**Kentucky Academic Standards for Science (High School) Crosswalk Overview**

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| **ACT Science** **Standard** | **Corresponding KAS for Science** **Science and Engineering Practices** | **Corresponding KAS Science****Cross Cutting Concepts** |
| Interpretation of Data (IOD) | * Analyzing and Interpreting Data
* Using Mathematical and Computational Thinking
* Asking Questions and Defining Problems
* Engaging in Argument from Evidence
* Obtaining, Evaluating, and Communicating Information
 | * Patterns
* Cause and Effect
* Scale, Proportion, and Quantity
* Systems and System Models
* Energy and Matter
* Structure and Function
* Stability and Change
 |
| Scientific Investigation (SIN) | * Asking Questions and Defining Problems
* Planning and Carrying Out Investigations
* Analyzing and Interpreting Data
* Using Mathematical and Computational Thinking
* Developing and Using Models
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| Evaluation of Models, Inferences, and Experimental Results (EMI) | * Developing and Using Models
* Constructing Explanations and Designing Solutions
* Engaging in Argument from Evidence
* Analyzing and Interpreting Data
* Obtaining, Evaluating, and Communicating Information
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| **ACT Science Test Passage Format** |  | **ACT Science — Benchmark Analysis** |
| **Category** | **General Description** | **Approximate Number of Questions** |  | To receive the benchmark score of **23**, students need to answer at least **24-25** questions correctly in **35 minutes.** 40 Questions35 Minutes  |
| Data Representation | Understand, evaluate, and interpret information presented in graphs, tables and/or charts | 15 |
| Research Summaries | Understand, evaluate, and analyze one or more experiments | 18 |
| Conflicting Viewpoints | Understand and evaluate conflicting viewpoints, theories, or hypotheses on a specific topic | 7 |

 **Key Ideas and Details: Interpretation of Data (IOD)**

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| **ACT Science: Interpretation of Data (IOD) Scoring Range with Standards** |
| **Approaching Benchmark** | **Meets Benchmark** | **Exceeds Benchmark** |
| **13-15** | **16-19** | **20-23** | **24-27** | **28-32** | **33-36** |
| IOD 201. Select one piece of data from a simple data presentation (e.g., a simple food web diagram) | IOD 301. Select two or more pieces of data from a simple data presentation | **IOD 401. Select data from a complex data presentation (e.g., a phase diagram)** | IOD 501. Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table) | IOD 601. Compare or combine data from a simple data presentation with data from a complex data presentation | IOD 701. Compare or combine data from two or more complex data presentations |
| IOD 202. Identify basic features of a table, graph, or diagram (e.g., units of measurement) | IOD 302.Understand basic scientific terminology | **IOD 402. Compare or combine data from a simple data presentation (e.g., order or sum data from a table)** | IOD 502. Compare or combine data from a complex data presentation | IOD 602. Determine and/or use a complex (e.g., nonlinear) mathematical relationship that exists between data | IOD 702. Analyze presented information when given new, complex information |
| IOD 203. Find basic information in text that describes a simple data presentation | IOD 303. Find basic information in text that describes a complex data presentation | **IOD 403. Translate information into a table, graph, or diagram** | IOD 503. Determine how the values of variables change as the value of another variable changes in a complex data presentation | IOD 603. Perform a complex interpolation or complex extrapolation using data in a table or graph |  |
|  | IOD 304. Determine how the values of variables change as the value of another variable changes in a simple data presentation | **IOD 404. Perform a simple interpolation or simple extrapolation using data in a table or graph** | IOD 504. Determine and/or use a simple (e.g., linear) mathematical relationship that exists between data |  |  |
|  |  |  | IOD 505. Analyze presented information when given new, simple information |  |  |

**Key Ideas and Details: Scientific Investigation (SIN)**

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| **ACT Science: Scientific Investigation (SIN) Scoring Range with Standards** |
| **Approaching Benchmark** | **Meets Benchmark** | **Exceeds Benchmark** |
| **13-15** | **16-19** | **20-23** | **24-27** | **28-32** | **33-36** |
| SIN 201. Find basic information in text that describes a simple experiment | SIN 301. Understand the methods used in a simple experiment | **SIN 401.Understand a simple experimental design** | SIN 501.Understand a complex experimental design | SIN 601. Determine the hypothesis for an experiment | SIN 701.Understand precision and accuracy issues |
| SIN 202. Understand the tools and functions of tools used in a simple experiment | SIN 302. Understand the tools and functions of tools used in a complex experiment | **SIN 402.Understand the methods used in a complex experiment** | SIN 502. Predict the results of an additional trial or measurement in an experiment | SIN 602. Determine an alternate method for testing a hypothesis | SIN 702. Predict the effects of modifying the design or methods of an experiment |
|  | SIN 303. Find basic information in text that describes a complex experiment | **SIN 403. Identify a control in an experiment** | SIN 503. Determine the experimental conditions that would produce specified results |  | SIN 703. Determine which additional trial or experiment could be performed to enhance or evaluate experimental results |
|  |  | **SIN 404. Identify similarities and differences between experiments** |  |  |  |
|  |  | **SIN 405. Determine which experiments utilized a given tool, method, or aspect of design** |  |  |  |

 **Key Ideas and Details: Evaluation of Models, Inferences, and Experimental Results (EMI)**

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| **ACT Science: Evaluation of Models, Inferences, and Experimental Results (EMI) Scoring Range with Standards** |
| **Approaching Benchmark** | **Meets Benchmark** | **Exceeds Benchmark** |
| **13-15** | **16-19** | **20-23** | **24-27** | **28-32** | **33-36** |
| EMI 201. Find basic information in a model (conceptual) | EMI 301. Identify implications in a model | **EMI 401. Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text** | EMI 501. Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with two or more data presentations, models, and/or pieces of information in text | EMI 601. Determine which complex hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text | EMI 701. Determine which complex hypothesis, prediction, or conclusion is, or is not, consistent with two or more data presentations, models, and/or pieces of information in text |
|  | EMI 302. Determine which models present certain basic information | **EMI 402. Identify key assumptions in a model** | EMI 502. Determine whether presented information, or new information, supports or contradicts a simple hypothesis or conclusion, and why | EMI 602. Determine whether presented information, or new information, supports or weakens a model, and why | EMI 702. Determine whether presented information, or new information, supports or contradicts a complex hypothesis or conclusion, and why |
|  |  | **EMI 403. Determine which models imply certain information** | EMI 503. Identify the strengths and weaknesses of models | EMI 603. Use new information to make a prediction based on a model |  |
|  |  | **EMI 404. Identify similarities and differences between models** | EMI 504. Determine which models are supported or weakened by new information |  |  |
|  |  |  | EMI 505. Determine which experimental results or models support or contradict a hypothesis, prediction, or conclusion |  |  |

**ACT Science Benchmark Descriptors Aligned with KAS for High School Science SEP Proficiency Descriptors**

 **Interpretation of Data (IOD)**

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| **Meets Benchmark – ACT Science (IOD)** | **High School Science - Science & Engineering Practice Descriptor for Proficiency** |
| **20-23** | **Analyzing and Interpreting Data** | **Using Mathematical and Computational Thinking** | **Asking Questions and Defining Problems** | **Engaging in Argument from Evidence** | **Obtaining, Evaluating, and Communicating Information** |
| **IOD 401. Select data from a complex data presentation (e.g., a phase diagram)** |  Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.  Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.  Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.  Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.  Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.  Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success | · Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.  Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.  Apply techniques of algebra and functions to represent and solve scientific and engineering problems.  Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model “makes sense” by comparing the outcomes with what is known about the real world.  Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3 , acre-feet, etc.). | · Ask questions o that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. o that arise from examining models or a theory, to clarify and/or seek additional information and relationships. o to determine relationships, including quantitative relationships, between independent and dependent variables. o to clarify and refine a model, an explanation, or an engineering problem.  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.  Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.  Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations. | · Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.  Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.  Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.  Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.  Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.  Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). | · Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.  Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.  Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.  Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.  Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, and mathematically). |
| **IOD 402. Compare or combine data from a simple data presentation (e.g., order or sum data from a table)** |
| **IOD 403. Translate information into a table, graph, or diagram** |
| **IOD 404. Perform a simple interpolation or simple extrapolation using data in a table or graph** |

 **ACT Science Benchmark Descriptors Aligned with KAS for High School Science SEP Proficiency Descriptors**

 **Scientific Investigation (SIN)**

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| **Meets Benchmark – ACT Science (SIN)** | **High School Science - Science & Engineering Practice Descriptor for Proficiency** |
| **20-23** | **Analyzing and Interpreting Data** | **Using Mathematical and Computational Thinking** | **Asking Questions and Defining Problems** | **Planning and Carrying Out Investigations** | **Developing and Using Models** |
| **SIN 401.Understand a simple experimental design** |  Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.  Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.  Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.  Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.  Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.  Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success | · Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.  Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.  Apply techniques of algebra and functions to represent and solve scientific and engineering problems.  Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model “makes sense” by comparing the outcomes with what is known about the real world.  Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3 , acre-feet, etc.). | · Ask questions o that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. o that arise from examining models or a theory, to clarify and/or seek additional information and relationships. o to determine relationships, including quantitative relationships, between independent and dependent variables. o to clarify and refine a model, an explanation, or an engineering problem.  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.  Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.  Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations. | · Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation’s design to ensure variables are controlled.  Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.  Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.  Select appropriate tools to collect, record, analyze, and evaluate data. Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.  Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables. | · Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.  Design a test of a model to ascertain its reliability.  Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.  Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.  Develop a complex model that allows for manipulation and testing of a proposed process or system.  Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. |
| **SIN 402.Understand the methods used in a complex experiment** |
| **SIN 403. Identify a control in an experiment** |
| **SIN 404. Identify similarities and differences between experiments** |
| **SIN 405. Determine which experiments utilized a given tool, method, or aspect of design** |

 **ACT Science Benchmark Descriptors Aligned with KAS for High School Science SEP Proficiency Descriptors**

 **Evaluation of Models, Inferences, and Experimental Results (EMI)**

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| **Meets Benchmark – ACT Science (EMI)** | **High School Science – Science & Engineering Practice Descriptor for Proficiency** |
| **20 - 23** | **Developing and Using Models** | **Constructing Explanations and Designing Solutions** | **Engaging in Argument from Evidence** | **Analyzing and Interpreting Data** | **Obtaining, Evaluating, and Communicating Information** |
| **EMI 401. Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text** |  Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.  Design a test of a model to ascertain its reliability.  Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.  Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.  Develop a complex model that allows for manipulation and testing of a proposed process or system.  Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. | Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.  Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.  Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.  Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. | · Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.  Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.  Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.  Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.  Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.  Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). | · Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.  Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.  Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.  Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.  Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.  Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success | · Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.  Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.  Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.  Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.  Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, and mathematically). |
| **EMI 402. Identify key assumptions in a model** |
| **EMI 403. Determine which models imply certain information** |
| **EMI 404. Identify similarities and differences between models** |

**ACT Science Benchmark Descriptors Aligned with KAS for High School Science CCC Proficiency Descriptors**

 **Interpretation of Data (IOD)**

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| **Meets Benchmark – ACT Science (IOD)** | **High School Science – Cross Cutting Concepts Descriptor for Proficiency** |
| **20-23** | **Patterns** | **Cause and Effect** | **Scale, Proportion, and Quantity** | **Systems and System Models** |
| **IOD 401. Select data from a complex data presentation (e.g., a phase diagram)** | Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system. | Students understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects | Students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Students use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). | Students can investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They can use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. They can also use models and simulations to predict the behavior of a system, and recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models. They can also design systems to do specific tasks. |
| **IOD 402. Compare or combine data from a simple data presentation (e.g., order or sum data from a table)** |
| **IOD 403. Translate information into a table, graph, or diagram** |
| **IOD 404. Perform a simple interpolation or simple extrapolation using data in a table or graph** |

**ACT Science Benchmark Descriptors Aligned with KAS for High School Science CCC Proficiency Descriptors**

 **Interpretation of Data (IOD)**

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| **Meets Benchmark – ACT Science (IOD)** | **High School Science – Cross Cutting Concepts Descriptor for Proficiency** |
| **20-23** | **Energy and Matter** | **Structure and Function** | **Stability and Change** |
| **IOD 401. Select data from a complex data presentation (e.g., a phase diagram)** | Students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. | Students investigate systems by examining the properties of different materials, the structures of different components, and their interconnections to reveal the system’s function and/or solve a problem. They infer the functions and properties of natural and designed objects and systems from their overall structure, the way their components are shaped and used, and the molecular substructures of their various materials. | Students understand much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability. |
| **IOD 402. Compare or combine data from a simple data presentation (e.g., order or sum data from a table)** |
| **IOD 403. Translate information into a table, graph, or diagram** |
| **IOD 404. Perform a simple interpolation or simple extrapolation using data in a table or graph** |

**ACT Science Benchmark Descriptors Aligned with KAS for High School Science CCC Proficiency Descriptors**

 **Scientific Investigation (SIN)**

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| **Meets Benchmark – ACT Science (SIN)** | **High School Science – Cross Cutting Concepts Descriptor for Proficiency** |
| **20-23** | **Patterns** | **Cause and Effect** | **Scale, Proportion, and Quantity** | **Systems and System Models** |
| **SIN 401.Understand a simple experimental design** | Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system. | Students understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects | Students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Students use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). | Students can investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They can use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. They can also use models and simulations to predict the behavior of a system, and recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models. They can also design systems to do specific tasks. |
| **SIN 402.Understand the methods used in a complex experiment** |
| **SIN 403. Identify a control in an experiment** |
| **SIN 404. Identify similarities and differences between experiments** |
| **SIN 405. Determine which experiments utilized a given tool, method, or aspect of design** |

**ACT Science Benchmark Descriptors Aligned with KAS for High School Science CCC Proficiency Descriptors**

 **Scientific Investigation (SIN)**

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| **Meets Benchmark – ACT Science (SIN)** | **High School Science – Cross Cutting Concepts Descriptor for Proficiency** |
| **20-23** | **Energy and Matter** | **Structure and Function** | **Stability and Change** |
| **SIN 401.Understand a simple experimental design** | Students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. | Students investigate systems by examining the properties of different materials, the structures of different components, and their interconnections to reveal the system’s function and/or solve a problem. They infer the functions and properties of natural and designed objects and systems from their overall structure, the way their components are shaped and used, and the molecular substructures of their various materials. | Students understand much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability. |
| **SIN 402.Understand the methods used in a complex experiment** |
| **SIN 403. Identify a control in an experiment** |
| **SIN 404. Identify similarities and differences between experiments** |
| **SIN 405. Determine which experiments utilized a given tool, method, or aspect of design** |

**ACT Science Benchmark Descriptors Aligned with KAS for High School Science CCC Proficiency Descriptors**

 **Evaluation of Models, Inferences, and Experimental Results (EMI)**

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| **Meets Benchmark – ACT Science (EMI)** | **High School Science – Cross Cutting Concepts Descriptor for Proficiency** |
| **20 - 23** | **Patterns** | **Cause and Effect** | **Scale, Proportion, and Quantity** | **Systems and System Models** |
| **EMI 401. Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text** | Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system. | Students understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects | Students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Students use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). | Students can investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They can use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. They can also use models and simulations to predict the behavior of a system, and recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models. They can also design systems to do specific tasks. |
| **EMI 402. Identify key assumptions in a model** |
| **EMI 403. Determine which models imply certain information** |
| **EMI 404. Identify similarities and differences between models** |

**ACT Science Benchmark Descriptors Aligned with KAS for High School Science CCC Proficiency Descriptors**

 **Evaluation of Models, Inferences, and Experimental Results (EMI)**

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| **Meets Benchmark – ACT Science (EMI)** | **High School Science – Cross Cutting Concepts Descriptor for Proficiency** |
| **20 - 23** | **Energy and Matter** | **Structure and Function** | **Stability and Change** |
| **EMI 401. Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text** | Students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. | Students investigate systems by examining the properties of different materials, the structures of different components, and their interconnections to reveal the system’s function and/or solve a problem. They infer the functions and properties of natural and designed objects and systems from their overall structure, the way their components are shaped and used, and the molecular substructures of their various materials. | Students understand much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability. |
| **EMI 402. Identify key assumptions in a model** |
| **EMI 403. Determine which models imply certain information** |
| **EMI 404. Identify similarities and differences between models** |