The Kansas Next Generation Science Standards Review Committee

Report and Recommendation

to the

Kansas State Board of Education

Regarding Adoption of the:

NEXT GENERATION SCIENCE STANDARDS

For States, By States

14 May 2013

The Kansas Next Generation Science Standards Review Committee Members

The Kansas Next Generation Science Standards Review Committee provided input on multiple releases of draft version of the Next Generation Science Standards (NGSS). The committee met both face-to-face and virtually from September of 2011 through April 2013. Members of the Committee volunteered their time to assure that the NGSS reflect the needs and desires of Kansas. The Committee Chairs thank members of the Kansas Next Generation Science Standards Review Committee for their efforts during this process.

Last Name:	First Name:	Institution/Company name:
Adams	Paul	Fort Hays State University
Ahrens	Anton	USD 501 Topeka Public Schools
Angel	Stephen	Washburn University
Atkins	Susan	USD 368 Cottonwood Elementary/Sunflower Elementary
Benz	James	USD 202 Turner
Bixby	Jared	Sunset Zoo; Flint Hills Discovery Center
Blake	Mindy	USD 379 Clay Center Community Middle School
Bollier	Barbara	Representative, State of Kansas
Cerny	Mary	USD 305 Schilling Elementary
Cleavinger	Laurie	University of Kansas
Cobble	Teresa	USD 259 Wichita Public School
Cooper	Jennifer	USD 475 Franklin Elementary
Coover	Donald	SEK Genetics
Culbertson	Chris	Kansas State University
Day	Lynette	USD 512 Shawnee Mission School District
Dennis	Dave	Kansas State Board of Education
Depenbusch	Joyce	USD 438 Skyline Schools
Downey	Laura	KACEE
Elder	Rob	Seaboard Farms
Ellis	James	University of Kansas
Grauer	Bette	Kansas State University
Griffith	George	USD 208 Trego County Schools
Hall	Kris	USD 217 Rolla Schools
Harmon	Marcel	M.E. Group
Harrington	John	Kansas State University
Harrison	Trey	USD 375 Circle High School
Hart	Stacey	USD 389 Eureka Jr/Sr High
Hawks	Anne	USD 497 Lawrence Public Schools
Hennessey-Springe	Margaret	Kansas Children's Discovery Center
Hillis	Maureen	USD 437 Auburn-Washburn
Jarboe	Mark	USD 450 Shawnee Heights High School
Kilgore	Rena	USD 340 Jefferson West High School
King	Alan	USD 500 Kansas City, Kansas Public Schools
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Kuhns	Brenda	USD 259 Wichita Public Schools-Jardine Middle School
Lief	Todd	Cloud County Community College
Loveless	Brad	Westar
McDonald	Harry	Self-employed, Science Education Consultant
Miller	Todd	USD 490 El Dorado High School
Neugebauer	Charlotte	USD 259 Gammon Elementary
Perkins	Doug	NuStar Energy, L.P.
Piva	Michell	USD 503 Parsons District Schools
Popp	John	USD 428 Great Bend High School
Powell	Judy	USD 462 Central Elementary
Ptacek	Pesha	USD 306 Southeast of Saline Schools
Ratzel	Marsha	USD 229 Leawood Middle School
Sanders	Christine	USD 458 Basehor-Linwood School District
Shane	Lyle	Kansas Geological Survey
Shepherd-Adams	Cheryl	USD 489 Hays High School
Smith	Dixie	Pittsburg State University
Spears	Jacqueline	Kansas State University
Staples	Kimberly	Kansas State University
Stockam	Angela	USD 266 Maize South High School
Swanson	Laura	USD 259 Wichita Public Schools
Toomey	Debbie	USD 446 Jefferson Elementary School
Troyer	Joyce	USD 378 Riley County Schools
Tschauder	Sarah	USD 409 Atchison High School
Wellman	Bruce	USD 233 Olathe Northwest High School
Wolken	Virginia	USD 101 ERIE HIGH CHARTER SCHOOL
Wooley	Paul	National Center of Innovation for Biomaterials in Orthopedic Research

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Executive Summary

The Kansas Next Generation Science Standards Review Committee recommends the April 2013 release of the Next Generation Science Standards be adopted as the Kansas science standards. The organization, emphasis, and structure of the NGSS reflect the evidence-based recommendations on teaching and learning in the sciences based on the research since the last major effort to produce comprehensive science standards dating back as far as twenty years ago (i.e. *Benchmarks for Science Literacy* (Project 2061, 1993) and the *National Science Education Standards* (NRC, 1996)). The consensus view of the Kansas NGSS review team is simple - these are a significant improvement over our current standards and have the potential to improve the science and engineering knowledge and skills of Kansas students.

On July 19, 2011, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (NRC, 2012)* was released. It was a critical first step of rebuilding a foundation for science education compiling the most current research on science and scientific learning and identifying the science and engineering topics all K–12 students should know. A consortium of twenty-six states, facilitated by Achieve and the National Academy of Sciences, developed the K-12 Next Generation Science Standards (NGSS). The NGSS have undergone numerous reviews and revisions based on input from the Kansas Next Generation Science Standards Review Committee, and similar committees in the twenty-six lead States, and two national public comment periods. The final draft of the NGSS was released in April 2013 for states to consider for adoption.

The *Framework* recognizes that science and engineering are major intellectual enterprises that improve people's lives. However, many of the challenges facing our students in the future, such as environmental, energy, and health issues, require a deeply informed knowledge in the underlying science and engineering factors. The *Framework* lays out a vision for K-12 education with students actively engaging in scientific and engineering practices while applying the crosscutting concepts that will deepen their understanding of the core ideas of all the academic fields of science and engineering. By the end of the 12th grade, students should be critical consumers of scientific information related to their everyday lives. This will allow them to continue to learn and use science throughout their lives, whether it is in college or in a career (NRC, 2012).

The *Framework* reflects the need for greater coherence in science education. It was the guide for the authors of the NGSS to accomplish three main goals:

1. Develop and promote the concept that learning is a developmental progression;
2. Narrow the focus to a limited number of core ideas in science and engineering within and across the disciplines;
3. Integrate knowledge and practice in science and engineering learning experiences.

It is important, however, to remember that the NGSS are not intended to define course structures, curriculum, or lesson plans. The NGSS were written as expectations for what all students should know and be able to do in science and engineering, but it does not limit instruction. District

curriculum, especially in elective courses, should push beyond these standards to address the needs of their best and brightest students and community. The standards maintain a sharp focus on the things that cannot be overlooked in our expectations for *every* student. The NGSS emphasize what is essential and provide the tools and core knowledge needed to succeed, whether in a post-secondary classroom or career.

The Kansas Next Generation Science Standards Review Committee provided meaningful and significant input into the development of the NGSS from September 2011 through the April 2013 release. The committee included sixty Kansas citizens ranging from elementary education, secondary education (6-12), post-secondary education, informal science educators (e.g. zoo educators, children's science museum educators), business and industry, and representation from the Kansas State Board of Education. In addition to this group, that actively reviewed four confidential drafts of NGSS, many others in Kansas participated in shaping these standards. During the final public review (January 2013), over 4,200 unique IP addresses from Kansas accessed the NGSS. This was the thirteenth highest total (among all fifty States and the District of Columbia) in number of responses and if adjusted as a proportion of population, Kansas ranked sixth in number of responses. Many Kansans not only reviewed the standards, but also provided comments on the NGSS.

Though other States were involved in the standards development process and they and others will be adopting NGSS for their State Science Standards, Kansans played a central role in shaping these standards and should rest assured that this is very much a Kansas document (refer to *Appendix A: Kansas Influence on the NGSS*). Working with other states in this process did not "dilute" the Kansas effort, rather it what Kansas brought to the table and produced a better set of standards than Kansas could produce independently.

Respectfully Submitted on Behalf of the Kansas NGSS Review Committee,

Paul Adams	Mary Cerny	John Popp
Anschutz Professor of Education	Elementary School Specialist	Curriculum Director
Professor of Physics		
Fort Hays State University	Salina Public Schools	Great Bend Public Schools

Co-chairs of the Kansas Next Generation Science Standards Review Team

Need for the Next Generation Science Standards

In Kansas, the Next Generation Science Standards (NGSS) have arrived at a critical juncture in Kansas standards adoption. The current Kansas State Science Education Standards are due for revision in 2014. As a lead state Kansas played a significant role in shaping these standards, with the backing of the National Research Council and the other lead states. The NGSS have been reviewed and revised based on input from Kansas, and reflect the rigor, coherence, and cohesiveness that will serve as the basis for developing STEM (science, technology, engineering, and mathematics) curriculum for this century. The need for the advancement of science and STEM education in Kansas schools is appropriate given the current needs of our society and world. "*A compelling case can … be made that understanding science and engineering, now more than ever, is essential for every American citizen. Science, engineering, and the technologies they influence permeate every aspect of modern life"*(NRC, 2012). In our ever-changing world, if we stay the same, we will fall hopelessly behind. Kansas students must be capable of meeting the needs of an increasingly technical and scientific work force to compete for jobs on the world stage.

In the wake of *No Child Left Behind (NCLB)*, students have become more adept at passing tests and regurgitating information, but not necessarily better at critically thinking and working through difficult problems. NCLB's increased emphasis on mathematics and reading, has forced many schools and systems to de-emphasize the teaching of other critical areas, such as science. There is a great need to establish science as equally important to mathematics and reading.

The Kansas College and Career Readiness Standards (KCCRS) have raised the bar for students in English Language Arts (ELA) and mathematics and more recently in Social Studies, History, and Government. The KCCRS empower us to change the education paradigm by challenging students to think deeper, to analyze, to create, and to justify their thoughts and actions. Students learn to research and develop logical arguments with evidence to support their position. The older model of just knowing "reading, writing, and arithmetic" is gone; we live in an age when information is ubiquitous and Kansas needs students who have the ability to solve problems, can think from a multidisciplinary perspective, can communicate and articulate their thought processes, can support their positions from evidence, and can use technology. This push should be reflected in science education. The NGSS have been written with the new KCCRS Standards in mind, tying every skill and standard to the KCCRS, and demonstrating how these are interwoven and complementary to one other. ELA and mathematics have always been important, but find additional relevance and application in the sciences: the "why" for mathematics is provided through science, meaningful application of ELA by communicating science ideas through the written and spoken word provides real and significant practice with these career-essential skills. By entwining KCCRS and STEM, students will experience a coherent school curriculum with the potential to maximize their learning. In order to address the performance expectations that define the NGSS, students will engage in high-level in-depth investigations and have meaningful dialogue through productive discourse, all while incorporating these science

and engineering practices with content. This engagement in science and engineering practices blended with content has been clearly demonstrated to not only increase student engagement in science, but also to increase their retention of content (NRC, 2006). The NGSS are not alone in this blending of content and practice as the redesign of the science Advanced Placement courses, the 2015 PISA (The Program for International Student Assessment (PISA) is an international assessment that measures 15-year-old students' reading, mathematics, and science literacy); Vision and Change in Undergraduate Biology and A New Biology for the 21st Century (two recent post-secondary science initiatives); and the Scientific Foundations for Future Physicians have all headed in this direction based on the research demonstrating its effectiveness. The NGSS does not ask less of our students; it asks more.

As Kansas continues to implement the Kansas College and Career Ready Standards, the NGSS will align with and invigorate that initiative. The career and college demands placed on students exiting high school necessitates a demanding science curriculum to prepare students for that transition from high school to the world of work or college. Adopting the standards is an investment in the intellectual capital of Kansas.

Motivation for Adopting the NGSS as the Kansas Science Standards

The College and Career Readiness Imperative

At the core of the NGSS is the vision that science competency unlocks the goal of all students becoming college- and career-ready upon graduation from high school and/or college. Kansas students have typically tested at or above average on a variety of measures of science competency. In 2011, the Kansas average score on the eighth grade National Assessment of Educational Progress (NAEP) was a 156—five points above the national average. In 2012, Kansas students taking the ACT scored an average of a 21.7, which continues a trend of at least the last five years of the Kansas science average being either at or just under a point better than the national average (20.9 in 2012). However, although an average of 21.7 is above the national average, only 35% of Kansas students that take the ACT reach ACT's college ready benchmark for science of a 24 on the science section (ACT, 2012). We can, and should, do better. Adoption of the NGSS as the new Kansas Science Standards, implemented with fidelity to the NGSS, has the potential to improve the performance of Kansas students on national comparisons, as it would better align instruction with evidence-based research on effective science teaching and learning. **Table 1 A Definition of College and Career Readiness in Science** operationally defines what we should expect to see in Kansas graduates.

Table 1: A Definition of College and Career Readiness in Science[1]

College- and Career-Ready Students can demonstrate evidence of:

- Applying a blend of Science and Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas (DCIs) to make sense of the world and approach problems not previously encountered by the student, new situations, new phenomena, and new information;
- Self-directed planning, monitoring, and evaluation;
- Flexible application of knowledge across various disciplines through the continual exploration of Science and Engineering Practices, Crosscutting Concepts and DCIs;

- Employing valid and reliable research strategies; and
- Exhibiting evidence of the effective transfer of mathematics and disciplinary literacy skills to science.

This working definition of college and career readiness in science is based on the following assumptions:

- As indicated in *A Framework for K-12 Science Education*, students are expected to operate at the nexus of the three dimensions of science: 1) Science and Engineering Practice; 2) Crosscutting Concepts; and 3) DCIs.
- The learning expectations are equivalent for college and career preparation.
- A student is ready to enter and succeed in coursework beyond high school in science and technical subjects that leads to a degree or credential. This includes the military and credentialing that can occur during the high school experience such as credentialing programs, dual enrollment programs and advanced placement courses.

[1]Source: NGSS, Appendix C

The Kansas Economy

Business leaders in Kansas have sounded an alarm. They cannot find the science, technology, engineering and mathematics (STEM) talent they need to stay competitive. Students' lagging performance in K–12 is a critical reason why (Change the Equation, 2012a).

The workforce for the 21st Century demands an increased proficiency in science, technology, engineering and mathematics (STEM) in all fields (Achieve, 2013). During the mid- to late 2000s recession, postings for STEM jobs outnumbered the STEM unemployed (Change the Equation, 2012b). In the most recent recession Kansas's demand for STEM skills remained high (see **Figure 1**) with a ratio of two jobs for every one unemployed person. Even when the United States fills STEM jobs, businesses rely heavily on foreign-born workers to fill these positions. In the last 60 years the percentage of foreign-born workers filling STEM positions has more than doubled from 7 percent in 1950 to 17 percent in 2008 (Carnevale, Smith, & Melton, 2011).

As Kansas builds its workforce in bioscience, energy, aviation, agriculture, telecommunications, and transportation, citizens will be needed with core science skills. It is imperative that the Kansas education sector produce skilled high school and college graduates to fill the workforce needs of the state. Potential employers need individuals who can communicate clearly, solve problems, analyze situations, and know how to learn. Adoption of the NGSS will force the development of curriculum that will build these skills and knowledge through the learning and application of science and engineering practices, disciplinary core idea, and crosscutting concepts.

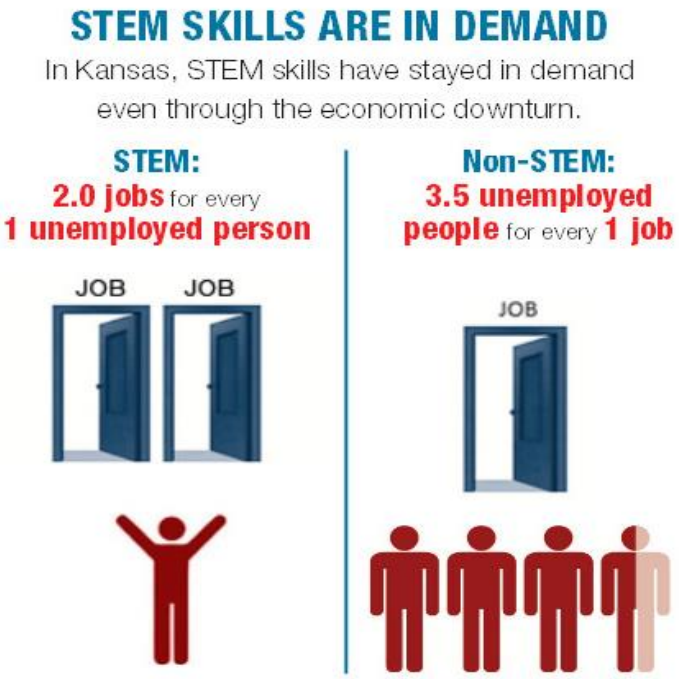

Figure 1. Kansas STEM Skill Demand. (Image Source: Change the Equation, 2012a)

Competition

If Kansas is to compete nationally and internationally for new business and industry it must develop its intellectual capital; the changing requirements for careers are a global phenomenon. As a state, Kansas has a history of being innovative and creative, with a work ethic second to none; however, without the raw talent needed for STEM related industries and business we cannot compete. Our current system of science education and standards only prepare us to be just above average in knowing science facts; we fail on students being able to perform in the STEM disciplines. This will not support growth in STEM related industries.

Will adopting standards with greater rigor that are defined by demonstrative skills improve student abilities and Kansas competitiveness? Kansas has already made the first step by the adoption of the Kansas College and Career Ready Standards for Mathematics. While not causal, the emphasis Kansas has placed on mathematics education in the last few years appears to have had a positive effect on student performance in mathematics as illustrated in **Figure 2**. The assessments being developed for the KCCRS have the potential to raise the bar on student performance to prepare them for careers or college after high school. Adopting the NGSS with its challenging standards appears to have the potential to raise student performance in science as a component of STEM.

Students have improved in math

Since 2003, eighth graders in Kansas have made gains on the National Assessment of Educational Progress (NAEP), also known as "the nation's report card." Yet many still have far to go to reach a score of 299, NAEP's cutoff for "Proficient" performance.

8th Grade NAEP scale scores, 2003 & 2011

	NAEP Scale Score		Change Since 2003	
	2003	2011	KS	Most Improved State
All	284	290	+5	+17 (DC)
Low Income	270	276	+6	+19 (MA)
White	290	295	+5	+17 (HI)
Black	252	269	+17	+19 (NJ)
Hispanic	263	274	+11	+24 (AR)

Totals may not sum due to rounding errors.

Figure 2: Kansas Improvement in 8th Grade Mathematics Measures. (Image Source: Change the Equation, 2012a)

Equity

True scientific literacy has historically been the province of more privileged students — something reserved for the "gifted" rather than a requirement for all. We cannot close the college and career readiness gap without giving every student the opportunity to build his or her skills in scientific practices — practices that will apply both in and beyond STEM fields. White men still dominate the science and engineering workforce, accounting for 55 percent of those in science and engineering occupations. White women make up 18 percent of those employed in science and engineering occupations. Black men and women comprise just 3 percent of the scientists and engineers in science and engineering occupations; Hispanic men and women comprise just 4 percent (National Science Foundation, 2011) (Achieve, 2013).

In Kansas we have struggled in developing science and mathematics literacy in all students as can be seen in **Figure 3** and **Figure 4**. Up to now, those who either a) came from more affluent backgrounds, b) had more family support and/or better home environments, and/or c) who have a natural ability for science/math are all more likely to receive additional help/encouragement outside of school and supplement the existing weaknesses in public school science/mathematics. With the adoption of the NGSS the need to go outside the public schools for adequate science and engineering education should be greatly reduced as the rigor and vision embodied in the NGSS will focus on preparing all students for college and career readiness. The Next Generation Science Standards *Appendix D: All Standards, All Students* describes in detail how the NGSS were designed and meticulously reviewed to promote science for all learners.

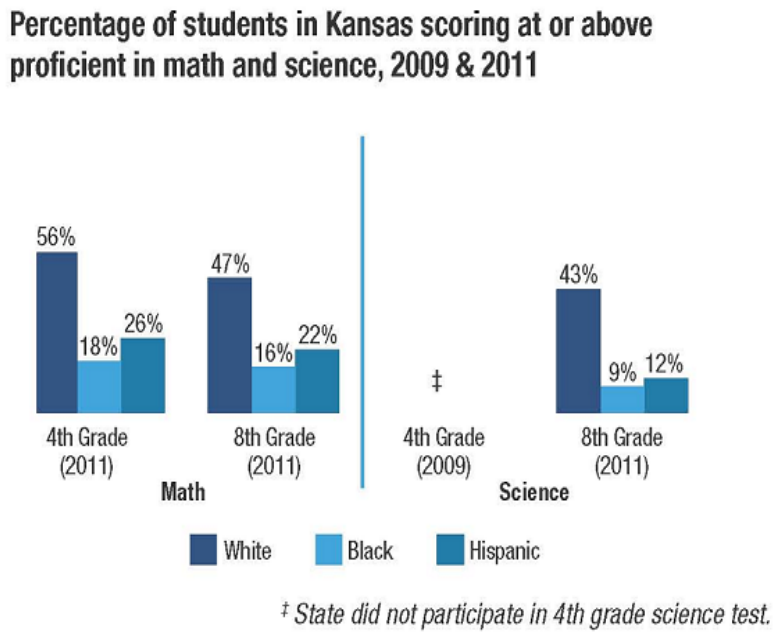

Figure 3. Percentage of Students in Kansas scoring at or above proficient in math and science, 2009&2011 disaggregated by ethnicity. (Image Source: Change the Equation, 2012a)

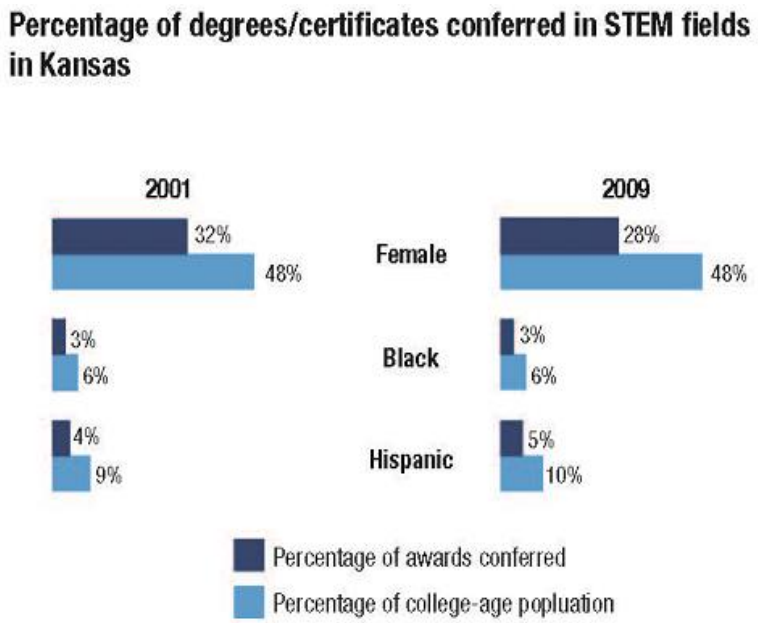

Figure 4. Percentage of degrees/certificates conferred in STEM fields in Kansas disaggregated by gender and ethnicity. (Image Source: Change the Equation, 2012a)

Informed Citizenry

Science — and therefore science education — is central to the lives of all Americans, preparing them to be informed citizens in a democracy and knowledgeable consumers in a world fueled by innovations in science and technology (Achieve, 2013).

To be science literate means teaching science and STEM in our schools. In 2008 Kansas spent only 1.8 hours a week teaching science in grades 1-4 (see **Figure 5**). Compounding this lack of science education is a dearth of challenging mathematics and science courses (see **Figure 6**). While the NGSS is not a panacea for the failure of science education to prepare all citizens, adopting the NGSS with its renewed emphasis on performance expectations and science and engineering practices that are seamless with the KCCRS hold great promise to improve science and STEM education of all or our citizens by leveraging cross-disciplinary connections, increasing the time spent on science and STEM and providing the background knowledge and skills requisite for challenging courses.

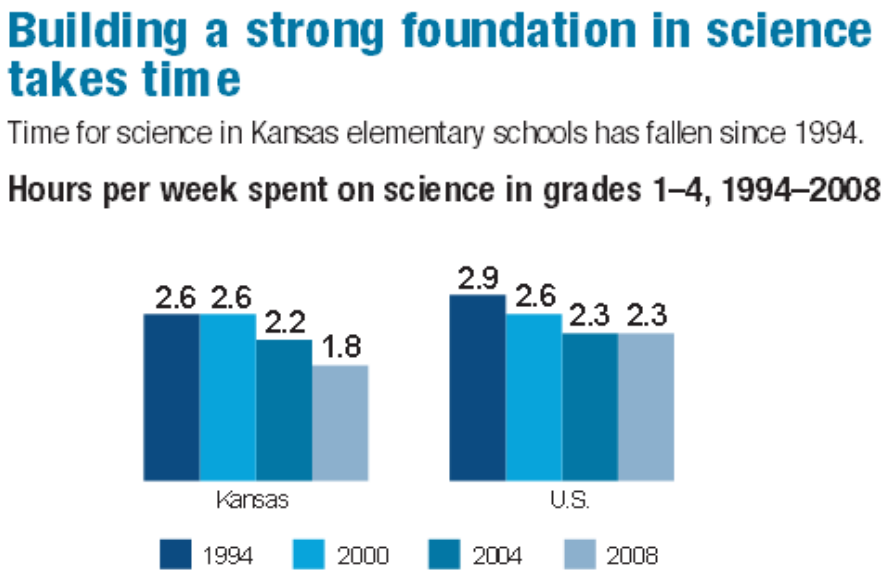

Figure 5. Time spent on science instruction grade 1-4. (Image Source: Change the Equation, 2012a)

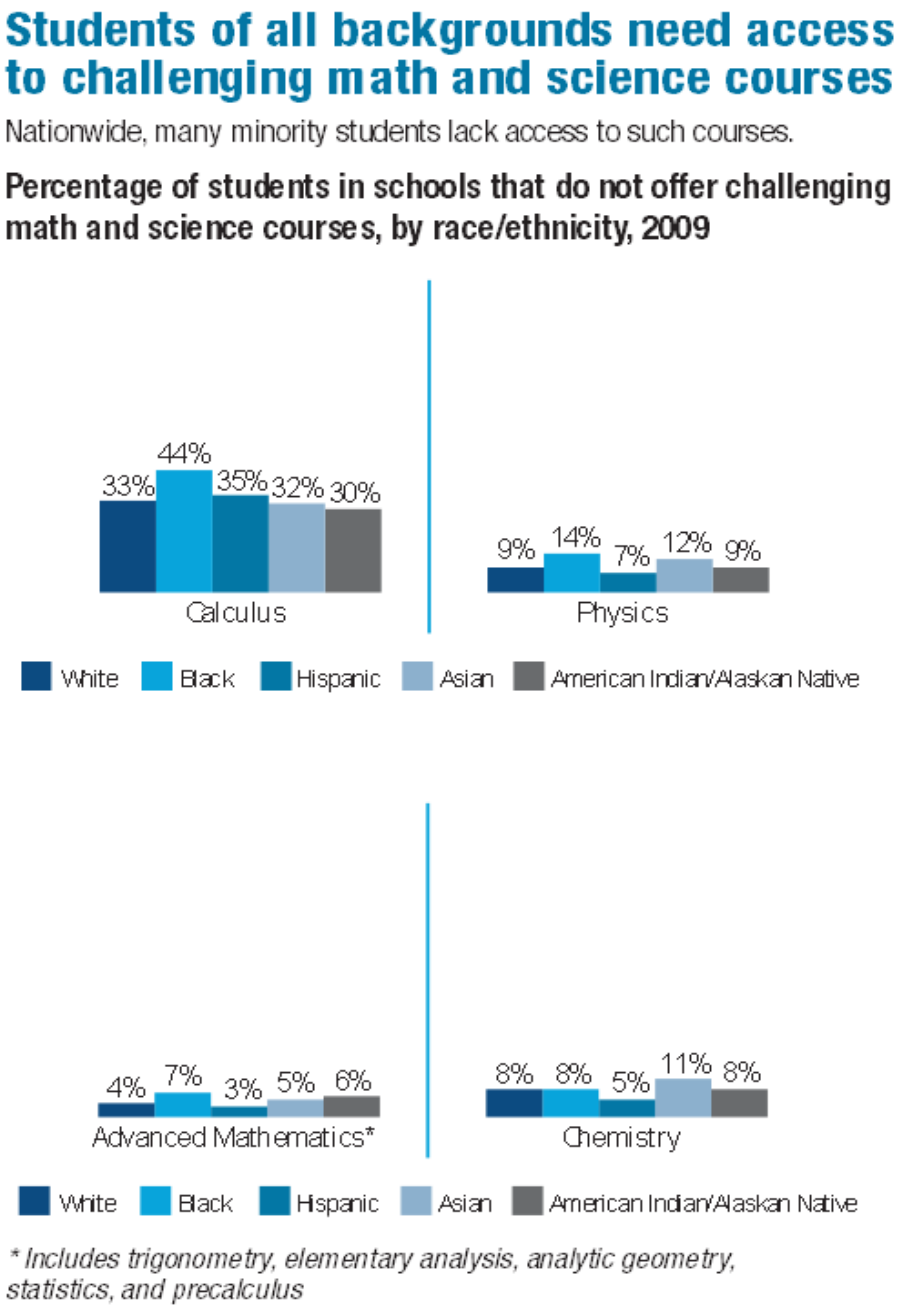

Figure 6. Percentage of challenging mathematics and science courses taken by students nationally. (Image Source: Change the Equation, 2012a)

What will change?

The adoption of the NGSS is not change for the sake of change. Our understanding of science teaching and learning has changed due to research, such as that identified in *How People Learn Science and Mathematics* (NRC, 2000) or *America's Lab Report: Investigations in High School Science* (NRC, 2006). Our current standards do not reflect this research base base. But what will we see as the NGSS are translated into curriculum and lessons that bundle the standards into teachable units? Table 2 summarizes the vision.

TABLE 2: An Introduction to the NGSS[2]

The overarching shift demanded by the NGSS is a change in the meaning of scientific proficiency. Students will demonstrate their proficiency in science not by recalling specific facts but by engaging in actual scientific practices that demonstrate the ability to apply scientific concepts and ideas in any context. Effective science teaching and learning comes from the combination of engaging in Disciplinary Core Ideas through Science and Engineering Practices, frequently in the context of Crosscutting Concepts. As such, the NGSS are organized around three dimensions:

- **Disciplinary Core Ideas** that are acquired by students through an overall K–12 learning progression and can be taught at increasing levels of depth and complexity over time.
- **Science and Engineering Practices,** like developing and using models or analyzing and interpreting data, are critical to scientific inquiry in any content area. These are not teaching strategies; they are a necessary student outcome to show proficiency in science.
- **Crosscutting Concepts,** like patterns and cause and effect, provide the connective tissue between sciences. These concepts are found throughout all scientific disciplines and will be continually revisited and built on through the exploration of core content.

At their core, the NGSS are defined and set apart by their focus on the blending of these three dimensions and the coherence between them. A student who can demonstrate understanding of these three dimensions as portrayed as performance expectations is literate in science.

How is this different from current science expectations in Kansas?

- **K–12 science education should reflect the interconnected nature of science as it is practiced and experienced in the real world.** Current Kansas standards express the three dimensions as separate entities, leading to their separation in both instruction and assessment. The NGSS expectations for both students and teachers are that they will engage at the nexus of these three dimensions, applying practices to content knowledge and making use of Crosscutting Concepts to do so.
- **The NGSS are student performance expectations — NOT curriculum.** The Disciplinary Core Ideas themselves form a progression of knowledge for students that are clearly laid out in the NGSS, but the Science and Engineering Practices and Crosscutting Concepts should not be limited to specific time periods of instruction. Rather, educators and students should

return to the Science and Engineering Practices and Crosscutting Concepts again and again, applying them to every Disciplinary Core Idea so that content knowledge progression is accompanied by skill development in the application of scientific practices and concepts. Simply said, the NGSS form the basis for student performance. Curriculum materials are state and local decisions that will encompass the order and day-to-day instructional needs to prepare students for the performances.

- **The science concepts in the NGSS build coherently from kindergarten through grade 12.** The focus on a few Disciplinary Core Ideas is a key aspect of a coherent science education. Historically, science education has been taught as a set of disjointed and isolated facts. The NGSS provide a more coherent progression aimed at overall scientific literacy, with instruction focused on a smaller set of ideas, while keeping an eye on what the students should have already learned and what they will learn at the next level. These progressions for each grade band assume that the student has learned the necessary previous material.

- **The NGSS focus on deeper understanding of content as well as application of content.** Within the Disciplinary Core Ideas, the focus of the NGSS is on conceptual understanding — not just the facts. Facts and details are important evidence, but can no longer be the sole focus of instruction. *A Framework for K-12 Science Education* casts this shift in terms of the difference between novices and experts: "Experts understand the core principle and theoretical constructs of their field, and they use them to make sense of new information or tackle novel problems. Novices, in contrast, tend to hold disconnected and even contradictory bits of knowledge as isolated facts and struggle to find a way to organize and integrate them." The NGSS aim to make students experts rather than novices.

- **Science and engineering are integrated in science education from kindergarten through grade 12.** Unlike the traditional science disciplines, engineering has not routinely been included in Kansas science standards, curricula, or assessments, or as a component of the education of new science teachers. The NGSS integrate engineering into the structure of science education by raising engineering design to the same level as scientific inquiry in classroom instruction and by giving core ideas of engineering and technology the same status as those in other major science disciplines.

- **The NGSS make explicit connections to the CCR (English language arts and mathematics).** The release of the NGSS comes as Kansas is implementing the CCR. This creates an opportunity for science to be part of a child's comprehensive education. The NGSS take into account the content and performance expectations of the CCR to ensure a symbiotic pace of learning in all content areas and specifically refer to related standards in the CCR.

[2] Source: Achieve, 2013.

What are the implications for Kansas Schools?

The NGSS are a product of both research and an understanding of best practices across states. Once Kansas districts understand the difference between our current standards and the NGSS and the conceptual shifts demanded, they can prioritize the curriculum changes for their districts and articulate why these priorities will make the most difference for their students. **Table 3** provides shifts in the science curriculum and questions that Kansas districts may want to consider if the NGSS are adopted as the Kansas Science Standards

TABLE 3: Implications of NGSS Conceptual Shifts for Educators and Students[3]

Shift	**Questions To Consider**
K–12 science education reflects the real-world interconnections in science.	• What do our current science standards require with respect to this shift (i.e., what is our baseline)? • Do our current science standards require students to demonstrate understanding by applying specific scientific practices and crosscutting concepts to core content knowledge and its acquisition? • Do our science educators emphasize this application in their expectations, instruction and assessment of students? • Do our schools and support systems facilitate collaboration among science educators to demonstrate the reach of scientific practices and crosscutting concepts across the core ideas in the disciplines? • Do we have a plan to ensure that our local summative science assessments are written for the NGSS?
All practices and crosscutting concepts are used to teach core ideas all year.	• Do our current science standards require students to build skills in scientific practices and crosscutting concepts by focusing on them — and connecting them to content — throughout each school year? • Do our science educators teach science practices and core concepts as a progression of core content rather than in addition to it? Do they use these practices and concepts to build in-depth student understanding in the context of the content areas covered throughout the school year? • Do our schools and support systems equip and encourage educators to plan their lessons in this way? • Do schools and teachers have access to the consumable physical materials (beyond textbooks/curriculum materials) to prepare and execute the classroom investigations and design work required by the NGSS?

Science concepts build coherently across K–12.	• Do our current science standards lay out expectations for student scientific knowledge as a progression across grades, or do they expect the same content (or unrelated content) to be taught across multiple years? • Do our science educators treat science content as a cumulative body of knowledge built year by year? Can they assess students' prior knowledge and take appropriate remedial action? • Do our schools and support systems emphasize the collaboration of educators across grade levels to ensure this progression of knowledge for their students?
The NGSS focus on deeper understanding and application of content.	• Do our current science standards expect students to master scientific core ideas and principles (e.g., "molecules are made up of atoms, and have different properties depending on their combination") and use them in multiple contexts, rather than memorizing particular facts or details with little or no context (e.g., "the molecule CO, carbon monoxide, is a poisonous gas")? • Can our science educators emphasize a deep understanding of core ideas, sometimes at the expense of particular details associated with those ideas? • Do our schools and support systems give educators what they need to keep coming back to and focusing on these Disciplinary Core Ideas?
Science and engineering are integrated in science education from kindergarten through grade 12.	• Do our current science standards require students to use engineering design ideas and practices alongside the traditional science disciplines from kindergarten through grade 12? • How comfortable are our current and candidate science educators with engineering design? Do they raise it to the same level as scientific inquiry as a core practice in science instruction? Do they give core ideas of engineering and technology equal weight with those in other disciplines? • Do our schools and support systems prepare our educators to teach engineering design and the core ideas of engineering and technology? Is this reflected in policy/funding for course offerings and their content?
Science standards coordinate with the CCR in English language arts/ literacy and mathematics.	• Are our current and candidate science teachers aware of and knowledgeable about the CCR? • Do our schools and support systems allow and encourage collaboration across scientific and nonscientific disciplines in the teaching of literacy, numeracy and science?

[3]Source: Achieve, 2013.

Recommendation

As discussed in the preceding sections, there are many reasons for Kansas to adopt the NGSS. The NGSS provide a substrate on which to construct curriculum that will strengthen our work force, prepare students for college or careers, expand the pool of STEM knowledgeable citizens, improve equity in our education system, and place Kansas as a leader in science and STEM education and workforce development. These are grand ambitions, and adopting the NGSS is a bold step. Though all indicators point to a dramatic improvement in science education and thus student learning, Kansas will be on the vanguard. As with any innovation there are rewards and risks. The risks – adopting the NGSS does not improve science education and student performance, there is no increase in the STEM workforce. Grim outcomes, yes, but we already are failing to fill the STEM workforce quota, and are not viewed as a STEM powerhouse. The potential reward for adopting the NGSS is improved student learning in science, a STEM workforce second to none, an improved economy, and establishing our leadership in science and STEM education. The return on investment from adopting the NGSS as the Kansas Science Standards is high if implemented with an eye towards fidelity of the NGSS and *Framework for Science Literacy*. The reward of investing in the NGSS, based on the analysis of the Kansas NGSS Review Committee, far outweighs the risk. Maintaining status quo is tantamount to failure to survive in the competitive market nationally and internationally.

The benefits offered in adopting the NGSS at this point in time, rather than waiting until 2014 or through piecemeal adoption will assist Kansas in becoming a leader not only in STEM education, but also revitalize our workforce. Why would we wait to implement a tool that could be so powerful for the students and the communities that they will grow to serve? The NGSS provide a solid foundation of skills, knowledge, and broader understanding of science than our current standards and better align with what has been learned about how students learn science. The Kansas NGSS Review Committee, based on its close review and opportunity to revise the NGSS, fully recommend the adoption of the Next Generation Science Standards. District curriculum based on these standards will serve our students and thus are state very well in the 21st Century.

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Appendix A: Kansas Influences on the Development of the Next Generation Science Standards

Taken on the whole, the Kansas NGSS Review Team very much felt that the Kansas feedback was listened to and incorporated into subsequent drafts of the standards—both on a global level in terms of the overall structure and direction of the standards and down to the finer grain size of individual performance expectations. This appendix attempts to summarize and document this feedback process across the drafts so that those that were a not a part of this process can see evidence for how the Kansas team helped to shape the final document of the Next Generation science standards. Be aware that all of the feedback presented in this appendix is based on past drafts of the standards and not the final documents.

The following topics are all ones advocated for by the Kansas NGSS Review Team that were directly in line with the direction taken in the final standards document. It be noted that, although many of the changes that were advocated for by the Kansas team, this is not necessarily because these topics were unique to the Kansas response. The NGSS development process was a true multi-state collaborative with decisions being made collectively for the betterment of the final document.

Web-based Presentation—The Kansas team advocated from the beginning that these standards go beyond a typical hard copy presentation. There were several times throughout this process where we advocated for flexibility in the online presentation of the standards. In the initial draft, all of the text in the performance expectations was color coded to match the foundation boxes. About half of our group really liked this and half found it distracting, so we advocated that this functionality should be able to be turned on and off in the online presentation of the document. In addition, we requested mouse-over pop-ups of the text to help connect the performance expectations to the information in the foundation boxes. Once this was included, we also advocated that this functionality be optional as it was sometimes a distraction (this functionality was also added). During the development of NGSS, there was a similar discrepancy between those that advocated for the standards to be arranged by the "Topics" that were used in writing the standards and some that advocated that they were arranged by the disciplinary core idea (DCI) they were linked to. Though we initially advocated for the topics arrangement, there were those in our group (and in other states) that advocated for the DCI arrangement. We asked for both and to be able to sort and search the performance expectations in a variety of ways. This functionality was available in the January 2013 Public draft and the NGSS final performance expectations are currently being coded so this functionality will be available soon.

Consistency in voice—in early drafts of the standards, this was a significant issue as the writing team worked in teams that were organized by content and/or grade level. Early drafts had many inconsistencies in voice between the groups. This included differences in language around how the practices verbs were used, how the crosscutting concepts were incorporated, how assessment boundaries and clarifying statements were used, and in the words that linked the dimensions of the performance expectation together. The Kansas team advocated for increased use of both assessment boundaries and clarification statements. The inconsistency was actually designed in deliberately so that the feedback from the states could guide the writers to what was the most effective language rather than this being pre-determined by the writers. The result is a final document with much more consistency and clarity in language.

Balancing content and grain size across grade levels—Initial drafts of the standards left much to be desired in this area. For reasons similar to what was described for voice, the grain size of individual performance expectations and the progression of content between grade levels was inconsistent across the standards. Correcting this was a theme that runs through the Kansas feedback and the final document shows much more consistency in both of these areas.

Engineering—Engineering is a fourth domain (in addition to Life Science, Physical Science, and Earth and Space Science) in the *Framework*. In the initial drafts of the NGSS, these standards were separated out without a specific science context to mirror the organization of the *Framework*, but the Kansas team expressed concern that this arrangement would lead the standards to become a separate unit or course rather than highlighting the overlap of science and engineering. We advocated that all the engineering performance expectations be incorporated within the other domains to support their integration into the classroom, but we still wanted to be able to sort these performance expectations out in the online presentation. We generally approved of the resulting integration, but our engineering review team felt that the engineering design component got a bit lost in the process. We now advocated that there be several stand-alone engineering performance expectations at each level to make sure that the design process of engineering was adequately addressed. This is the arrangement of the final document.

Keeping the focus on depth over breadth—As the drafts progressed, the Kansas team became concerned that there were so many PEs that it would be difficult to actually engage in the science and engineering practices in line with the vision of the standards. We really began to push for removing redundancies within and across grade levels to make sure there was room for teachers to reach the rigor of the depth of the standards. As a result of this feedback from Kansas and others, quite a number of the performance expectations were removed before the final draft as the coherence across grade levels was refined.

Additional support materials—Due to the multi-dimensionality of these standards, it was difficult to simultaneously follow all three dimensions across the K-12 progression. While it was understood that the middle school and high school standards would be grade banded, we requested there be support for districts to make good decisions about how to organize these standards into courses. These materials and others are provided in the appendices to the NGSS.

General Feedback

In addition to feedback on each performance expectation, there were multiple opportunities provided for the Kansas Next Generation Science Standards (NGSS) review committee to provide feedback on the overall picture of the standards document. This section of the appendix highlights the Kansas response to the general questions over the development of the NGSS.

December 2011 draft

In the responses to the first draft, the Kansas team saw potential, but this draft was not an entirely complete draft and the team was hesitant to be too positive until they were able to see everything. There was still a lot of work to do. The following information is a summary of the information provided within pages 440-462 of the complete Kansas Feedback for the December 2011 draft. For the December 2011 draft, the responses in this section were based on whether or not reviewers agreed with particular statements and then there was an opportunity to comment. The complete answers and all comments for this section can be found online (http://www.ksde.org/Default.aspx?tabid=5688), but this section strives to summarize the responses for this draft rather than just copy and paste. In subsequent drafts (at least in part due to a request from the Kansas team, these survey questions were more open-ended and the direct responses are included in this report.

When asked whether or not the architecture (or structure) of how the standards were presented (with color coded text in the performance expectations at the top, color coded foundation boxes in the middle, and connections boxes at the bottom) was easy to follow, only just over 60% of the group either agreed or strongly agreed. In comments in their reviews and in our face-to-face discussion, about half of the group liked the colors in the text and about half result. One of the primary things that we advocated for in

conversations with other states (who had similar splits) was to be able to turn the colors in the text on and off. Beginning with the May 2012 Public draft, this functionality became a part of the standards.

When asked about whether or not the performance expectations represented the disciplinary core ideas, science and engineering practices, and the crosscutting concepts, the group again saw potential but also saw that there was a fair amount of work to be done. Even though a majority either agreed, or strongly agreed to all three questions, comments indicated that some areas were significantly better than others and there was concern about balance and grain size across the standards—between content areas and grade levels. Furthermore, this innovation of multidimensional standards would need revision as the connections between the three dimensions in an individual performance expectation sometimes seemed forced or "clunky." Additionally, the group found it difficult to track these dimensions across time and requested separate documents to help teachers understand how the different dimensions progressed over time. Starting with the May 2012 Public draft of the standards, there have been appendices to address this very issue.

Taking into account that this was an early draft with much work to do, the Kansas team already thought that these standards had potential for guiding instruction for K-12, supporting curriculum development, and developing new assessments, but this support (75% either agreed or strongly agreed) was given with a strong dose of caution that there was still a lot of work to do. In particular, there was a concern from the elementary teachers in our group that elementary teachers would need some addition specifics to support the performance expectations and make sure that they understood what they were describing. The writing committee's response to this was to include clarification statements and assessment boundaries along with the performance expectations to help support teachers.
Overall, the feedback was that this was a good start, but that there was much good work to do for these standards to realize the vision that was laid out in *A Framework for K-12 Science Education*.

January/February 2012 draft
This was the first complete draft of the standards with all performance expectations at all grade levels. The following description includes a summary of the responses to the quantitative questions and directly quoted open responses for the state report.
Elementary quantitative response summary: Progressions--K-2 prepares for 3-5—yes; all 8 practices and 7 CC in yes, but slightly less confident about math (5. Using Mathematics, and Computational Thinking); not enough guidance in the document for elementary educators, elementary curriculum development, or assessment development at elementary level

> *Standards language needs to be simplified so the average elementary teacher can pick up the standards and be equipped to choose curriculum to fit the desired performance expectation. There needs to be an increase in assessment boundaries as it is not consistent across standards. Also, the limits described are broad and do not provide a consistent view of where the standard ends and what is the appropriate level within the standard.*

Middle school quantitative response summary: would have good understanding of DCI, CC, and SEP— somewhat agree; all 8 practices and 7 CC in yes, but less confident about math (5. Using Mathematics, and Computational Thinking) and scale(CC #3. Scale, proportion, and quantity); not enough guidance in the document for MS educators, or assessment development at MS level, but probably enough for MS curriculum development; some concern about clarity of language

> *Engineering principles and practices are different than those of the natural sciences. I am not sure there is enough material to support teachers as they help students differentiate the disciplines.*
> *There appears to be a weakness in the mathematical representation of the concepts in the*

physical science. A stronger basis on the math is needed to achieve that wanted at the high school True that qualitative understanding is critical, but there needs to be a clearer path in applying mathematics.

High school quantitative response summary: students would have good understanding of DCI, CC, and SEP—somewhat agree; all 8 practices and 7 CC in--yes, but less confident about math (5. Using Mathematics, and Computational Thinking) and scale(CC #3. Scale, proportion, and quantity); not enough guidance in the document for HS educators, or assessment development at HS level, but probably enough for HS curriculum development; some concern about clarity of language

The high school standards seem the clearest and most comprehensive of the grade levels. There is a large jump/gap between what is said at the middle level and what is needed at the high school level; K-2 flows to 3-5 and 3-5 to 6-8, but gap at high school; Also there is a lack of coordination between the physical science standards - some duplication and lack of building on each other.

May 2012--Public Draft

The comments here are taken directly from "KS Feedback May 2012 Public Draft," (available here: http://www.ksde.org/Default.aspx?tabid=5688)

General Feedback

--"use models" is too vague of a term and mostly used in these standards as "regurgitate with a visual aide" rather than use to make predications and test those predictions...it would be much more useful to students identify the value, data used to create

--rather the same verbs at different grade levels, but meaning different things (sometimes even within levels), it would be helpful to use the language that is specific to the grade band. For example rather than saying "Asking questions" at all levels, at the K-2 level, use "Develop simple descriptive questions about____that can be tested" otherwise asking questions just becomes a KWL activity. Use the verbs from the grade band description of the practice rather than always just using the bold words.

--more alignment is needed between the naming of standards between grade bands, especially between K-5 and the MS/HS

--really would like the term engaging in scientific discourse to be a part of argumentation--we are firmly grounded in awareness of what argumentation is and the role that it plays and the research behind it, but the lift of distinguishing between arguing and argumentation will likely sabotage implementation with fidelity to the standards; even though argumentation is used in the framework and is used in common core...

--would like more about evaluating the credibility of resources as a part of evaluating the validity of claims and arguments

--we like language that focuses teacher and students on evidence supporting claims and the argument being the language that connects the evidence to the claim rather than saying that "evidence supports an argument"

--a preponderance of "obtaining" or "obtaining and communicating" about topics, but a scarcity of evaluating...this speaks to breadth over depth

--the use of investigation is not consistent--sometimes it implies discovery, sometimes do an experiment, sometimes it just means gather information from a variety of sources--this needs clarification and consistency. Rather than using the same word in multiple contexts to mean different things, It would be good to sample from the other verbs (more than just the ones in the titles) from the practices for clarification.

--something to remember in looking at K-12 progression of practices...planning and carrying out investigations, in order to be the most instructionally valuable, will likely incorporate most if not all of the other practices
--Kansas DEFINITELY wants the engineering PEs integrated into the other content areas at middle school and high school. Replace one or more of the existing PEs with one that is focused on engineering. We still want to be able to sort the engineering out, but they should be incorporated with the other DCIs or we will likely just re-live what happened with inquiry--the engineering will either be ignored, or taught in a separate unit if there is time. The intent of the framework from our reading is to look at the integration of science and engineering--that won't happen if they are just listed in a separate dci. We've learned this lesson. Let's not make the same mistake twice.
--In some standards (as noted in the individual standards) there are too many PEs that result in a return to breadth of coverage over depth. In general, those that moved past 5 PEs seemed to be sliding down the slope toward coverage.
--In general, we liked the clarification statements and examples as they did add clarity, but wondered if they weren't too limiting sometimes. Visually they sometimes added to the clutter. It might be nice to either be able to have a view that turns them off, or have an icon to click to show them.
--There needs to be a concerted effort to evaluate the grain size of both standards and PEs. Not to say that they all need to be equal, but some PEs are particularly broad.
--There are several pieces of content that appear in several PEs--horizontally and vertically. Future revisions should look at these connections carefully to make sure that they really are building off each other rather than just repeating. For example, it seemed like there were quite a number of times that students were creating a model of the carbon cycle. Let's make it once and then start using it to make predictions.
Suggestions for future feedback surveys:
--It would be MUCH easier to answer all questions about each performance expectation one at a time rather than having to keep jumping back to re-evaluate several questions about the same expectation at different times. We want to give a global/overall rating for a performance expectation and then select/explain the reasons for the rating. Our tendency was to end up rating an expectation similarly on both questions...in other words, if a PE is actually clearly written, but the practices don't really match up with the content, it is likely to get rated low twice, whereas, if we could late it overall and then give an explanation for the rating (checkboxes for clarity/practices/other and a textbox). We also think this would lead to more targeted and constructive feedback.
--the previous button should go to the standard before it rather than jumping all the way back to the beginning
--the checks in the STOC clear if the previous button is clicked more than once...frustrating;
Web-based Presentation of the Standards
Let me start by saying that I am absolutely thrilled with the progress to this point, but I think there is still quite a ways to go to really make the web-based interface user friendly. Here is a list of features that would take us in that direction…in no particular order:
1. a view where I can track standards across grades in a particular topic (boxes collapsed or eliminated) on one page
2. a view where I can track a particular practice at a given grade level on one page (boxes collapsed or eliminated)

3. same thing for crosscutting concepts
4. For every standard page view, a link or mouseover that provides a visual representation of where this standard fits into K-12 progressions (by dci, cc, and sep)...in general more visual representations of progressions would be helpful
5. Ability to drag and drop individual performance expectation into a workspace for lesson plan development--if we want teachers to be able to see how multiple PEs can fit together in one lesson, there needs to be a tool to facilitate this process
6. Being able to select which boxes you want to be collapsed in default view and the ability to collapse/expand manually in any view.
7.when clicking on the links in the connections boxes below (great that these are links, BTW) I automatically what to put in a view where I see thes standards side by side rather than having to go back and forth. I minimal version of this would be to have them open in another window, but the best case scenario would be a view where I can view the two together--I'm thinking of a "compare" feature from online shopping...I can remove a standard, add a different one, "continue shopping" and add something later, etc.
8. Similarly, when I click on the links in the foundation boxes, I want that, at a minimum to open in another window so I can see things side by side, but best case scenario, this takes me to a different view where I can see them side by side and even better, interact with them in some way.
9. I want to be able to log in to an account and annotate the standards in a meaningful way online...and share my annotations with others...make meaningful of PEs (as mentioned above) and then share these with others
10. maybe not during the review process, but in the final web presentation, a key word search would be helpful
11. Potential additional mouse-over text for the titles of each of the foundation boxes:
a)At this grade level, in this set of performance expectations, these are the aspects of the disciplinary core ideas (DCI) that are addressed. Click on the DCI to get a more complete explanation of each DCI and its K-12 progression.
b)At this grade level, in this set of performance expectations, these are the aspects of the crosscutting concepts (CC) that are most prominent. Click on the CC to get a more complete explanation of each CC and its K-12 progression.
c)At this grade level, in this set of performance expectations, these are the aspects of the science and engineering practices (SEP) are addressed. Click on the SEP to get a more complete explanation of each SEP and its K-12 progression.
12. It would be nice to be able to turn mouse-over text off. It's great for new users, but it kind of gets in the way after you've been working in the standards awhile.
13. When in a "standard view" need a way to easily navigate to the "search by topic" and "search PE" views.
14. In Search by topic view, the K-5 storylines aren't really organized by topic; this made tracking down K-12 progressions difficult--one K-5 box with columns for each grade and rows for content--(parallel coding with the dci's?)
15. A much bigger difference in the saturation of color between the blue and the green (for B-G colorblind folks)--received a specific complaint from the field
16. Why the view with practices and core, practices and CC, but not all three?
Despite all of these critiques/suggestions, this is so much better than interacting with a 2D pdf. PLEASE don't make us go back to using that for future confidential reviews--maybe just secure the standards web page with a password?

September 2012 Draft

The general response of the Kansas group is that we like the direction that things are going, but there is still work to do. In addition to the specific feedback on individual performance expectations that follows, we have feedback on several topics to offer in guiding the revisions for the next draft.

Engineering Integration—

The Kansas Review team generally liked the intent of the engineering integration and still think that this direction is the right way to go, but this first stab at integration was quite rough. There needs to be a more coherent representation of the cyclical iterative process of engineering across the topics. At this point it seems quite haphazard. Part of this could be accomplished by making sure that the practices verbs are more clearly engineering—investigate seems more of a science term, but was used in quite a number of the "engineering" PEs. Another aspect of engineering that seems to have been lost in the integration is iterative prototype development. In ideal solutions students are evaluating designs and they must have the information (criteria) that led to creation of those designs. They need to propose the next iteration and how it will solve the problem. We would like to see more integration of engineering within the life sciences and wonder if the bioengineering of prostheses and artificial joints and/or biotechnology are fertile ground for this connection. The Kansas review committee felt that there needed to be a couple of standalone performance expectations related to an engineering design cycle.

Math Integration—

The Kansas review group was generally positive about the level of integration of mathematics and the resulting narrowing of grain size in PEs. In some of the PEs (as is indicated in the later feedback) it would be helpful to actually have more specificity at least within the clarification statements and/or assessment boundaries that more explicitly makes connections to the common core. For example, rather than just having a generic "analysis of data," it would be helpful to refer to specific data analysis skills that are called for at that level by the CC.

Elementary topics and storylines—

We liked the changes in elementary topic names to better represent K-12 progressions while retaining elementary-friendly language and the elementary storylines were also helpful. We hope these will be stretched into a K-12 narrative.

Nature of Science—

We like the general pattern of highlighting what is there in terms of Nature of Science rather than adding additional PEs. In some PEs, changes that were made to highlight NOS resulted in clunky PEs. The NOS emphasis can't be done by just adding it in on top of whatever the PE was already expecting; the PE needs to be modified so that it is not asking for two separate, but related expectations.

Assessment boundaries—

Though it is mentioned in the front matter, our group thinks that there needs to be a way to emphasize that assessment boundaries are not necessarily instructional boundaries. This might be through a mouse-over on "Assessment Boundary" that says something to the effect of, "Assessment boundaries are put in place to delineate what is expected of all students and to keep

the focus on depth over breadth, but do not mean that topics beyond the scope of the assessment cannot be a part of instruction," and/or through changing the language within the assessment boundaries from statements like, "is not intended" and "is not required," to " is beyond the scope of an assessment based on these standards for all students."

Cross-disciplinary topics—
It may well be too late for this shift, but we would like to see at least one deliberately cross-disciplinary topic in MS and HS. Though topics aren't exclusively DCI specific, it would be appreciated if there was more of a deliberate and explicit effort to be cross-disciplinary.

Topics vs. DCI arrangement—
With the matrices that make a comparison of both arrangements, this is less of a concern for us—it is likely that the primary use for teachers in KS would be the online version anyway. It is much more about the professional development that supports the standards than it is about the default arrangement. If KS successfully adopts these standards, I will certainly encourage districts to save their money and use the online version. The topics would be more valuable and more meaningful if they were deliberately cross-disciplinary.

Models—
It would be helpful to use modifiers of "models" whenever possible. There seem to be many times when a particular type of model is implied by the PE, but the generic "use models" or "create a model" is used. This practice is a stretch for teachers and it would be helpful if words like conceptual, physical, mental, etc. were used to modify model whenever appropriate.

Survey tool—
MUCH MUCH better! The arrangement of the questions and the navigation through the survey were so much more user friendly than the previous rounds! With the electronically dynamic review of the public draft, it would be good to have questions about K-12 progressions paired with a matrix that has PEs as clickable links.

Guidance for Assessment and Curriculum Development, but not curriculum as is—
It is absolutely essential that there are user friendly tools to support district curriculum leaders and teachers understanding that these standards are not just curriculum, but that they need to build a curriculum that supports the standards. The process of arranging the PEs into paths (not pathways—this is a CTE term with a specific meaning) may inform what is needed here, but in addition to dividing PEs into courses or grade-levels, there need to be tools to enable teachers to EASILY track which aspects of each practice, DCI, and CCC they are using each day.

Argumentation--
There is still inconsistency about how argumentation is used across the topics. For example, the phrase, "Engage in arguments from evidence..." is used several times (in MS.IRE and HS.IRE for sure)and this phrase conjures up images of arguing rather than engaging in argumentation. This phrase should be either "Engage in argument (no "s")" or "Engage in argumentation..." A way of thinking that makes sense to us is that the "argument" is the deliberately made connection between the claims and the evidence--it explains why the evidence supports the claim.

January 2013 Public draft
The following is a direct quote from the Kansas Team report:
Overall very pleased with the progression of these standards through the drafts and the responsiveness to feedback.

Continue to like the direction of integration of engineering within the other core ideas, but it will be important to include some explanatory text with the views of the engineering standards to indicate that these very PEs are embedded elsewhere--we like the double listing, but newcomers were sometimes confused.

The DCI coding seems to make the topics arrangement obsolete and, though we have advocated for the topics coding in the past, it probably makes more sense to just have one coding--the "topics" arrangement could actually live within the DCI arrangement and coding. This could be done by carefully making the connections between content in the DCI connections box. These could create cross-disciplinary topic groups. If there was an option to see all of the "connected" PEs, it may end up looking quite a bit like the topics arrangement with a stronger emphasis on cross-disciplinary connections. Having both arrangements is nice in some ways, but it adds a level of complexity for the general user that makes it less user-friendly

The DCI arrangement exposed some patterns or ruts in pairing practices with content. This may have been deliberate, or it may have been a result of the writers of a particular group being more comfortable with/fond of particular practices. For example, MS LS1 has a lot of argumentation; HS LS1 has a lot of models that are physical representations, LS2 has a lot of mathematics connections; MS LS4 has a lot of "constructing explanations." If the patterns are a deliberate matching of content and practice that is balanced by other areas, that's probably okay, but it is worth a look to make sure that they aren't just the result of getting in a writing rut.

There are a couple of instances where the clarifying statements or assessment boundaries actually make better PE than the PEs themselves

It may be helpful to identify an audience for "explanations" and "arguments." By varying the audience (younger students, parents, non-science teachers, peers), it would seem less like explanations are being developed for the teacher, who already knows the explanation.

We were not fond of the phrase "that support the explanation..." in all its various forms. It comes across as reinventing the wheel/regurgitation/cookie cutter labs. We would like to see more PEs that are applying knowledge to novel situations or evaluating whether or not the data align with current understandings rather than just gathering data to support an already existing explanation. It sets up a situation where results either agree with the given explanation or they are wrong, rather than a situation where you try to model or investigate a situation and then figure out what your data mean. HS PS4 does a good job of using "evaluate" to address this issue.

It may be helpful to identify an audience for "explanations" and "arguments." By varying the audience (younger students, parents, non-science teachers, peers), it would seem less like explanations are being developed for the teacher, who already knows the explanation.

In general, there is still too much that is about generating information that already exists, or verifying existing information. This is most prevalent in ESS2 and 3 MS and HS. Just opening these pages is overwhelming from the sheer volume of PEs, many of which are very broad and involve students creating models for known explanations. More than the other areas, these PEs seemed like curriculum designed to "cover the information." All four sections need pruning and/or revision.

"Assessment boundary" needs a new name. The added support of knowing what should be provided on assessments was a welcome addition when it was provided, but this is not a boundary--perhaps "Assessment Guidance" or just "Assessment."

More variation in verbiage surrounding models is needed. There are too many instances when PEs just say, "make a model," "build a model," or "create a model" and not nearly enough instances of evaluating the limitations of a given model--especially for concepts that have well established models--or using an established model to make or test predictions. It would even be good to have PEs where students evaluate different representations of a model to see which is the most effective in communicating a concept. If you can google the model, do students need to "create" it? ...maybe...sometimes...but these instances should be carefully chosen rather than being the default

"Asking questions" is a practice that is also not effectively used. To frequently "asking questions" simply precedes a list of information that students are supposed to discover by asking questions. More PEs are needed that actually develop the question asking process. PEs that ask students to analyze, compare, or evaluate questions are needed.
In general, a wider variety of the bulleted components of the practices from the practices matrix should be systematically spread through the PEs. There are significant chunks (identified in review of the matrix) that, although they are implied, are never explicitly addressed. By guiding instruction and eventually assessment systematically to these components rather than always to the 10,000 foot view of the practices, implementation will be improved AND the specificity also makes the PEs sound less like projects and more like specific expectations for students at the end of the grade/grade band. It also does a lot to limit scope creep of practices. Content has been narrowed to focus on the core ideas more often than not, but that space has been overstuffed with practices.

The current documents (Framework excepted) don't give a clear explanation of the overarching importance of the CCCs. These inter-disciplinary concepts needed to be fleshed out in NGSS document (or at least the supporting documents) as they were in the Framework.

Web Presentation--
Truly impressed with the presentation--this is revolutionary for standards--but still a few ideas to make it even better.
--To really get a feel for how the three dimensions progress across time, we need to be able to easily sort by each dimension. To really develop curriculum, teachers will need to be able to see the spectrum of what is expected from each dimension.
--within the DCI foundation box, move all of the (secondary to...) framework text to the bottom, separate with a dotted line and a short sentence that describes that they are links to other DCIs (is

this actually repetition of the connection box?
--when DCI connections at grade level and across grade levels are added, it would be nice to get a view of one PE and the PEs it is connected with and to be able to click on the links and hop to any of the individual PEs (this would facilitate cross-disciplinary conversations and may actually eliminate the need for the "topics" view)
--make the code within the performance a hyperlink that either jumps to a page with only that PE and its associated foundation box material, or highlights the relevant text in the boxes (maybe instead of the mouse-overs?)
--make the common core connections hyperlinks
--it would be very interesting to have some crowd-source based evaluations of PEs embedded within the presentation of the standards--not just for resources, but for the PEs themselves...maybe these tools could be added in later a year or two in advance of scheduled revision to gather feedback.

March Feedback—no general response—all feedback was on the PE-specific level.

Standard-specific Feedback

In addition to feedback on broad topics, the Kansas review team provided a great deal of feedback on the standards of the NGSS that influenced the final document. The following section organizes this feedback across the drafts of the standards. The complete Kansas team feedback as submitted can be found online here: http://www.ksde.org/Default.aspx?tabid=5688

Kindergarten Science Standards

April 2013

K-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to

January 2012

Students who demonstrate understanding can:

K-ESS2-1. *Use and share observations of local weather conditions to describe patterns over time.*

K-ESS2-1. *Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.*

No Kansas Comments

April 2013

K-ESS3 Earth and Human Activity

Students who demonstrate understanding can:

K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals
(including humans) and the places they live.

K-ESS3-2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.*

K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living thing in the local environment.*

January 2012

Students who demonstrate understanding can:

K-PS3-1. *Make observations to determine the effect of sunlight on Earth's surface.*

K-PS3-2. *Use tools and materials to design and build a structure that will reduce the warming effect of*

No Kansas Comments

STANDARD NOT FOUND IN JANUARY 2012 DRAFT

April 2013

K-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

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.

K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*

No Kansas Comments

STANDARDS NOT INCLUDED IN FINAL VERSION AS COMPARED TO JAN 2012

K.SPM Structure and Properties of Matter

Students demonstrate understanding of observable properties of matter by:
a. Investigating collaboratively and *demonstrating that substance (e.g., wood, metal, glass, paper) can be described and classified by their observable properties.*
b. Comparing the properties *of solids and liquids (e.g., solids retain their shape, liquids can be poured) and using the properties to decide whether an object is either a solid or a liquid at room*
c. Carrying out *investigations to show that some materials are solid when they are cold and liquid when they are warm (e.g. butter, chocolate, water, cheese, ice cream).*
d. Asking scientific *questions and gathering evidence collaboratively about a set of object to support the claim that a given object occurs naturally or is manufactured (e.g., rock, brick, tree limb, wooden*

This Performance Expectation was not continued to the final set of standards in the Kindergarten level.
No Kansas Comments

Students demonstrate understanding of weather by:
a. Carrying out an investigation *to determine the effect of sunlight on a variety of natural objects on Earth's surface (e.g., rocks, ponds, soil, sand).*
b. Observing, recording, and sharing *findings of different kinds of local weather over a period of time (e.g., hourly, daily, weekly, school year).*
c. Developing , using, and sharing representations *of weather conditions to describe changes over time*
d. Displaying and discussing weather data *(i.e., sunlight, wind, snow or rain, and temperature) comparing typical weather with severe weather in a season (e.g., a snowstorm in winter, heat wave in summer, thunderstorm in spring or fall) or a given region (e.g., tornados in Plains states, hurricanes*

e. Asking questions and discussing *how forecasting of severe weather can help keep people safe.*

This Performance Expectation was not continued to the final set of standards in the Kindergarten level.
No Kansas Comments

K.OTE Organisms and Their Environments

Students demonstrate understanding of how organisms live in and interact with their environment by:
a. Asking questions *and obtains information about what animals and plants need to survive.*
b. Analyzing observations *and information, and sharing findings about how animals and plants meet their needs (e.g., cows eat grass), including the places the live and how they can change the*

environment (e.g., ants build anthills; plant roots can break cement).

c. Constructing explanations *of why animals may for groups to communicate how being part of a group can help animals meet their needs and survive (e.g., family groups, pairs, herds).*

d. Sharing observations *and developing explanations of how some human choices impact the world around them and presenting solutions that reduce human impact (e.g., avoid littering, recycling).*

This Performance Expectation was not continued to the final set of standards.
No Kansas Comments

1st Grade Science Standards

April 2013

1-PS4 Waves and their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

1-PS4-2. Make observations to construct an evidence-based account that objects can be seen only when illuminated.

1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam if light.

1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.*

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

January 2012

1.LS Light and Sound

Students demonstrate understanding of light and sound by:

a. Providing evidence *that when light is not present objects cannot be seen (e.g., pinhole box, completely dark room) and that very hot objects give off their own light (e.g., fire, sun).*

b. Carrying out investigations *collaboratively and evaluating evidence to show that some materials allow light to pass through, others only allow some light to pass through, and some materials black all of the light, creating a shadow.*

c. Carrying out investigations *to show that mirrors can reflect light.*

d. Carrying out investigations *to show that sound can cause matter to vibrate (e.g., talking into a piece of paper) and that vibrating matter creates sound (e.g., tuning forks, plucking a stretched string.)*

e. Designing and sharing solutions *that use light or sound to send a signal over a distance (e.g., flashlight with removable cover to send signals, paper cup and string "telephone", drum beats).*

Kansas Influence:

Performance Expectation changed into 1-PS4 Waves and their Applications in Technologies for Information Transfer. Using multiple examples of the expectation was found to be very useful and continued to the final draft. Also, the investigative "hands on " in the Design Challenge helps to provide a good understanding of science.

Raw Kansas comments:

1.LS Light and Sound

I appreciate the emphasis on investigations in each of the performance standards and the "Design Challenge" present in e. which will require the students to apply what they have learned. I believe this is how science should be taught.

Very clear and well defined – really appreciate the use of examples.

May 2012

1W.a-Suggestion: ...light bounces off an object and then travels to your eye.

1Wb _ A clarification statement would be helpful for types of investigations.

1Wc - The cross-cutting concepts implies student tests, but the practice is about gathering information

General comment - The science and engineering principles on We, Wc, Wd are a bit confusing. Most of these require the students to record and observe, so should this not be done for all?"

Sept. 2012
don't like the phrase "Investigate to describe;" investigate seems forced since the word is in the practices, but these end up sounding very proscriptive

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April 2013

1-ESS1 Earth's Place in the Universe

Students who demonstrate understanding can:
1-ESS-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.
1.ESS1-2. Make observations at different times of year to related the amount of daylight to the time of year.

This Performance Expectation continued to the final set of standards, no Kansas comments.

April 2013

1-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:
1-LS3-1. Make observation to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

This Performance Expectation continued to the final set of standards, no Kansas comments.

April 2013

1-LS1-1. From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:
1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. *
1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

This Performance Expectation continued to the final set of standards, no Kansas comments.

STANDARDS THAT DID NOT GO TO THE FINAL FIRST GRADE LEVEL

January 2012

1.SF Structure and Function

Students demonstrate understanding of the structure, function, and development of organism by:

a. ***Evaluating the external*** *structures of animals and plants and explaining how these structures help them survive and meet their needs.*
b. ***Providing evidence*** *to show that plants and animals have parts that enable them to respond to external inputs (e.g., stems bend towards light, ears for hearing, legs for moving).*
c. ***Using evidence to explain*** *that animals and plants grow and change as young organisms mature into adults (e.g., human babies grow into adults, kittens into cats, and sprouting seeds into mature plants) and not all individuals of the same kind of organism look exactly the same.*
d. ***Obtaining and communicating*** *information to show that parents and offspring engage in patterns of behaviors (e.g., crying, chirping, providing food) that help the offspring survive.*
e. ***Designing an object to fulfill*** *a need or desire whose function replicates the function of structure present in a plant or animal (e.g. tweezers and birds' beaks, grabber tool and hand, burr and Velcro, or an excavator bucket with badger claws).*

This Performance Expectation was not continued to the final set of standards.

January 2012

1.PCS Patterns and Cycles in the Sky

Students demonstrate understanding of patterns and cycles in the sky by:

a. ***Asking scientific questions*** *to discuss how some natural events occur quickly (e.g., rain storm, gust of wind) and other natural events occur slowly (e.g. growth of grass).*
b. ***Recording and sharing observations*** *about how some events have cycles and patterns (e.g. day and night) whereas other events have a clear beginning and end (e.g., storms).*
c. ***Obtaining information and sharing*** *observations to determine simple patterns of objects in the sky (e.g., sun rises in the east and sets in the west, stars are visible at night).*
d. ***Displaying and discussing*** *data about objects in the sky to predict simple seasonal patterns (e.g., amount of daylight is less in the winter).*
e. ***Obtaining information*** *to show that some tools (e.g., telescopes, binoculars) allow people to see more objects in the sky (e.g., stars) and in greater detail (e.g., moon).*

This Performance Expectation was not continued to the final set of standards.

Second Grade Science Standards

April 2013

2-PS1 Matter and its Interactions

Students who demonstrate understanding can:

2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.*
2-PS1-3. Make Observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.
2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

January 2012

2.SPM Structure, Properties, and Interactions of Matter

a. Investigating and making a scientific argument *that changing the size or shape of an object does not change the weight of the object.*
b. Evaluating natural or designed *objects to explain how the properties of the materials suit their purposes (e.g., pillows are made of soft materials, windows are made of clear glass.)*
c. Collaborating with others *to design a device built from components to solve a technological problem (e.g., transporting or supporting an object).*
d. Providing evidence *to support the claim that some changes caused by heating or cooling can be reversed (e.g., melting chocolate, freezing liquids) and some cannot (e.g., cooking an egg).*
e. Measuring and comparing *the physical properties (i.e. weight, length) of objects, using non-standard and standard units, and explaining the benefits of using standard units.*

Kansas Influence:

This Performance Expectation evolved into Matter and its Interactions. The expectation began with too broad of approach for 2nd graders and needed to be more specific. Terminology may have been too broad in the beginning.

Kansas Comments:
2.SPM Structure, Properties, and Interactions of Matter
Change "weight" to "mass". Use the example that our mass would be the same if we traveled to the moon but our weight would be less because the gravity is less.
Crosscutting Concepts, fourth bullet punctuation is needed between properties of, are … It is confusing without. Second graders won't plan an investigation independently.
Need to define the difference between mass and weight better.
The interactions of ETS are not clearly reflected in the standard.
May 2012
"a) don't like ""could"" in clarification statements; should be an assessment boundary
b) Communicate and compare...
c)--clarification statement...within parameters safe in the classroom (what won't phase change until the right conditions?
d)...not sure what the ""evidence"" and the ""opinions"" would be here
e)example is very narrowing to extremely basic types of objects d) practice seems tacked on to the rest and lots of overlap with e rather the same verbs at different grade levels, but meaning different things (sometimes even within levels), it would be helpful to use the language that is specific to the grade band. For example rather than saying ""Asking questions"" at all levels, at the K-2 level, use ""Develop simple descriptive questions about…that can be tested"" otherwise asking questions just becomes a KWL activity. Use the verbs from the grade band description of the practice rather than always just using the bold words."
Sept 2012
"2SPM.b - The standard is too broad - build an object - additional information or clarification of types of objects would be useful. The crosscutting concept for this standard mentions environmental impact, but the PE does not. It's not entirely clear why this PE is in this topic--maybe connecting the comparison to the materials they are built from would make this connection
2.SPM.c - Suggestion-- ""...some changes to objects...""""

April 2013

Result 2: 2.LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

2.LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.

2.LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*

Jan 2012 *– Prior standards that converged into the current standard*

2.IOS Interdependence of Organisms and Their Surroundings

2.IRE Interdependent Relationships in Ecosystems

Kansas Influence:

The original standards were not appropriate for the grade level, resulting in the current standard. However, not all Kansas concerns were addressed in the rewritten version.

Kansas Comments

Second graders are not ready to construct explanations, planning their own investigations, constructing an argument or providing evidence. They are just grasping the concept of reading for information and most of their explanations or arguments are regurgitated. They can carry out investigations that have been planned by a teacher then led to discover the concepts they need to discover.

Sept. 2012

"2.IRE.b This is something I have done with 3rd grade science classes which have learned about plants' needs and seed dispersal in 2nd grade. I don't feel that my 2nd graders would be developmentally ready to do a thorough job with it and so would not learn as much. Evidence supports a claim--the argument links the claim to the evidence.

2.IRE.d ""are extinct" "rather than ""that once lived"

April 2013

Result 2: 2.LS4 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

2.LS4.1 Make observations of plants and animals to compare the diversity of life in different habitats

January 2012

Product: 2.IOS Interdependence of Organisms and Their Surroundings

a. Constructing an explanation *of how plants and animals depend on their environment and each other (e.g., for food) to meet their needs in a system.*

b. Planning and carrying out investigations *collaboratively to show that different kinds of plants have varied needs for water and sunlight.*

c. Recording and sharing observations *to show that there are many different kinds of living things in any area (e.g., plants and animals in the school yard, a park, a pond, a terrarium, and aquarium).*

d. Developing a representation *(map) of a particular habitat (e.g., school yard, park, pond, terrarium, aquarium) showing the locations and shapes of both land and water features of that habitat.*

e. Constructing an argument *that if an environment changes (e.g., becomes hotter, drier, food disappears) the plants and animals that live there may not survive.*

f. Providing evidence *that some kind of animals and plants that once lived on Earth (e.g., saber toothed cats and mammoths) are no longer found anywhere, although others living now may resemble them (e.g., tigers and elephants).*

Kansas Influence:

The original standard changed to Biological Evolution: Unity and Diversity. A critical change that was made was the Kansas observation that the investigation element should not be included at this stage due to student development.

Kansas Comments:

Second graders are not ready to construct explanations, planning their own investigations, constructing an argument or providing evidence. They are just grasping the concept of reading for information and most of their explanations or arguments are regerjitated. They can carry out investigations that have been planned by a teacher then led to discover the concepts they need to discover.

April 2013

2-ESS1 Earth's Place in the Universe

Students who demonstrate understanding can:

2-ESS1-1. Make observations from media to construct an evidence-based account that Earth events can occur quickly or slowly.

2-ESS2 Earth's Systems

Students who demonstrate understanding can:

2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.*

2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.

2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.

January 2012 *Versions (have been combined and dropped for the final standard)*

2.ESP Earth's Surface Processes

2.ECS Earth's Changing Surface

Students demonstrate understanding of how wind and water shape Earth's surface and affect its systems by:

a. Obtaining information and providing *evidence that water exists in solid and liquid forms within natural landscapes (e.g., oceans, rivers, lakes, ponds, glaciers).*

b. Developing a physical model *of a landform to show that wind and water can change the shape of land (e.g., using sand and soil that is subjected to flowing water and blowing air) and explaining the difference between the model and the real world.*

c. Carrying out investigations *collaboratively to show that wind and water can move rock, soil, and other items from one place to another.*

d. Designing and evaluating *a technological solution that prevents wind or water from changing the shape of the land (e.g., using sandbags to prevent coastal erosion, planting trees to prevent soil erosion) and sharing findings.*

e. Obtaining and sharing information *to show how landforms provide homes for living things.*

Kansas Influence

This standard evolved into two separate expectations, Earth's Place in the Universe and Earth's Systems. Incorporated expectation involving all of the Earth's Systems, part of the original expectation may have been a tough concept for 2nd graders to grasp. The current standard reflects a better progression of understanding as suggested by Kansas reviewers.

Kansas Comments:

2.ECS Earth's Changing Surface

Second graders have a very limited view of the world outside of how it directly applies to them. Students working on Designing and evaluating will not have enough background knowledge or enough worldly wisdom to accomplish the task unless they have had experience with erosion and

the solutions for it. They view grass and trees as a way to decorate things. At this age the solutions will have to be mainly teacher led. Second semester third graders would be more appropriate for this.

May 2012

"a) Communicate that water...

Investigate

c) if they are designing and testing, it seems they would always have a physical model…"

2.ESP Earth's Surface Processes

Sept. 2012

"2.ESP.a--""home"" is watering down expectations. Habitat should a word that used consistently and thus would be appropriate for grade 2.

2.ESP.b. - The performance expectation is about landforms so the clarifying statement should be more focused on landscapes (e.g., desert, wetlands, rain forests) rather than water bodies (e.g., oceans, rivers, lakes).

2.ESP.d -wording is awkward and a clarifying statement would be helpful."

APRIL 2013

K-2-ETS1 Engineering Design

Students who demonstrate understanding can:

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Standards Not In the Second Grade April 2013

Product: 2.FM Forces and Motion

Students demonstrate understanding of forces and motion by:
a. Carrying out investigations *to determine the cause and effect relationship between pushes and pulls of different directions and strengths and the resulting motion of objects.*
b. Constructing an explanation *for why an object that is being pushed or pulled might not change position.*
c. Carrying out investigations *to determine the relationships between friction and the motion of objects, and between friction and the production of heat.*
d. Developing and evaluating *a design solution to reduce friction between two objects.*
e. Collaborating to develop and explanation *for the motion of a designed object (e.g., rolling pin, scissors, toy cars) based on pushes and pulls and how they relate to the function of the object.*
f. Carrying out investigations collaboratively *to explain the change in motion and/or shape when objects touch or collide.*

Kansas Influence:
This standard did not make it to the final draft, which reflects the Kansas view that the original standard was too advanced for second grade.

Kansas Comments:
2.FM Forces and Motion
Incorporate history with Newton and his Laws of Motion. Model for students how scientists share information and build on each other's work.
The performance expectations of c-f are to advance for second graders. They are just learning how to describe motion and that forces are needed to create motion. They can comprehend friction in a directly visual way but d-f need to be moved to and older grade.
Need more of an explanation for what "patterns" are.
CC: Influence of Science, Engineering and Technology on Society and the Natural World – Natural and designed are used a lot throughout the standards to describe the world around us – it is critical that we be careful how we're using these terms and not subconsciously reinforce the erroneous dichotomy of the natural and designed or human world, particularly from a young age. We are part of the natural world and our designs are adaptations to the physical and social/cultural world around us. So think that this statement should read 'Technologies are designed by applying knowledge from the physical and social/cultural world around us." Or something similar.
Why shy away from recognizing friction as a force? Not putting it into the class of forces as a push or pull plants the seeds of a misconception. This should be improved in the disciplinary core.
<u>Sept. 2012</u>
"2.FM.a - refers to only one or two pushes or pulls in the clarification statement. This restriction doesn't seem to be necessary
2.FM.b - how fast they are going before or after the collision or both--please clarify
2.FM.c - clarification statement--on observations of
2.FM.d - A clarification statement would be useful here."

3rd Grade Science Standards

April 2013

3-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

3-PS2-3. Ask questions to determine cause and effect relationship of electric or magnetic interactions between two objects not in contact with each other.

3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.*

January 2012

3.FI Forces and Interactions

Students demonstrate understanding of forces and the interactions they produce by:

a. Using a model to predict the future motion *of an object (e.g., pendulum) based on its regular pattern of motion.*

b. Carrying out investigations on objects *at rest subject to balanced forces and measuring the relative sizes and directions of the forces (e.g., two horizontal spring scales pulling on a stationary object sitting on a table).*

c. Constructing a model of a system *in which the forces on an object are balanced to explain how quickly or slowly the system changes when the forces become unbalanced (e.g., heavier and lighter weights on a see saw, pushing or pulling an object with varying force).*

d. Making observations, collecting *data, and identifying patterns of the forces that magnets and magnetized materials exert on each other and the resulting motion of those objects.*

e. Designing and refining technological *solutions to a problem that use magnetized materials (e.g., moving a metal ball through a maze with a magnet) as a tool to produce or control motion and sharing solutions.*

Kansas Influence:

This Performance Expectation evolved into Motion and Stability: Forces and Interactions. Kansan's proposed the idea of using electricity to demonstrate bi-directional force in the expectation. Elements of this standard are taken from the original second grade standard in Jan 2012, reflecting the view that the initial second grade standards were not at an appropriate level. The final version of the standard also valued the concept of building on the previous grade level expectations.

Kansas Comments:

3.FI Forces and Interactions

Good opportunity to discuss Isaac Newton and Laws of Motion

I really like statement (e).

The wordiness of the practices, core ideas, and crosscutting concepts gets in the way of my understanding. This takes so long to think about and try to figure out what you want that most will not get the whole idea.

Not sure why "systems" are included in this standard.

The see saw discusses the use of weights, yet gravity as a force (are we talking about weight) is not to be addressed. This is a conflict. On the technology in the standard – using magnetic force as an option, why not consider electrical force as another option? Also, in the core ideas it is mentioned that magnetic force has two directions, why no mention of electrical?

May 2012

b) not sure what use models means in this context

3) is effectively the same as a PE from 2nd grade--let's build from grade to grade!

Sept. 2012

"3.FM.a-wording is awkward and seems manipulated to work a practice in...what is really called for here is ""Identify repeated patterns in the motion of objects and use these patterns to create a simple model that can predict future motion"" or if the practice has to be first, ""Create a conceptual model based on a consistent pattern observed in a moving object that can be used to predict future motion of the object.""

3FMd - very vague. A clarification statement is needed. Does the teacher provide the problem? Who decides the problem?"

Also refer to Second Grade Standards that were not included. Aspects of the original second grade standard show up here reflecting the view that the material was too advanced for second grade. It is more appropriate for third grade.

April 2013

3-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

3-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

3-LS2-1Construct and argument that some animals form groups that help members survive

3-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

3-LS3-1 Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms

3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment

3-LS4 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.

3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.*

January 2012

3.SFS Structure, Function, and Stimuli

Students demonstrate understanding of the structures of organisms and how they function to consume resources, reproduce, and sense their environment by:

a. Using models to analyze *how internal and external structures and systems in animals and plants allow them to grow, survive, and reproduce. [Assessment Boundary: Focus is on what the organs and systems do for the organism (e.g. breakdown food, provide oxygen, move fluids and dissolve materials, process information); details of how they function are not expected]*

b. Using evidence to show that *animals and plants can be classified based on their structures (e.g. vertebrates have backbones, mammals have hair, insects have six legs, birds have feathers; plants have flowers, make cones, or have spores).*

c. Obtaining information to show that *animals respond to information detected by their senses through instinct or memory (e.g., blinking cockroaches run from light, dog comes when called).*

d. Developing and validating simple graphical representations to show that *when light is reflected off an object and enters the eye, we are able to see the object, but if the light cannot reach the eye, the object cannot be seen (e.g., using a periscope to see around the corner). [Assessment Boundary: The law of reflection is not included]*

e. Carrying out investigations to show that the color *of light and properties of the surface influence what is seen (e.g., illuminating different objects with different colors of light).*

f. Designing and constructing *a technological solution that used an internal or external structure of an organism as a model to solve a problem.*

3.ENS Environments and Survivability

Students demonstrate understanding of habitats, organisms, and survival by:

a. Constructing an argument that *organisms can survive only in environments in which their particular needs are met (e.g., types of plants in the desert, types of animals in a pond).*

b. Providing evidence that *environmental change in a system (e.g., extra water in a normally dry area, pollution, or fire) can affect the number and types of organisms that live there as some remain, move, and/or die.*

c. Constructing an argument that *people obtain living and non-living resources from the environment.*

d. Evaluating and communicating information that *the characteristics of a group of animals help individual animals survive.*

Kansas Influences

This Performance Expectation evolved into four separate expectations, Molecules to Organisms: Structures and Processes, Ecosystems: Interactions, Energy, and Dynamics, Biological Evolution: Unity and Diversity, Heredity: Inheritance and Variation of Traits. This clarification and separation was an improvement over the original standard which, based on Kansas review, required a great deal of clarification. Language improvements were included to make the standards more accessible to third grade students.

Kansas Comments:

3.SFS Structure, Function, and Stimuli

No performance expectation referenced to in SEP, Constructing Explanations and Solutions.

Again, third graders are 8 years old. I am not sure what performance expectation f would look like in a 3rd grade classroom. I don't know how I would teach internal and external body or plant systems to 8 year olds. I'm not sure how we could teach performance expectation c in a school setting. I don't understand what Performance Expectation F wants either.

"c) ""an external structure""? this seems unnecessarily vague
d) unclear how models are to be used here
e) only obtain? how will we know they've obtained it? need communication of some sort"

Sept. 2012

"3.SFIP.b--though the team was generally positive here, some thought that testing and comparing designs would require several students or groups of students to design the same solution, then determine controlled testing and comparing the results, this seems too much to expect of 3rd graders; it would be helpful to provide potential criteria for evaluation

SFIPc - teachers may need clarification on this more than just learned and innate behaviors, they will need examples"

Se"3.MEOE.b-a fits better with this practice--this is more about obtaining information than about analyzing data

3.MEOE.c--an argument links the claim to the evidence; the claim is given in the PE; Suggestion--Obtain information to construct an argument that supports the claim that changes in a habitat may be beneficial or harmful to different organisms in the same habitat."pt. 2012

3.ENS Environments and Survivability
Not sure about the identifying of the major features of scientific arguments in 8 year olds. Also, these verbs again aren't appropriate for 8 year olds. They need hands on, doing verbs not research paper verbs.
LS2.D: Social Interactions and Group Behavior – It is also important to point out that the individuals may or may not be related, and that the degree and type of social connections among group members will vary across different groups.

May 2012

a) what type of questions? e) ....and some changes can be harmful…
too much reading, listening, and regurgitating science in this standard--not enough using science to solve problems/answer questions; name of standard should better parallel MS and HS; c) is data analysis needed for this?

April 2013

3-ESS2 Earth's Systems

Students who demonstrate understanding can:

3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.

3-ESS3 Earth and Human Activity

Students who demonstrate understanding can:
3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.*

January 2012

3.WCI Weather, Climate, and Impacts

Students demonstrate understanding of patterns and the interdependence of climate and weather on natural hazards and their impact on environment and society by:

***a. Gathering local weather data** (e.g., temperature, precipitation, wind speed) **and identifying** day-to-day variations as well as long-term patters (i.e., climate). [Assessment Boundary: Air pressure is not included]*

***b. Obtaining information** about different climatic areas **to predict typical** weather conditions expected in a particular season in a given area.*

***c. Obtaining information about** natural hazards (e.g. severe weather, floods, and erosion) and how they cause negative impacts on humans.*

***d. Designing collaboratively and evaluating multiple** technological solutions that reduce the environmental or societal impact of a natural hazard.*

STANDARD WITH NO BEGINNING DRAFT

April 2013

3-5-ETS1 Engineering Design

Students who demonstrate understanding can:

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

4th Grade Science Standards

April 2013

Result 1: 4-PS4 Waves and their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. (Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.)

4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen

4-PS4-3. Generate and compare multiple solutions that use patterns to transfer

information.* (Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.)

January 2012

Product 1: 4.WAV Waves

Students demonstrate understanding waves by:
***a. Asking questions about waves**, observing their creation by disturbing the surface of water, and sharing observations about patterns in the waves.*
***b. Using a physical model** (e.g., rope, slinky) to analyze the characteristics of waves (e.g., amplitude, wavelengths).*
***c. Carrying out investigations** to show that waves affect the motion of objects and transfer energy to objects (e.g., corks bobbing up and down) as a wave passes.*
***d. Carrying out investigations** to provide evidence that waves can add or cancel each other as they cross (e.g., the pattern of waves created by two pebbles dropped in water) depending on the relative phase of the wave (i.e., relative position of peaks and troughs of the waves).*
***e. Carrying out investigations** to provide evidence that waves will pass through each other and emerge unaffected (e.g. waves created by two pebbles dropped in water).*
***f. Obtaining and sharing** evidence that waves exist in nature (e.g., ocean waves, sound waves, seismic waves) and transfer energy (e.g., coastal erosion, earthquake damage.) g. Designing, refining, and evaluating a device that uses a mechanical wave to transmit both analog and digital information (e.g., drums can send information through sound waves as patterns that have specific meaning – analog – or as high and low notes that represent ones and zeros – digital).*

Kansas Influence:

The standard tile was modified to 4-PS4 Waves and their Applications in Technologies for Information Transfer. This is a direct reflection of the lack of boundaries associated with the standard's beginning. By narrowing the subject matter of waves and information transfer aids in the "how to teach" this subject.

Kansas Comments:
4.WAV Waves
PS4.C - repeats,convert it from digitized form to voice-convert it from digitized form to voice and vice versa.
The standards need boundaries to be more precisely defined. The concept of superposition of waves is indicated yet not explicitly stated. Teachers at this level need greater guidance to make sense of how to teach this.
Sept. 2012
"4Wa - The vocabulary here requires quantitative understanding, yet 4Wb indicates qualitative understanding. A clarifying statement and/or example might be helpful in 4.W.a.
4.Wd- replacing ""solution to the problem of"" with ""a device to be used for"" would make the intent more clear.
4We - This should probably specify physical model to distinguish this from other types of models if that is what is intended. use ""how"" rather than ""that""""

April 2013

Result 2: PS3 Energy

Students who demonstrate understanding can:

4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. (Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.)

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* (Clarification Statement: Examples of devices could include electric circuits that covert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device

January 2012

Product 2: 4.E Energy:

Students develop understanding of energy and energy transfer:

a. observing the interactions *within a system to identify the presence of energy with the motion of objects or the presence of heat, light, sound, or electric currents (e.g. pendulums, heat from an incandescent light bulb, battery to light a bulb, sound coming from a vibrating object as a tuning fork. (Assessment Boundary: No attempt is made to give a precise definition of energy.)*

b. Carrying out investigations *to provide evidence that energy is transferred from place to place by sound, light, heat, electric currents, or moving objects. (Assessment Boundary: Quantitative measurements of energy are beyond this scope.)*

c. Constructing an explanation *for how technology uses stored energy for practical use (e.g., batteries in electrical devices).*

d. Designing a technological *solution (e.g., flashlight, windmill, watermill, alarm circuit, doorbell) that uses the conversion of energy to produce motion, sound, heat, or light to solve a problem.*

e. Constructing an argument *that some sources of energy are renewable (e.g., water, wind, geothermal, plants, solar) and some are not (e.g. fossil fuels, nuclear fuels). (Assessment Boundary: Should not include climate change.)*

f. Carrying out investigations *to provide evidence that energy is transferred when magnets interact and objects collide.*

Summary:

More value is being placed on the value of work supplied by different types of energy. It is also suggested here that the theory of electrical current may be to complex for this grade level. Also the concept of energy itself must be narrowed for better learning and teaching results.

Kansas Comments:

4.E Energy

S & E practices first bullet: Construct a model but I don't see that verbage in the performance expectations. I am unclear what Performance Expectation b would look like.

The concept of transfer of energy is vague.

On a in the standard it is stated that no precise definition for energy is required. This is vague and needs to be pinned down a bit further for teachers to make use of these. On f – why are electrical forces not considered?

May 2012

a) what types of patterns should be identified? f) wording is confusing g) what info is being obtained and communicated?

Sept. 2012

"4Eb - Why does this need to be magnets? Could it be something else? This seems very directive.

4Ec - Electric currents are introduced here. At what point are the students learning the basics of electricity for this to be a possibility?

4Ee - Need clarification statement.

4.E.f-""in the solution"" is redundant and makes the wording more awkward

--e and f are redundant--cut one and/or combine--just add ""within given design constraints"" to e and drop f

4.E.g-assessment boundary doesn't seem to match PE"

April 2013

Result 3: 4-ESS1 Earth's Place in the Universe:

Students who demonstrate understanding can:

4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. (Clarification Statement: Examples of evidence from patterns could include rock layers with shell fossils above rock layers with plant fossils and no shells, indicating a change from water to land over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.)

Result 3: 4-ESS2 Earth's Systems:

Students who demonstrate understanding can:

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. (Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.)
4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features. (Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.)

Result 3: 4-ESS2 Earth and Human Activity

Students who demonstrate understanding can:

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. (Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.)
4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.* (Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity

January 2012

Product 2: 4.PSE Processes that Shape the Earth

Students demonstrate understanding of processes that shape the Earth over time by:
a. Carrying out investigations *to show that flowing water can shape the land (e.g. erosion and decomposition form a river) and evaluating the effect of different variables (e.g. elevation, slope, flow rate) on erosion. (Assessment Boundary: Observations are qualitative not quantitative.)*
b. Evaluating claims *that the history of Earth's climate (e.g., drought, flooding, ice age), as determined by data (e.g., tree rungs, ice cores), has affected organisms over time (e.g., species, population changes). (Assessment Boundary: Students are not to be assessed on their understanding of deep time.)*
c. Using evidence *to show that physical characteristics of an area are affected by both living*

things (e.g., plants' roots hold soil in place, beaver shelters and human-built dams alter the flow of water) and the natural processes of weathering and erosion.
d. Evaluating the claim *that the remains of organisms, including fossils, contribute to the formation of rocks and soil using a variety of evidence.*
e. Evaluating claims *that fossils provide evidence of the types of organisms that have lived of Earth and their environments, citing their similarities and differences to currently living species. (Assessment Boundary: Students are not to be assessed on their understanding of deep time.)*
f. Evaluating the locations *of a variety of Earth's features and mapping the geographic patterns that emerge (e.g., volcanoes are found on the continents and on the ocean floor, major mountain chains form inside continents or near their edges.)*
g. Using maps and data *to predict the likelihood of natural hazards occurring in an area and evaluating the possible effects on landforms and organisms. (Assessment Boundary: Predictions are qualitative).*
h. Constructing, testing, and refining *collaboratively a design solution that mitigates the effects of a natural hazard.*

Kansas Influence:

The original standard was split into three separate individual PE's. Trying to cover a lot of information in a limited time frame, there is a need to condense or separate the subject matter. The PE's are asking for a lot of individual evaluation of data, not sure not sure that this is grade appropriate. May be there is some discrimination of urban systems by not having access to data related to the subject matter.

Kansas Comments:

4.PSE Processes that Shape the Earth

Four of the performance standards require students to "evaluate" information to pose an argument.

Grades 3-5 may have a difficult time doing this much evaluation.

There's a lot to be done in this standard with the limited time allowed at elementary schools.

Five of the eight performance objectives call for evaluating. That would insinuate that the students have the materials beyond pictures in a book to evaluate from.

May 2012

a) best use of asking questions that I've seen yet!

too many PEs for one standard; though they are pretty solid, trimming is necessary

Sept. 2012

"4.ESP.a - not plausible to test all of those
4.ESP.b - this will be hard for many urban students other than looking at man-made structures and the effects, who are the peers this is referencing?
--lots of overlap between a and b--don't think a is needed with b there
4.ESP.c needs a clarifying statement--are we really wanting them to develop the explanation or link the evidence to the explanation?
4.ESP.e - Needs to be rewritten for clarity of expectations."

April 2013

Result 4: 4-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. (Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.)

4-LS1-2. Use a model to describe that animals' receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. (Clarification Statement: Emphasis is on systems of information transfer.)

January 2012

Product 4: 4.RH Reproduction and Heredity

Students demonstrate understanding of reproduction and the traits of organisms by:

a. Carrying out investigations *of the life cycles of a variety of animals and plants, communicating similarities, differences, an patterns in their development.*

b. Constructing an argument *that the characteristics of organisms can be inherited from parents (e.g., eye color, breed characteristics of dogs), caused by the environment (e.g., stunted growth, migration patterns), or a result from a combination of both (e.g., weight, height of people). (Assessment Boundary: Discussion of traits should be qualitative not quantitative.)*

c. Obtaining and communicating *information to show that individuals of a species may inherit different versions of single traits (e.g., eye color in humans, flower color in some plants) that can lead to variations in appearance and function. (Assessment Boundary: Discussion of traits should be qualitative not quantitative).*

d. Using evidence *to support the claim that some characteristics that vary among individuals in a single species can provide them an advantage in surviving, finding mates, and reproducing in a particular environment (e.g., more colorful feathers attract mates, a faster runner may more easily escape a predator, being more resistant to a disease can help you survive illness.)*

Kansas Influence:

This Performance Expectation (4RH) and (4IVT) evolved into From Molecules to Organisms: Structures and Processes. Teachers felt that there was not enough investigating, the use of actual "hands on" inquiry. Also the PE required to much emphasis on scientific writing.

Kansas Comments:

4.RH Reproduction and Heredity

These performance standards require a considerable amount of analysis, evaluation, and arguing. Only one of the standards mentions investigating.

Again this standard is heavy on research writing. 9 year olds learn better with hands on active verbage; however I can see this standard being taught as a science fair project starting with the research, then carrying out an investigation and ending with drawing conclusions.

Disciplinary Core Ideas: In this discussion of heredity, variation of traits and natural selection, important to bring in cultural transmission, traits associated with technology/culture, and natural selection acting upon human individuals/groups relative to how adaptive their cultural/technological traits are.

May 2012

a)..use of investigate is not consistent across standards; vague and broad PE; not sure how "investigate in this sense would/could be assessed b) what evidence is being used? evidence that they are genetic/environmental? epigenetics really muddies these waters c) from the SAME parents; the later explanatory power is significantly diminished for students with siblings from different parents unless this clarification is made here d)unclear if you want a focus on differences that are in homologous structures e) does the assessment boundary mean that it's not important for students at this stage to have a firm grasp on whether or not the trait is genetic or not, or just that don't have to know about chromosomes and meiosis

Sept. 2012

"IVTb - ""influenced by the environment"" will require clarification. It needs more than just the assessment boundary.

4.IVT.a--Between the PE and the clarification statement (including in the foundation box below, there is a confusion between life cycles and the cycle of life. Death, a part of the cycle of life of an individual, is not part of a life cycle (which is a feature of the species not just the individual). Death is part of a life history which, though typical for the species, is specific to each organism. The whole concept of a cycle is that it is ongoing and thus can't continue if there is death as part of it. Do we want kids to know about life cycles, life histories, or both. We just shouldn't include death as part of a life cycle. leave death out of life cycles".

5th Grade Science Standards

April 2013

Result 1: 5-PS1 Matter and Its Interactions

Students who demonstrate understanding can:

5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. (Clarification Statement: Examples of evidence could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water

5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. (Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that forms new substances.)

5-PS1-3. Make observations and measurements to identify materials based on their properties. (Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.)

5-PSI-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Result 2: 5-PS2 Motion and Stability: Forces and Interaction

Students who demonstrate understanding can:

5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down. (Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.)

Result 3: 5-PS3 Energy

Students who demonstrate understanding can:

5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. (Clarification Statement: Examples of models could include diagrams, and flow charts.)

January 2012

Product 1: 5.SPM Structure, Properties, and Interactions of Matter

Students demonstrate understanding of the structure and properties of matter and that substances can combine or change to form a new substance by:

a. Explaining everyday phenomena *using the particle model that matter is made of particles too small to be seen (e.g., inflating a balloon, effect of air on large objects, smell of baking cookies).*

b. Observing and analyzing *the properties of substances (e.g., color, hardness, reflectivity, response to magnets, electrical conductor versus insulator, melting point) to identify them.*

c. Investigating and providing evidence *to support the claim that when two or more different substances are mixed, one or more new substances with different properties may be formed (e.g., mixing baking soda and water does not form new substances, but mixing baking soda and vinegar does.)*

d. Planning and carrying out *investigations to support the claim that the total weight of a substance does not change when it undergoes physical changes (e.g., change of shape, change from solid to liquid, being dissolved in a liquid). (Assessment Boundary: No attempt should be made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)*

e. Investigating and constructing *arguments to support the claim that the total weight of matter does not change when substances react chemically to form new substances. (Assessment Boundary: Mass and weight are not distinguished at this grade level.)*

Product 2: MEE Matter and Energy in Ecosystems

Students demonstrate understanding of matter and energy transfer in ecosystems by:

a. Evaluating the interdependence *of organisms in a variety of ecosystems (e.g., woodland, meadow, pond) to analyze the relationships among the organisms.*

b. Evaluating the claim *that a stable ecosystem is one in which multiple species of different types are each able to meet their needs and constructing an argument that the introduction of new species can damage the balance of an ecosystem.*

c. Obtaining and communicating *information to support the claim that plants aqire the material they need to grow from air and water, using energy from the sun. (Assessment Boundary: Details of photosynthesis are not included.)*

d. Using models to represent *the boundaries that define a particular ecosystem (e.g., edges of lake or meadow), inputs to (e.g., sunlight, precipitation) and outputs from (e.g., through fishing and hunting, logging, oxygen produced) of that ecosystem.*
f. Planning and carrying out *investigations collaboratively to determine the role of light in plant growth and the production of food. (Assessment Boundary: Details of photosynthesis are not included.)*
g. Constructing a model *that tracks energy flow through an ecosystem as energy enters, is used in*
Kansas Influence:
It is suggested here to use the term of "mass" instead of "weight" but the request is ignored. The boundaries were too broad and were therefore narrowed. It is also suggested that the wording be revised concerning the mixing of substances to form new substances.

Kansas Comments:
5.SPM Structure, Properties, and Interactions of Matter
Not understanding why mass is not introduced at this grade level. Also throws in Conservation of Mass in crosscutting.
Use mass instead of weight.
May 2012
a) Use the partical model (explain it in clarification statement and not in sentence)
b) make sure this is thoughtfully built off earlier similar Pes; The use of the word "investigate" continues to be inconsistent
Sept. 2012
"The mathematics of comparison would be enhanced by including density within DCI as a comparison.
5SPMa - The standard is vague - see the comment on the DCI for this standard - a bit more information about types of properties to be measured and measurement outcomes would be helpful. There is no clear connection to time due to the vagueness, also need to consider density.
5.SPM.b--awkward wording--suggestion: Plan and carry out investigations that mix two or more substances and determine whether or not a new substances with new properties was formed.
WARNING!--5.SPM.c-An assessment boundary is necessary here--although we are not yet distinguishing between mass and weight, to use weight here is actually incorrect if a gas is produced that is lighter than air--this will have mass, but not weight due to the upward buoyant force;m the statement in the PE is ONLY true if the gas is heavier than air--either change PE to mass, or simply limit to reactions that do not produce gas lighter than air. In order to not add in the weight/mass difference here an assessment boundary is needed and the clarification statement should be changed to reflect why this assessment boundary is necessary"

April 2013

Result 1: 5-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water. (Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from soil.)

Result 2: 5-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. (Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth) (Assessment Boundary: Assessment does not include molecular explanations).

April 2013

Result 1: ESS1 Earth's Place in the Universe

Students who demonstrate understanding can:

5-ESS1-1. Support an argument that the apparent brightness of the sun and stars is due to their relative distances from Earth.

5-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some starts in the night sky. (Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.)

Result 2: 5.ESS2 Earth's Systems

Students who demonstrate understanding can:

5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. (Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate;

and the influence of mountain ranges on wind and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system
5-ESS2-2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

Result 3: 5.ESS3 Earth and Human Activity

Students who demonstrate understanding can:
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

January 2012

Product 1: 5.ESI Earth Systems and Their Interactions

Students demonstrate understanding of the components of Earth's major systems and human interactions with those systems by:
a. Obtaining information *about the distribution of water on Earth to show that water is found everywhere in the environment in a variety of forms.*
b. Constructing models *of the major systems that make up the Earth (i.e., geosphere, hydrosphere, atmosphere, biosphere).*
c. Providing evidence *that oceans support of a variety of ecosystems and organisms, shape landforms, and influence climate.*
d. Evaluating claims *that the atmosphere, oceans, and landforms interact with each other to produce weather and climate.*
e. Providing evidence *that human activity can produce change in in Earth's systems (e.g., overgrazing can convert grassland to desert, logging can change a forest ecosystem.)*
f. Designing and evaluating *technological solutions (e.g. water filtration system) collaboratively based on criteria and constraints (e.g., cost, energy use) to minimize unwanted outcomes of human activity (e.g., pollution).*
g. Providing evidence *that increases in Earth's temperature will affect humans and other organisms (e.g., changes in crop growing seasons, changes in coral reefs, loss of habitat of penguins.) (Assessments Boundary: Greenhouse effect and climate changes are not included.)*

Product 2: 5.SSS Stars and the Solar System

Students demonstrate understanding of the solar system, stars, and light by:
a. Providing evidence *that the Sun is a star like other starts, only much closer and, as a consequence, much brighter.*
b. Providing evidence *that the Earth is spherical and constructing an argument that the gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.*
c. Using the model of *the solar system and Earth's motion (rotation and revolution around the sun) to explain the apparent motion of stars, constellations, and planets.*
d. Using the model of *the solar system and the relative positions and motion of the Earth, the Sun, and the Moon to explain patterns such as day and night and daily and seasonal changes in the length and direction of shadows.*
e. Using the model *of the solar system to explain the pattern of lunar phases in terms of the relative positions of the Sun, Earth and Moon. (Assessment Boundary: Eclipses not to be addressed.)*
f. Providing evidence *that the positions of stars and constellations have been used as*

navigational tools.
g. Carrying out investigations *to show that lenses bend light and provide evidence that lenses are used to magnify images in telescopes and microscopes or to correct vision. (Assessment Boundary: Only qualitative investigation of the effect of a lens on light and images and description of the use of lenses to magnify.)*
h. Engaging in arguments *based on evidence to show that devices such as the telescope have led to significant changes in our understanding of the universe, and that our understanding of physical phenomena such as light has led to the development of new technologies (e.g., lasers).*

Kansas Influence:
This began as one PE and was divided into three separate PE'S. It is suggested that the incorporation of more examples and model limits will provide a better understanding of the Earth's systems. Some also suggest that level of argumentation is too advanced for this grade level. Also that there should have been more taught at the earlier grade levels to build on.

Kansas Comments:
5.ESI Earth Systems and Their Interactions
Perhaps more examples could be given for designing and evaluating technological solutions. Also, these standards rely on providing evidence…sounds like students are going to be doing a ton of reading.
Performance Expectation f is confusing.
May 2012
Sept. 2012
"ESPa still needs more clarification other than just listing the earth's systems; Suggestion: Identify the limitations of models that describe the interactions among Earth's systems. (to identify the limitations, they will have to understand the interactions)
ESPe is too high for elementary students as written unless the designs could be """"science fiction"""" type and disregard cost, material, etc limitations
It is obvious that life, physical, earth/space science are addressed at each grade level. It is not readily clear how one set of PEs in a topic connect with another set of PEs in a different topic. Tools for discerning these connections would be helpful."
5.SSS Stars and the Solar System
Try to incorporate more investigation with using language such as "Observe the phases of the moon to gain evidence for understanding…"
May 2012
e) what is done with the information obtained?
Sept. 2012
"This seems to be a quantum leap from the level that is addressed at first grade. Also, elementary needs to continue to push some opinion points for upper elementary. CCSS focuses on opinion at elementary as a precursor to argumentation. 5.SS.b addresses argumentation, but in this case the content of the argument is too difficult for grade 5.
5.SS.e is much more appropriate for PS4.b than 5.SS.a.
Wish there had been more at the lower grade levels leading up to this
Much of this standard only requires stating the facts - that is these could be looked up using Google. This one should be reworked to provide a performance that utilizes the knowledge

rather than the knowledge being the sole piece of action. The PEs taken as a whole, while reflecting the knowledge that we would like, it is not as clear that these will lead to understanding.
many of the earth/space topics flow well thru the elementary, building on each year. Space is the exception. It starts in 1st grade, nothing else is mentioned till 5th grade, then there is a big leap from this content to the MS content."""

Middle School Science Standards

Physical Science

April 2013 Draft

Result 1: MS-PS1 Matter and Its Interactions

Students who demonstrate understanding can:

MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*

January 2012 Draft

Product 1:MS.PS-SPM Structure and Properties of Matter

Students demonstrate understanding of the properties of matter by:

a. constructing and using models *to explain the different ways atoms combine to form new substances of varying complexity. (Assessment Boundary: Valence electrons and bonding energy are not addressed.)*
b. designing investigations *and collecting data to provide evidence supporting the claim that one pure substance is different from another substance based on their characteristic properties (e.g., melting and boiling points, density, solubility, reactivity, flammability, phase). (Assessment Boundary: Basic physical and chemical properties of pure substances are intended.)*
c. analyzing and interpreting *data to communicate the relationship between molecular structure and physical properties (i.e., temperature, thermal energy, the motion of atoms and molecules in various phrases). (Assessment Boundary: Common molecules or pure substances are intended.)*
d. designing and manipulating *a model to determine the effect on the temperature of different substances when thermal energy is added or removed. (Assessment Boundary: Not intended for advanced mathematical formulas.)*
e. constructing an argument *to make claims about the effect of adding or removing thermal energy to a substance in various phases and during a phase change. (Assessment Boundary: Not intended for advanced mathematical formulas.)*

Kansas Influence:

The standards are more defined and allow for middle school students to strengthen their critical thinking skills by allowing them to plan an investigation to generate evidence for a claim instead of just giving them the instructions.

Kansas Comments:

The language and definitions tend to be vague and informal ("some 100 atoms"). "Pure substances are made from a single type of atom or molecule". What about ionic compounds?---not molecular.

What is meant by models and patterns is confusing; 6-8 grade would have difficulties presenting an argument.

Performance expectation "c" seems to depend upon IMFA and would be difficult to teach without bonding valence electrons.

The wording in the standard make this difficult to implement. As it reads now this appears to lend itself to students conducting a series of "cookbook" laboratories.

May 2012

c) to determine what happens to temperature and particle motion when thermal energy... b) don't like the idea of generating evidence to support a claim--smacks of cookie cutter lab; plan investigation to generate evidence to test the claim…; d) is this an argument or just an explanation...?

Sept. 2012

"MS.SPM.a--with varying complexity is not needed in the PE since it is in the the clarifying statement; crystals should be identified as ""extended structures in the clarification statement

MS.SPM.b--comes across as cookie cutter lab; suggestion: Plan and carry out an investigation that will evaluate the claim that one pure substance can be distinguished from another pure substance based on their characteristic properties; would leave off methane, propane, hydrogen, and oxygen as they would be difficult to actually test (and not just look up information about).

MS.SPM.c--unecessarily complicated; suggestion: Manipulate simulations of the speed and position of atoms in solids, liquids and gases to determine the effect of adding thermal energy to the system."

April 2013

Result 2: MS-PS3 Energy

Students who demonstrate understanding can:

MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

MS-PS3-3. Apply Scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*

MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

MS-PS3-5. Construct, use, and present arguments to support the claim that when the motion energy of an object changes, energy is transferred to or from the object.

January 2012

Product 1: MS.PS-CR Chemical Reactions

Students demonstrate understanding of energy in chemical processes by:

a. analyzing and interpreting *data to predict and describe the characteristic ways substances react chemically. (Assessment Boundary: Reaction characteristics describe reactions between metals and nonmetals but should not involve valence electrons, bonding energy, or angles).*

b. comparing and analyzing *the physical and chemical properties of reacting substances to the properties of new substances produced through chemical reactions to show that new properties have emerged. (Assessment Boundary: Comparison and analysis should not involve statistical techniques.)*

c. developing representations *showing how atoms rearrange during chemical reactions to account for the conservation of mass. (Assessment Boundary: Representations should not involve bonding energy or valence electrons.)*

d. obtaining and communicating *information to support claims that when combining simpler molecules (e.g., H2O and CO2) into complex molecules (e.g., sugars) or breaking down complex molecules to simpler molecules, energy can be used, stored, or released. (Assessment Boundary: Further details of the photosynthesis process are not addressed.)*

e. developing a model *to represent the movement of matter and energy in the cycling of carbon (e.g., carbon in the atmosphere and carbon in living things). (Assessment Boundary: Further details of the photosynthesis process are not addressed.)*

Product 2: MS.PS-E Energy

Students demonstrate understanding of energy and its relationship with forces by:

a. analyzing and interpreting *data to explain that the kinetic energy of an object is proportional to the mass of a moving object and grows with the square of its speed. (Assessment Boundary: Qualitative, not quantitative.)*

b. using qualitative representations *of potential energy to analyze how much energy an object has when it's in different positions in a(n) electrical, gravitational, and magnetic field (e.g.,*

roller coaster cart at varying positions on a hill, objects at varying heights on shelves, iron nail with magnet being moved closer together, a balloon with static electric charge being brought closer to a classmate's hair.)
c. planning and carrying out investigations *to show that in some chemical reactions, energy is released and in others, energy is absorbed (e.g., baking soda reacting with vinegar, calcium chloride reacting with baking soda.) (Assessment Boundary: Qualitative, not quantitative.)*
d. using arguments and evidence *to support an explanation for the transfer of energy caused by the interaction of forces between two objects (e.g., between a bat hitting a ball and a ball hitting a bat, a person with static electrical charge and a metal doorknob.) (Assessment Boundary: Qualitative, not quantitative.)*

Product 2: MS.PS-ECT Energy Conservation and Transfer

Students demonstrate understanding of energy transfer between objects and systems by:
a. developing models or representations *to communicate the means by which thermal energy is transferred during conduction, convection, and radiation (e.g., a diagram depicting thermal energy transfer through a pan to its handle, warmer water in the pan rises as cooler water sinks, model using a heat lamp for the sun and a globe for the earth.)*
b. planning and carrying out investigations *to examine the relationship between the change in the temperature of a sample and the nature of the matter, the size of the sample, and the environment (e.g., comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature.)*
c. designing a device *or process that maximizes or minimizes thermal energy transfer, and defending the selection of materials chosen to construct the device. (Assessment Boundary: Excludes semiconductors and heat sinks.)*
d. planning and carrying *out investigations to examine energy transfer in moving objects due to friction and the conversion of motion energy to heat (e.g., rubbing hands together) and explaining why energy must be added to moving objects to keep them in motion when they experience friction. (Assessment Boundary: Qualitative, not quantitative).*
e. defining functional problems *about energy dissipation in everyday machines (e.g., skateboard, bicycle, lawnmower, skis, toy car), and designing and evaluating solutions that minimize friction and energy dissipation in machines (e.g., use of oil as lubricant on a skateboard, bicycle, or in a lawnmower engine, wax on skis).*
f. identifying and evaluating *various technological devices (e.g., thermos, car brakes, solar water heaters) that are based on an understanding of the transfer of energy.*

Kansas Influence:

The standards are more concise and require middle school students to heighten their vocabulary. The performance expectations allow for deeper meaning in each area instead of the mile wide inch deep standards.

Kansas Comments:

MS.PS-E Energy

In trying to use science and engineering practices, none of the science concepts are explained and there is no evidence that the student understands what any of them are. It is possible to use all of the practices suggested for forces and energy and but know what they are. No explanation is offered for what energy is and does.

Too many concepts are in this standard – too many for MS to understand at this level. Break down the concepts for better understanding.

Square of speed seems very quantitative to me, but boundary says only qualitative. Seems contradictory.
In the standard – why use the word "grows" (also in the core idea) instead of "increases or varies" – grows seems to imply a biological connection. Also there needs to be a boundary on b. On the core ideas – the inclusion of conservation of matter/mass would seem to be needed to better reflect the standard.
It is noted that students' understanding of kinetic energy (that it's proportional to the square of the object's velocity) should be demonstrated qualitatively, not quantitatively. Teachers will need guidance on how to present this idea conceptually rather than mathematically.
May 2012
a) conceptual rather than qualitative?
d) and/or? how about just construct; c) this PE would likely be a carry out rather than a plan and carry out
Sept. 2012
"E.a.- Core idea of ETS1.A. is not met by this PE because students are not directly involved in evaluating a design option based upon criteria or constraints. Students need to be involved with comparing specific design choices to specified constraints in order to evaluate whether that design choice will be acceptable or if they need to suggest a different design in order to satisfy a given constraint. Suggestion for change: Design a traffic pattern and set of speed limits for a given setting which takes into account the kinetic energy of various vehicles in the traffic pattern.
E.f.- This PE is well written as an engineering design PE. However, the Clarification Statements do not guide teachers to viable design items that can be constructed and evaluated by middle school students. Suggestions for change: Clarification Statement – Solutions can include use of lubricant on an axle for a wheel, etc. Everyday machines or systems such as wheels on toy cars, insulating cups, heat sinks on computers, etc… Solutions should focus on the use of various materials based upon the properties of those materials. There need to be further examples to support the the use of advances in technology. As now done, this is not addressed well or clear how one would do this.
""Some felt the math was not as explicit as it could be. For example, math isn't stated that it is used to analyze data. Teachers are required to access the math standards to teach the science standards. Perhaps it would be easier to specifically state the math standard to make it more user friendly (or hyperlink). Math terminology """"linear relationships, analyzing data, simple functions" is acceptable as long as it's understood a 6th grader might have a different level of understanding than an 8th grader. Some want the engineering design process stated in a clear manner. Also, the concept of reverse engineering design (taking things apart) was suggested as a step before the engineering step. Needs to be cross referenced with the common core standards. Doesn't speak to the common core standards for math, what it speaks to is the mathematical practices and that is not giving teachers specific clues about what should be taught. Terminology needs to be more specific and consistent across the subjects.
For example, """"When I'm looking at really small numbers, this (stated specifically) is where it is found in the math standards (exponents)""

April 2013 Draft

MS-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*

MS-PS2-2. Plan in investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

January 2012 Draft

MS.PS-FM Forces and Motion

Students demonstrate understanding of how forces affect the motion of objects by:

a. Formulating questions that arise from investigating *how critical the point of view (i.e., frame of reference) of an observer and choice of units of size are to communicating the motion and position of an object. [Assessment Boundary: Observations are made at the macro scale only]*

b. Graphically and mathematically communicating observations and information to represent how an object's position, *velocity, and direction of motion are affected by forces acting on the object. [Assessment Boundary: Restrict to motion in one dimension; the use of vectors is not an expectation]*

c. Collecting data to investigate and generate reliable evidence supporting *Newton's Third Law which state that when two object interact they exert equal and opposite forces on each other. [Assessment Boundary: Restrict to vertical or horizontal interactions; interactions at angles requiring trigonometry is not an expectation]*

d. Planning and carrying out investigations to identify the *proportional relationship between the acceleration of an object and the force applied upon the object and the inversely proportional relationship to its mass. [Assessment Boundary: Simple formulas such as F=ma and w=mg could be used quantitatively; the use of trigonometry is not an expectation]*

e. Using mathematics and computational thinking, describe the effect forces have on an object's *shape, velocity, orientation, and direction of motion. [Assessment Boundary: when discussing an object's shape, description is purely qualitative. Simple formulas such as s=d/t and F=ma could be used quantitatively]*

f. Analyzing and interpreting data to determine *the cause and effect relationship between the motion of an object and the sum of the forces acting upon it, and if the forces are unbalanced. [Assessment Boundary: Simple free-body diagrams are acceptable; the use of trigonometry is not an expectation]*

MS.PS-IF Interactions of Forces

Students demonstrate understanding of the underlying forces responsible for various interactions by:
a. Planning and carrying out investigations (e.g., observing the forces produced between two charged objects at different *distances, measuring the magnetic force produced by an electromagnet with a varying number of wire turns) to determine the factors that affect the strength of electric or magnetic (electromagnetic) forces. [Assessment Boundary: Qualitative, not quantitative; no discussion of Coulomb's law]*
b. Modifying a model or using various representations *to determine the relationship among gravitational force, the mass of the interacting objects, and the distance between them. [Assessment Boundary: Simulations may be used to introduce and manipulate variables]*
c. Planning and carrying out investigations in order to demonstrate *that some forces act at a distance through fields (i.e., gravitational, electric, magnetic). [Assessment Boundary: Determination of fields are qualitative not quantitative; forces between two human-scale objects are too small to measure without sensitive instrumentation]*
d. Examining given data to develop a simple mathematical model that represents *the relationship of gravitational interactions and the motion of objects within the solar system (e.g., what happens when you change the length of a string attached to an object). [Assessment Boundary: Use models to determine a relationship conceptually not quantitatively]*
e. Developing or modifying virtual or real world models to demonstrate *that systems can withstand small changes, relying on feedback mechanisms to maintain stability (e.g., roller coasters, Rube Goldberg machines). [Assessment Boundary: Use models to determine a relationship conceptually not quantitatively]*.
Kansas Influence: The standards are condensed down for deeper understanding.
Kansas Comments:
MS.PS-FM Forces and Motion

There is no evidence that the students understand what a force is.

Need to define grade bands – to complicated for a 6th grader. Doesn't flow well from 5th grade.

The emphasis on one dimension seems to be in conflict with standard f. Why not included combined horizontial and vertical forces as long as there are no angles.

May 2012

a) too much in one PE--questions and investigation--leads to convoluted syntax; f) data-based scenarios rather than just data

a. too much in one PE--maybe formulate questions to drive investigations… c. What if their data doesn't support due to equipment or reader error? And what do they do with the data they have collected? Collect data to evaluate the claim of Newton's Law that when two objects interact, they exert equal and opposite forces on each other. Evaluation should include analysis of potential error in data collection procedure.

Sept. 2012

"FM.a. Seems to start in the middle of the design cycle.

What is the idea of Engineering Design? This should be a process, not a thing (which is, at first glance, what these are)

Investigate vs. design – engineers don't investigate (or do they?) vs. scientists do more investigation

FMb - again, the vague nature of this makes it difficult to determine appropriateness; the design process would better be directed by including the need for students to propose the

next iteration of the design based upon data related to a specific criterion, Suggestion for change: Analyze data from different design solutions to propose an improvement to the design given a specific criteria related to the acceleration of an object.
FMc - Here is a place that does ask for quantitative information. Good - but not in alignment with the qualitative asked for in other sections of MS. The other areas need to ramp up to the quantitative analysis - ie mathematical thinking such as here.
FM.d.-PE specifies manufacturing process but the Clarification Statement only mentions a lump of clay which is more like a science experiment. Suggestions for change: Provide some clarification statements that direct the audience to a manufacturing process, such as constructing a support for building or object that has to support a large amount of weight, which shape (circular, rectangle, triangle, etc) provides the greatest support with the least amount of building material?""
FMf - There is a need for further clarification. At this stage it appears as if the tried and true demonstrations run the show rather than the PE defining the content.

Life Science
April 2013

MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*

MS-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

MS-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different number and types of cells.
MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of group of cells.

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant

structures affect the probability of successful reproduction of animals and plants respectively.

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending message to the brain for immediate behavior or storage as memories.

MS-LS4 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

MS-LS4-3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationship not evident in the fully formed anatomy.

MS-LS4-4. Construct an explanation of based on evidence that describe how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Ms-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in population over time.

January 28, 2012 Draft

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

Students demonstrate understanding of how organisms obtain and transfer the matter and energy needed by:

a. Developing an explanation *for the role of photosynthesis in the cycling of matter and flow of energy on Earth*

b. Developing and using models *of the cycling of matter among living and nonliving parts of ecosystems.*

c. Using models *to explore the transfer of energy into, out of, and within the ecosystems.*

d. Constructing and communicating models *of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem.*
e. Using evidence to explain that matter is conserved *as atoms in food are rearranged as they pass through different organisms in a food web.*
f. Using evidence from credible sources to support arguments *that changing a component of an ecosystem affects the species in the ecosystem.*

MS.LS-IRE Interdependent Relationships in Ecosystems

Students demonstrate understanding of ecosystems and the interactions of species in ecosystems by:
a. Constructing and communicating models to investigate *the effect of resource availability on the populations of organisms in an environment.*
b. Analyzing data to determine the *patterns of interactions across multiple ecosystems that demonstrate competitive, predatory and/or mutually beneficial relationship among organisms.*
c. Asking researchable questions *about the way organisms obtain matter and energy across multiple and varied ecosystems.*
d. Using models to explain *the resiliency of ecosystems as a function of biodiversity.*
e. Constructing explanations from evidence for *the role of genetic variation within a species as an essential component of shifts in populations.*
f. Engaging in arguments from evidence *that changing any physical or biological component of an ecosystem results in shifts in populations.*
g. Designing solutions *to achieve sustainable ecosystems near cities, towns, and/or farms.*
h. Posing questions *about patterns in social interactions and grouping behaviors of animals that contribute to a survival advantage across many species.*

Kansas Influence:

No comments

Kansas Comments

No MS.LS-MEOE comments

No MS.LS-IRE comments

STANDARDS NOT CONTINUED TO APRIL 2013

January 28, 2012 Draft

MS.LS-SFIP Structure, Function, and Information Processing

Students demonstrate understanding of how structures in organisms enable life functions and responses to the environment by:

- ***a. Investigating and presenting evidence*** *that the structure of class in both unicellular and multicellular organisms is related to how cells function.*
- ***b. Using data to generate*** *explanations that unicellular and multicellular organisms obtain food, water, and places for waste disposal from the environment to survive.*
- ***c. Explaining the function*** *of specific parts of cells (i.e., cell membrane, cell wall, nucleus, chloroplasts, mitochondria).*
- ***d. Generating an explanation*** *for the way the structure of the cell membrane maintains a stable internal environment by controlling what enters and leaves the cell.*
- ***e. Constructing models*** *and representations of body systems to show multiple interacting subsystems and structures.*
- ***f. Providing explanations*** *of how sense receptors respond to stimuli by sending messages to the brain to processed and stored and information (i.e., immediate behaviors, long term memory).*
- ***g. Communicating an explanation*** *about how the storage of immediate behaviors and long-term memories requires changes in the structure and function of millions of interconnected nerve cells in the brain.*

Kansas Influence:

Standard not continued.

Kansas Comments

I read your justification for this and do not agree that it warrants its own standard. While neurobio is important, the emphasis will take away from the idea of organisims functioning as a result of many systems/parts working in conjuction with one another. If the goal is to view systems as a whole, we need that to be reflected in the standards. This idea had broad application to life as well when we ask students to work together to achieve a goal.

Performance objective (f) does not address receptors responding to different inputs, core idea LS1.D. The second bullet on core idea LS1.D needs more specifics as to what changes in the structure and functioning of many millions of interconnected nerve cells allow inputs to be stored as memories.

May 2012

Investigate is very unclear in this PE--does it mean conducting an ivesitagtion, or gather info, or either? c)run-on; 1 explanation or one for each? this standard has generally awkward phrasing

need uniform use of "investigate"; lots of overlap betweeen a and c; it seems that the evidence for a is c; b) doesn't require generating evidence...just drawing on life experiences; what is the difference from providing and constructing explanations? (c and e); c)just dressed up regurgitation

Sept 2012

"MS.SPM.a--with varying complexity is not needed in the PE since it is in the the clarifying statement; crystals should be identified as ""extended structures in the clarification statement

MS.SPM.b--comes across as cookie cutter lab; suggestion: Plan and carry out an investigation that will evaluate the claim that one pure substance can be distinguished from another pure substance based on their characteristic properties; would leave off methane, propane, hydrogen, and oxygen as they would be difficult to actually test (and not just look up information about).
MS.SPM.c--unecessarily complicated; suggestion: Manipulate simulations of the speed and position of atoms in solids, liquids and gases to determine the effect of adding thermal energy to the system."

January 28, 2012

MS.LS-GDRO Growth, Development, and Reproduction of Organisms

Students demonstrate understanding of the growth, development, and reproduction of organisms by:

a. Using evidence to support explanations *of how environmental and genetic factors affect the growth of organisms.*

b. Investigating and presenting evidence *that plant growth can continue throughout the plant's life through production of plant matter by photosynthesis.*

c. Using models and/or simulations *to construct an explanation of how the genetic contribution from each parent in sexual reproduction results in variation in individuals.*

d. Constructing an argument explaining *how specialized plant structures and specific animal behaviors (e.g., placement of stamen and bees gathering nectar, hard shells on pine nuts, squirrels burying nuts) are related to successful reproduction of plants.*

e. Identifying and evaluating *the impact of characteristic behaviors (e.g., birds building nests to protect young, brown trout spawning in late fall when predators are less active) of animals on their odds of successfully reproducing.*

f. Providing explanation *of how changes (mutations) to genes, which are located on chromosomes, affect specific inherited traits resulting in harmful, beneficial, or neutral effects.*

g. Communicating explanations *of ways technologies enable humans to influence the inheritance of certain traits in plants and animals (e.g., breeds of cattle for various purposes, disease resistant crops, genetically modified organisms).*

Kansas Influence

Standard not continued.

Kansas Comments

Performance objective (c) does not insure learning about Core Idea LS1.B asexual reproduction. Performance objective definitely do not guarantee learning of Core Idea LS3.A.
May 2012
d) if specific models are desired, they should be named; e) add an "a' after how;
b) "Investigate implies conducting an investigation...really just obtaining info; d) not an investigation; this is obtaining info; too much of just "using models" in standards in general just when models have to be used becuase things are microscopic; focus is needed in PEs on looking at limitations and applications of models rather than just using them to explain--if you know the limitations of the model, you know what the model is representing (and what it can't); In general, I would use language to indicate that evidence supports a CLAIM and the Argument is the explanation of HOW the evidence supports the claim; f and g need assessment boundaries; What is the difference between providing explanations and communicating explanations (f,g,h)? clarify or eliminate one; lots of "explaning" in this standard
Sept. 2012
"MS.GDRO.a- this seems more like an argument than an explanation. Students are asked to make a claim as to whether or not a similarity between parent and offspring is due to environmental or genetic causes (or both) and then support this claim with evidence.
MS.GDRO.b--don't need generate and collect--generate is sufficient
MS.GDRO.c--it seems like saying that asexual reproduction results in identical individuals is an unnecessary oversimplification that doesn't acknowledge what we now know about epigenetics; should be sufficient to compare them in more relative terms--significantly more or less similar
MS.GDRO.d--specialized plant structures is too vague--a clarification and perhaps assessment boundary statement are needed
MS.GDRO.e--supporting a claim, not an argument--the argument is the connection between the evidence and the claim
MS.GDRO--value neutral ""changed"" would be better than ""improved""
MS.GDRO.h - needs clarification."

January 28, 2012 Draft

MS.LS-NSA Natural Selection and Adaptations

Students demonstrate understanding of the evidence explaining the relationships among species by:

a. Analyzing and interpreting patterns *of change in fossils over time that provide evidence of the history of life on Earth and relationships between organisms.*

b. Using evidence to construct explanations *for the anatomical similarities and differences between organisms living today and the organisms in the fossil records, as is relates to evolutionary history and descent from a common ancestor.*

c. Developing explanations *for why the remains of most individual organisms do not form fossils.*

d. Recognizing and comparing patterns *in the embryological development across species to show relationships not evident in the fully formed anatomy.*

e. Constructing arguments *that the development of new technologies has added significant evidence to the theory of descent from common ancestry and diversity of life on Earth.*

f. Communicating explanations *for the genetic variations in a population that give some individuals an advantage over others to survive and reproduce in a specific environment resulting in these genetic traits becoming more common in that population.*

g. Using mathematical models *to explain that natural selection over generations results in changes within species in response to environmental conditions that lead to the predominance of suppression of certain traits in a population.*

h. Obtaining and evaluating *information about how separated populations in different environmental conditions may evolve to become separate species.*

Kansas Influence

No comments

Kansas Comments

No MS.LS.NSA comments.

Earth and Space Science
April 2013 Draft

MS-ESS3 Earth and Human Activity

Student who demonstrate understanding can:

MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

January 28, 2012 Draft

MS.ESS-HI Human Impacts

Students demonstrate understanding of how past and current human activities and technological developments have altered Earth's environments and systems by:

a. Using system models and representatives *to explain how human activities significantly impact: (1) the geosphere (e.g., changes in land use, resource development), (2) the hydrosphere (e.g., water pollution, urbanization), the atmosphere (e.g., air pollution of gases, aerosols, particulates), (3) the biosphere (e.g., changes to natural environments), and (4) global temperatures (e.g., through the release of greenhouse gases).*

b. Generate and revise explanations from data for *the impacts on Earth's systems that result from increases in human population and rates of consumption.*

c. Designing technological and engineering solutions *for stabilizing changes to communities by: (1) using water efficiently, (2) minimizing human impacts on environments and local landscapes by reducing pollution, and (3) reducing greenhouse gases.*

d. Asking questions and defining problems about the way *continued technological monitoring of Earth's systems can provide the means of informing social policies and regulations that will reduce human impact on Earth's systems.*

e. Using arguments and empirical evidence to evaluate *technologies that responsibly exploit renewable energy resources.*

Kansas Influence

No comments

Kansas Comments

No MS.ESS-HI comments.

High School Science Standards

Earth and Space Science

April 2013 Draft

HS-ESS2 Earth's Systems

Students who demonstrate understanding can:

HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.

HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surfaces processes.

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

January 28, 2012 Draft

HS.ESS-ES Earth's Systems

Students demonstrate understanding of how Earth's interconnected systems of rock, water, air, and life work together to form and alter Earth and the places humans inhabit by:

a. Constructing and revising arguments *from geophysical, and geothermal evidence (e.g., drill cores, gravity, seismic waves, laboratory experiments on Earth materials) that support the model of Earth's zoned interior.*

b. Analyzing a model of Earth's *interior involving the mechanism of thermal convection to explain the cycling of matter and the impact of plate tectonics on Earth's surface.*

c. Investigating the mechanisms *by which water impacts the flow of energy and the cycling of matter within and among Earth systems.*

d. Using an Earth System's model *to explain the change and stability of features within different regional landscapes (e.g., Earth's internal processes drive plate tectonics while Earth's surface processes drive weathering and erosion, combinations and feedbacks of several Earth systems at different spatial and temporal scales result in the different regional landscapes and bathymetries.)*

e. Constructing an evidence-based claim *about how a change to one part of a system created feedbacks that cause changes in other systems (e.g., coastal dynamics, watershed and reservoir management, stream flow and erosion rates, changes in ecosystems.)*

HS.ESS-CC Climate Change

Students demonstrate understanding of mechanisms controlling climate change by:

a. Evaluating and communicating *the climate changes that can occur when certain components of the climate system are altered (e.g., variations in incoming solar radiation as well as its*

reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems).

b. Constructing a scientific argument *showing that changes to any one of many different Earth and Solar System processes (e.g., the sun's energy output, Earth's orbit or axis orientation, tectonic events, ocean circulation, volcanic activity, glacial activity, the biosphere, human activities) can affect global and regional climates.*

c. Using mathematical models to *analyze geologic evidence that past climate changes have occurred over a wide range of time scales that can occur over 10s-100s of years (e.g., changes in solar output, ocean circulation, volcanic activity), 10s-100s of thousands of years (e.g., changes to Earth's orbit and the orientation of its axis), or 10s-100s of millions of years (e.g., long-term changes to atmospheric composition).*

d. Constructing and revising arguments *to show that simple climate models satisfy evidence of part climate variations (i.e., global climate models incorporate scientists' knowledge of the many different interactions among relevant systems and their physical and chemical processes.)*

e. Using current global climate models *to explain and predict the relationships between global temperature changes and their outcomes to the amounts of natural and human-generated greenhouse gases added to the atmosphere (e.g., when and which natural resources will become scarce, how weather patterns will change, how rapidly sea levels will rise).*

f. Asking questions to investigate *how humans may predict and manage their impacts on future global climate systems.*

Kansas Influence:

The difference in vocabulary and condensing the standards down.

Kansas Comments

May 2012

"a) that has occurred?

d) not clear what ""critical reading"" is; is this supposed to be an ""or""? If so, why is the list needed?

f) why an e.g. here instead of a clarification statement?

"

"a) is the expecation that students communicate on all of them? If so, this is too broad

c) Analyze geologic evidence to determine the range of time scales for past climate changes. [Clarification statement: In examining evidence from ice core data, the fossil record, sea level fluctuations, glacial features, students should determine that climate change has happened over a wide range of time scales.

d) how would a teacher know if a student is doing this--what exactly is meant by ""critical reading?""

e) remove section after comma"

Sept. 2012

There is much in this that is too much to expect to be learned in HS.

April 2013 Draft

HS-ESS1 Earth's Place in the Universe

Students who demonstrate understanding can:

HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.

HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

January 28, 2012 Draft

HS.ESS-SS Space Systems

Students demonstrate understanding of the Universe and how objects in the Solar System affect Earth by:

a. Using diagrams to communicate *how the stability and structure of the Sun change over its lifetime (of approximately 10 billion years).*

b. Using mathematical, graphical, or computational models *to represent the distribution and patterns of galaxies and galaxy clusters in the Universe in order to describe the Sun's place in space.*

c. Constructing explanations *from the spectral data (e.g., red shift, intensity) of the light from galaxies to support the Big Bang theory as the mechanism for the formation of the Universe.*

d. Obtaining, evaluating, and communicating *information about the process by which stars produce all elements except those elements which formed during the Big Bang (i.e., nuclear fusion without stars produces atomic nuclei lighter than and including iron; heavier elements are produced when certain massive stars achieve a supernova stage and explode).*
e. Using mathematical representation*s of the positions of objects in our Solar System in order to predict their motions and gravitational effects on each other.*
f. Analyzing evidence to *correlate the way in which changes in Earth's orbital parameters alter the intensity and distribution of sunlight, causing cyclical climate changes that include past Ice Ages.*

HS.ESS-HE History of Earth
Students demonstrate understanding of Earth's history and how life has coevolved along with it by:
a. Analyzing observed *isotope ratios within Earth materials to establish the planet's age, the ages of Earth's events and rocks, and the overall time scale of Earth's history.*
b. Constructing an argument *in support of plate tectonic theory based on general trends of the ages of continental and oceanic crust, as well as patterns of topographic features (e.g., the youngest seafloor rocks are located at mid-ocean ridges, the oldest ocean rocks are located near ocean trenches, age bands are parallel across mid-ocean ridges).*
c. Constructing explanations *about changes that occurred during Earth's early history (i.e., Hadean Eon) based on data from Earth materials, planetary surfaces, and meteorites (e.g., though dynamic Earth processes have destroyed most of Earth's very early rock record, lunar rocks, asteroids, and meteorites have remained relatively unchanged and provide evidence for conditions during Earth's earliest time periods).*
d. Constructing scientific arguments *to support the claim that dynamic causes, effects, and feedbacks among Earth's systems result in continual co-evolution of Earth and the life that exists on it.*

Kansas Influence:

There is more assessment boundaries for teachers to really understand what needs to be taught and the vocabulary was clarified.

Kansas Comments:

HS.ESS-SS Space Systems
Need more assessment boundaries.
May 2012
"c) seems like constructing an argument for the claim..
b) not sure what the student is exactly responsible to do here; this seems like a lower level version of e)"
Sept. 2012
e, f, g extend beyond what every student needs to know by the time they graduate HS.

HS.ESS-HE History of Earth
May 2012
"a) do we need valid and reliable--aren't those supposed to be what we are always aiming for with scientific claims; if not, why just here?

a) a scientific argument rather than ""scientific arguments"""

Sept. 2012
The overall concern that I have is that several of these PE's are great for a complete understanding of Earth Science, but not a realistic goal for what every student needs to know by the end of HS. Many of these topics are not even taught in entry level college courses.

April 2013 Draft

HS-ESS3 Earth and Human Activity

Students who demonstrate understanding can:

HS-ESS3-1. Construct and explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-2. Evaluate competing design solutions for developing, managing, utilizing energy and mineral resources based on cost-benefit ratios.

HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associate future impacts to Earth systems.

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

January 28, 2012 Draft

HS.ESS-HS Human Sustainability

Students demonstrate understanding of how humans can manage a long-term and sustainable coexistence with Earth's systems by:

a. Clarifying and critiquing arguments *about how natural resources availability (i.e., locations of streams, deltas, high concentrations of minerals, ores, coal, and hydrocarbons) has guided the development of human society.*

b. Reflecting and revising on design *solutions for local resource development (e.g., water use, mining for coal and minerals, pumping for oil and natural gas, soil use for agriculture) that would increase the ratio of benefits to costs and risks to the community and its environment.*

c. Constructing valid scientific claims *of how increases in human populations and rates of consumption cause mineral and fossil fuel resources to become scarcer and more valued.*

d. Constructing scientific arguments *from evidence to support claims that natural hazards and other geologic events have shaped aspects of the course of human history.*

e. Constructing valid scientific claims *about the impacts of human activities on the frequency and intensity of some natural hazards (e.g., floods, droughts, forest fires, hurricanes).*
f. Using mathematical relationships *and models to assess the global sustainability of human society as a function of the availability and consumption of natural resources.*
g. Constructing arguments *about how human activities can be regulated to mitigate global environmental impacts (e.g., acid rain, steam pollution, the ozone hole).*
h. Using computational models *based on GIS and other digital data to investigate how the ocean, atmosphere, geosphere, and biosphere are being modified in response to human interactions.*

Kansas Influence:

The performance assessment was changed from Human Sustainability to Earth and Human Activity to incorporate the Earth Science into the standards. Also deciding when this should be taught because of the grade level ability.

Kansas Comments

HS.ESS-HS Human Sustainability

General comment: I know that this is earth and space, but if the title of this is "Human Sustainability" it can't just be in reference to natural resources, which is given the heavy focus here, True sustainability involves an interdisciplinary approach that looks at all aspects of the social/cultural and physical environments. Thought this is handled better in the Disciplinary Core Ideas than in the eight statements. Performance expectation "a": guided is too strong and leading of a word choice here. "Influenced" would be more accurate. Could also use "shaped aspects" like is done in d. below. Many other factors also influence society and depending on the contexts in question may have a much more significant impact on human social development than natural resource availability for any given space and time. Performance expectation "h": Can't ignore the other economic, social/cultural and physical environmental factors. These are as critical to human sustainability as natural resource availability (and more likely so). Performance expectation "g": Regulation is only (1) possible way to impact human activities/behaviors. Other behavioral modification means that work at various levels (individual to society as a whole) need to be included. ESS3.A: Natural Resources: Influenced or shaped , not guided.

May 2012

"c) too many clauses in this sentence; simplify the syntax
g) why ""scientific arguments"" on d and ""arguments"" on g?"
"b) like local application
c) this PE is not at all clear; not sure how to fix, but part of it might be that this isn't the right marriage of practice and dci
f) :production and consumption of natural resources"" makes it sounds like they are two parts of the same process--the same ""person"" is doing both
g) too many phrases
Construct arguments about how engineering solutions are designed and implemented to mitigate local or global environmental impacts.
h) would like a communicate in this PE"
Sept. 2012

Engineering Technology Science Standards

April 2013 Draft

HS-ETS1 Engineering Design

Students who demonstrate understanding can:

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social cultural, and environmental impacts.

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem

January 28, 2012 Draft

HS-ETS-ETSS Links Among Engineering, Technology, Science, and Society

Students demonstrate understanding of the relationships among engineering, technology, science, and society by:

a. Using appropriate scientific *and technical sources, gather information on the research and development (R&D) cycle that has resulted in a modern technological system, identifying contributions made by individuals with different areas of expertise (e.g., medical imaging devices used to study the structure and function of human organ systems developed and tested by teams that include physicists, electrical engineers, doctors and technicians, methods for using radioactive-decay lifetimes and isotopic content in rocks as a means for dating geologic formations, developed and validated by teams of nuclear scientists, chemical engineers, and geologists.)*

b. Gathering evidence *to test different explanations for the widespread adoption of a modern technology such as societal demands, market forces, evaluations by scientists and engineers, and government regulation (e.g., the widespread adoption of centralized power plants using fossil fuels may have a variety of casual explanations, such as: a growing demand for electrical energy, availability of inexpensive coal and oil, development of energy and power technologies by scientists and engineers, governmental financial and regulatory decisions.)*

c. Analyzing and comparing *different technologies designed to accomplish the same function but with different methods and materials (e.g. paper vs. electronic books, nuclear vs. coal-fired*

power plants) using data to compare their relative environmental impacts, costs, risks, and benefits.
d. Constructing or critiquing *arguments based on evidence that illustrate how major technological systems (e.g. agriculture, health, water, energy, transportation, manufacturing, construction, communications) have changed over time to accommodate the changing needs of society.*
e. Using mathematics and computational *thinking to define problems that future engineers will need to solve if the world population continues to grow at the current rate (e.g. increasing crop yields, providing new supplies of water for drinking and irrigation, reducing habitat destruction so as to preserve biodiversity, developing means for generating energy from renewable sources.)*
f. Planning and carrying out an investigation, *including field research, to improve a technological system in order to increase benefits while decreasing costs and risk (e.g., investigate the school heating system, light bulbs and fixtures, energy guidelines for students and teachers, procedures used in the school cafeteria or sports program.)*
g. Using data, predict the future course *of a new technological innovation in terms of its beneficial effects, and what might be done to reduce potentially negative impacts should they arise (e.g. using data on the rate at which solar and wind energy installations, and projected demands for new energy supplies, predict the future course of these renewable energy sources, identifying possible negative impacts and what can be done to reduce or avoid them).*

HS-ETS-ED Engineering Design

Students demonstrate understanding of how to develop, test, and improve solutions to problems by:
a. Asking questions and collecting information *to quantify the criteria for success and constraints, or limits of a design problem (e.g., determine the carrying capacity of a refugee camp, starting with the food, water, and space needs of camp residents and taking into account the available resources.)*
b. Analyzing data on the functioning *of a human-built system to identify problems or opportunities for improvement (e.g., conduct an energy audit of a school by determining current costs for utilities, problems not anticipated when the systems were designed, and identify opportunities for better performance, increased efficiency, and lower costs.)*
c. Redefining a large complicated *design problem related to a major local, national, or global issue by breaking it down into multiple, simpler components, identifying parts that can and cannot be solved with existing technology (e.g., break down the problem of global climate change into questions that can be answered scientifically, problems that will require engineering solutions, and those that will involve changes in national policies or international cooperation, research the component problems to determine the easiest to solve and the greatest challenges.)*
d. Choosing the most promising *idea for further development by prioritizing criteria and constraints and using a trade-off matrix, numerical weighting system, or other systematic process to rank each possible solution (e.g., choosing the best device for communicating between two locations on opposite sides of the Earth, taking into account the properties of the electromagnetic waves used by each device with respect to the criteria and constraints of the problem.)*
e. Refining a solution *by taking into account the life cycle of a given product or technological system, including the raw materials and energy needed for production, transport, use,*

maintenance, upgrading, and disposal of the product or system (e.g., analyze the materials and processes used in a school cafeteria to recuse the system's environmental impact and costs).
f. Planning and carrying out a quantitative investigation *to compare the effectiveness of different designs and improve the solution to a given problem (e.g., design, build, and improve a simple stringed instrument, conduct a series of simulated collusions on a computer to design safety guidelines for cars of different masses and speeds.)*
g. Using words, tables, diagrams, and graphs *to communicate how sensors (i.e. inputs) and actuators (i.e. outputs) can be used to regulate the function of a design through feedback and control (e.g., explain how an elevator door uses sensors and actuators to avoid injuring people.)*
h. Using appropriate technical sources *explain how the molecular structure of a material can be manipulated using tools, machines, and techniques to better meet the criteria and constraints of a problem (e.g., explain how the molecular structure of carbon can be manipulated to produce materials that have superior light absorption properties and enable the design of better sensors.)*
i. Arguing from evidence to validate a *computer simulation to support a proposed solution (e.g., compare the predictions of an existing computer simulation of the spread of an epidemic with data from an actual epidemic and use the results to support recommendations for reducing or preventing an epidemic.)*
j. Analyzing a complex system *to identify any emergent properties that could not have been predicted when the system was first developed (e.g., development of cities has resulted in expansion of some plant and animal species and decline and sometimes extinction of other species, the development of antibiotics has resulted in new strains of resistant bacteria.)*
k. Communicating the optimal design *based on the needs of the end user with supporting quantitative evidence.*

Kansas Influence:

The standards were condensed down in a more concise vocabulary, but still allows for the technology side of Engineering Design. It is geared now more towards using technology in the engineering side of science.

Kansas Comments:

HS-ETS-ETSS Links Among Engineering, Technology, Science , and Society

This standard is unreachable at the HS level.

General comment: It's important that we put the science and engineering standards together, that when discussing the "natural environment" and "society" that these are NOT set up as distinct and different entities. Our societies are part of the natural worl – we are not distinct or separate from it. That is a false dichotomy (born out of certain religious/cultural world views) which clouds much of our thinking about the world around us. Our technologies (including the built environment) are adaptations to the world around us, just as termite mounds or the use of a shell by a hermit crab are. Performance expectation "b": Also including competition among groups and the functional integration within groups, and group vs. individual adaptations and selective pressures. Performance Expectation "c": Compare their impacts on costs, (first and life cycle) of, and risks and benefits to the physical and social/cultural environment. Performance Expectation "d": accomadate the changing needs of society and /or changing conditions in the physical environment. Performance Expectation "e": more important to emphasize adapting to climate change as opposed to population growth – if population growth is referenced, then bring in the disproportionate differences in population growth among different parts of the globe (i.e., developed vs. developing parts of the globe) and the trends that they are following – this is much more critical than population growth as a whole. Performance Expectation "f": HVAC (heating,

ventilating and air conditioning) system, not just "heating". Light fixtures/lamps instead of light bulbs and fixtures, custodial practices, building operations and maintenance practices. Performance Expectation "g": Include the direct and indirect subsidizations of energy (including oil and Gas) as part of the example. Planning and Carrying Out Investigations: define what a "safe and ethical manner" are, or refer to scientific/industry standards that define this. Interdependence of Science, Engineering, and Technology bullet point 3: Only place I've seen sociology mentioned; the use of anthropology, sociaology and psycology as part of this needs to be expanded on. Interactions of Engineering, Technology, Science, Society, and the Natural Environment bullet point 2: decreasing costs and risks, both known and unknown. Interactions of Engineering, Technology, Science, Society, and the Natural Environment bullet point 3: or other social demands/constraints; also dependent on the nature of the physical environment. Interactions of Engineering, Technology, Science, Society, and the Natural Environment bullet point 4: our physical and social/cultural environments. Interactions of Engineering, Technology, Science, Society, and the Natural Environment bullet point 6: Not just prevent, but quickly react to unintended harm when it does occur – in this case technological systems include the larger societal processes/procedures in play that both guide technologies development but also oversee its implementation and use. The more "interdisciplinary" such processes/procedures are, the mor likely the development, implementation and use of technology avoid unintended harm. Cause and Effect bullet point 2: empirical evidence coupled with statistical analyses.

May 2012

clarification statements are visually distracting. Would it be possible to have a little icon for clarification statements that you could click on? a) could easily be incorporated in several other standards and would instantly become more meaningful--AND the other standards would be better off as well.

Sept. 2012

HS-ETS-ED Engineering Design

"If a student successfully met…" – That is a big IF! The expectation are incredibly high-reaching given the allotment of time and funds available in a high school setting. Each expectation assumes a great level of preparation and background knowledge that I have seen in only about 2% of 12th grade students. ALL students should be able to do these things? I wonder what kind of teacher in a super school it woul take to accomplish such lofty ideas.

The performance standards have no reference to the ability to measure, plan, and analyze for engineering, they appear to be directed toward science rther than engineering. H. is especially confusing, because molecular properties are very different from properties at the macro level. Since most school districts will look at these expectations and just drop any notion to take these seriously, Iwould recommend coming up with some other examples that are doable for the average school and ones that would not require more than a few days to accomplish. Otherwise schools will be forced to treat the NGSS standards as a buffet of ideas from which to pick and choose what they can accomplish.

Examples are very helpful but these standards will take a lot of time and teachers will professional development.

I feel these standards are heavy handed toward environmental concerns. While it is good to teach students to be stewards of the environment, you need to be careful on how you use examples. The examples are what the teachers are going to use to creats lessons and it is important to be broad in the fields that are covered. I also feel that safety and human interaction should play a larger role in the design process.

Students need to be required to measure and perform pre site assessments. What is the existing object, site? What are the needs. Second, engineering requires systems thinking rather thatn analysis (breaking down). Engineering design requires examining the site, identifying the parts of the system, and determining all existing factors and then determining the design. No mention is made of collaborative problem solving or design.
General Comment: don't understand JUST THE PARETHESIS AND E.G. IN GREEN. Performance Expectation "b": revise wording to - conduct an energy audit of a school by using utility data to determine facility performance, evaluating how the facility is currently used and operated, assessing problems not anticipated when the building and its systems were designed and/or constructed, and identifying opportunities for occupant behavior changes, building operationsl changes and facility changes to improve facility performance/efficiency and lower operating costs. Performance Expectation "d": Important that such a matrix take into account as wide a view as possible, from social/cultural factors to codes/standards. Performance Expectation "f": I would include a qualitative investigation as well, that includes end user assessment (which can be both quantitative and qualitative). Performance Expectation "h": Daylight harvesting or thermostats would be a better example of this. Performance Expectation "i": Make it clear that this includes both comparing to data from other related problems (before solution is implemented) as well as data gathered after the solution has been implemented to verify the computer simulation. Performance Expectation "j": Not sure that these are good examples of emergent properties; seem more like unanticipated consequences. Performance Expectation "k": Use BOTH quantitative and qualitative evidence. The stories/anecdotes gathered from end users can be very effective at helping to communicate the results of the quatitative analysis. Asking Questions and Defining Problems: Define what you mean by "successful results or solutions" and "acceptable solutions". Planning and Carrying Out Investigations: This is the engineering section, so I would say "design problem". Also you need to define somewhere what is a "safe and ethical manner", or refer to other documents/standards that define this. Constructing Explanations and Designing Solutions: case studies, scientific/engineering literature, etc. Defining and Delimiting and Engineering Problem 1st bullet point: Affordability - first cost, payback, return on investment. Defining and Delimiting and Engineering Problem 2nd bullet point: refinement of existing technologies, policy/regulation changes (new and modification to existing) and behavioral changes. Engineers don't approach these problems in a vacuum. Developing Possible Solutions 1st bullet point: design cycle can involve refining and existing technological process. It can also refer to both process and the technology itself. And make sure the entire cycle is included (evaluation post use or post occupancy; which is then fed back into design). Developing Possible Solutions 4th bullet point: major item is testing a single design solution under different simulated real world conditions; one of the computers biggest advantages in engineering – make sure you include this here. This is different than testing different solutions per se. Developing Possible Solutions 7th bullet point: includes development, production, transport, use, maintenance, upgrading/renovating, disposing/recycling/re-purposing. Developing Possible Solutions 8th bullet point: Make sure emergent properties is clearly defined somewhere and differentiated from unintended consequences. Elsewhere I have seen what seem to be unintended consequences used as examples of emergent properties. While emergent properties are most likely unanticipated, they are still properties of the system being analyzed. Optimizing the Design Solution 3rd bullet point: Real world field investigations to feed back into existing and future designs. Cause and Effect2nd bullet point: empirical evidence coupled with statistical analysis. Cause and Effect 3rd

bullet point: Typically what is done in larger, complex systems is to do everything possible to control all of the variables you are not interested in focusing on and increase your sample size. Systems and System Models 1st bullet point: and internal and external interactions. Structure and Function 1st bullet point: and the way they interact with their contextual surroundings.

Life Science

April 2013 Draft

HS-LS4 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can:

HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

January 28, 2012 Draft

HS.LS-NSE Natural Selection and Evolution

Students demonstrate understanding of natural selection and how genetic information provides evidence to support explanations of biological evolution by:

a. Using models of natural selection *to explain the contribution of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the selection of those organisms that are better able to survive and reproduce in the environment.*

b. Engaging in evidence-based argument *to explain the process of natural selection leading to adaptions resulting in populations dominated by organisms that are anatomically, behaviorally, and physiologically able to survive and/or reproduce in a specific environment.*

c. Analyzing and interpreting data *and testing the claim that organisms with an advantageous heritable trait, tend to increase in numbers in future generations; while organisms that lack an advantageous heritable trait, tend to decrease in numbers in future generations.*

d. Obtaining and communicating *information describing how changes in environmental conditions can affect the distribution of traits in a population and cause increases in the numbers of some species, the emergence of new species, and the extinction of other species.*

e. Using evidence *obtained from new technologies such as similarity in DNA sequence along with anatomical and embryological comparison to support multiple lines of descent in evolution.*

Kansas Influence:

Instead of just understanding the steps of evolution and explaining ancestry, the standards are now about applying them to the natural world and the influences they have.

Kansas Comments:

HS.LS-NSE Natural Selection and Evolution

Too simplistic.

Specific references to commonly used mathematical and technological practices are missing. These practices also reiterate the importance of understanding basic concepts of DNA replication and protein synthesis.and to get this, students need and understanding of DNA structure, protein synthesis etc. as genetics provides the most convincing evidence for E by NS. Also, these do not address newer research into the role of HOX genes and switch genes that are providing the key to macro changes in species (limb development etc) related to speciation. I would also change DNA to “biological molecules” in e since comparisons of proteins and the genetic code also support the idea.

Expectation c should specifically include Hardy-Weinberg as a mathematical model; expectation e should include amino acid sequence
This standard provides the best perceived connection between practices and performance expectations. However, the practice box extends well beyond what might be inferred from the performance expectations. An explanation/justification for why specific practices are connected to particular performance standards would help teachers understand what is expected for teaching and learning.
The language of the Engineering practices seems to be beyond what is needed at the high school level. The performance expectations are written at a manageable level, but the modeling and analysis that the blue box seems to be suggesting would be appropriate for a University sophomore or junior level genetics course.
Evolution needs to be understood as a lens to look at the natural world and understand the relationships observed. It is a powerful frame that is useful in understanding how science thinking and process occurs. I would like to seem more application to process in the standard.
Disciplinary Core Ideas: Need to make multi-level selection theory more of a component of the core ideas.
May 2012
"b) not sure how evidence will be used to support the process...
c) analyze and interpret to explain is an awkward phrase that sort of reminds one of a cookie cutter lab--this is the answer that you need to get, now jump through these hoops to ""discover"" the answers yourself (see suggestion for improving in other comment box)
d) would say ""have affected"" rather than ""can affect""""
"a) if it's use rather than create models (which makes sense here), it would be good for teachers to give examples of what is meant
b) this would be enhanced if it invoked imagination--using evidence to support predictions of what would be expected to happen to a (mythical?) species in a carefully defined environment; this changes it from applying knowledge to a known situation (less motivating and potentially more likel to provoke an emotional response) to a more creative realm (more motivating for students and a safer emotional place)
c)would like this more to be about analyzing data to determine what the advantageous trait was--with students supporting their claim using evidence; in general, for successful implementation, whenever we say ""analyze and interpret data, we're going to have to provide sample data sets (or facilitate a process for finding them) or many teachers won't know where to start.
e) is there tons of new technology information about anatomical structures? not amino acids? would still like a stronger emphasis on molecular evidence in this area.

Disciplinary Core Idea: LS2.D: Social Interactions and Group Behavior • More emphasis needs to be placed on this as part of multi-level selection theory or group selection theory. There is no mention of either terminology relative to evolutionary theory or natural selection. Nor any discussion of multi-level selection theory relative to gene focused or individual focused selection, and the historical arguments between these various evolutionary camps. "
Sept. 2012
"Natural selection and evolution (common ancestry) are separate concepts: common ancestry is inferred from many sources of evidence (see HS.LS-NSE-e), and natural selection is ONE mechanism affecting the outcome of common ancestry. As in the MS standards, natural selection and adaptation are closely related. In short, not all natural selection results in evolution, and not

all evolution results from natural selection. Natural selection is one of many mechanisms affecting evolution (common ancestry), but none of the additional ones are included in any of these statements. There is nothing on neutral evolution (genetic drift), or speciation, much less endosymbiosis, horizontal gene transfer, epigenetics – or even cladistics, which is the normal way that classification is performed these days. Combining "Natural Selection and Adaptation" (a middle school standard) makes a lot of sense, because natural selection is all about adaptation. Maybe call this Evolution through Natural Selection?
HS.NSE.d could be strengthened by incorporating mathematical modeling to communicate information describing how changes in environmental conditions affect the disctribution of traits in a population causing: 1) increases in population of some species, 2) the emergence over time of new species, and 3) the extinction of other species.
no place to evaluate HS.NSE.e.--this PE would definitely be strengthened with a clarification statement and/or assessment boundary to establish more clarity about the scope of these experiments"

April 2013

HS-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. [Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]

HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

January 28, 2012 Draft

HS.LS-SFIP Structure, Function, and Information Processing

Students demonstrate understanding of how structures in organisms enable life functions and interactions with the environment and other organisms by:

a. Obtaining and communicating information *explaining how systems of specialized cells help organisms perform the essential functions of life.*

b. Communicating information *about how DNA's sequence determines the structure and function of protein. [Assessment Boundary: Limited to conceptual understanding of how the sequence of nitrogen bases in DNA determine the amino acid sequence and the structure and function of the protein it codes for, not the actual protein structure.]*

c. Developing and using models *to explain the hierarchical organization of multiple interacting systems working together to provide specific functions within multicellular organisms. [Assessment Boundary: The focus is on the basic functions of life at several levels of organization: cell, tissue, organ, system, and organism.]*

d. Using modeling to explain the function *of positive and negative feedback mechanisms in maintaining homeostasis that is essential for living organisms. [Assessment Boundary: The focus is on conceptual models explaining examples of both types of feedback systems.]*

e. Using information from new technologies *to investigate the structure and function of the brain. [Assessment Boundary: Limited to analysis of visual perception, auditory perception, interpretation of perceptual information, guidance of motor movement, and decision-making using technologies such as MRI's and CAT scans.]*

f. Gathering and communicating information *to explain the structures that enable the integrated functioning of all parts of the brain for successful interpretation of inputs and*

generation of behaviors in response. [Assessment Boundary: Specific to how an organism's ability to sense and respond to its environment affects its chances of surviving and reproducing.] ***g. Analyzing and interpreting data*** *to identify patterns of behavior that motivate organisms to seek rewards, avoid punishments, develop fears, or form attachments to members of their own species and, in some cases, to individuals of other species.*

Kansas Influence:

The expectations are more consistent the standards go deeper in meaning and how allow for students to see how it affects the natural world.

Kansas Comments:

HS.LS-SFIP Structure, Function, and Information Processing

The core ideas emphasized by these two performance objectives, € and (f) ar only generally needed by graduates to enter work or college. They seem to emphasize detail of structure and function for the nervous system that is not found in coverage of other body systems. While a general knowledge and understanding are important, I think these PE's and accompanying CO's are too detailed.

The wording of performance expectation c and f does not communicate well. The level of detail in practices is not represented well in the performance expectations.

It would be nice if there was way to ask questions about brain functions. Conducting experiments in this section could be possible as well.

In the performance expectation (b) Re: DNA and protein structure. There doesn't seem to be much segue or transition from the protein structure prior to homeostasis, brain function, etc. It just doesn't seem like these expectations are cohesive as they are currently worded. I think by rephrasing the latter expectation statements, the classroom teacher could better make connections between item (b) and the rest of the expectations.

This is perhaps one of the most straight forward content areas. Information processing may be the most difficult concept for students to relate to organisms.

May 2012

Sept. 2012

"Topic title suggestion: H.S. H.S.I.P. (Structure, Function, and Information Processing) could be titled Structure, Function, and Integrated Systems. This shifts from rudimentary data information processing to integrating concepts to making relationships across multiple systems systems. Increase the infusion of biotechnology to faciliate understanding of the role of engineering design in explaining DNA, models of feedback mechanisms, and organismic behaviors. The biotechnology angle here would definitely be a way to incorporate more engineering into the Life Science area...Construct an explanation of how a given sequence of DNA would need to be changed to make the resulting protein meet specific criteria.

HS.SFIP.f -the questions don't establish the strength...""Ask questions that could be used to evaluate the strength....""

April 2013 Draft

HS-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

HS-LS3-2. Make and defend a claim based on evidance that inheriable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occuring during repliucation, and/or (3) mutations caused by environmental factors.
HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

January 28, 2012 Draft

HS.LS-IVT Inheritance and Variation of Traits

Students demonstrate understanding of how characteristics in one generation are related to previous generations and why individuals within the same species vary by:
a. Using models to develop *and explain that mitotic cell division results in daughter cells with identical genetic materials essential for growth and repair of multicellular organisms. [Assessment Boundary: The focus is on conceptual understanding of the process.]*
b. Constructing explanations *that cellular division and differentiation produce and maintain a complex organism composed of systems of tissues and organs that work together to meet the needs of the entire organism. [Assessment Boundary: The focus is on the concept that a single cell can give rise to complex, multi-cellular organisms consisting of many different cells with identical genetic material.]*
c. Constructing an explanation *of cell differentiation as a result of the activation or inactivation of specific genes due to genetic instructions as well as small differences in the immediate environment. [Assessment Boundary: Limited to the concept that a single cell develops into a variety of differentiated cells and thus a complex organism.]*
d. Communicating information *about the role of the structure of DNA and the mechanism of meiosis transmitting genetic information from parents to offspring. [Assessment Boundary: The focus is on conceptual understanding of the process; details of the individual steps of the process of meiosis are beyond the intent.]*
e. Gathering data and constructing explanations *for variation that results through sexual reproduction from: (1) genetic combinations in haploid sex cells, (2) errors occurring during replication, (3) crossover between homologous chromosomes during meiosis, and (4) environmental factors that may cause mutations, all, which, if viable, may be inherited. [Assessment Boundary: The focus is on conceptual understanding of the sources of genetic variation that are heritable.]*
f. Analyzing and interpreting data *using mathematical techniques to evaluate the cause of variation and distribution of expressed traits in a population due to genetic and environmental factors.*
g. Asking, obtaining, and communicating information *about the role of chromosomes, DNA, and genes in the inheritance of traits.*
Kansas Influence:

The standards are now able to prepare students for a college class and also allow students to sharpen their critical thinking skills by making them defend a claim with evidence they have discovered.

Kansas Comments:

HS.LS-IVT Inheritance and Variation of Traits

Leaving out details of the processes of mitosis and meiosis causes students to encounter these in college for the first time at a level far more complex.

In order to meet expectations e,f, and g, students would need to understand the steps of meiosis. At the very least, the details of mitosis should be included. #1 it provides a basis for understanding meiosis, #2 learning the process is a great exercise in thinking and logic. #3 Taught in reference to the cell cycle gives context to the ideas of how genetic variation arises.

Remove the assessment boundary in d.

The assignment of science and engineering practices to individual performance expectations seems arbitrary and requires explanation and justification. Also, the crosscutting concepts seem loosely linked to the performance expectations.

It would be nice if students planned and conducted an experiment (fast plants or fruit flies) to see transmission of traits.

I wonder about teaching Mendel and Punnett squares. It seems to lead to old central dogma (one gene, one protein thinking) and can mislead students as we move into genomics and more complex genetic understandings.

May 2012

"a) not sure what questions students would be asking in this context that would be meaningful

e) would like clarifying sttement or addition to assessment boundary on whether the intent is to include crossing over

g) mathematical probability, or just qualitative comparisons (more/less likely)?

"

Sept. 2012

"HS.IVT.a-Ask questions aimed at trying to determine...or...that will reveal critical information about...

HS.IVT.e-Construct an explanation and create a model"" about how a chromosome is changed during meiosis should begin the statement for HS.IVT.e. This strengthens the critical imperative to compare and contrast mitosis and meiosis from a illuminating genetic variability and natural selection. Once again leaving out the processes involved in passing genetic information reduces the concept to individual facts that do not make sense out of context.

HS.IVT.f-not sure what is meant by ""viable"" in #2--it gives the impression that inheritable genetic information is only affected by ""positive"" replication errors; if it means errors that don't prevent the cell from surviving, that is not clear with this wording; could be changed to (2) inaccuracies during replication that aren't severe enough to prevent the cell's survival"

April 2013 Draft

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

HS-LS2-1. Use mathematical and/or computation representations to support explanations for factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-3. Construct and revise an explanation based on evidence for the cycling matter and flow of energy in aerobic and anaerobic conditions

HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

January 28, 2012 Draft

HS.LS-IRE Interdependent Relationships in Ecosystems

Students demonstrate understanding of the importance of biodiversity in ecosystems, how organisms interact with their environment to obtain matter and energy, and the human impact on biodiversity by:

a. Evaluating data *on resource availability and environmental factors to support conclusions about the carrying capacity of ecosystems.*

b. Designing solutions *for creating or maintaining the sustainability of local ecosystems.*

c. Constructing models and representations *to communicate how complex sets of interactions in ecosystems maintain relatively stable numbers and types of organisms over long periods of time under stable conditions.*

d. Constructing arguments *from evidence about the effects of small to large biological or physical disturbances in ecosystems in terms of time needs to reestablish a stable system and the degree to which the new system approximates the original system.*

e. Using evidence to construct explanations *and design solutions for the impact of human activities on the environment and ways to sustain biodiversity and maintain the planet's natural capital.*

f. Obtaining and evaluating *primary scientific literature demonstrating ways group behavior has evolved to increase the chances of survival for individuals and their genetic relatives.*

Kansas Influence:

The standards allow for students to connect the mathematical and engineering relationships better and the standards are more specific as to how to do this. It also forces students to design their own experiments which are flowed through all of the science standards.

Kansas Comments:

HS.LS-IRE Interdependent Relationships in Ecosystems

Many of the statements read more like the social science of environmental studies rather than the science of ecology. I do not disagree with the statements or the understandings, it is just that they need to be more grounded in science principles.

I believe it is a mistake to put all emphasis on human impact on ecosystems. Students are much more interested in (and you get more buy in if you start with) how organisms affect each other: invasive species, mutualism & other symbiotic relationships, coevolution etc. are missing here.

This standard seems better than others at connecting science and engineering practices with the performance expectations, but teachers would benefit from an explanation and justification for why particular practices are appropriate for particular performance expectations and not others.

I think there is a disconnect between the Performance Standards that focus on physical characterization of ecosystems, while the Core Ideas deal with extinction to a great extent. I'm not sure teachers can get from these Performance Standards to the Core Ideas. Language. Re: Disciplinary Core LS4.D Biodiversity and Humans. Bullet 2….probably someone's pride and joy, BUT the use of the phrase "is a critical factor in reducing the planet's natural capital" sounds like someone is trying to impress us with erudity. Same term is found in Performance Expectation (e). I understand that it is technically a more inclusive phrase than "permanently reduces Earth's natural resources", but fewer people will struggle with the simpler phrasing. There should be no need to define extinction in the third bullet, ie. "as many species or population….". Leave that phrase out of this extremely long and clumsy sentence to simplify it for the reader. Also, bullet 4 in this same section is a fragment.

LS2.D: Social Interactions and Group Behavior: Do NOT ignore selection at the level of the group; providing explanary power only from the individual and genetic levels ignores a multi-level selection theory within evolution.

May 2012

"b) love this PE! would like it ""promoted to ""a"" though we know that the order is not supposed to indicate priority, this PE could be the context for all the rest

d) clarifications statement--could needs to be should/shouldn't for assessment boundary

e) awk...not sure what the explanations are here...would drop this part

f) concern about ""Argue from evidence"" becoming ""debate"" "

"a) ""could?"" either it should , or it shouldn't for assessment purposes

would like b) and e) to be connected--the design solutions should be taking into account how humans impact the env

This is a more general comment about writing the standards, but especially with new verbs, we will have to provide examples of data sets and what is meant by models, etc. I (this is Matt specific) would actually prefer that these examples aren't specifically ""in"" the standards, but they need to be linked and they need to be there when the standards are released.

what is the difference between ""construct arguments form evidence (d) and Argue from evidence (f)? this will either need to be carefully clarified or unify the language

g) practice here is potentially a bit difficult to accomplish in some settings"

Sept. 2012

"LS2A - Disciplinary Core Ideas should specifically include the role of of symbiosis in maintaining or altering relationships in ecosystems.

HS.IRE.b-Using the phrase ""Design solutions"" makes this PE seem engineering-ish, but the rest of the PE doesn't continue to support this. Either revise so that ""Design solutions is more sciencey, or ramp up the engineering to be something like...Evaluate proposals for technological

solutions that will maintain or increase biodiversity of a given ecosystem based on the criteria of cost, total footprint of development and use, and potential overall effectiveness."" HS.IRE.d--In general, the phrase ""Engage in arguments from evidence..."" is problematic in that it invokes arguing. It should be either ""Engage in Argumentation"" or engage WITH arguments or Evaluate arguments—“arguments” are things in this discussion, not processes. Actually, Engage in argument isn't quite right either...Develop (or evaluate competing) an argument HS.IRE.g-forced NOS-The mathematical comparisons aren't describing the tentative nature of science, rather the uncertainties in the models represent the attempt to quantify how tentative the proposed answer is. The clarification statement is a better PE."

Physical Science Standards
April 2013 Draft

HS-PS3 Energy

HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flow in and out of the system are known.
HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields.
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy
S-PS3-4. Plan and conduct an investigation to provide evidence that the transfer to thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
S-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

January 28, 2012 Draft

HS.PS-ECT Energy Conservation and Transfer

Students demonstrate understanding of the conservation of energy and energy transfer by:
a. Constructing and defending models and representations *(e.g. visual or computational) that show that over time the total energy within an isolated system is constant, including accounting for transformations within the system. [Assessment Boundary: Computational accounting for energy in a system limited to systems of three or fewer components.]*
b. Conducting investigations, *using mathematical techniques to track the total energy in a system and show that energy is neither created nor destroyed. [Assessment Boundary: Computational accounting for energy in a system limited to systems of three or fewer components.]*
c. Identifying problems *and suggesting design solutions to optimize the energy transfer into and out of a system (e.g., insulating a structure, microchip temperature control, cooking electronics, roller coaster design.) [Assessment Boundary: Limited to mechanical and thermal systems.]*
d. Analyzing data to support claims *that closed systems move toward more uniform energy distribution.*
e. Ask questions and define problems *related to a system's inclination to degrade (e.g. wearing down due to friction, increase in disorder, radioactive decay) in order to identify the flow of energy in the system or design a solution to minimize or slow the degradation.*
f. Ask questions and define problems *related to a situation where energy is the limiting factor in order to generate and evaluate design solutions to the defined problems.*
g. Obtaining and communicating information *about the economic, social and environmental costs and benefits of various energy sources (e.g., nuclear, hydroelectric, photovoltaic, coal).*
h. Constructing models *to show that energy is transformed and transferred within and between living organisms. [Assessment Boundary: Does not mean particular biological processes such as Krebs cycle.]*

HS.PS-E Energy

Students demonstrate understanding of what energy is by:
a. Using mathematical relationships and energy *as a quantitative property to analyze a system. [Assessment Boundary: The system should have of three or fewer quantitative components.]*
b. Constructing representations *that show that various forms of energy (e.g. thermal, electromagnetic, sound) are best understood at the molecular or atomic scale. [Assessment Boundary: Limited to conceptual understanding; quantitative representations are not required.]*
c. Designing, building, and evaluating devices *(e.g. roller coasters, Rube Goldberg devices, wind turbines, generators, light bulbs) that convert one form of energy to another form of energy.*
d. Planning and carrying out *investigations that relate changes in motion to changes in energy.*
e. Constructing arguments *to show that all forms of energy can be modeled as either the movement of particles or energy stored in fields. [Assessment Boundary: Arguments regarding field energies need not be mathematical.*
Kansas Influence:
The redundancy of the standards was cut out and they do a much better job connecting the standards to the middle school standards. The vocabulary in the sections was changed to allow for a more universal understanding for all teachers.
Kansas Comments:

HS.PS-ECT Energy Conservation and Transfer

This should be tied a bit closer with the force standards due to the relation to work-energy theory. The other Concern is the large “jump” from MS to here. The lack of mathematical application and depth at the MS will make this a difficult standard to achieve.
Need assessment boundaries.
May 2012

HS.PS-E Energy

The concept of work should be brought out in these standards.
With regard to the performance expectaions, I had quite a few problems with (a). First, it isn’t clear what performance demonstrates that the student has “analyzed a system”. Second, I wonder if “energy as a quantitative property” is needed. Once the performance expectation starts with “mathematical relationships”, it would seem to be obvious that energy will need to be treated quantitatively. With regard to (b), it amight be helpful to specify whether “various” means “some” or “all”.
May 2012
"b) of a given system
c) to check for support for...
d)awkward wording!"
"e) redundant with ecosystems energy transfer; we don't need similar PEs in both places, but highlight the links...the one in this standard should focus on the idea that the ""energy"" in this standard connects with the ""energy talked about in bio--just redoing a similar PE doesn't do that lots of constructing models in this standard...it's not that it's necessarily a bad match in any PE, but would like a better spread of practices"
Sept. 2012
E.e could be clarified by adding the phrase "with its surroundings." To me, minimizing the flow in or out of the system would not affect the equilibrium within the system.

April 2013

Result 1: HS-PS4 Waves and Their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

HS-PS4-1. Use Mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.
HS.PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

HS.PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

HS.PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*

January 2012 Draft

Product 1: HS-W Waves

Students demonstrate understanding of waves and their use in information technologies by:
a. planning on carrying out investigations *to determine the mathematical relationships among wave speed, frequency, and wavelength and how these are affected by the medium through which the wave travels. (Assessment Boundary: Algebraic calculations wavelength and how these are affected by the medium through which the wave travels. (Assessment Boundary: Algebraic calculations only.)*
b. investigating how crossing the *boundary between two media affects the reflection, refraction, and transmission of waves (including mathematical relationships). (Assessment Boundary: Algebraic calculations only).*
c. Investigating the patterns *created when waves of different frequencies combine and explain how these patterns are used to encode and transmit information. (Assessment Boundary: Qualitative only.)*

d. Using models *and carrying out investigations to explain that resonance occurs when waves add up in phase in a structure and that all structures have a unique frequency at which resonance occurs. (Assessment Boundary: Qualitative only).*
e. Constructing explanations *to show how resonance is used in speech and in the design of musical instruments.*

Product 1: HS-PS-ER Electromagnetic Radiation

Students demonstrate understanding of how properties of electromagnetic waves determine their uses by:
a. constructing an argument *that electromagnetic radiation can be described using both a wave model and a particle model, and that for some situations one model provides a better explanation of phenomena than the other. (Assessment Boundary: limited to the understanding*

that the quantum theory relates the two models but do not need to know the specifics of the quantum theory.)
b. Obtaining, evaluating, and communicating *information to show that all electromagnetic radiation travels through a vacuum at the same speed, called the speed of light, and constructing explanations for why the wavelength of an electromagnetic wave determines its use for certain applications. (Assessment Boundary: Algebraic calculations only.)*
c. Obtaining, evaluating, and communicating *information about the effects different types of electromagnetic radiation have on matter when it is absorbed by the matter. (Assessment Boundary: Qualitative descriptions only.)*
d. Analyzing data *of both atomic emission and absorption spectra of different samples to make claims about the presence of certain elements in the sample.(Assessment Boundary: Students should understand the algebraic relationships in energy level diagrams.*
e. Construct an explanation *of how photovoltaic materials work using the particle model of light, and describing their application in everyday devices (e.g., solar cells, barcodes). (Assessment Boundary: Qualitative explanations only.)*
f. Obtaining, evaluating, and communicating *information about the differences and similarities between analog and digital representations of information to describe the relative advantages and disadvantages. (Assessment Boundary: Qualitative explanations only.)*
g. Obtaining, evaluating, and communicating *information about a current technology that is based on wave-matter interactions. (e.g. following the trail of an e-ray form capture to a person for interpretation to storage.) (Assessment Boundary: Qualitative explanations only.)*
Kansas Influence:

The standards allow for students to become more engaged in their learning versus just looking up facts.

Kansas Comments:

HS.PS-W Waves

No Comments

HS.PS.-ER Electromagnetic Radiation

Performance Expectations:

This standard is a stand-alone at this moment and is not integrated with the chemistry concepts where the practical application of these ideas would be useful.

Recommendations:

The problem here is that while it is good to bring in quantum in standard a, it has not been done with other standards in the physical sciences. This should take on a role across the board and not just here. While it is difficult, qm is here- and is showing up in macroscopic systems meaning this knowledge Is needed for the world of work. The other concern is the large "jump" from MS to here. The lack of mathematical application and depth at the MS will make this a difficult standard to achieve.

WERa: the clarification might include glass as a amedium in alignment with DCI PS4A.

WERb/WERc: There were no CC's Linked to the PE.

Observations:

One item to consider is the balance between looking up information vs. engaging the students in investigations. The impression for this standard was that it may lean too heavily on the former. This was also a concern with other standards in the Physical Science Section. During the next revision a close look at the balance between finding information and producing information that the students are to interpret.

It was noted that there will need to be professional development for WER d and e. A few more explicit clarifications, without being overly prescriptive, would be useful.

April 2013 Draft

Result 2: HS.PS1 Matter and Its Interactions

Students who demonstrate understanding can:

HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-2. Conduct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-4. Develop a model io illustrate that the release of absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-5. Apply scientific principles and evidence to provide and explanation about the effects of changing the temperature of concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

January 2012 Draft

Product 2: HS.PS-CR Chemical Reactions

Students demonstrate understanding of the ways substances combine or change to make new substances by:
a. Analyzing and interpreting data *to support claims that energy of molecular collisions and the concentration of the reacting particles are related to the rate at which a reaction occurs. (Assessment Boundary: Limited to simple (zero or first order in each reactant) reactions, the exact relationship between rate and temperature is not required.)*

b. using models *(e.g., computer models, ball and stick models, drawings) to support claims and communicate that atoms (and therefore mass) are conserved during a chemical reaction. (Assessment Boundary: Stoichiometric calculations not required.)*

c. Analyzing and interpreting data *to make claims that reaction conditions (temperature, pressure, concentrations of all substances in a system) can be used to optimize the output of a chemical process. (Assessment Boundary: Limited to simple reactions.)*

d. constructing mathematical models *to explain how the energy changes that accompany chemical reactions are caused by changes in binding energy as the reactants form products. These changes are matched by changes in the kinetic energy of the system, which can be detected as a change in temperature. (Assessment Boundary: Limited to calculating the change in binding energy and resulting change in thermal energy for simple chemical reactions, (i.e., reactions of simple hydrocarbons with oxygen.)*

e. Constructing and communicating an explanation *using atomic molecular theory and knowledge of the patterns of chemical properties to predict the outcome of simple chemical reactions. (Assessment Boundary: Those readily predictable from the element's position on the periodic table and combustion reactions.)*

f. constructing and communicating explanations *that show how chemical processes (e.g., oxidation of hydrocarbons, reactions of CO2 and H2O to give hydrocarbons) and/or properties of materials (e.g., water expanding when freezing) are central to biological and geophysical systems. (Assessment Boundary: Restricted to overall chemical processes (e.g., oxidation of carbon compounds), or construction of carbon compounds (photosynthesis); details of biochemical pathways are not required (e.g., Krebs Cycle)).*

g. Using system models *(computer or drawings) to construct molecular-level explanations to predict the behavior of systems where a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (Assessment Boundary: Limited to simple reactions, adding or removing one reactant or product at a time.)*

h. Constructing explanations *using data from system models or simulations that systems with many molecules have predictable behavior of individual molecules is unpredictable.*

Product 2: HS.PS-NP Nuclear Processes

Students demonstrate understanding of nuclear processes by:
a. constructing models and explanations *to examine the process of fission, fusion, and radioactive decay and the factors that determine nuclear stability. (Assessment Boundary: Alpha, beta, gamma decay only.)*

b. analyzing and interpreting data *to determine the age of samples (rocks, organic material) using the mathematical model of radioactive decay. (Assessment Boundary: Graphical interpretation only.)*

c. Constructing an argument to support claims *about how the Sun and other stars produce light, and how this process and the explosion of supernovae leads to the formation and abundance of elements in the universe. (Assessment Boundary: Qualitative only.)*

d. evaluating and explaining *the potential design solutions of nuclear technology (e.g., smoke detectors, nuclear medicine) to increase benefits and decrease costs and risks to environmental safety and health factors.*

e. Asking questions and constructing arguments *about the relative merits of nuclear processes compared to other means of energy production. (Assessment Boundary: Merits to include economic, safety, and environmental.)*

Product 2: HS.PS-SPM Structure and Properties of Matter

Students demonstrate understanding of the way particles combine to form substances by:
a. Constructing explanations *that stable forms of matter (e.g., noble gas atoms, simple molecules, simple ionic substances) are those in which the electrical field energy within and between atoms is minimized and that energy must provide to take the molecule apart. (Assessment Boundary: Only for common substances (e.g., water, carbon dioxide, common hydrocarbons, sodium chloride)*

b. using evidence from the arrangement *of the periodic table to make predictions about the patterns of electrons in the outer level of atoms, and providing explanations for why those patterns affect properties of elements. (Assessment Boundary: Only for main group elements (not transition metals or elements beyond the third row).)*

c. Constructing arguments *for which type of atomic and molecular model (e.g., computer based, simulations, physical, ball and stick, symbolic) best explains a given property of matter (e.g., reactivity, identity from the number of protons). (Assessment Boundary: Not theoretical models)*

d. analyzing and interpreting *bulk properties (e.g., melting point, boiling point) to explain the relative strength of the interactions among particles (i.e., atoms, ions, molecules). (Assessment Boundary: Comparisons between ionic and molecular species or network and molecular species, but not those that require understanding of different intermolecular forces.)*

Kansas Influence:

The performance expectations are less abstract and more defined with the normal changes in vocabulary.

Kansas Comments:

HS.PS-CR Chemical Reactions

Performance Expectations:

These performance expectations do not prepare a HS student to work as a chemist, but they may be ready to study chemistry in college.

Recommendations:

PS2.c Not sure what that is all about. PS3.a Using “generally” or “may mean” implies you are fudging or not sure of the meaning. Why not just use “energy is…”? Why is the last statement about “Historically…” relevant? All that does is add to overall confusion. a. What is meant by the energy of a molecular collision? At a given temperature, all molecules have the same kinetic energy? c. What is optimization of a reaction? f. Too many concepts in this performance expectation. h. Not sure how useful this is (mile wide, inch deep).

In general, the performance expectations are pretty abstract. I realize that the teachers pick the context through which to help students be able to meet the performance expectations, but I wonder at how easily teachers can match context to the performance expectations. I had other problems with some of the wording. Within the performance expectations: (a) what does 'reacting particles' refer to? Are particles the same as molecules? (c) what does 'substances' refer to? What does 'output of a chemical process refer to? (d) Not sure I would use "are caused by" – better to say something like "can by explained by." (g) Not sure I understand what this refers to. With regard to Science and Engineering Practices, I'm not sure (d) links to 'Constructing Explanations and Designing Solutions.'(d) does ask for an explanation, but how is that different from 'developing and using models' to explain and predict? Under Disciplinary Core Ideas, FS2.C refers to "trajectories." I'm not sure teachers will understand what that means. PS3.A refers to (d), but that didn't seem clear. (d) seems pretty restricted to chemical energy. With regard to "Crosscutting Concepts," need to replace "its" with "their."
Add a performance expectation dealing with solutions, acids and bases.
While I did not put in a "no" I am concerned with the lack of engineering aspects of this standard. It is a weakness. The other concern is the large "jump" from MS to here. The lack of mathematical application and depth at the MS will make this a difficult standard to achieve.

HS.PS-NP Nuclear Processes

Performance Expectations:

It's difficult to consider a student educated in nuclear processes when no mention is made of ionizing radiation and its effects, or how radiation damages living cells or construction materials.

Recommendations :

Add effects of the different types of radiation on living and nonliving materials.
Just a few editorial comments: In the performance expectations, (b), it seemed unnecessarily vague to substitute "mathematical model" for "exponential decay law." I realize why it was done, but certainly makes the performance expectation unnecessarily vague. I suppose a student might invent a different "mathematical model," but will teachers tolerate that? Under "Science and Engineering Practices I continue to find it difficult to resolve the difference between "Developing and Using Models" and "Constructing Explanations and Designing Solutions." Seems like these haven't been resolved enough. Under 'Disciplinary Core Ideas," the box referred to performance expectation (f), which no longer exists. I also wondered whether another point needed to be made. The first bulleted point talks about the three nuclear decay processes, but it wasn't all that clear how that tied to (d). It seemed that something related to the curve of average binding energy per nucleon as a function of number of nucleons would be helpful, would have been helpful to include.

HS.PS-SPM Structure and Properties of Matter

Performance Expectations:

a. The reference to stability and energy is vague. Not all compounds are molecular. Ionic solids are not molecules, and it doesn't take much energy to separate the ions. D. Properties need to be understood at the macro level and the nano level for students to be ready for college. i.e. stress, strain, fracture, bulk modulus, nano surface properties.
There is a lack of discussion on bond types, which is part of the common language in this field. This seems to be a major weakness. Also, as a general observation, there is no engineering application.

Recommendations:
Microscale properties are not enough for engineering design. Extend behavior and properties to the nano and macro level.
The other concern is the large "jump" from MS to here. The lack of mathematical application and depth at the MS will make this a difficult standard to achieve.
General:
HS.SPM Structure and Properties of Matter – Suggest possible changes for those performance expectations that need additional work:
SPMa seems to match the DCI about structure and interactions of matter better than the atomic structure statement in PS1.a. A suggestion for the PE is to evaluate various representations of single and multiple atom systems in terms of the representation's strength in the explanation of a given property of matter and the limitations of that specific representation of matter.
SPM.a.-PE suggestion for change: Evaluate various representations of single and multiple atom systems in terms of the representation's strength in the explanation of a given property of matter and the limitations of that specific representation of matter.
SPMd is not listed in the crosscutting concept column. IT could fit into structure and function.
SPMh-The PE as written implies a bias toward the use of nuclear energy. This PE needs to be rewritten in a more neutral manner to assure that students examine the merit and drawbacks of all types of energy production.
DCI includes strong and weak interactions that are not explicitly included in the PE.s.
A great deal of professional development will be needed to construct or work through the data needed to teach g and h.

April 2013 Draft

Result 3: HS-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

HS-PS2-4. Use mathematical representation of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS2-5. Plan and conduct and investigation to provide evidence that an electric current can produce a magnetic field and that **a changing magnetic field can produce an electric current.**

HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

January 2012 Draft

Product 3: HS.PS-FM Forces and Motion

Students demonstrate understanding of the relationships between forces on an object, its momentum, and motion by:

a. planning and carrying out investigations *to show that the relationship between the total force on macroscopic objects and the resulting change in motion is accurately predicted by Newton's second law of motion. (Assessment Boundary: Restricted to one- and two-dimensional motion).*

b. using mathematical and computational thinking *to calculate the resulting acceleration of an object of a given mass when a net force is applied. (Assessment Boundary: Does not apply in the case of subatomic scales or for speeds close to the speed of light.)*

c. using data *to show that the total momentum of a system of objects before an interaction is the same as the total momentum of the system of objects before an interaction is the same as the total momentum of the system of objects after an interaction (conservation of momentum).*

d. using mathematical and computational thinking *to predict the velocities of objects after an interaction when the masses and velocities of objects before the interaction are known. (Assessment Boundary: Restricted to macroscopic interactions and only two objects moving in one or two dimensions.)*

e. Designing and evaluating devices *that minimize the force on a macroscopic object during a collision.*

f. constructing a scientific argument *supporting the claim that the predictability of changes within systems can be understood by defining the forces that exist both inside and outside the system and by considering the momentum changes both within the outside of the system. (Assessment Boundary: Restricted to macroscopic interactions.)*

g. Communicating effectively *arguments to support claims that Newton's laws of motion applies to macroscopic objects but not to objects at the subatomic scales or speeds close to the speed of light. (Assessment Boundary: Not details of quantum physics or relativity are included.)*

Product 3: HS.PS-IF Interactions of Forces

Students demonstrate understanding that forces are caused by variety of interactions by:
a. using mathematical and computational thinking *to determine the electrostatic and gravitational forces between objects (Assessment Boundary: Only situations with two objects.)*

b. using models to explain the relationship *between the variables in Newton's Law of Universal Gravitational and Coulomb's Law, showing how they describe and predict the effect of gravitational and electrostatics forces between distant objects.*

c. Using models to demonstrate *that electric forces at the atomic scale affect and determine the structure, properties (including contact forces), and transformations of matter. (Assessment Boundary: Only a qualitative understanding is expected.)*

d. planning and carrying out investigations *to test the claim that magnets, electric currents, or changing electric fields cause magnetic fields and electric charges or changing magnetic fields cause electric fields.*

e. obtaining, evaluating, and communicating information *to show that strong and weak nuclear interactions inside atomic nuclei determine which nuclear isotopes are stable, and that the pattern of decay of an unstable nucleus (e.g., by alpha or beta radiation) can often be predicted. (Assessment Boundary: Only a qualitative understanding of nuclear interactions is expected.)*

f. obtaining, evaluating, and communicating information *to show how scientists and engineers take advantage of the effects of electrical and magnetic forces in materials to design new devices (e.g., magnetic strips on credit cards, laser printers and photo copiers) through a process of research and development.*

Product 3: HS.PS-FE Forces and Energy

Students demonstrate understanding of the relationships among forces, fields, and energy by:
a. planning and carrying out investigations *in which a force field is mapped to provide evidence that forces act at a distance. (Assessment Boundary: Mapping only the direction of the force field.)*

b. Conducting investigations *to support the claim that when objects interact at a distance, the energy stored in the field changes (e.g., repelling magnets move apart and reduce the repelling force and the strength of the field between them.) (Assessment Boundary: Qualitative comparisons only).*

c. conducting investigations *to support the claim that energy can be transferred back and forth between the motion of objects and energy stored in fields. (Assessment Boundary: Qualitative descriptions only)*

d. evaluating natural and designed systems *where there is an exchange of energy between objects and fields (e.g., motors generators, speakers, microphones, aurorae) and explaining how they operate. (Assessment Boundary: Qualitative explanations only).*

Kansas Influence:

Consistency in language is better and the standards are more doable at the High School level. The jump from Middle to High School is better.

Kansas Comments:

HS.PS-FM Forces and Motion

Performance Expectations:

g. Not sure this is doable at HS level.

While the emphasis is on motion that is also a needed connection to energy on these two items. In part this is to distinguish elastic and inelastic collision which can be lost as a concept if not emphasized and will hinder career development. Also, there should probably be mention of impuse – a needed concept in the rocketry.

Recommendations:

We are side-stepping the quantum theory in most of the PS standards. Are we doing enough for our future physists?

The language here is not very consistent. With regard to the performance expectations, 'total' force is used in (a) and 'net force' is used in (b). In (c) I assume the performance expectation refers to a 'closed' system, but the word 'closed' is not included. In (f), there should probably be a descriptor that limits the 'changes' to those observable through examining forces and motion. In (g), 'applies' should be replaced by 'apply.' With regard to 'Scientific and Engineering Practices,' I don't think it is particularly realistic to include 'identify covariate and multivariate experimental procedures' as having been covered here. At the high school level, physics teachers control variables rather than examine covariate and multivariate procedures. With regard to 'Using Mathematics and Computational Thinking,' it wasn't clear what 'relationships students are expected to evaluate and revise. Under 'Disciplinary Core Ideas,' the wording on the second bulleted point suggests that 'depends on their mass and speed' refers to the particular system. I wondered whether the fourth bulleted point also encompassed performance expectation (f). Finally, with regard to 'Cross Cutting Concepts,' I found the first bulleted point under 'Cause and Effect' to be vague and, beyond that, wondered when physics teachers ever dealt with correlation in addition to causation.

There should be an inclusion of energy and impulse here, or at least a stronger connection made at this grade level. The other concern is the large "jump" from MS to here. The lack of mathematical application and depth at the MS will make this a difficult standard to achieve.