.* • *Work with and develop the ideas that underly science and engineering practices.* • *See connections of science ideas over a period of years.* • *Engage with the interconnectedness of the three dimensions of science.* • *Make sense of the natural world.* • *Have access to high-quality professional learning and resources.*	 **Writers' Vision Statement (2)** "The writing team was guided by a vision for equitable science education in Kentucky that begins in kindergarten and progresses yearly through grade 12 to ensure that all students possess sufficient understanding of the science and engineering practices, crosscutting concepts and core ideas of science to engage in public discussions on science-related issues and are critically educated consumers of scientific information related to their everyday lives. To achieve this, *all* students at *all* grade levels must experience multiple sustained and authentic learning opportunities to investigate phenomena, engage in collaborative conversations and reflect the diversity encountered within the classroom in the local community and across the globe. "To meet this vision, the writers recognize that students need sustained opportunities to work with and develop the ideas that underly science and engineering practices and to appreciate how those ideas are interconnected over a period of years rather than weeks or months. Students should be provided multiple, ongoing opportunities to engage with the interconnectedness of the three dimensions of science as they work to make sense of the natural world. To assist teachers in this endeavor, the writers recommend that teachers at all grade levels have ongoing access to high-quality professional learning and resources about science." *(Kentucky Academic Standards for Science – page 6)* Kentucky Department of EDUCATION
Explain: Take a minute to record the title, "Writers' Vision" in your notebook. Finish the sentence stems: • These foundational beliefs would mean the student experience in K-12 should… • These foundational beliefs would mean the teacher should… *Facilitator Notes:* *Some things to look for in their responses are:* • *Students should receive science instruction every year.* • *Students should understand and be able to use the science and engineering practices and crosscutting concepts and the disciplinary core ideas.*	**Slide 13**  **Reflect on the Writers' Vision** What do those foundational beliefs mean for the students' and teachers' experience in K-12? Kentucky Department of EDUCATION

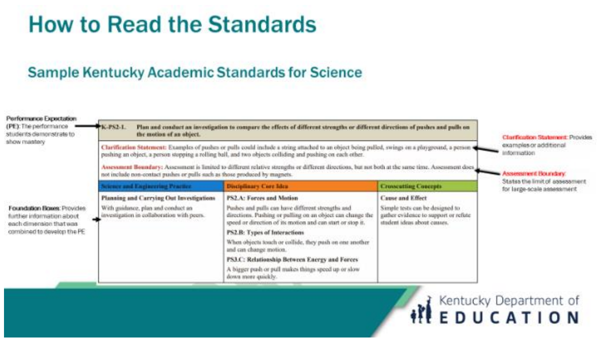
Facilitator Notes	Accompanying Slide(s)
• *Students should engage in collaborative discussions on science related issues.* • *Students should be critical consumers of scientific information.* • *The learning should be authentic.* • *Students should be investigating phenomena.* • *Students should be able to see how science ideas are interconnected over the years.* • *Teachers should have ongoing access to high quality professional learning.* • *Teachers should have high-quality resources about science.* *Provide time for some discussion in small groups. As you walk around and listen to discussions, ask some to share if they specifically target one of the ideas above. Allow the participants to share out in whole group.*	
Explain: Here we see the intended use for standards. Standards are the **baseline** of what students should know and be able to do and are not to be used as a set of assessment tasks or curriculum. The standards are a responsibility of the Kentucky Board of Education and the Kentucky Department of Education. The curriculum addresses **how** learning experiences are designed at the local level.	**Slide 14**  Standards Use and Development Standards are: √Statewide **baseline** of what students should know and be able to do after instruction Standards are NOT: × A set of instructional or assessment tasks × Curriculum "The standards address a foundational framework of what is to be learned, but do not address how learning experiences are to be designed or what resources should be used." (*Kentucky Academic Standards for Science* page 10) Kentucky Department of EDUCATION
Background for Facilitator: *This information is found in the Kentucky Academic Standards for Science at a Glance Document and highlights some key features of the architecture.*	**Slide 15**  Understanding the Architecture • **Standards** place an **equal** importance on the mastery of important science concepts and the use of the science and engineering practices and cross cutting concepts. • Arranged in **grade-level view**, followed by **standard breakdown**, which provides clarity to the depth of rigor required • **Overviews** were added for kindergarten through high school. These provide an overview of the key disciplinary science ideas at each grade as well as the science and engineering practices and crosscutting concepts students are expected to use to demonstrate their understanding of these ideas. Note: For high school teachers, the overviews are provided for each discipline as opposed to grade levels to coincide with the flexibility given to local districts to determine curriculum. Kentucky Department of EDUCATION

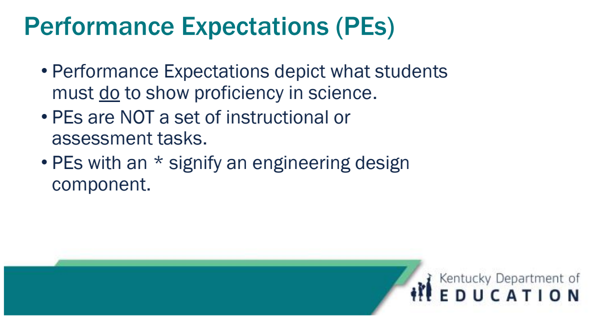
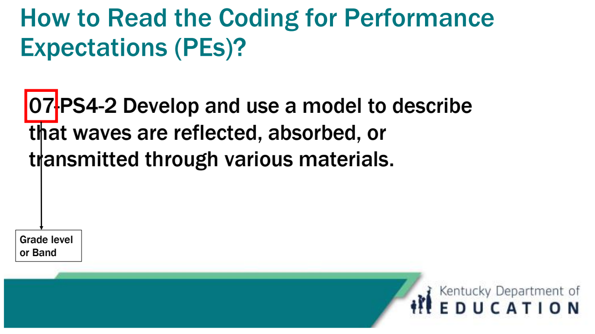
Facilitator Notes	Accompanying Slide(s)
Explain: Grade level overviews were added for kindergarten through high school. These provide an overview of the key disciplinary science ideas at each grade and, for high school, each discipline. The science and engineering practices and crosscutting concepts students are expected to use to demonstrate their understanding of these ideas are also included in the overview. In addition to grade level overviews, grade-band overviews for engineering design describe the key components of the engineering design process. These can be found on pages 47, 96, 158 and 164 of the *KAS for Science*. Additional examples of the specific overviews are identified in the Table of Contents.	**Slide 16**  Grade Level Overview Sample Kindergarten Overview To meet the kindergarten performance expectations, students are expected to demonstrate grade-appropriate proficiency in asking questions; developing and using models; planning and carrying out investigations; analyzing and interpreting data; designing solutions; engaging in argument from evidence; and obtaining, evaluating and communicating information. Students are expected to use these practices to demonstrate their understanding of the core ideas. Kindergarten performance expectations include pushes and pulls, weather and animal habitats. Students are expected to develop understanding of patterns and variations in local weather and the purpose of weather forecasting to prepare for, and respond to, severe weather. Students can apply an understanding of the effects of different strengths or different directions of pushes and pulls on the motion of an object to analyze a design solution. Students also are expected to develop understanding of what plants and animals (including humans) need to survive and the relationship between their needs and where they live. The crosscutting concepts of patterns that include cause and effect, systems and system models are highlighted as organizing concepts for these disciplinary core ideas. *Note* While only a subset of science and engineering practices and crosscutting concepts are explicitly identified as the mechanism for how students demonstrate mastery at the end of instruction, students should still utilize all of the science and engineering practices and crosscutting concepts as they develop their understanding. See front matter for more information. Kentucky Department of EDUCATION
Explain: Find the overview for your grade level. While you are carefully reading through the overview, underline, highlight or circle elements that impact instruction. Hint: Pay attention to the science and engineering practices, crosscutting concepts and disciplinary core ideas that are included for this grade level. *Facilitator Notes: You may consider grouping participants according to the grade level they teach so that participants can support one another as they examine the overview. Circle back around to the essential question for Session A recorded in your notebook and add ideas for how the overviews are useful in communicating with different stakeholders. You can facilitate some discussion around question 2 using the Think-Write-Pair-Share strategy. The traditional Think-Write-Pair-Share strategy is designed to differentiate instruction by providing participants with time and structure for thinking about a given topic, enabling them to formulate individual ideas and share these ideas with a peer. Allow time for participants to share ideas in whole group.*	**Slide 17**  Reflect on the Grade-Level Overview 1. Read through your grade-level overview, and underline, highlight, circle, etc., elements that impact instruction. 2. With these elements in mind, how might the information in the grade-level overview be useful in communicating with different stakeholders (parents, students, teachers, administrators, district leaders)? Kentucky Department of EDUCATION
Explain: "Each one of the performance expectations is three-dimensional, meaning that the performance expectations are made up of a science and engineering practice, crosscutting concept, and a disciplinary core idea.	**Slide 18**

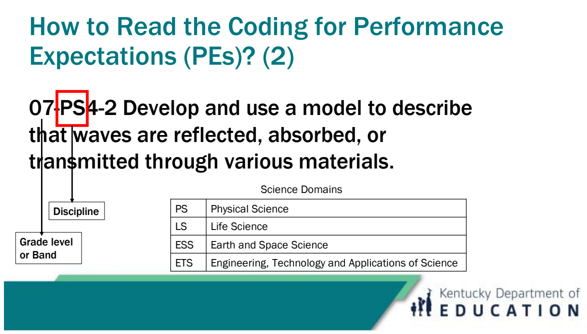
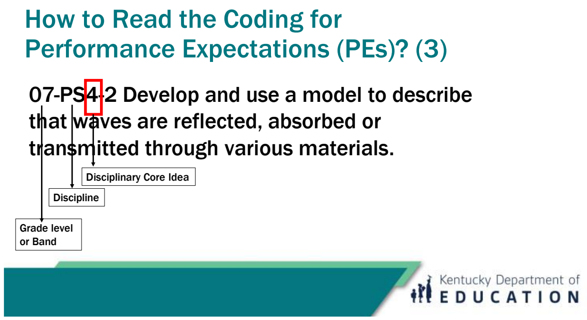
Facilitator Notes	Accompanying Slide(s)
Science and Engineering Practices refer to what the students do and describes the way in which scientists and engineers engage in their work. They engage in wonder, design, modeling, argumentation, communication, and engineering thinking. While a specific practice may be identified in each performance expectation, students should engage in all practices to help them understand how scientific knowledge develops and the links between science and engineering. Disciplinary Core Ideas refer to what the students know. Core ideas found in the *Kentucky Academic Standards for Science* are foundational understandings so that students may later acquire additional information on their own. The core ideas are organized by discipline: physical science, life science and earth/space science. Also found here are the ideas used in the engineering design process, identified as ETS (engineering, technology, and application of science). Crosscutting Concepts are conceptual tools that are used as lenses for understanding the natural/designed world. They provide ways of thinking and reasoning about phenomena across disciplines, uniting core ideas throughout the fields of science and engineering. While specific crosscutting concepts may be identified in each performance expectation, explicit instruction and engagement in all crosscutting concepts is expected.	 Practices describe behaviors scientists and engineers engage in "What students DO" Disciplinary core ideas describe the core ideas in the science disciplines "What the students KNOW" The crosscutting concepts describe concepts linking the different domains of science "How the students think" Kentucky Department of EDUCATION
Explain: "Think of the three components of three-dimensional learning as three intertwining strands of a rope. While the rope can be separated into its three different strands, the strength of the rope is determined by the strands working together; separating the strands weakens the rope so that it is no longer effective for our intended use. In the past, we may have separated out the knowledge and skills students need in the study of science. Knowing and doing cannot be separated if our goal is the kind of usable, conceptual understanding students need to think, act, and learn like scientists.	**Slide 19**  Three-Dimensional Standards (2) As students engage in the science and engineering practices and look through the lens of the cross-cutting concepts, they learn the disciplinary core ideas to make sense of phenomena or design solutions to problems. Kentucky Department of EDUCATION

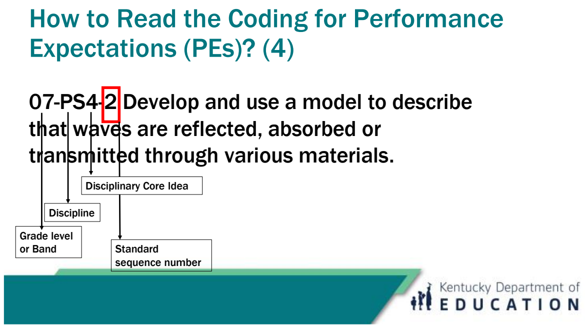
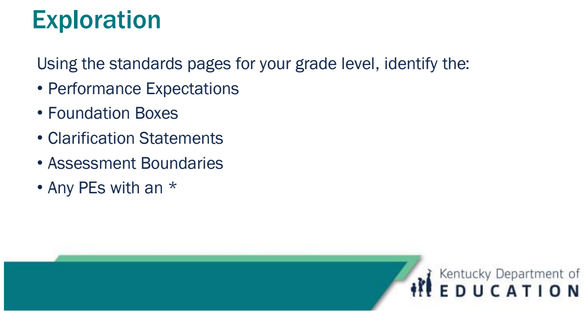
<table>
<tr><th>Facilitator Notes</th><th>Accompanying Slide(s)</th></tr>
<tr><td>Three-dimensional learning (science and engineering practices, core ideas, and crosscutting concepts working together) is therefore a non-negotiable for science lessons and units.”

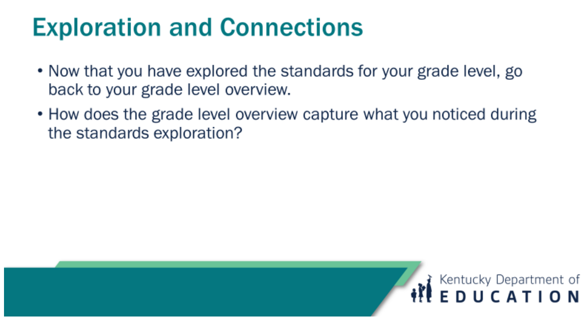
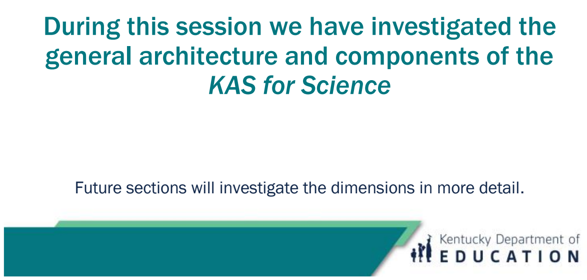
Facilitator Note:
Have the participants read the quote on the slide to help them understand how the students use each of the three dimensions to make sense of the world around them.</td><td></td></tr>
<tr><td>Explain:
“This table provides a summary of each science dimension. We will have the opportunity in the future sessions to gain a more in-depth understanding of each of the dimensions.”</td><td>Slide 20
Three-Dimensional Standards
<table><tr><th>Science and Engineering Practices</th><th>Disciplinary Core Ideas</th><th>Cross Cutting Concepts</th></tr><tr><td>Asking questions or defining problems
Developing and using models
Planning and carrying out investigations
Analyzing and interpreting data
Using mathematics and computational thinking
Constructing explanations and designing solutions
Engaging in argument from evidence
Obtaining, evaluating and communicating information</td><td>Physical Sciences:
(PS1) Matter and Its Interactions
(PS2) Motion and Stability: Forces and Interactions
(PS3) Energy
(PS4) Waves
Life Sciences:
(LS1) Molecules to Organisms
(LS2) Ecosystems
(LS3) Heredity
(LS4) Biological Evolution
Earth and Space Sciences:
(ESS1) Earth’s Place in the Universe
(ESS2) Earth’s Systems
(ESS3) Earth and Human Activity
Engineering Design:
(ETS1.A) Defining and Delimiting an Engineering Problem
(ETS1.B) Developing Possible Solutions
(ETS1.B) Optimizing the Design Solution</td><td>Patterns
Cause and effect mechanisms and explanation
Scale, proportion and quantity
Systems and system models
Energy and matter flows, cycles and conservation
Structure and function
Stability and change</td></tr></table></td></tr>
<tr><td>Facilitator Notes:
Allow some reflection time after learning about the three-dimensionality of the KAS for Science. To allow participants a voice, use the Think-Write-Pair-Share strategy once again to create some small group discussion prior to whole group discussion.</td><td>Slide 21
Reflection on the Three-Dimensionality of the Standards
• How is three-dimensional instruction the same and different from what you have experienced in the past as a student and as a teacher?
Kentucky Department of EDUCATION</td></tr>
<tr><td>Explain:
“In addition to this sample of the Kentucky Academic Standards for Science, you can find a sample layout with the key components labelled on page 12 of the KAS for Science”. As you examine this together, point out the following:</td><td>Slide 22</td></tr>
</table>

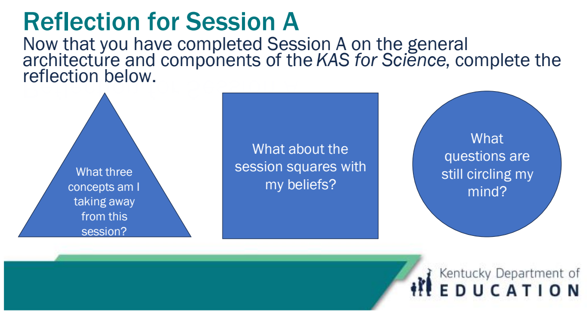
Facilitator Notes	Accompanying Slide(s)
• “The foundation boxes provide additional clarity to the performance expectation as they contain specific information around each of the three dimensions: Science and Engineering Practices, Disciplinary Core Ideas, and the Crosscutting Concepts. • The examples in the clarification statements are just that—examples. Teachers are not expected to teach each one of these and may choose other examples that relate to the intent of the PE. • Due to the adoption of new Mathematics and Reading and Writing standards in Kentucky, the connection boxes have been removed. • Since the standards were written specifically for large-scale (state) assessment, the assessment boundaries determine what can/cannot be assessed on a state assessment.” ***Background for the Facilitator:*** *The NGSS are based on A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (Framework) developed by the National Research Council (NRC). In putting the vision of the Framework into practice, the NGSS have been written as performance expectations (PEs), that depict what students must do to show proficiency in science. To show alignment and coherence to the Framework, the NGSS include the “foundation boxes” to ensure that curriculum and assessment developers would not be required to guess the intent of the PEs.* *Facilitator Notes:* For this discussion, you may wish participants to have access to the *KAS for Science*, especially if they are unfamiliar with the layout. *Facilitators may note here that teachers may choose to go beyond the state boundary in instruction, especially to meet the needs of their students.*	 How to Read the Standards Sample Kentucky Academic Standards for Science **Performance Expectation (PE):** The performance students demonstrate to show mastery **K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.** **Clarification Statement:** Examples of pushes or pulls could include a string attached to an object being pulled, swings on a playground, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other. **Assessment Boundary:** Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets. **Clarification Statement:** Provides examples or additional information **Assessment Boundary:** States the limit of assessment for large-scale assessment **Foundation Boxes:** Provides further information about each dimension that was combined to develop the PE **Science and Engineering Practice** **Planning and Carrying Out Investigations** With guidance, plan and conduct an investigation in collaboration with peers. **Disciplinary Core Idea** **PS2.A: Forces and Motion** Pushes and pulls can have different strengths and directions. Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. **PS2.B: Types of Interactions** When objects touch or collide, they push on one another and can change motion. **PS3.C: Relationship Between Energy and Forces** A bigger push or pull makes things speed up or slow down more quickly. **Crosscutting Concepts** **Cause and Effect** Simple tests can be designed to gather evidence to support or refute student ideas about causes. Kentucky Department of EDUCATION
Explain:	**Slide 23**

Facilitator Notes	Accompanying Slide(s)
“The *KAS for Science* are adapted from the *Next Generation Science Standards.* They were officially adopted on June 5, 2013 by the Kentucky Board of Education and then revised July 5, 2023.” *Talking Points:* • Due to the structure, the PEs depict what students must do to demonstrate their ability to utilize science and engineering practices and crosscutting concepts to understand the science concepts. • An engineering design component means that there is an application of science to solve some human need.	Performance Expectations (PEs) • Performance Expectations depict what students must do to show proficiency in science. • PEs are NOT a set of instructional or assessment tasks. • PEs with an * signify an engineering design component. Kentucky Department of EDUCATION
Explain: “The codes for the performance expectations were derived from the Framework for K-12 Science Education. The first digits indicate a grade K-8 or HS (high school).” *Talking Points:* • All components of the *KAS for Science* are grade-banded. • Kentucky determined into which grade the Middle School PEs would be divided. • Kentucky has associated the High School PEs with some courses that schools may offer. These can be accessed at the Course Standards webpage. • While some PEs may incorporate engineering design principles, there are specific engineering design standards for each grade band.	**Slide 24** How to Read the Coding for Performance Expectations (PEs)? 07-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. Grade level or Band Kentucky Department of EDUCATION
Explain: “The next alpha-numeric code specifies the discipline. The chart on the screen shows the 4	**Slide 25**

Facilitator Notes	Accompanying Slide(s)
disciplines in science. Since this performance expectation (PE) contains the PS code, this PE falls under the Physical Science Discipline.”	 How to Read the Coding for Performance Expectations (PEs)? (2) 07-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. Science Domains PS Physical Science LS Life Science ESS Earth and Space Science ETS Engineering, Technology and Applications of Science Kentucky Department of EDUCATION
Explain: “After the discipline, you see an addition number, corresponding to a specific core idea in that discipline. The core ideas can be seen on slide 19. Since this has the number 4 following the PS, that means that this PE addresses Waves. ”	**Slide 26**  How to Read the Coding for Performance Expectations (PEs)? (3) 07-PS4-2 Develop and use a model to describe that waves are reflected, absorbed or transmitted through various materials. Kentucky Department of EDUCATION
Explain: “Finally, the number at the end of each code indicates the order in which that statement appeared as a DCI in the Framework.”	**Slide 27**

Facilitator Notes	Accompanying Slide(s)
	 How to Read the Coding for Performance Expectations (PEs)? (4) 07-PS4-2 Develop and use a model to describe that waves are reflected, absorbed or transmitted through various materials. Disciplinary Core Idea Discipline Grade level or Band Standard sequence number Kentucky Department of EDUCATION
Facilitator Notes: *Allow participants 2-3 minutes to explore the standards page for their grade/grade level/course identifying the:* • *Performance Expectation* • *Foundation Boxes* • *Clarification Statements* • *Assessment Boundaries* • *Performance Expectations with an * (Note: the Performance Expectations marked with an * signify an engineering design component.)* **Explain**: "With others in your [grade/grade band/course] share some findings you had. Discuss any surprises or concerns you may have." *Facilitator Notes:* *During this time, you may wish to walk around and listen to the conversations. If there are few people present, you may wish to have one group discussion. When sharing out, have participants share their findings, surprises, ah-ha's, concerns, etc.*	**Slide 28**  Exploration Using the standards pages for your grade level, identify the: • Performance Expectations • Foundation Boxes • Clarification Statements • Assessment Boundaries • Any PEs with an * Kentucky Department of EDUCATION

Facilitator Notes	Accompanying Slide(s)
Explain: “Now that you have had the opportunity to explore your grade level standards, take some time to compare this with your grade level overview. How does the grade level overview capture what you noticed in your standards?” Discuss your thoughts with others in your [grade/grade band/course]. *Facilitator Notes:* *Again, you may wish to walk around and listen to the conversations. You should ensure that everyone sees the connection between the grade level overview and the standards. They should see that the overview is simply a high-level summarization of the standards. The overview only includes disciplinary core ideas, science and engineering practices and crosscutting concepts found within the standards of that particular grade level.*	**Slide 29**  Exploration and Connections • Now that you have explored the standards for your grade level, go back to your grade level overview. • How does the grade level overview capture what you noticed during the standards exploration? Kentucky Department of EDUCATION
Explain: “We have spent some time investigating the general architecture of the *KAS for Science*. In future sessions we will look at each of the dimensions of science in more detail.”	**Slide 30**  During this session we have investigated the general architecture and components of the *KAS for Science* Future sections will investigate the dimensions in more detail. Kentucky Department of EDUCATION
Explain: “At this time, we are going to Stop and Reflect on the learning from Session A. Using your paper/journal, answer the questions on the slide.” *Facilitator’s Notes:* *You may decide to allow participants to share or just use the prompt for the participants’ self-reflection. You can ask the participants to post their questions to the Issues Bin created at the*	**Slide 31**

Facilitator Notes	Accompanying Slide(s)
beginning of this module.	 Reflection for Session A Now that you have completed Session A on the general architecture and components of the *KAS for Science*, complete the reflection below. What three concepts am I taking away from this session? What about the session squares with my beliefs? What questions are still circling my mind? Kentucky Department of EDUCATION

Module 1: The Kentucky Academic Standards (KAS) for Science: An Overview

Preparation for Session B: Dimensions of Science: Disciplinary Core Ideas (DCIs)

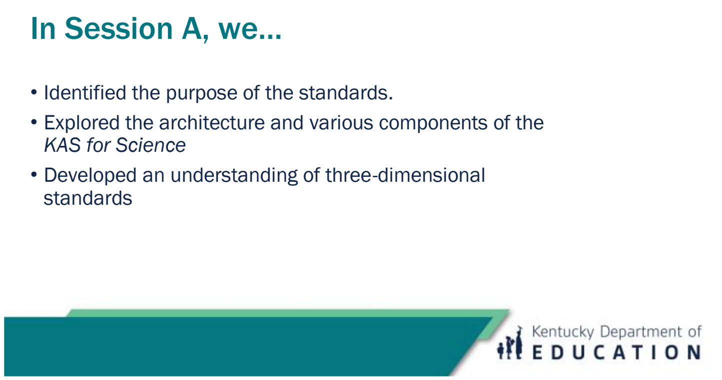
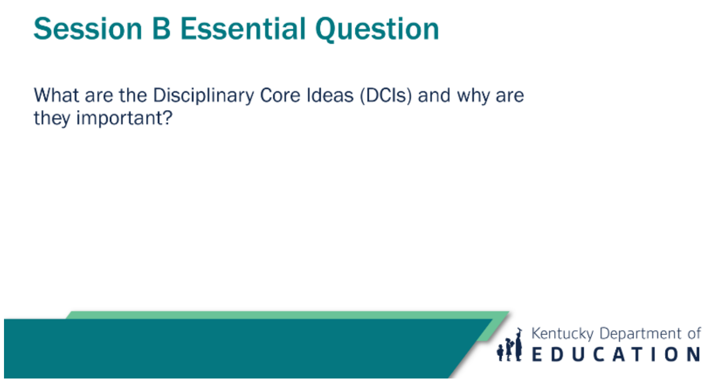
Facilitator Work Session Supplies Needed:

These items will be needed with this module.

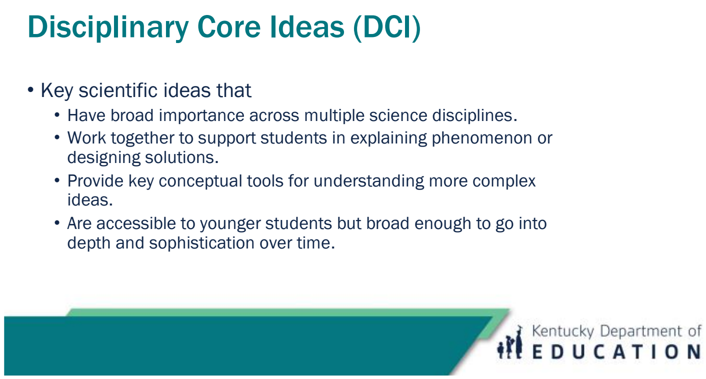
- Computer with access to the *KAS for Science: An Overview* slide presentation
- Technology with projection capability, including a speaker system
- Appendix E (paper or electronic)
- Appendix I (paper or electronic)
- Poster paper (if facilitator chooses a gallery walk for DCI sharing)
- Self-sticking notes (if facilitator chooses a gallery walk for DCI sharing)

Session B: Dimensions of Science: Disciplinary Core Ideas (DCIs)

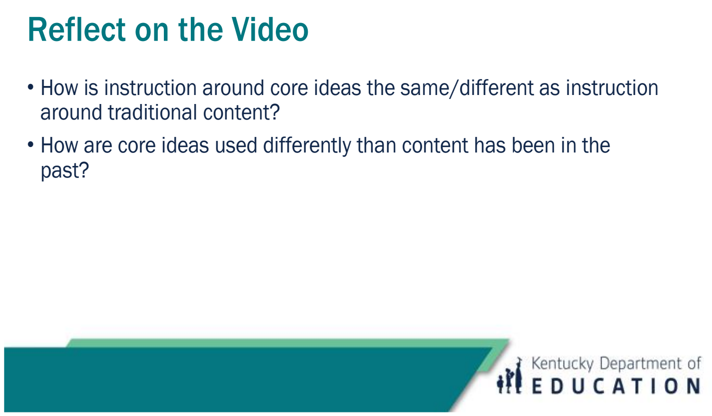
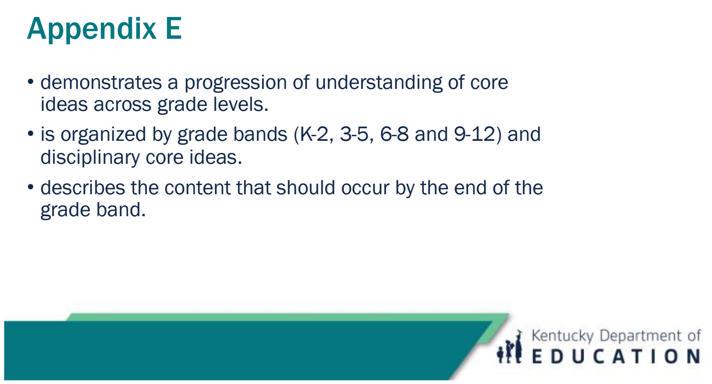
Facilitator Notes	Accompanying Slide(s)
Explain: "We will now be investigating the three dimensions of the *KAS for Science*. We will begin with the Disciplinary Core Ideas, or DCIs." *Background Information for Facilitator:* *The Framework focuses on a limited number of core ideas in science and engineering both within and across the disciplines. This decision was made to avoid the shallow coverage of a large number of topics and to allow more time for teachers and students to explore each idea in greater depth. Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented. Delimiting what is to be learned about each core idea within each grade band also helps clarify what is most important to spend time on and avoid the proliferation of detail to be learned with no conceptual grounding. (NRC, 2012)* *There is an additional section on Engineering Design, which also falls under the DCIs. Facilitators may wish to combine the two concepts together or keep them as separate discussions.*	**Slide 32**  The *Kentucky Academic Standards for Science*: An Overview Session B: Dimensions of Science: Disciplinary Core Ideas (DCI) Kentucky Department of EDUCATION 29
Facilitator Notes: *Briefly review learning and experiences from the previous learning, using information on this slide for guidance. You may also bring out any discussions that came out in the previous session.*	**Slide 33**

Facilitator Notes	Accompanying Slide(s)
	 **In Session A, we…** - Identified the purpose of the standards. - Explored the architecture and various components of the *KAS for Science* - Developed an understanding of three-dimensional standards Kentucky Department of EDUCATION
Explain*:* “During this session we will take a closer look at the Disclipinary Core Ideas and consider why they are so important to science teaching and learning.”	**Slide 34**  **Session B Essential Question** What are the Disciplinary Core Ideas (DCIs) and why are they important? Kentucky Department of EDUCATION

Facilitator Notes	Accompanying Slide(s)

Explain:
“Because of the easy access of information, or facts, an important role of science education is to prepare students with sufficient core knowledge so that they can acquire additional information on their own. Therefore, a small set of core ideas that meet these criteria were developed. These core ideas, or elements of them, appear across science domains.”
	Slide 35
	
	Disciplinary Core Ideas (DCI)
	- Key scientific ideas that
	  - Have broad importance across multiple science disciplines.
	  - Work together to support students in explaining phenomenon or designing solutions.
	  - Provide key conceptual tools for understanding more complex ideas.
	  - Are accessible to younger students but broad enough to go into depth and sophistication over time.
	Kentucky Department of EDUCATION

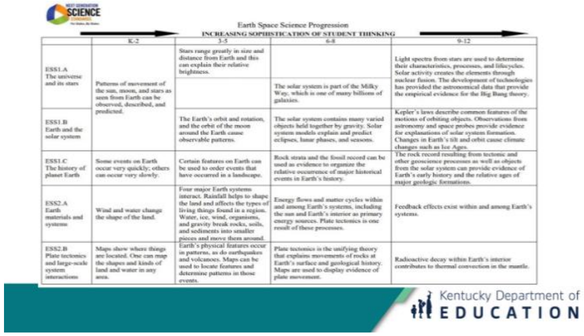
This video highlights the DCIs and why they are important. After watching the video, participants will be asked to reflect on what they saw and heard. Facilitators may wish to share the questions shown on the next slide in order to set the stage for the video. Video can be found at https://www.nextgenscience.org/resources/video-ngss-disciplinary-core-ideas.	**Slide 36**  Disciplinary Core Ideas This video highlights the Disciplinary Core Ideas in a teacher Professional Learning Session. Disciplinary Core Ideas Kentucky Department of EDUCATION

Facilitator Notes	Accompanying Slide(s)
After watching the video, participants should reflect on these two questions. How this reflection could occur is up to the facilitator. However, participants should be provided time to reflect individually before whole group reflection/discussion occurs. *Ideas to listen for:* • *Teaching is not around specific scientific "facts."* • *Instruction is around "Big Ideas."* • *Student discourse assists in leading toward understanding.* • *Application of the "big ideas" are readdressed within the same school year and across years.*	**Slide 37**  Reflect on the Video • How is instruction around core ideas the same/different as instruction around traditional content? • How are core ideas used differently than content has been in the past? Kentucky Department of EDUCATION
Explain: "To see how these core ideas progress across grade bands, a progressions document, Appendix E, was developed. The information provided here is not exhaustive of all the elements of the DCIs, but does provide a general overview of how an idea increases in depth and sophistication over time." *Slides 36-38 provide further background about the DCIs and the progressions from K-HS. Participants will need access to Appendix E as they will be using this during the exploration described in Slide 37. You should determine when would be best for participants to access Appendix E.* *Access to Appendix E at https://www.nextgenscience.org/sites/default/files/resource/files/AppendixE-ProgressionswithinNGSS-061617.pdf*	**Slide 38**  Appendix E • demonstrates a progression of understanding of core ideas across grade levels. • is organized by grade bands (K-2, 3-5, 6-8 and 9-12) and disciplinary core ideas. • describes the content that should occur by the end of the grade band. Kentucky Department of EDUCATION

Facilitator Notes | **Accompanying Slide(s)**

This is a sample page showing some of the Physical Science progressions.

Slide 39



Earth Space Science Progression

INCREASING SOPHISTICATION OF STUDENT THINKING

	K-2	3-5	6-8	9-12
ESS1.A The universe and its stars	Patterns of movement of the sun, moon, and stars as seen from Earth can be observed, described, and predicted.	Stars range greatly in size and distance from Earth and this can explain their relative brightness.		Light spectra from stars are used to determine their characteristics, processes, and lifecycles. Solar activity creates the elements through nuclear fusion. The development of technologies has provided the astronomical data that provide the empirical evidence for the Big Bang theory.
			The solar system is part of the Milky Way, which is one of many billions of galaxies.	
ESS1.B Earth and the solar system		The Earth's orbit and rotation, and the orbit of the moon around the Earth cause observable patterns.	The solar system contains many varied objects held together by gravity. Solar system models explain and predict eclipses, lunar phases, and seasons.	Kepler's laws describe common features of the motions of orbiting objects. Observations from astronomy and space probes provide evidence for explanations of solar system formation. Changes in Earth's tilt and orbit cause climate changes such as Ice Ages.
ESS1.C The history of planet Earth	Some events on Earth occur very quickly; others can occur very slowly.	Certain features on Earth can be used to order events that have occurred in a landscape.	Rock strata and the fossil record can be used as evidence to organize the relative occurrence of major historical events in Earth's history.	The rock record resulting from tectonic and other geoscience processes as well as objects from the solar system can provide evidence of Earth's early history and the relative ages of major geologic formations.
ESS2.A Earth materials and systems	Wind and water change the shape of the land.	Four major Earth systems interact. Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, organisms, and gravity break rocks, soils, and sediments into smaller pieces and move them around.	Energy flows and matter cycles within and among Earth's systems, including the sun and Earth's interior as primary energy sources. Plate tectonics is one result of these processes.	Feedback effects exist within and among Earth's systems.
ESS2.B Plate tectonics and large-scale system interactions	Maps show where things are located. One can map the shapes and kinds of land and water in any area.	Earth's physical features occur in patterns, as do earthquakes and volcanoes. Maps can be used to locate features and determine patterns in those events.	Plate tectonics is the unifying theory that explains movements of rocks at Earth's surface and geological history. Maps are used to display evidence of plate movement.	Radioactive decay within Earth's interior contributes to thermal convection in the mantle.

Kentucky Department of EDUCATION

Explain:
"Take a few moments to explore the DCI progressions."

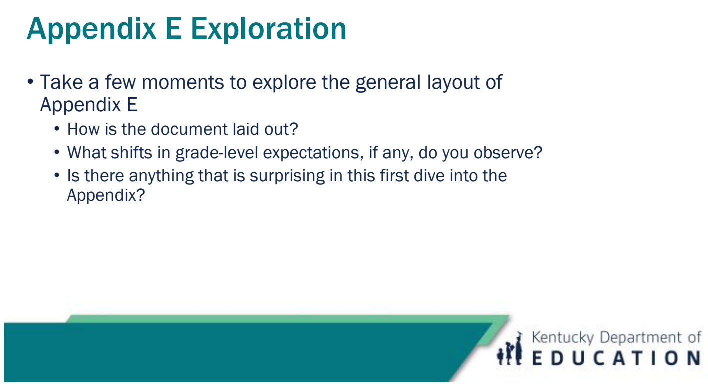
Facilitator Notes:
Allow participants two or three minutes to individually explore Appendix E. After this time, lead a discussion of the large group, sharing their findings, surprises, ah-ha's, etc.

Some findings to point out:

- *Some sub-DCIs at particular grade-bands contain an "N/A" (e.g., PS3.A for K-2)*
- *Some sub-DCIs are combined into a single statement for some grade bands (e.g., LS3.A & LS3.B for K-2 and 3-5)*
- *Some content for a given sub-DCI is located elsewhere (e.g., LS2.B for K-2)*

**Important Note: The progressions shown in this Appendix provide a big picture of the core ideas presented. In addition, these are expectations at the end of the grade band. More detail about each core idea is provided in the Framework. A resource that goes into further detail for each progression is [Disciplinary Core Ideas: Reshaping Teaching and Learning]*

Slide 40



Appendix E Exploration

- Take a few moments to explore the general layout of Appendix E
  - How is the document laid out?
  - What shifts in grade-level expectations, if any, do you observe?
  - Is there anything that is surprising in this first dive into the Appendix?

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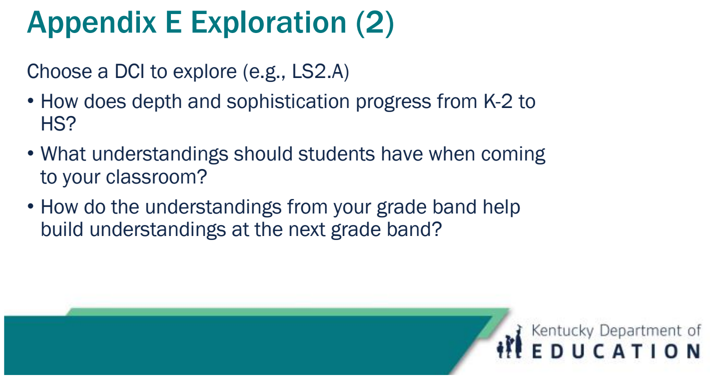
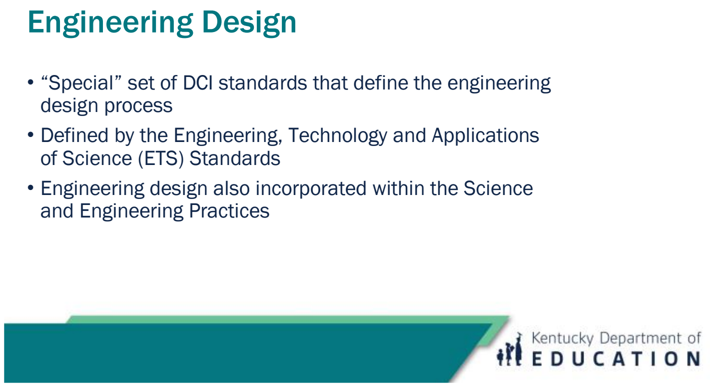
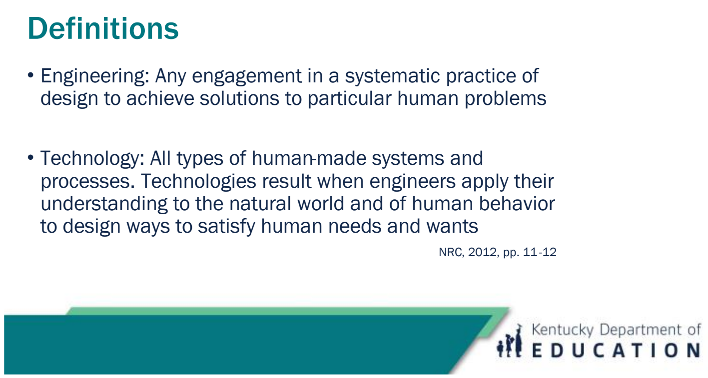
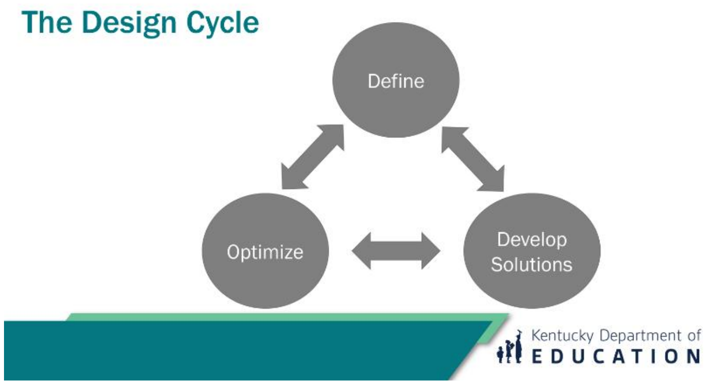
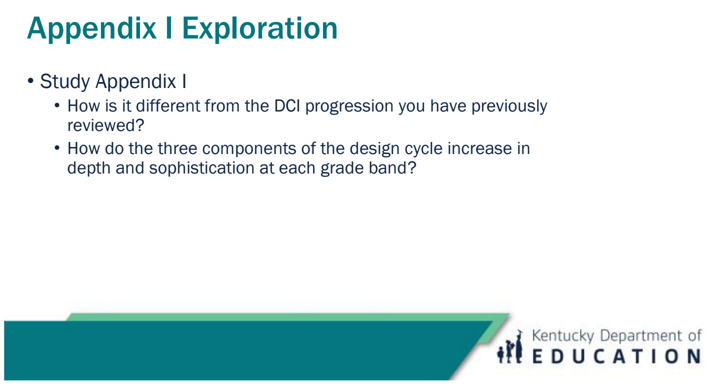
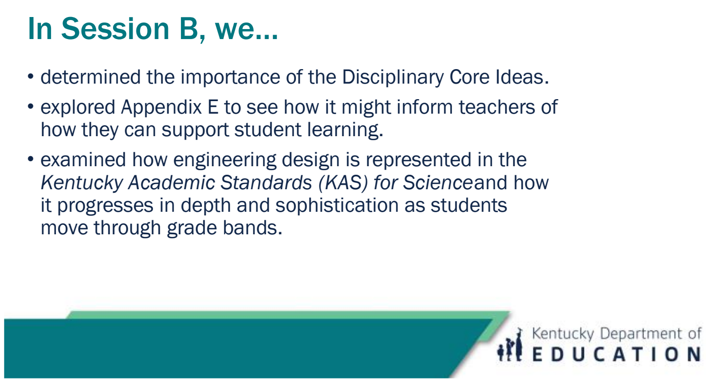
Facilitator Notes	Accompanying Slide(s)
Explain: “We will now explore the progression in a bit more depth.” *Possible set-ups for this exploration:* - *Whole group looking at the same sub-DCI(s)* - *Small heterogeneous groups having discussions about different sub-DCIs. Findings could be posted and a gallery walk/carousel could follow.* - *Small homogeneous (same grade/grade and/course) groups having discussions about different sub-DCIs and the implications for their curriculum. A jigsaw protocol could be used to share across the entire group.* *If small groups are chosen, the facilitator may wish to walk around and listen to the conversations.*	**Slide 41**  Appendix E Exploration (2) Choose a DCI to explore (e.g., LS2.A) • How does depth and sophistication progress from K-2 to HS? • What understandings should students have when coming to your classroom? • How do the understandings from your grade band help build understandings at the next grade band?
Explain: Also incorporated within the DCIs are standards defining Engineering Design, which we will now explore.” *Background Notes for Facilitators:* *The term “engineering design” has replaced the older term “technological design,” consistent with the definition of engineering as a systematic practice for solving problems, and technology as the result of that practice. According to the Framework: “From a teaching and learning point of view, it is the iterative cycle of design that offers the greatest potential for applying science knowledge in the classroom and engaging in engineering practices” (NRC, 2012, pp. 201-202).*	**Slide 42**  Engineering Design • “Special” set of DCI standards that define the engineering design process • Defined by the Engineering, Technology and Applications of Science (ETS) Standards • Engineering design also incorporated within the Science and Engineering Practices

Facilitator Notes	Accompanying Slide(s)
In the NGSS, engineering design is integrated throughout the document. First, a fair number of standards in the three disciplinary areas of life, physical, and earth and space sciences begin with an engineering practice. In these standards, students demonstrate their understanding of science through the application of engineering practices. Second, the NGSS also include separate standards for engineering design at the K-2, 3-5, 7-8, and 9-12 grade levels. This multi-pronged approach, including engineering design both as a set of practices and as a set of core ideas, is consistent with the original intention of the Framework. *The NGSS do not put forward a full set of standards for engineering education, but rather include only practices and ideas about engineering design that are considered necessary for literate citizens.*	
Explain: "To ensure that we have a common understanding of what is meant by engineering and technology, these definitions were presented in the *Framework*. These definitions will be used as we think about engineering and technology as used in the *KAS for Science*." *Facilitator Notes:* *The Framework's definitions address two common misconceptions. The first is that engineering design is not just applied science. As described in Appendix F, the practices of engineering have much in common with the practices of science, although engineering design has a different purpose and product than scientific inquiry. The second misconception is that technology only refers to computers or electronic devices. From this definition, we can see that technology describes all the ways that people have modified the natural world to meet their needs and wants.* *The purpose of defining "engineering" more broadly in the Framework and the NGSS is to emphasize engineering design practices that all citizens should learn. For example,*	**Slide 43**  Definitions - Engineering: Any engagement in a systematic practice of design to achieve solutions to particular human problems - Technology: All types of human-made systems and processes. Technologies result when engineers apply their understanding to the natural world and of human behavior to design ways to satisfy human needs and wants NRC, 2012, pp. 11-12 Kentucky Department of EDUCATION

Facilitator Notes	Accompanying Slide(s)
students are expected to be able to define problems—situations that people wish to change--by specifying criteria and constraints for acceptable solutions, generating and evaluating multiple solutions, building and testing prototypes, and optimizing a solution.	
Explain: "Engineering design is based upon the design cycle. Notice how this cycle is iterative and not moving in a single direction. What implications does this have for science education?" *The question posed is a thought-question. Facilitators may wish to have people share out their ideas to the whole group, share at a table, or have an individual think time.* *Facilitator Notes:* *The emphasis here is on the idea that there is no clear-cut solution to any problem, and that such solutions can possibly become "better" (optimized). The classic example is the cleaning product, Formula-409. The number "409" represents the 409th formula developed that solved the defined problem.*	**Slide 44**  The Design Cycle Define Develop Solutions Optimize Kentucky Department of EDUCATION

Explain:
"We will now take some time to explore Appendix I, which shows the progression of engineering design for each grade band."
 	
Facilitator Notes:
Allow participants 2-3 minutes to individually explore Appendix I. After this time, lead a discussion with the large group, sharing their findings and thoughts to the questions posed in this slide.
 	
Link to Appendix I:
	Slide 45
	
	Appendix I Exploration
	• Study Appendix I
	  • How is it different from the DCI progression you have previously reviewed?
	  • How do the three components of the design cycle increase in depth and sophistication at each grade band?
	Kentucky Department of EDUCATION

Facilitator Notes	Accompanying Slide(s)
https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20I%20-%20Engineering%20Design%20in%20NGSS%20-%20FINAL_V2.pdf	
Facilitator Notes: *Remind participants of the learning experienced in this section, using information on the slide as guidance. You may also bring out any points or ideas from prior discussions.*	**Slide 46**  In Session B, we... • determined the importance of the Disciplinary Core Ideas. • explored Appendix E to see how it might inform teachers of how they can support student learning. • examined how engineering design is represented in the *Kentucky Academic Standards (KAS) for Science*and how it progresses in depth and sophistication as students move through grade bands. Kentucky Department of EDUCATION
Explain: "This is the end of Session B. Please take time to Stop and Reflect on how your thinking has changed since the beginning of this learning experience."	**Slide 47**  Reflection for Session B Now that you have completed Session B on Disciplinary Core Ideas, complete this sentence stem on your own paper. I used to think…but now I know… Kentucky Department of EDUCATION

Module 1: The Kentucky Academic Standards (KAS) for Science: An Overview

Preparation for Session C: Dimensions of Science: Science and Engineering Practices (SEP)

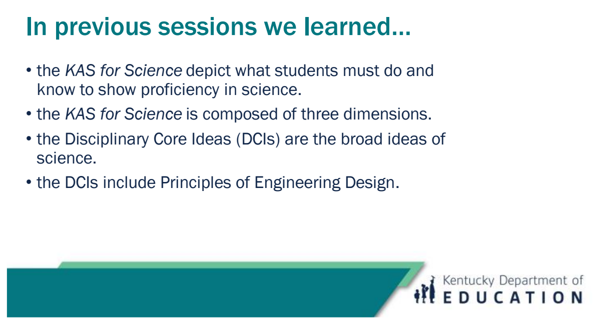
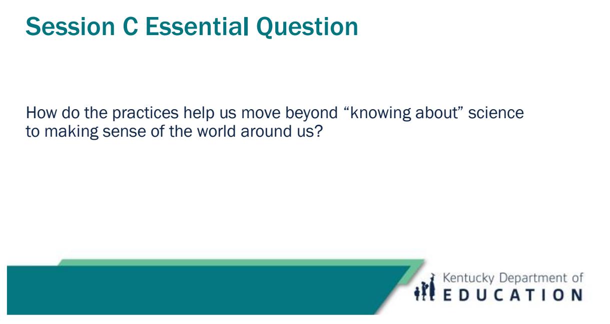
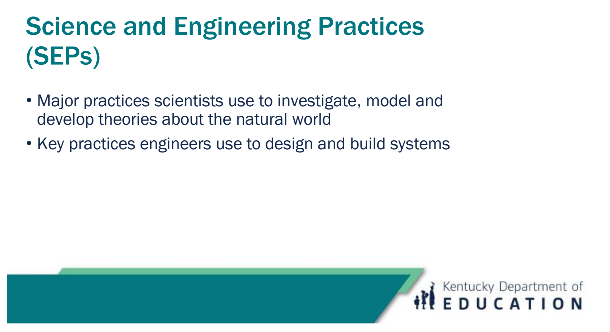
Facilitator Work Session Supplies Needed:

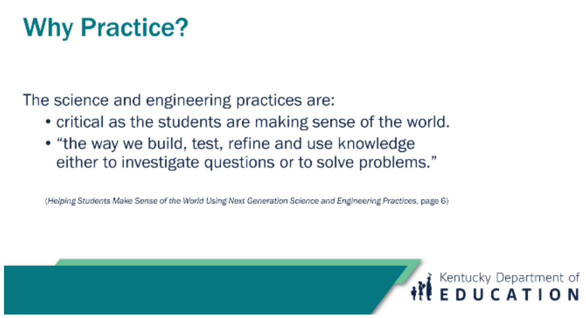
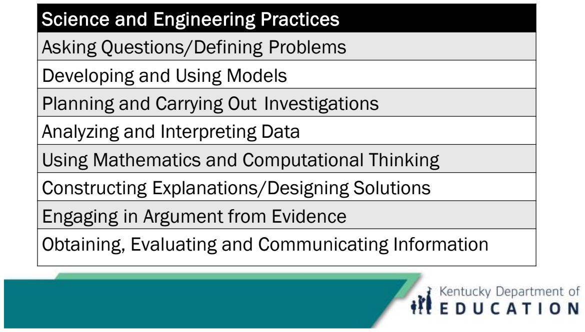
These items will be needed with this module.

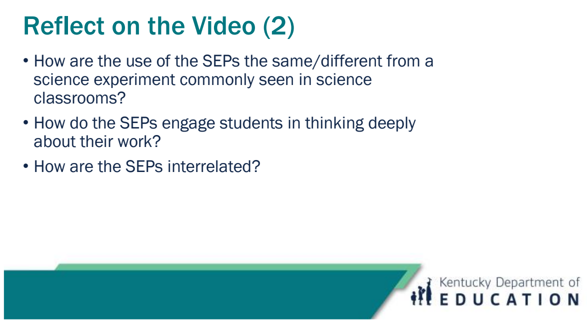
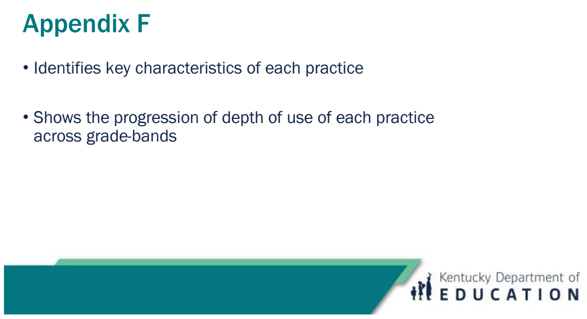
- Computer with access to the *KAS for Science: An Overview* slide presentation
- Technology with projection capability, including a speaker system
- Appendix F (paper or electronic)
- Poster paper (if facilitator chooses posting of findings and sharing)
- Self-sticking notes (if facilitator chooses posting of findings and sharing)

Session C: Dimensions of Science: Science and Engineering Practices (SEP)

Facilitator Notes	Accompanying Slide(s)
Explain: "We will now be looking at the next dimension: The Science and Engineering Practices. These are often referred to as the SEPs or the Practices. *Background Notes for Facilitator:* *Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Likewise, engaging in the practices of engineering helps students understand the work of engineers, as well as the links between engineering and science. Participation in these practices makes students' knowledge more meaningful and embeds it more deeply into their worldview.* *The actual doing of science or engineering can also pique students' curiosity, capture their interest, and motivate their continued study; the insights gained help them recognize that the work of scientists and engineers is a creative endeavor…one that has deeply affected the world they live in. Students may then recognize that science and engineering can contribute to meeting many of the major challenges that confront society today.* *"Any education that focuses predominantly on the detailed products of scientific labor—the facts of science—without developing an understanding of how those facts were established or that ignores the many important applications of science in the world misrepresents science and marginalizes the importance of engineering." (NRC, 2012, pp. 42-43)* *An additional resource that goes into further detail about the Science and Engineering Practices is [Helping Students Make Sense of the World]()*	**Slide 48**  The *Kentucky Academic Standards for Science*: An Overview Session C: Dimensions of Science: Science and Engineering Practices (SEP) Kentucky Department of EDUCATION 44
Facilitator Notes: *Briefly review learning and experiences from the previous segment, using information on this slide for guidance. You may also bring out any discussions from the previous session.*	**Slide 49**

Facilitator Notes	Accompanying Slide(s)
	 In previous sessions we learned… • the *KAS for Science* depict what students must do and know to show proficiency in science. • the *KAS for Science* is composed of three dimensions. • the Disciplinary Core Ideas (DCIs) are the broad ideas of science. • the DCIs include Principles of Engineering Design. Kentucky Department of EDUCATION
Explain: "In this session, we will examine how the Science and Engineering Practices help us to move beyond "knowing about" science to making sense of the world around us. "	**Slide 50**  Session C Essential Question How do the practices help us move beyond "knowing about" science to making sense of the world around us? Kentucky Department of EDUCATION
Explain: "Key to the vision expressed in the *Framework* is that students learn the Disciplinary Core Ideas (DCIs) in the context of science and engineering practices. Students are expected to be able to use their understanding of the DCIs to investigate the natural world through the practice of science inquiry and solve meaningful problems through the practices of engineering design."	**Slide 51**  Science and Engineering Practices (SEPs) • Major practices scientists use to investigate, model and develop theories about the natural world • Key practices engineers use to design and build systems Kentucky Department of EDUCATION
This explains the rational by the Framework committee as to why we speak about practices of science instead of science inquiry.	**Slide 52**

Facilitator Notes	Accompanying Slide(s)
	 Why Practice? The science and engineering practices are: • critical as the students are making sense of the world. • “the way we build, test, refine and use knowledge either to investigate questions or to solve problems.” (Helping Students Make Sense of the World Using Next Generation Science and Engineering Practices, page 6) Kentucky Department of EDUCATION
Explain: These are the eight Science and Engineering Practices. Remember that these are practices in which students engage during the course of instruction.	**Slide 53**  Science and Engineering Practices Asking Questions/Defining Problems Developing and Using Models Planning and Carrying Out Investigations Analyzing and Interpreting Data Using Mathematics and Computational Thinking Constructing Explanations/Designing Solutions Engaging in Argument from Evidence Obtaining, Evaluating and Communicating Information Kentucky Department of EDUCATION
This video describes the reasons for the practices and why they are important. After watching the video, participants will be asked to reflect on what they saw and heard. Facilitators may wish to share the questions shown on the next slide to set the stage for the video.	**Slide 54**  Science and Engineering Practices (2) This video highlights the Science and Engineering Practices in a teacher Professional Learning Session. Science and Engineering Practices Kentucky Department of EDUCATION
After watching the video, participants should reflect on these three questions. How this reflection	**Slide 55**

Facilitator Notes	Accompanying Slide(s)
could occur is up to the facilitator. However, participants should be provided time to reflect individually first before whole group/reflection/discussion occurs. *Ideas to listen for:* • *Engagement of the practices is more than just "doing" them but leads to further questioning and depth of understanding.* • *"Traditional" science labs often do not lead towards explanation or argumentation that demonstrates true understanding of a concept.* • *Instruction with the practices is beyond confirming information, but often leads to further questioning.*	 Reflect on the Video (2) • How are the use of the SEPs the same/different from a science experiment commonly seen in science classrooms? • How do the SEPs engage students in thinking deeply about their work? • How are the SEPs interrelated? Kentucky Department of EDUCATION
Explain: "To see how the SEPs progress across grade bands, a progression document, Appendix F, was developed. Here you can see the characteristics of each SEP at each grade band. *Talking Points:* • *Even through specific SEPs are identified for each PE, students should have experiences utilizing* <u>*all*</u> *the SEPs.* • *While the SEPs are identified, they are often hard to distinguish one from another.* *Slides 53-55 provide further background about the SEPs and the progressions from K-HS. Participants will need access to Appendix F as they will be using this during the exploration described in slide 55. You should determine when would be best for participants to access Appendix F.* *Full appendix may be found at* *https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf*	**Slide 56**  Appendix F • Identifies key characteristics of each practice • Shows the progression of depth of use of each practice across grade-bands Kentucky Department of EDUCATION

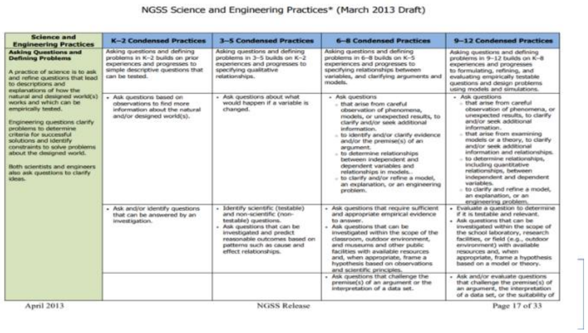
<table>
<tr><th>Facilitator Notes</th><th>Accompanying Slide(s)</th></tr>
<tr><td>

Explain:
"Here is a sample page showing the progression of the SEP Asking Questions and Defining Problems."

Facilitator Notes:
There are two different layouts for the progressions: a table form (pp. 4-15) and a chart form (pp. 17-32). Both layouts have the same information. The chart layout, however, shows how each element of the SEP progresses across grade-bands.

</td><td>

Slide 57



NGSS Science and Engineering Practices* (March 2013 Draft)

<table>
<tr><th>Science and Engineering Practices</th><th>K–2 Condensed Practices</th><th>3–5 Condensed Practices</th><th>6–8 Condensed Practices</th><th>9–12 Condensed Practices</th></tr>
<tr><td>**Asking Questions and Defining Problems**
A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested.
Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world.
Both scientists and engineers also ask questions to clarify ideas.</td><td>Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.</td><td>Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.</td><td>Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.</td><td>Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.</td></tr>
<tr><td></td><td>• Ask questions based on observations to find more information about the natural and/or designed world(s).</td><td>• Ask questions about what would happen if a variable is changed.</td><td>• Ask questions
- that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
- to identify and/or clarify evidence and/or the premise(s) of an argument.
- to determine relationships between independent and dependent variables and relationships in models..
- to clarify and/or refine a model, an explanation, or an engineering problem.</td><td>• Ask questions
- that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
- that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
- to determine relationships, including quantitative relationships, between independent and dependent variables.
- to clarify and refine a model, an explanation, or an engineering problem.</td></tr>
<tr><td></td><td>• Ask and/or identify questions that can be answered by an investigation.</td><td>• Identify scientific (testable) and non-scientific (non-testable) questions.
• Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.</td><td>• Ask questions that require sufficient and appropriate empirical evidence to answer.
• Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.</td><td>• Evaluate a question to determine if it is testable and relevant.
• Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.</td></tr>
<tr><td></td><td></td><td></td><td>• Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.</td><td>• Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of</td></tr>
</table>

April 2013 NGSS Release Page 17 of 33

</td></tr>
<tr><td>

Explain:
"We will now explore the progressions in a bit more detail."

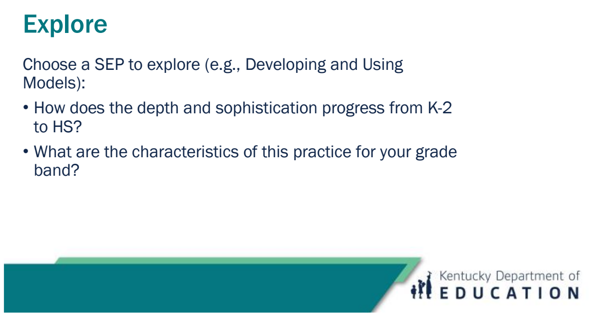
Possible Set-ups for this exploration:

- *Whole group discussion looking at the same SEP from K-HS*
- *Small groups looking at different SEP progressions from K-HS. Small groups would then share out how depth and sophistication progress, jigsaw findings, post on chart paper, etc.*

If small groups are chosen, the facilitator may wish to walk around and listen to the conversations.

</td><td>

Slide 58



Explore

Choose a SEP to explore (e.g., Developing and Using Models):

- How does the depth and sophistication progress from K-2 to HS?
- What are the characteristics of this practice for your grade band?

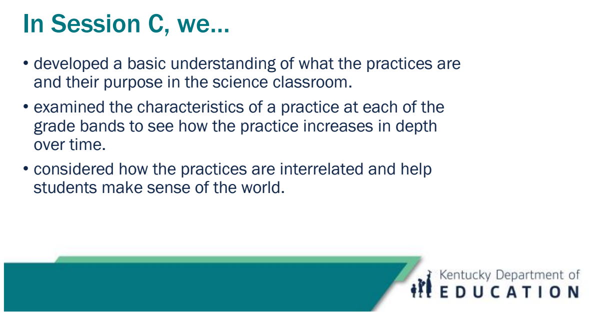
Kentucky Department of EDUCATION

</td></tr>
<tr><td>

Facilitator Notes:
Remind participants of the learning experienced in this section, using information on the slide as guidance. You may also bring out any points or ideas from any prior discussions.

</td><td>

Slide 59



In Session C, we…

- developed a basic understanding of what the practices are and their purpose in the science classroom.
- examined the characteristics of a practice at each of the grade bands to see how the practice increases in depth over time.
- considered how the practices are interrelated and help students make sense of the world.

Kentucky Department of EDUCATION

</td></tr>
</table>

Facilitator Notes	Accompanying Slide(s)
Explain: **"**This is the end of Session B. Please take time to Stop and Reflect on your learning about the science and engineering practices. What is your key take away from today?" *Facilitator Notes:* *Encourage participants to share their tweets along with the resource on Twitter so others may find this resource to support them in learning more about the KAS for Science.*	**Slide 60** Reflection for Session C It's all about social media: Think about the learning from this session. Compose a social media post consisting of 280 characters to share your key take away. Consider sharing it on any social media along with the link to the resource! Kentucky Department of EDUCATION

Module 1: The Kentucky Academic Standards (KAS) for Science: An Overview

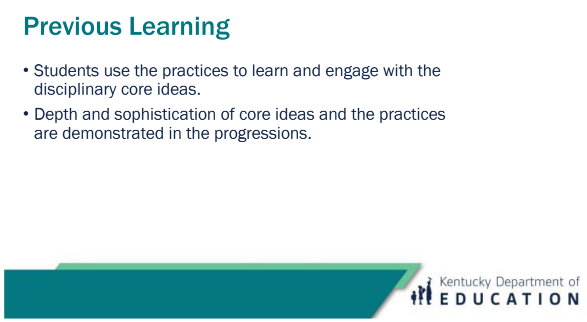
Preparation for Session D: Dimensions of Science: Crosscutting Concepts (CCC)

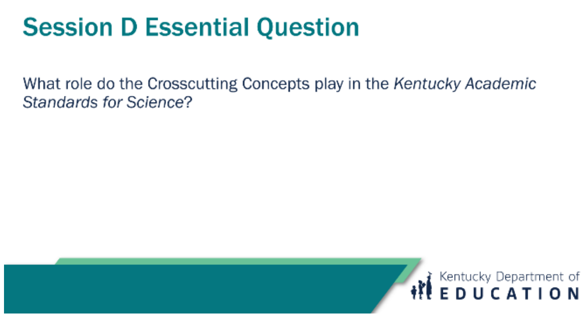
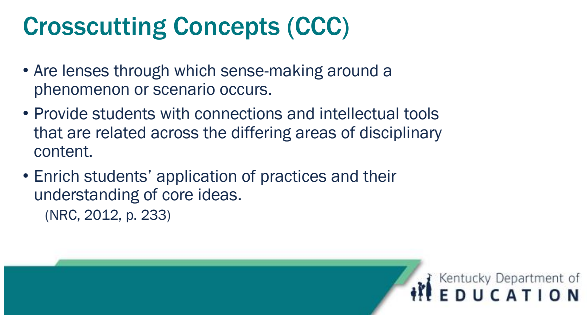
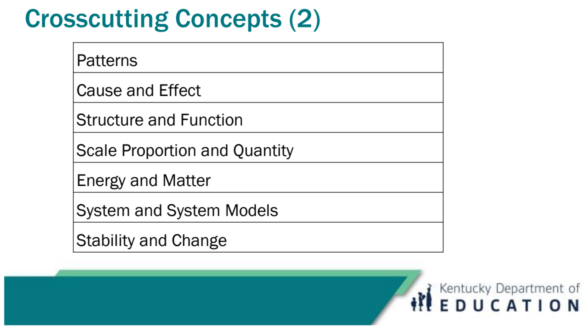
Facilitator Work Session Supplies Needed:

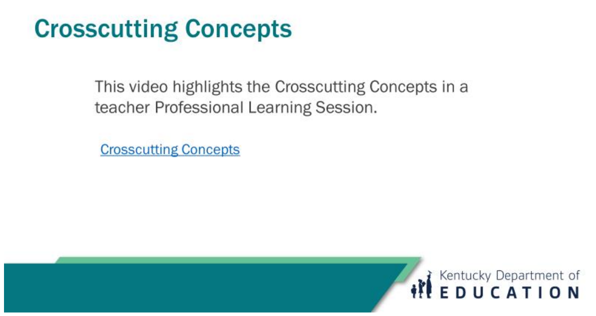
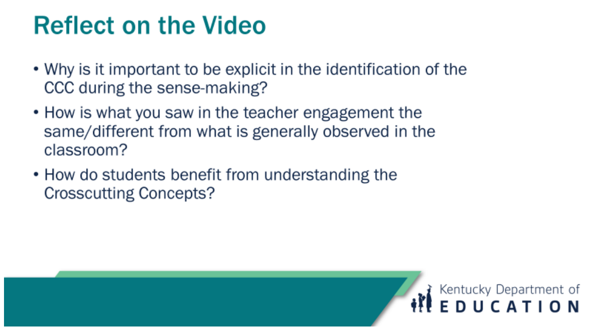
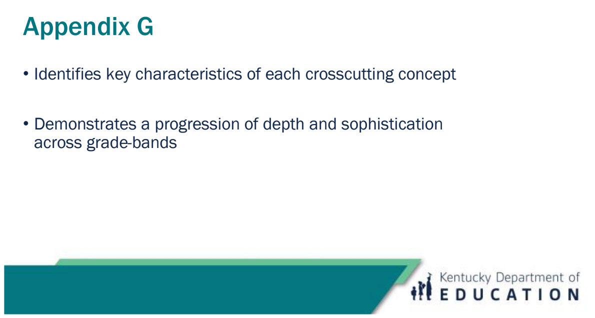
These items will be needed with this module:

- Computer with access to the *KAS for Science: An Overview* slide presentation
- Technology with projection capability, including a speaker system
- Appendix G (paper or electronic)
- Poster paper (if facilitator chooses posting of findings and sharing)
- Self-sticking notes (if facilitator chooses posting of findings and sharing)

Session D: Dimensions of Science: Crosscutting Concepts (CCC)

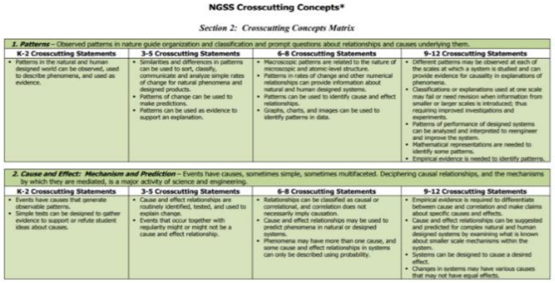
Facilitator Notes	Accompanying Slide(s)
Explain: “We will now be looking at the third dimension: the crosscutting concepts, or CCCs.” *Background Notes for Facilitators:* *According to the Framework, the purpose of the CCCs is to help students deepen their understanding of the disciplinary core ideas and develop a coherent and scientifically based view of the world. While “crosscutting ideas” have been featured in other framework documents over the past two decades, the Framework recognizes that “students have often been expected to build such knowledge without any explicit instructional support. Hence the purpose of highlighting them as Dimension 2 of the Framework is to elevate their role in the development of standards, curricula, instruction, and assessments” (NRC, 2012, p. 83).*	**Slide 61**  The *Kentucky Academic Standards for Science*: An Overview Session D: Dimensions of Science: Crosscutting Concepts (CCC) Kentucky Department of EDUCATION
Facilitator Notes: *Briefly review learning and experiences from the previous learning, using information on this slide for guidance. You may also bring out any discussions from the previous session.*	**Slide 62**  Previous Learning • Students use the practices to learn and engage with the disciplinary core ideas. • Depth and sophistication of core ideas and the practices are demonstrated in the progressions. Kentucky Department of EDUCATION
Explain: “In Session D, we will continue with looking at each of the three dimensions by examining the role of the Crosscutting Concepts in the Kentucky Academic Standards for Science. “	**Slide 63**

Facilitator Notes	Accompanying Slide(s)
	 Session D Essential Question What role do the Crosscutting Concepts play in the *Kentucky Academic Standards for Science*? Kentucky Department of EDUCATION
Explain: "The framework identifies seven CCC that bridge disciplinary boundaries, uniting core ideas throughout the fields of science and engineering. Their purpose is to help students deepen their understanding of the DCIs and develop a coherent and scientifically based view of the world."	**Slide 64**  Crosscutting Concepts (CCC) • Are lenses through which sense-making around a phenomenon or scenario occurs. • Provide students with connections and intellectual tools that are related across the differing areas of disciplinary content. • Enrich students' application of practices and their understanding of core ideas. (NRC, 2012, p. 233) Kentucky Department of EDUCATION
Explain: "These are the seven crosscutting concepts. Much like the practices, the CCCs are often intertwined and hard to distinguish." *Talking Points (some examples to share):* • *Students may use <u>patterns</u> in data to identify <u>cause and effect</u> relationships.* • *Students may study a <u>system</u> at different <u>scales.</u>*	**Slide 65**  Crosscutting Concepts (2) Patterns Cause and Effect Structure and Function Scale Proportion and Quantity Energy and Matter System and System Models Stability and Change Kentucky Department of EDUCATION

Facilitator Notes	Accompanying Slide(s)
This video describes the importance of crosscutting concepts in the understanding of science and the natural world at large. After watching the video, participants will be asked to reflect on what they saw and heard.	**Slide 66**  Crosscutting Concepts This video highlights the Crosscutting Concepts in a teacher Professional Learning Session. Crosscutting Concepts Kentucky Department of EDUCATION
After watching the video, participants should reflect on these three questions. How this reflection could occur is up to the facilitator. However, participants should be provided time to reflect individually first before whole group reflection/discussion occurs. *Ideas to listen for:* • *CCC are used by students to organize ideas and make sense of the science around a phenomenon.* • *CCC are ideas that can be used within disciplines or across disciplines.* • *CCC are used in conjunction with the practices in the understanding of phenomena.*	**Slide 67**  Reflect on the Video • Why is it important to be explicit in the identification of the CCC during the sense-making? • How is what you saw in the teacher engagement the same/different from what is generally observed in the classroom? • How do students benefit from understanding the Crosscutting Concepts? Kentucky Department of EDUCATION
Explain: "To see how the CCCs progress across grade bands, a progressions document, Appendix G, was developed. Here you can see the characteristics of each CCC at each grade-band. *Facilitator Notes:* *Slides 63-65 provide further background about the CCC and the progressions from K-HS. Participants will need access to Appendix G as they will be using this during the exploration described in slide 65. You should determine when would be best for participants to access*	**Slide 68**  Appendix G • Identifies key characteristics of each crosscutting concept • Demonstrates a progression of depth and sophistication across grade-bands Kentucky Department of EDUCATION

<table>
<tr><th>Facilitator Notes</th><th>Accompanying Slide(s)</th></tr>
<tr><td>Appendix F.</td><td></td></tr>
<tr><td>
Explain:
“Here is a sample page showing the progression of the two CCCs Patterns, and Cause and Effect”

Facilitator Notes:
There are two different layouts for the progressions: a narrative (pp. 3-11) and a chart form (pp. 15-17). The chart form is where you will find the specific characteristics for each CCC.
</td><td>
Slide 69



NGSS Crosscutting Concepts*

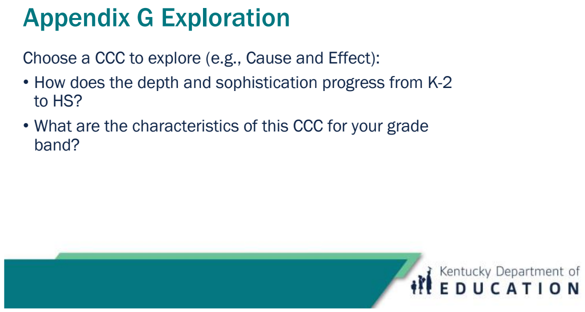
Section 2: Crosscutting Concepts Matrix

<table>
<tr><th colspan="4">1. Patterns – Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.</th></tr>
<tr><th>K-2 Crosscutting Statements</th><th>3-5 Crosscutting Statements</th><th>6-8 Crosscutting Statements</th><th>9-12 Crosscutting Statements</th></tr>
<tr><td>• Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.</td><td>• Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products.
• Patterns of change can be used to make predictions.
• Patterns can be used as evidence to support an explanation.</td><td>• Macroscopic patterns are related to the nature of microscopic and atomic-level structure.
• Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.
• Patterns can be used to identify cause and effect relationships.
• Graphs, charts, and images can be used to identify patterns in data.</td><td>• 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.
• Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments.
• Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.
• Mathematical representations are needed to identify some patterns.
• Empirical evidence is needed to identify patterns.</td></tr>
</table>

<table>
<tr><th colspan="4">2. Cause and Effect: Mechanism and Prediction – Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.</th></tr>
<tr><th>K-2 Crosscutting Statements</th><th>3-5 Crosscutting Statements</th><th>6-8 Crosscutting Statements</th><th>9-12 Crosscutting Statements</th></tr>
<tr><td>• Events have causes that generate observable patterns.
• Simple tests can be designed to gather evidence to support or refute student ideas about causes.</td><td>• Cause and effect relationships are routinely identified, tested, and used to explain change.
• Events that occur together with regularity might or might not be a cause and effect relationship.</td><td>• Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
• Cause and effect relationships may be used to predict phenomena in natural or designed systems.
• Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.</td><td>• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
• Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
• Systems can be designed to cause a desired effect.
• Changes in systems may have various causes that may not have equal effects.</td></tr>
</table>
</td></tr>
<tr><td>
Explain:
“We will now explore the progressions in a bit more depth.”
ro
Possible Set-ups for this exploration:

Whole group discussion looking at the same CCC from K-HS
Small groups looking at different CCC progressions from K-HS. Small groups would then share out how depth and sophistication progress by using jigsaw findings, posts on chart paper, etc.

If small groups are chosen, the facilitator may wish to walk around and listen to the conversations.
</td><td>
Slide 70

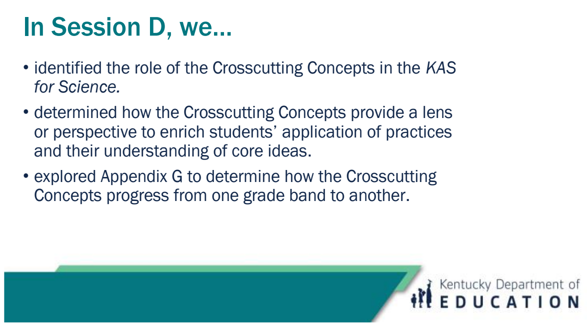
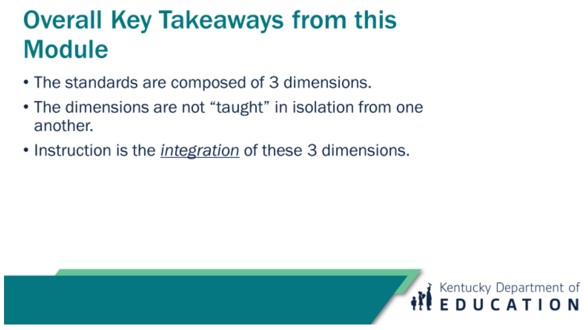


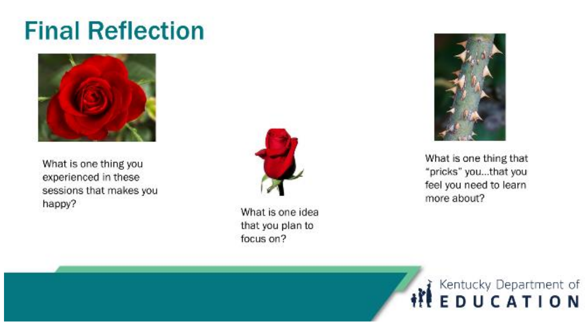
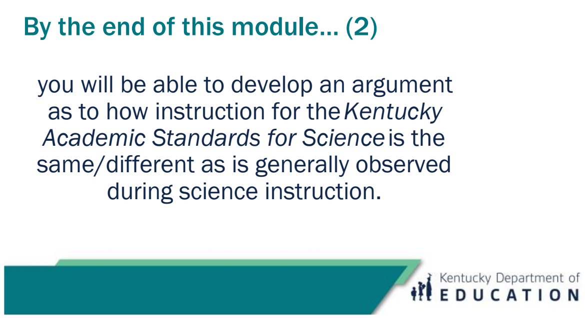
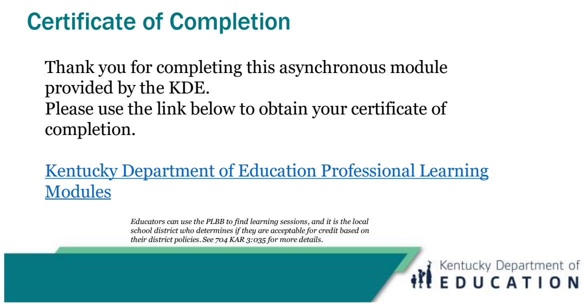
Appendix G Exploration

Choose a CCC to explore (e.g., Cause and Effect):

- How does the depth and sophistication progress from K-2 to HS?
- What are the characteristics of this CCC for your grade band?

</td></tr>
<tr><td>Facilitator Notes:</td><td>Slide 71</td></tr>
</table>

Facilitator Notes	Accompanying Slide(s)
Remind participants of the learning experienced in this section, using information on the slide as guidance. You may also bring out any points or ideas that were brought out during any of the discussions.	 In Session D, we… • identified the role of the Crosscutting Concepts in the *KAS for Science.* • determined how the Crosscutting Concepts provide a lens or perspective to enrich students' application of practices and their understanding of core ideas. • explored Appendix G to determine how the Crosscutting Concepts progress from one grade band to another. Kentucky Department of EDUCATION
Explain: "You have now completed Session D, the final session of this module. Take a moment to stop and reflect on your learning around the crosscutting concepts using the reflection task on the slide." *Facilitator's Notes:* *"You may wish to have the participants share out their learning from this session with a shoulder partner, then share out as a group."*	**Slide 72**  Reflection for Session D After completing Session D, pick an emoji that describes how you feel about your learning from this session. Explain why you chose that emoji Kentucky Department of EDUCATION
After completing the learning experiences within this module, these are the three key takeaways participants should walk away with. You may wish to question participants about their big takeaways and/or ideas from the learning.	**Slide 73**  Overall Key Takeaways from this Module • The standards are composed of 3 dimensions. • The dimensions are not "taught" in isolation from one another. • Instruction is the *integration* of these 3 dimensions. Kentucky Department of EDUCATION

Facilitator Notes	Accompanying Slide(s)
In this reflection exercise called “rose, bud and thorn,” the rose is a used to represent a learning that is “blossoming” in the participant’s understanding. The bud represents something that is forming but not yet blossomed into something meaningful. The thorn represents some learning that is “hurtful”; an idea that a participant may need more information. Facilitators can use this information to determine what supports educators may need or what further information may be needed to help bring clarity to the science dimensions. This reflection is intended for participants to think about all the learning that has occurred throughout the course of this module.	**Slide 74**  **Final Reflection** What is one thing you experienced in these sessions that makes you happy? What is one idea that you plan to focus on? What is one thing that “pricks” you…that you feel you need to learn more about? Kentucky Department of EDUCATION
*After participants have engaged with all sessions within this module, they will develop an “elevator speech” addressing this statement. And elevator speech is a quick 1-2 minute talk that provides a quick synopsis of a particular topic. As participants are writing in the form of an argument, their elevator speech should have a claim, evidence to support their claim and **how** that evidence supports their claim.* *As time permits, you may wish to have participants share their speech with one another to receive feedback and perhaps clarify any points of support.*	Slide 75  **By the end of this module… (2)** you will be able to develop an argument as to how instruction for the *Kentucky Academic Standards for Science* is the same/different as is generally observed during science instruction. Kentucky Department of EDUCATION
Explain: “The KDE needs your feedback on the effectiveness of this module, the learning platform and how the consultants may best support you as you take the next steps. We are going to complete a short survey to share our thinking and provide them with feedback on how the KDE can best meet our needs. Feedback from our surveys will be used by the KDE to plan and prepare future professional learning.” *Provide participants with the survey links:* Kentucky Department of Education Professional Learning Modules Feedback Survey *Be sure to thank participants for their work throughout this module as it has provided a*	**Slide 76**  **Certificate of Completion** Thank you for completing this asynchronous module provided by the KDE. Please use the link below to obtain your certificate of completion. Kentucky Department of Education Professional Learning Modules *Educators can use the PLBB to find learning sessions, and it is the local school district who determines if they are acceptable for credit based on their district policies. See 704 KAR 3:035 for more details.* Kentucky Department of EDUCATION

Facilitator Notes	Accompanying Slide(s)
foundation for future knowledge. *To you, the facilitator, thank you for providing participants with knowledge and support throughout this process. The KDE greatly values your role in facilitating this Getting to Know the KAS for Science Module. We appreciate your time and effort in leading your school and district in the successful implementation of the KAS for Science. Thank you!*	