CONNECTICUT STATE DEPARTMENT OF EDUCATION

Office of Academics

SCIENCE STANDARDS

CONTENT CROSSWALK REPORT

A COMPARISON OF SCIENCE AND ENGINEERING CONCEPTS IN

NEXT GENERATION SCIENCE STANDARDS

AND

CONNECTICUT CORE SCIENCE CURRICULUM FRAMEWORK AND CURRICULUM STANDARDS

APRIL 25, 2013

DRAFT

CONNECTICUT STATE DEPARTMENT OF EDUCATION

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Commissioner of Education

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INTRODUCTION

This "Science Standards Content Crosswalk Report" presents the results of a comparison between Core Concepts in Next Generation Science Standards for K-12 (NGSS, 2013) and concepts in the Connecticut Core Science Curriculum Framework for K-10 and Curriculum Standards for Prekindergarten to Grade 8 Science (Connecticut State Department of Education, 2004; 2010).

A committee of 36 science educators worked under the direction of the Connecticut State Department of Education (CSDE) to review each NGSS subconcept (the bullets found in the NGSS Foundations Boxes) and determine whether there is a conceptual match for it in current Connecticut science standards. Matches were rated as either "strong" or "partial"; as well as "at the same grade" or "at a grade higher or lower". NGSS concepts not addressed in Connecticut's K-10 science standards were rated "No match." (See agenda in Appendix A.)

A strict interpretation approach was used when making decisions about matches between both sets of standards. Reviewers were trained to pay close attention to the specific subconcepts included in each content standard. The prevailing mindset was to find out what would be different if NGSS were adopted; not to stretch to match standards that were topically similar but conceptually different (see Appendix B).

The NGSS-Connecticut Standards Content Crosswalk Study was designed to answer the following questions:

1. What NGSS concepts are currently in CT standards at the same grade;
2. What NGSS concepts are currently in CT standards at an earlier grade; or at a later grade;
3. What NGSS concepts are not found in current CT standards and would be new for Connecticut's teachers and students; and
4. What Connecticut concepts are not found in the NGSS and might be abandoned if NGSS were adopted by Connecticut.

It is important to note the questions that the Content Crosswalk did not attempt to answer. The study was specifically focused only on science content standards because these were viewed to be most informative for district leaders concerned about potential changes to curriculum and instructional materials resulting from NGSS adoption. The Content Crosswalk did not address similarities and differences in the science inquiry practices or performance expectations defined in Connecticut standards and in NGSS. In addition, the Content Crosswalk did not include Connecticut's "Enrichment Standards" for Grades 11 and 12.

The NGSS state Leadership Team decided not to compare Performance Expectations in both sets of standards due to the innovative nature of the NGSS Performance Expectations. Their integration of three "dimensions" -- science Practices with Core Ideas and Crosscutting Concepts – is a groundbreaking way of thinking about learner outcomes that challenges current principles of assessment design. Therefore, there would be few, if any, CMT and CAPT Expected Performances in the Connecticut science standards that would be similar to those in NGSS. Because the Practices and their relationship to the Performance Expectations have such a prominent impact on the way in which science is taught and on what students would be expected to and be able to do, **these instructional implications of NGSS adoption are treated in a separate report to be published by CSDE**.

The results of the Content Crosswalk are somewhat skewed by the difference in grade spans addressed in the two sets of standards. The NGSS standards apply to Kindergarten through Grade 12, and the Connecticut science standards apply to Prekindergarten through Grade 10. Connecticut's "Enrichment Standards" for Grades 11-12 were not included in the comparison because these are not assessed on the Connecticut Academic Performance Test (CAPT) administered in March of Grade 10. Hence, the percentage of concepts that would be "new" for Connecticut is somewhat inflated because of the comparison between standards for two years of high school science versus standards for three years of high school science.

The findings of CSDE's Content Crosswalk are useful for identifying the effects of an NGSS adoption on the science curriculum currently taught in Connecticut schools. This knowledge can support projections of the needs for new instructional materials and for content-focused professional development.

ACKNOWLEDGEMENTS

The Connecticut State Department of Education (CSDE) wishes to acknowledge the generous and tireless efforts of the following Connecticut science education leaders who have contributed in several ways to a thoughtful and inclusive process for reinvigorating science education in Connecticut.

The following members of the state **NGSS Leadership Team** represent K-12 and informal science education as well as higher education teacher preparation programs. The Leadership Team works under the direction of CSDE Science Consultant Elizabeth Buttner. They have met regularly since 2012 to establish and carry out Connecticut's strategic plan for building awareness and capacity to implement the improvements to K-12 science teaching and learning envisioned in the *Framework for K-12 Science Education* (National Research Council, 2012):

Nick Balisciano – Connecticut Center for Advanced Technology (CCAT), Education Program Manager
Dr. Marsha Bednarski – Central Connecticut State University, Science Teacher Education
Jeff Greig – CSDE Bureau of Student Assessment
Hank Gruner – Connecticut Science Center, Vice President of Programs and Exhibits
Josiah Hills – CREC, Educational Technology Specialist
Dr. John Settlage – University of Connecticut, Science Teacher Education
Richard Therrien – New Haven Public Schools, K-12 Supervisor of Science

The state **NGSS Content Review Committee** is composed of educators who were selected through a rigorous application process in 2012. Selected for their perspectives on science teaching in Grades K-5, 6-8, or 9-12, they evaluated two NGSS drafts to generate Connecticut's feedback to Achieve prior to the final publication of the Next Generation Science Standards (NGSS) in April 2013. Additionally, in collaboration with the NGSS Leadership Team, these educators did the work of the NGSS-Connecticut Content Standards Crosswalk activity. Their collective expertise, insights and dedication to excellence in teaching are truly exemplary:

Lauren	Amaturo	CREC Magnet Schools
Peter	Bernson	Newtown Public Schools
Christine	Bouchard	Milford Public Schools
Terry	Contant	President, CT Science Teachers Association
Michael	Curry	Trumbull Public Schools
Jeanelle	Day	ECSU Science Education Faculty
Christian	Dockum	New Canaan Public Schools
Elaine	Dolnack	Suffield Public Schools
John	Duffy	Canton Public Schools
Art	Ellis	Windham Public Schools
Gail	Emilsson	New Haven Public Schools

Lori	Farkash	Wallingford Public Schools
Sarah	Faulkner	CREC Magnet Schools
Holly	Garavel	Newington Public Schools
Matthew	Griffiths	University of New Haven-Physics Dept.
Tyler	Hoxley	East Hartford Public
Kirsten	Kechejian	Bethel Public Schools
Kimberly	Kuta	Stepping Stones Museum
Rachael	Manzer	Hartford Public Schools
Barbara	Marroquin	CT Technical High cc
Louise	McMinn	Stamford Public Schools
Thomas	Menditto	CCSU Technology Education
Melinda	Meyer	President, CT Science Supervisors Association
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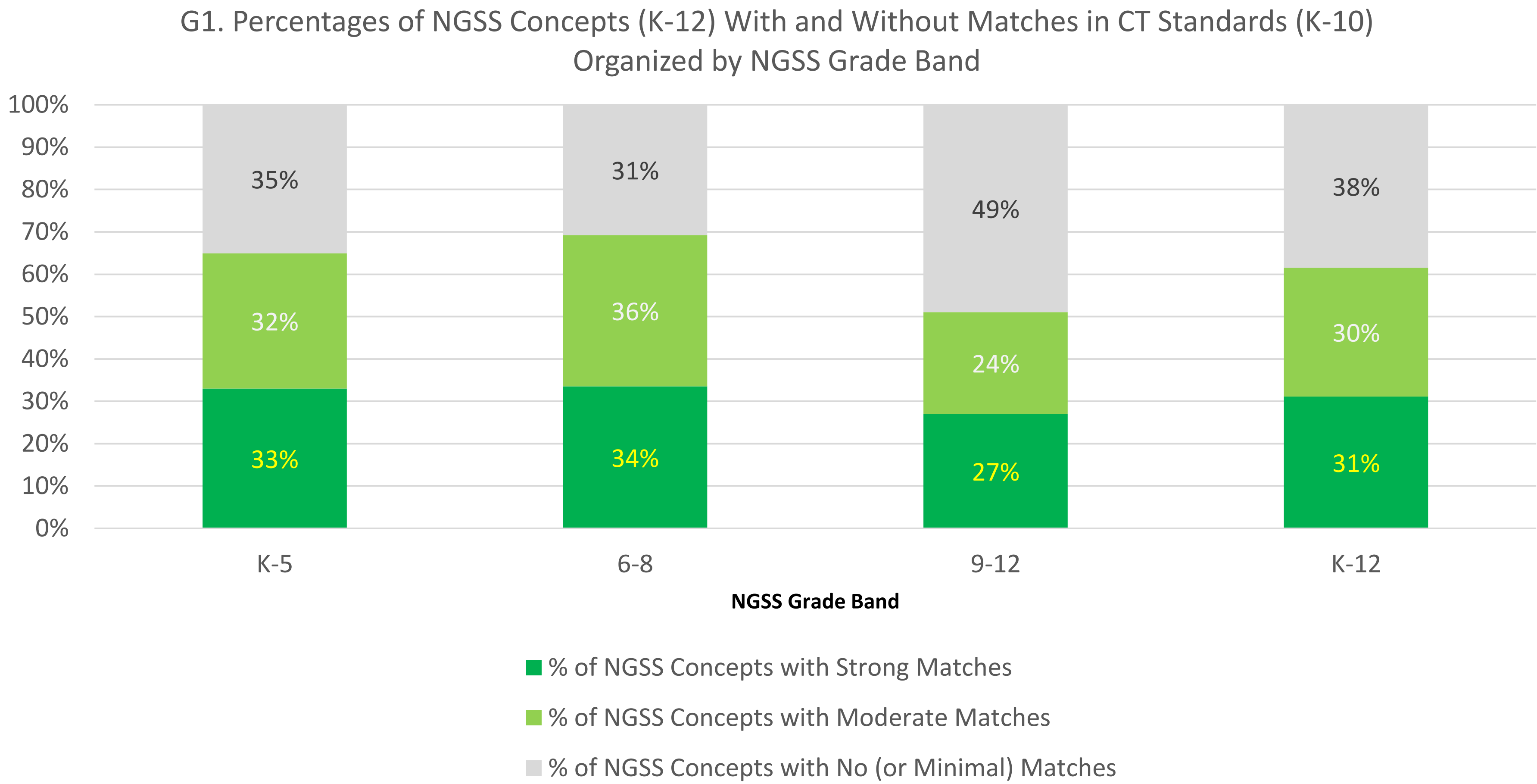
Diana	Payne	UCONN-CT Sea Grant
Richard	Pelczar	Middletown Public Schools
Theresa	Rangel	Danbury Public Schools
Kristen	Record	Stratford Public Schools
MaryLou	Smith	EASTCONN Science Ed Specialist
Henry	Speno	Cromwell Public Schools
Angel	Tangney	Meriden Public Schools
Richard	Therrien	New Haven Public Schools
Hank	Weiner	CT Technical High Schools
Terry	Wilson	CREC Magnet Schools
Kari	Yacawych	Region 15 Public Schools

CT-NGSS CONCEPT CROSSWALK RESULTS

SUMMARY OF GRAPHS AND TABLES

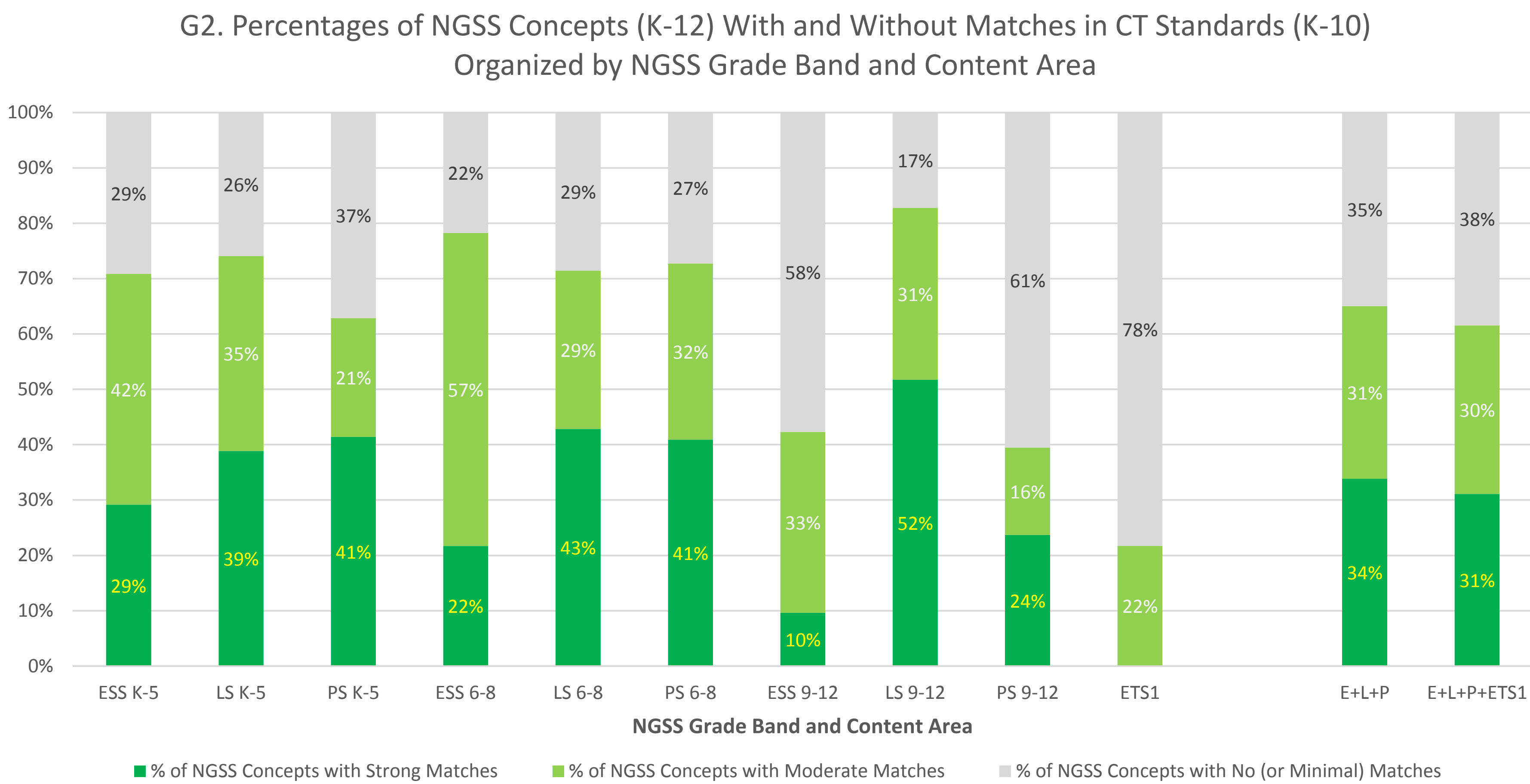
GRAPH/ TABLE	GRAPH/TABLE TITLE	HIGHLIGHTS	SEE ALSO
G01	Percentages of NGSS Concepts (K-12) With and Without Matches in CT Standards (K-10), Organized by NGSS Grade Band	Over 60% of NGSS concepts are addressed to some degree in current CT K-10 science standards. The 6-8 grade band has the greatest percentage of matched concepts. About half of the Grade 9-12 NGSS concepts are addressed in CT K-10 standards. This is to be expected since CT science standards define learning outcomes for 2 years of high school science, while NGSS defines learning outcomes for 3 years.	For a content area breakdown, see Graph G2. For detail about matched concepts, see Graphs G3-5. For detail about new concepts, see Graph G6.
G02	Percentages of NGSS Concepts (K-12) With and Without Matches in CT Standards (K-10), Organized by NGSS Grade Band and Content Area	Over half of the NGSS concepts in Gr. 9-12 Earth & Space Science and Gr. 9-12 Physical Science are not addressed in current CT K-10 science standards. This is to be expected since CT science standards define learning outcomes for 2 years of high school science, while NGSS defines learning outcomes for 3 years. Due to the NGSS commitment to integrating engineering design into the structure of science education, over three-fourths of the engineering design concepts (ETS1) are not addressed in current CT K-10 science standards.	For detail about matched concepts, see Graphs G3-5. For a list of new concepts, see Table C6.
G03	Where Matched NGSS Concepts (K-12) Were Found in CT K-10 Standards, Organized by NGSS Grade Band	About three-fourths of the matched NGSS concepts in Grades 6-12 were found within the same grade bands in CT standards. A majority of NGSS concepts found in K-5 CT science standards appear at earlier grades in NGSS than in the CT Framework.* Of the Gr. 9-12 NGSS concepts that appear in CT K-10 science standards, one-fourth of them would shift from CT middle grades to high school grades. Conversely, one-fifth of the 6-8 NGSS concepts that appear in CT K-10 science standards would shift from CT high school to middle grades.	For a content area breakdown, see Graph G4.
G04	Where Matched NGSS Concepts (K-12) Were Found in CT K-10 Standards, Organized by NGSS Grade Band and Content Are	Four-fifths of the matched NGSS K-5 Physical Science concepts would be taught at earlier grades if NGSS were adopted. Similarly, three-fifths of the matched NGSS K-5 Earth & Space Science concepts would be taught at earlier grades. Almost half of matched NGSS concepts for Grade 9-12 Earth & Space Science were found in CT's current standards for Gr. 6-8; these concepts would be taught at later grades if NGSS were adopted.	
G05	How Much Each CT K-10 Standard Was a Match for NGSS Concepts (K-12), Organized by CT Standard	This graph indicates that some CT standards, such as 4.2 and 10.5, would have relatively higher prominence in the curriculum if NGSS were adopted than other CT standards, such as 4.3 and 10.2. While both sets of standards include concepts related to Science, Technology, and Society (STS), CT's STS standards are content-specific, while the NGSS ETS2 concepts are content-neutral. Although no strong matches were found in the asterisked CT STS standards, they could remain in the curriculum as useful contexts for teaching NGSS ETS2 (Links among engineering, technology, science and society). (ETS2 was not a part of the crosswalk.)	
G06	NGSS Concepts that Would Be New for CT, Organized by NGSS Grade (K-5)/Grade Band (6-8, 9-12) then by Content Area	Some of the NGSS Disciplinary Core Ideas (DCIs) and Component Ideas listed may at first seem similar to general topics in current CT standards. However, it is important to look more closely at the specific concepts addressed in both sets of standards. The NGSS concepts listed here are not included in current state standards. Therefore, curriculum learning units would need to be redesigned to reflect the distinct conceptual emphases in NGSS. For example, the new concept associated with NGSS Grade 3 PS2.A "Forces and Motion" differs significantly from anything included in the current CT standard of the same name (CT 4.1).	To see new concepts sorted by Component Idea, see Table C6.
G07	CT Standards in which Alignments to NGSS Concept Matches were Found, Organized by NGSS Component Idea	NGSS concepts were found in a variety of CT standards across all grade levels.	

GRAPH/ TABLE	GRAPH/TABLE TITLE	HIGHLIGHTS	SEE ALSO
C01	Percentages of NGSS Concepts (K-12) With and Without Matches in CT Standards (K-10) Organized by NGSS Content Area	The content area with the highest percentage of NGSS concept matches to CT K-10 standards is Life Science, followed by Physical Science and Earth & Space Science. The area with the least percentage of matches is Engineering Design. This is not surprising due to the NGSS commitment to integrating engineering design into the structure of science education.	For a grade band breakdown, see Graph C2.
C02	New NGSS Earth & Space Science Concepts by Component Idea and Grade Band	There is wide variation in the number of new Earth & Space Science concepts in each Component Idea as well as in what grade or grade band the new concepts would be found if NGSS were adopted. For example, there would be several new concepts related to the Universe and Its Stars, most of them added in Gr. 9-12. By contrast, there would be no entirely new concepts related to Human Impacts on Earth Systems. Low numbers can mean that CT standards already address the concepts and/or that NGSS does not address the concepts at a given grade band.	For a list of the new concepts, see Table C6.
C03	New NGSS Life Science Concepts by Component Idea and Grade Band	There is wide variation in the number of new Life Science concepts in each Component Idea as well as in what grade or grade band the new concepts would be found if NGSS were adopted. For example, there are multiple new concepts in LS1.B and LS4.A; most of them would be added in Gr. 6-8, and none would be added in Gr. 9-12.	For a list of the new concepts, see Table C6.
C04	New NGSS Physical Science Concepts by Component Idea and Grade Band	There is wide variation in the number of new Physical Science concepts in each Component Idea as well as in what grade or grade band the new concepts would be found if NGSS were adopted. The "0" for PS2.C is due to the fact that this Component Idea was eliminated in the final NGSS publication in response to concerns about there being too much content in earlier drafts. Note that Wave Properties (PS4.A) and Electromagnetic Radiation (PS4.B) would be new, especially in Grades 9-12, if NGSS were adopted.	For a list of the new concepts, see Table C6.
C05	New NGSS Engineering Design Concepts by Component Idea and Grade Band	There is wide variation in the number of new Engineering Design (ETS1) concepts in each Component Idea as well as in what grade or grade band the new concepts would be found if NGSS were adopted. The "0" for ETS1.A Gr. 6-8 indicates that NGSS engineering concepts related to Defining and Delimiting an Engineering Problem were moderately matched in CT standard 8.4. Note, however, that a significant number of new concepts related to Developing Possible Solutions and Optimizing the Design Solution would appear in Gr. 6-8 if NGSS were adopted.	For a list of the new concepts, see Table C6.
C06	NGSS Concepts that Would Be New for CT Organized by Content Area then by Grade (K-5)/Grade Band (6-8, 9-12)	Some of the NGSS Disciplinary Core Ideas (DCIs) and Component Ideas listed may at first seem similar to general topics in current CT standards. However, it is important to look more closely at the specific concepts addressed in both sets of standards. The NGSS concepts listed here are not included in current state standards. Therefore, curriculum learning units would need to be redesigned to reflect the distinct conceptual emphases in NGSS. For example, the new concept associated with NGSS Grade 3 PS2.A "Forces and Motion" differs significantly from anything included in the current CT standard of the same name (CT 4.1).	To see new concepts sorted by grade/grade band, see Table G6.



Highlights: Over 60% of NGSS concepts are addressed to some degree in current CT K-10 science standards. The 6-8 grade band has the greatest percentage of matched concepts. About half of the Grade 9-12 NGSS concepts are addressed in CT K-10 standards. This is to be expected since CT science standards define learning outcomes for 2 years of high school science, while NGSS defines learning outcomes for 3 years.

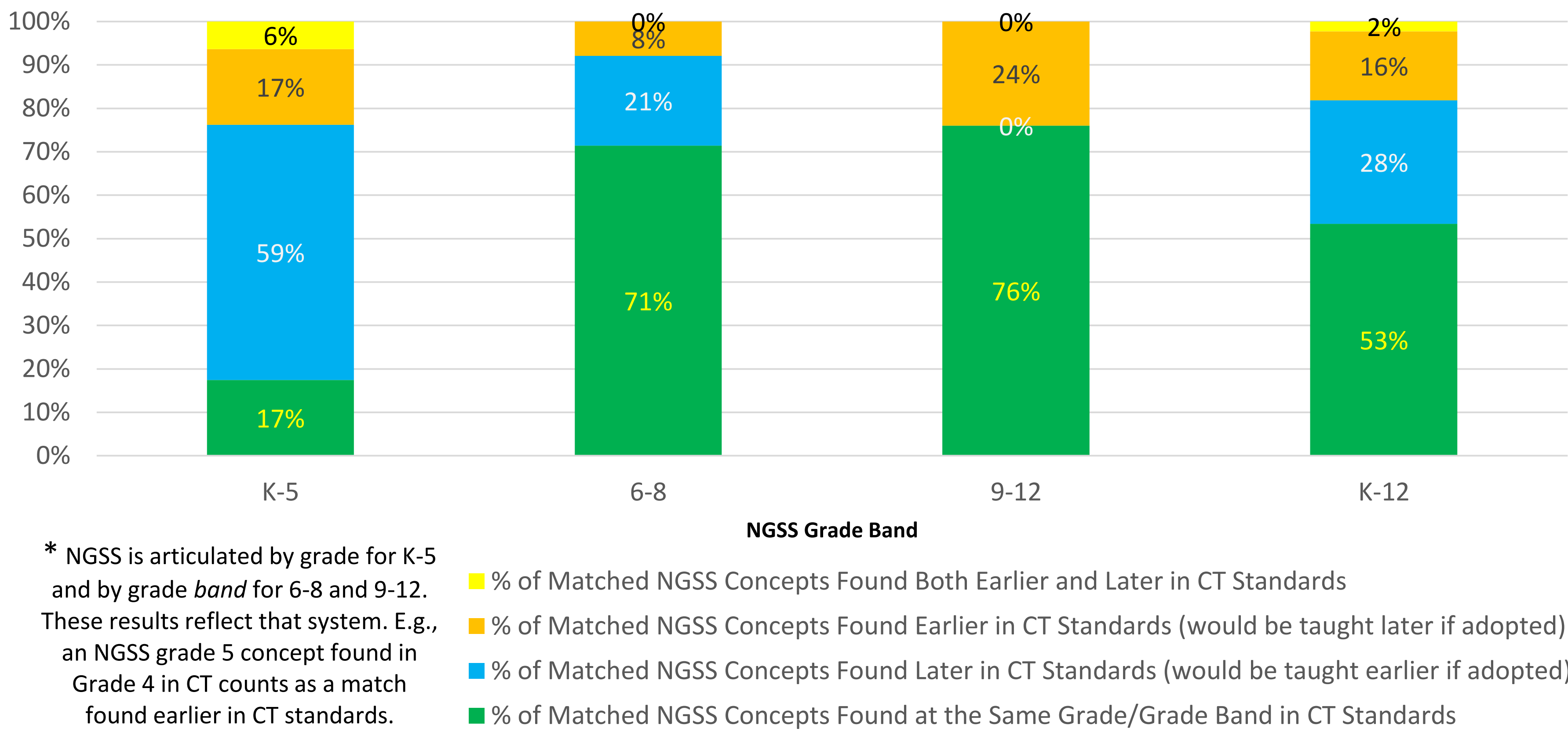
For a content area breakdown, see Graph G2. For detail about matched concepts, see Graphs G3-5. For a list of new concepts, see Table C6.



Highlights: Over half of the NGSS concepts in Gr. 9-12 Earth & Space Science and Gr. 9-12 Physical Science are not addressed in current CT K-10 science standards. This is to be expected since CT science standards define learning outcomes for 2 years of high school science, while NGSS defines learning outcomes for 3 years. Due to the NGSS commitment to integrating engineering design into the structure of science education, over three-fourths of the engineering design concepts (ETS1) are not addressed in current CT K-10 science standards.

For detail about matched concepts, see Graphs G3-5. For a list of new concepts, see Table C6.

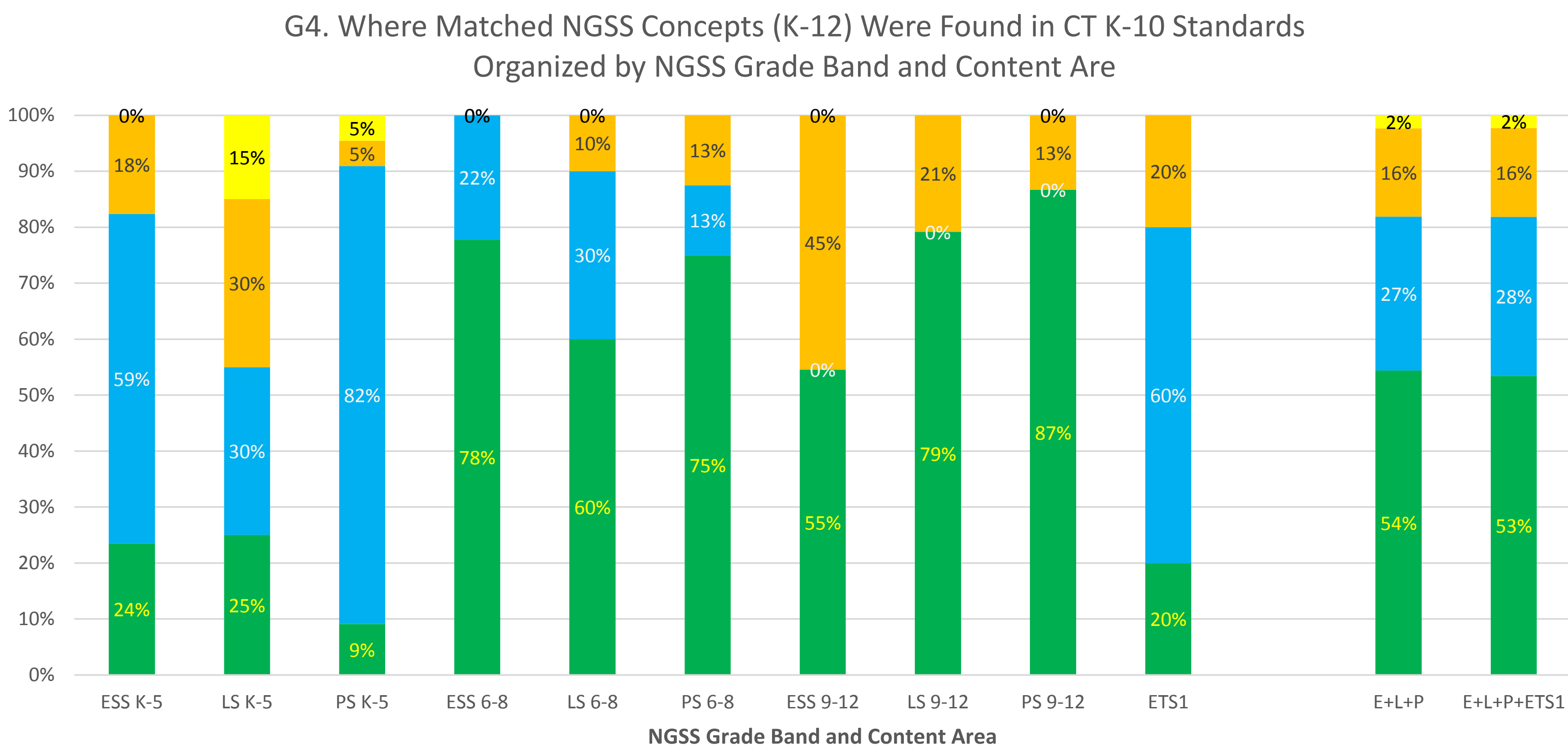
G3. Where Matched NGSS Concepts (K-12) Were Found in CT K-10 Standards Organized by NGSS Grade Band*



* NGSS is articulated by grade for K-5 and by grade *band* for 6-8 and 9-12. These results reflect that system. E.g., an NGSS grade 5 concept found in Grade 4 in CT counts as a match found earlier in CT standards.

<u>Highlights</u>: About three-fourths of the matched NGSS concepts in Grades 6-12 were found within the same grade bands in CT standards. A majority of NGSS concepts found in K-5 CT science standards appear at earlier grades in NGSS than in the CT Framework.* Of the Gr. 9-12 NGSS concepts that appear in CT K-10 science standards, one-fourth of them would shift from CT middle grades to high school grades. Conversely, one-fifth of the 6-8 NGSS concepts that appear in CT K-10 science standards would shift from CT high school to middle grades.

For a content area breakdown, see Graph G4.

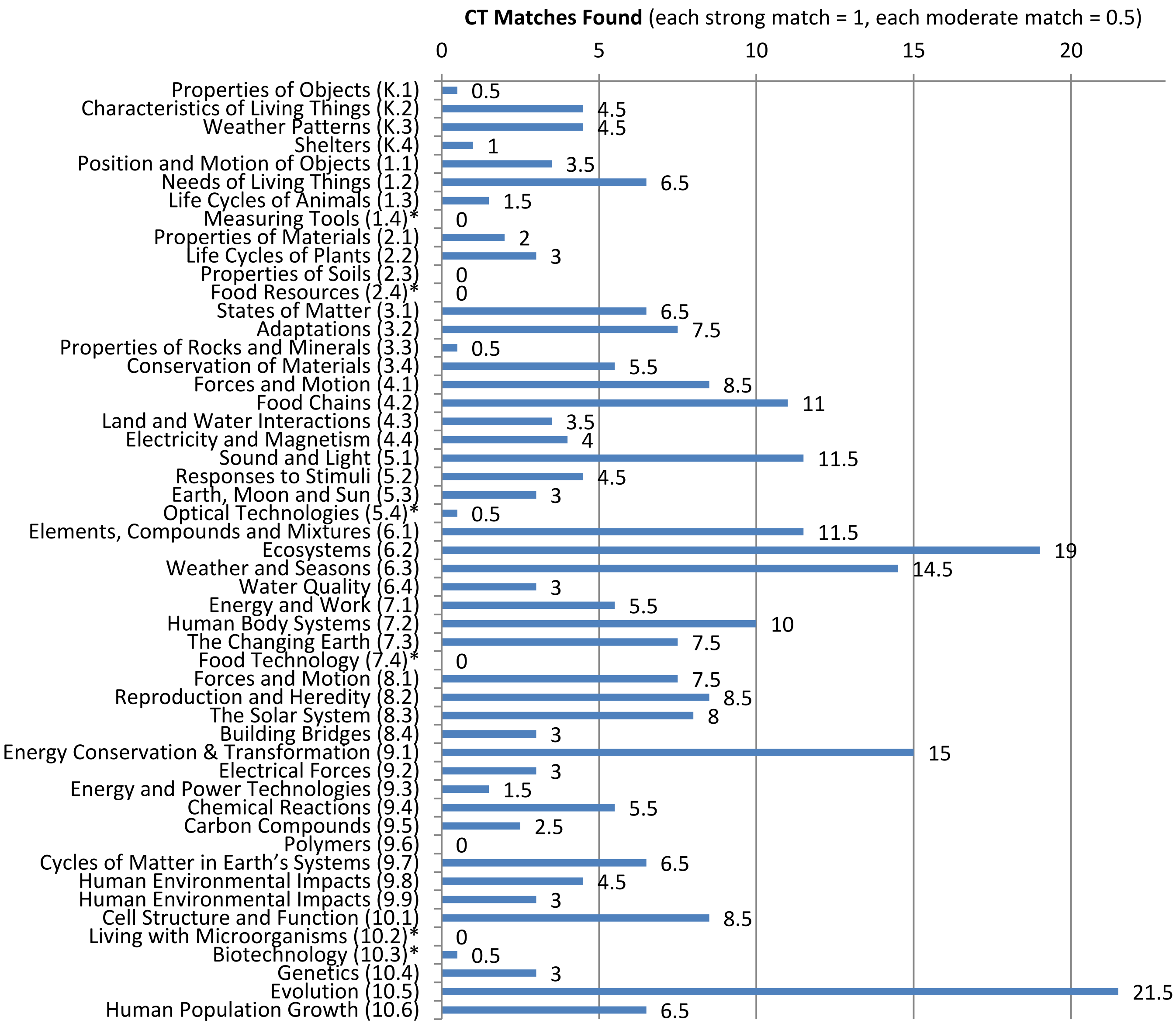


* NGSS is articulated by grade for K-5 and by grade *band* for 6-8 and 9-12. These results reflect that system. E.g., an NGSS grade 5 concept found in Grade 4 in CT counts as a match found earlier in CT standards.

- % of Matched NGSS Concepts Found Both Earlier and Later in CT Standards
- % of Matched NGSS Concepts Found Earlier in CT Standards (would be taught later if adopted)
- % of Matched NGSS Concepts Found Later in CT Standards (would be taught earlier if adopted)
- % of Matched NGSS Concepts Found at the Same Grade/Grade Band in CT Standards

Highlights: Four-fifths of the matched NGSS K-5 Physical Science concepts would be taught at earlier grades if NGSS were adopted. Similarly, three-fifths of the matched NGSS K-5 Earth & Space Science concepts would be taught at earlier grades. Almost half of matched NGSS concepts for Grade 9-12 Earth & Space Science were found in CT's current standards for Gr. 6-8; these concepts would be taught at later grades if NGSS were adopted.

G5. How Much Each CT K-10 Standard Was a Match for NGSS Concepts (K-12) Organized by CT Standard



<u>Highlights</u>: This graph indicates that some CT standards, such as 4.2 and 10.5, would have relatively higher prominence in the curriculum if NGSS were adopted than other CT standards, such as 4.3 and 10.2. While both sets of standards include concepts related to Science, Technology, and Society (STS), CT's STS standards are content-specific, while the NGSS ETS2 concepts are content-neutral. Although no strong matches were found in the asterisked CT STS standards, they could remain in the curriculum as useful contexts for teaching NGSS ETS2 (Links among engineering, technology, science and society). (ETS2 was not a part of the crosswalk.)

G6. NGSS Concepts that Would Be New for CT*
Organized by Grade (K-5)/Grade Band (6-8, 9-12) then by Content Area

* Note that the CT Content Crosswalk did not include CT enrichment standards, so these concepts are new versus the CT K-10 standards.
To see concepts sorted by Content Area then Grade Band, see Table C6.

Highlights: Some of the NGSS Disciplinary Core Ideas (DCIs) and Component Ideas listed may at first seem similar to general topics in current CT standards. However, it is important to look more closely at the specific concepts addressed in both sets of standards. The NGSS concepts listed here are not included in current state standards. Therefore, curriculum learning units would need to be redesigned to reflect the distinct conceptual emphases in NGSS. For example, the new concept associated with NGSS Grade 3 PS2.A "Forces and Motion" differs significantly from anything included in the current CT standard of the same name (CT 4.1).

NGSS DCI (Disciplinary Core Idea)	NGSS Component Idea	New NGSS Concepts for K-5, sorted by Grade then Content Area
ESS2: Earth’s systems	ESS2.E: Biogeology	K-ESS2.E-1: § Plants and animals can change their environment. (K-ESS2-2)
ESS3: Earth and human activity	ESS3.B: Natural Hazards	K-ESS3.B-1: § Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (K-ESS3-2)
ETS1: Engineering design	ETS1.A: Defining and Delimiting an Engineering Problem	K,2-ETS1.A-1: § A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (secondary to K-PS2-2) (K-2-ETS1-1)
ETS1: Engineering design	ETS1.A: Defining and Delimiting an Engineering Problem	K,2-ETS1.A-2: § Asking questions, making observations, and gathering information are helpful in thinking about problems. (secondary to K-ESS3-2) (K-2-ETS1-1)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	K,2-ETS1.B-1: § Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem’s solutions to other people. (secondary to 2-LS2-2) (secondary to K-ESS3-3) (K-2-ETS1-2)
LS1: From molecules to organisms: Structures and processes	LS1.B: Growth and Development of Organisms	1-LS1.B-1: § Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)
PS4: Waves and their applications in technologies for information transfer	PS4.C: Information Technologies and Instrumentation	1-PS4.C-1: § People also use a variety of devices to communicate (send and receive information) over long distances. (1-PS4-4)
ESS1: Earth’s place in the universe	ESS1.C: The History of Planet Earth	2-ESS1.C-1: § Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)
ESS2: Earth’s systems	ESS2.B: Plate Tectonics and Large-Scale System Interactions	2-ESS2.B-1: § Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2-2)
PS1: Matter and its interactions	PS1.A: Structure and Properties of Matter	2-PS1.A-1: § A great variety of objects can be built up from a small set of pieces. (2-PS1-3)
ETS1: Engineering design	ETS1.A: Defining and Delimiting an Engineering Problem	2-ETS1.A-3: § Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)
ESS3: Earth and human activity	ESS3.B: Natural Hazards	3, 4-ESS3.B-2: § A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.) (3-ESS3-1) (Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)
LS2: Ecosystems: Interactions, energy, and dynamics	LS2.D: Social Interactions and Group Behavior	3-LS2.D-1: § Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size (Note: Moved from K-2). (3-LS2-1)
LS3: Heredity: Inheritance and variation of traits	LS3.A: Inheritance of Traits	3-LS3.A-3: § Other characteristics result from individuals’ interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2)
LS3: Heredity: Inheritance and variation of traits	LS3.B: Variation of Traits	3-LS3.B-2: § Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1)

LS3: Heredity: Inheritance and variation of traits	LS3.B: Variation of Traits	3-LS3.B-3: § The environment also affects the traits that an organism develops. (3-LS3-2)
LS4: Biological evolution: Unity and diversity	LS4.A: Evidence of Common Ancestry and Diversity	3-LS4.A-1: § Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1)
LS4: Biological evolution: Unity and diversity	LS4.A: Evidence of Common Ancestry and Diversity	3-LS4.A-2: § Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (Note: moved from K-2) (3-LS4-1)
PS2: Motion and stability: Forces and interactions	PS2.A: Forces and Motion	3-PS2.A-4: § The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2)
PS2: Motion and stability: Forces and interactions	PS2.B: Types of Interactions	3-PS2.B-3: § Objects in contact exert forces on each other. (3-PS2-1)
ESS2: Earth's systems	ESS2.E: Biogeology	4-ESS2.E-2: § Living things affect the physical characteristics of their regions. (4-ESS2-1)
PS3: Energy	PS3.A: Definitions of Energy	4-PS3.A-2: § The faster a given object is moving, the more energy it possesses. (4-PS3-1)
PS3: Energy	PS3.B: Conservation of Energy and Energy Transfer	4-PS3.B-3: § Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2),(4-PS3-3)
PS3: Energy	PS3.B: Conservation of Energy and Energy Transfer	4-PS3.B-4: § Light also transfers energy from place to place. (4-PS3-2)
PS3: Energy	PS3.C: Relationship Between Energy and Forces	4-PS3.C-2: § When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	4-PS4.A-2: § Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	4-PS4.A-3: § Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; it does not move in the direction of the wave except when the water meets the beach. (Note: This grade band endpoint was moved from K-2). (4-PS4-1)
PS4: Waves and their applications in technologies for information transfer	PS4.C: Information Technologies and Instrumentation	4-PS4.C-2: § Digitized information transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa. (4-PS4-3)
ETS1: Engineering design	ETS1.C: Optimizing the Design Solution	4, 5-ETS1.C-2: § Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)
ESS1: Earth's place in the universe	ESS1.A: The Universe and its Stars	5-ESS1.A-2: § The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1)
PS1: Matter and its interactions	PS1.A: Structure and Properties of Matter	5-PS1.A-4: § Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model shows that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects. (5-PS1-1)
PS2: Motion and stability: Forces and interactions	PS2.B: Types of Interactions	5-PS2.B-4: § The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	5-ETS1.B-3: § At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	5-ETS1.B-4: § Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)

NGSS DCI (Disciplinary Core Idea)	NGSS Component Idea	New NGSS Concepts for GRADES 6-8, sorted by Content Area
ESS1: Earth's place in the universe	ESS1.A: The Universe and Its Stars	6-8-ESS1.A-1: § Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)
ESS1: Earth's place in the universe	ESS1.B: Earth and the Solar System	6-8-ESS1.B-1: § The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)
ESS1: Earth's place in the universe	ESS1.C: The History of Planet Earth	6-8-ESS1.C-2: § The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)
ESS2: Earth's systems	ESS2.A: Earth Materials and Systems	6-8-ESS2.A-2: § The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)
ESS2: Earth's systems	ESS2.C: The Roles of Water in Earth's Surface Processes	6-8-ESS2.C-3: § Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)
LS1: From molecules to organisms: Structures and processes	LS1.B: Growth and Development of Organisms	6-8-LS1.B-1: § Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)
LS1: From molecules to organisms: Structures and processes	LS1.B: Growth and Development of Organisms	6-8-LS1.B-2: § Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)
LS1: From molecules to organisms: Structures and processes	LS1.B: Growth and Development of Organisms	6-8-LS1.B-4: § Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
LS2: Ecosystems: Interactions, energy, and dynamics	LS2.C: Ecosystem Dynamics, Functioning, and Resilience	6-8-LS2.C-1: § Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)
LS4: Biological evolution: Unity and diversity	LS4.A: Evidence of Common Ancestry and Diversity	6-8-LS4.A-2: § Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)
LS4: Biological evolution: Unity and diversity	LS4.A: Evidence of Common Ancestry and Diversity	6-8-LS4.A-3: § The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1)
LS4: Biological evolution: Unity and diversity	LS4.B: Natural Selection	6-8-LS4.B-1: § In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5)
LS4: Biological evolution: Unity and diversity	LS4.D: Biodiversity and Humans	6-8-LS4.D-1: § Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on–for example, water purification and recycling. (MS-LS2-5)
PS1: Matter and its interactions	PS1.B: Chemical Reactions	6-8-PS1.B-1: § Some chemical reactions release energy, others store energy. (MS-PS1-6)
PS3: Energy	PS3.A: Definitions of Energy	6-8-PS3.A-3: § Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)
PS3: Energy	PS3.A: Definitions of Energy	6-8-PS3.A-4: § Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (secondary to MS-PS1-4)
PS3: Energy	PS3.B: Conservation of Energy and Energy Transfer	6-8-PS3.B-2: § The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4)
PS3: Energy	PS3.C: Relationship Between Energy and Forces	6-8-PS3.C-1: § When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	6-8-PS4.A-1: § A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	6-8-PS4.B-1: § A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	6-8-PS4.B-2: § However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)
PS4: Waves and their applications in technologies for information transfer	PS4.C: Information Technologies and Instrumentation	6-8-PS4.C-1: § Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	6-8-ETS1.B-9: § There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5) (secondary to MS-PS3-3) (MS-ETS1-2) (MS-ETS1-3)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	6-8-ETS1.B-8: § Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	6-8-ETS1.B-7: § Models of all kinds are important for testing solutions. (MS-ETS1-4)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	6-8-ETS1.B-6: § A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (secondary to MS-PS1-6) (secondary to MS-PS3-3) (MS-ETS1-4)
ETS1: Engineering design	ETS1.C: Optimizing the Design Solution	6-8-ETS1.C-4: § The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (secondary to MS-PS1-6) (MS-ETS1-4)
ETS1: Engineering design	ETS1.C: Optimizing the Design Solution	6-8-ETS1.C-3: § Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process–that is, some of the characteristics may be incorporated into the new design. (secondary to MS-PS1-6) (MS-ETS1-3)

NGSS DCI (Disciplinary Core Idea)	NGSS Component Idea	New NGSS Concepts for GRADES 9-12, sorted by Grade then Content Area
ESS1: Earth's place in the universe	ESS1.A: The Universe and Its Stars	9-12-ESS1.A-1: § Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2),(HS-ESS1-3)
ESS1: Earth's place in the universe	ESS1.A: The Universe and Its Stars	9-12-ESS1.A-2: § The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS-ESS1-2)
ESS1: Earth's place in the universe	ESS1.A: The Universe and Its Stars	9-12-ESS1.A-3: § The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1)
ESS1: Earth's place in the universe	ESS1.A: The Universe and Its Stars	9-12-ESS1.A-4: § The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2),(HS-ESS1-3)
ESS1: Earth's place in the universe	ESS1.C: The History of Planet Earth	9-12-ESS1.C-1: § Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6)
ESS1: Earth's place in the universe	ESS1.C: The History of Planet Earth	9-12-ESS1.C-2: § Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)
ESS2: Earth's systems	ESS2.A: Earth Materials and Systems	9-12-ESS2.A-1: § Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1),(HS-ESS2-2)
ESS2: Earth's systems	ESS2.A: Earth Materials and Systems	9-12-ESS2.A-3: § The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)
ESS2: Earth's systems	ESS2.B: Plate Tectonics and Large-Scale System Interactions	9-12-ESS2.B-1: § Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (ESS2.B Grade 8 GBE) (HS-ESS2-1) (secondary to HS-ESS1-5)
ESS2: Earth's systems	ESS2.C: The Roles of Water in Earth's Surface Processes	9-12-ESS2.C-1: § The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)
ESS2: Earth's systems	ESS2.D: Weather and Climate	9-12-ESS2.D-3: § Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7)
ESS3: Earth and human activity	ESS3.A: Natural Resources	9-12-ESS3.B-1: § Resource availability has guided the development of human society. (HS-ESS3-1)
ESS3: Earth and human activity	ESS3.B: Natural Hazards	9-12-ESS3.B-2: § Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)
ESS3: Earth and human activity	ESS3.D: Global Climate Change	9-12-ESS3.D-1: § Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)
ESS3: Earth and human activity	ESS3.D: Global Climate Change	9-12-ESS3.D-2: § Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)
LS1: From molecules to organisms: Structures and processes	LS1.A: Structure and Function	9-12-LS1.A-2: § Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)
LS1: From molecules to organisms: Structures and processes	LS1.C: Organization for Matter and Energy Flow in Organisms	9-12-LS1.C-2: § As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7)

LS2: Ecosystems: Interactions, energy, and dynamics	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	9-12-LS2.B-3: § Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)
LS4: Biological evolution: Unity and diversity	LS4.C: Adaptation	9-12-LS4.C-5: § Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)
LS4: Biological evolution: Unity and diversity	LS4.D: Biodiversity and Humans	9-12-LS4.D-1: § Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)
PS1: Matter and its interactions	PS1.A: Structure and Properties of Matter	9-12-PS1.A-2: § Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)
PS1: Matter and its interactions	PS1.B: Chemical Reactions	9-12-PS1.B-1: § Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4),(HS-PS1-5)
PS1: Matter and its interactions	PS1.B: Chemical Reactions	9-12-PS1.B-2: § In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)
PS1: Matter and its interactions	PS1.B: Chemical Reactions	9-12-PS1.B-3: § The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)
PS1: Matter and its interactions	PS1.C: Nuclear Processes	9-12-PS1.C-1: § Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8)
PS1: Matter and its interactions	PS1.C: Nuclear Processes	9-12-PS1.C-2: § Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary to HS-ESS1-5),(secondary to HS-ESS1-6)
PS2: Motion and stability: Forces and interactions	PS2.A: Forces and Motion	9-12-PS2.A-1: § If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3)
PS2: Motion and stability: Forces and interactions	PS2.A: Forces and Motion	9-12-PS2.A-2: § Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved. (HS-PS2-2)
PS2: Motion and stability: Forces and interactions	PS2.B: Types of Interactions	9-12-PS2.B-3: § Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)
PS3: Energy	PS3.A: Definitions of Energy	9-12-PS3.A-4: § These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as either motions of particles or energy stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)
PS3: Energy	PS3.B: Conservation of Energy and Energy Transfer	9-12-PS3.B-4: § The availability of energy limits what can occur in any system. (HS-PS3-1)
PS3: Energy	PS3.B: Conservation of Energy and Energy Transfer	9-12-PS3.B-5: § Uncontrolled systems always evolve toward more stable states–that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)
PS3: Energy	PS3.C: Relationship Between Energy and Forces	9-12-PS3.C-1: § When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)
PS3: Energy	PS3.D: Energy in Chemical Processes and Everyday Life	9-12-PS3.D-2: § Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary to HS-ESS1-1)

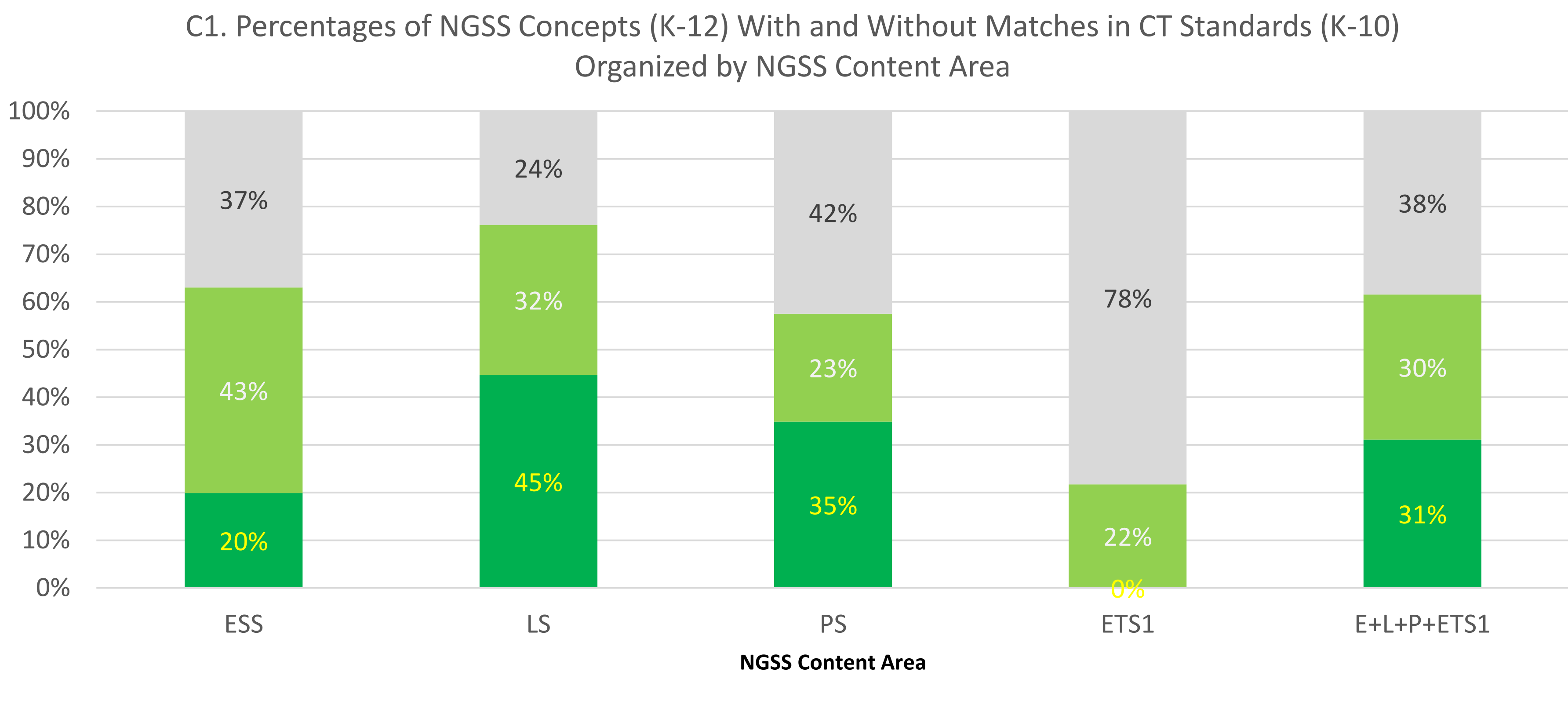
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	9-12-PS4.A-1: § [From the 3-5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	9-12-PS4.A-2: § Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to HS-ESS2-3)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	9-12-PS4.A-3: § Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2),(HS-PS4-5)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	9-12-PS4.A-4: § The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	9-12-PS4.B-1: § Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (secondary to HS-ESS1-2)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	9-12-PS4.B-2: § Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	9-12-PS4.B-3: § Photovoltaic materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	9-12-PS4.B-4: § When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4)
PS4: Waves and their applications in technologies for information transfer	PS4.C: Information Technologies and Instrumentation	9-12-PS4.C-1: § Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)
ETS1: Engineering design	ETS1.A: Defining and Delimiting an Engineering Problem	9-12-ETS1.A-7: § Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)
ETS1: Engineering design	ETS1.A: Defining and Delimiting an Engineering Problem	9-12-ETS1.A-6: § Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3) (secondary to HS-PS3-3) (HS-ETS1-1)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	9-12-ETS1.B-11: § When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (secondary to HS-LS2-7) (secondary to HS-LS4-6) (secondary to HS-ESS3-2) (secondary to HS-ESS3-4) (HS-ETS1-3)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	9-12-ETS1.B-10: § Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (secondary to HS-LS4-6) (HS-ETS1-4)
ETS1: Engineering design	ETS1.C: Optimizing the Design Solution	9-12-ETS1.C-5: § Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6) (secondary to HS-PS2-3) (HS-ETS1-2)

G7. CT Standards in which Alignments to NGSS Concept Matches were Found
Organized by NGSS Component Idea

Highlights: NGSS concepts were found in a variety of CT standards across all grade levels.

Note: This table does not show equivalency -- it only shows that at least one review team found at least one strong or moderate match to at least one NGSS concept in (K-10) CT science standards. It does not indicate how much of the NGSS component idea is addressed in the CT Framework; nor does it show how much of a CT standard is addressed in NGSS.

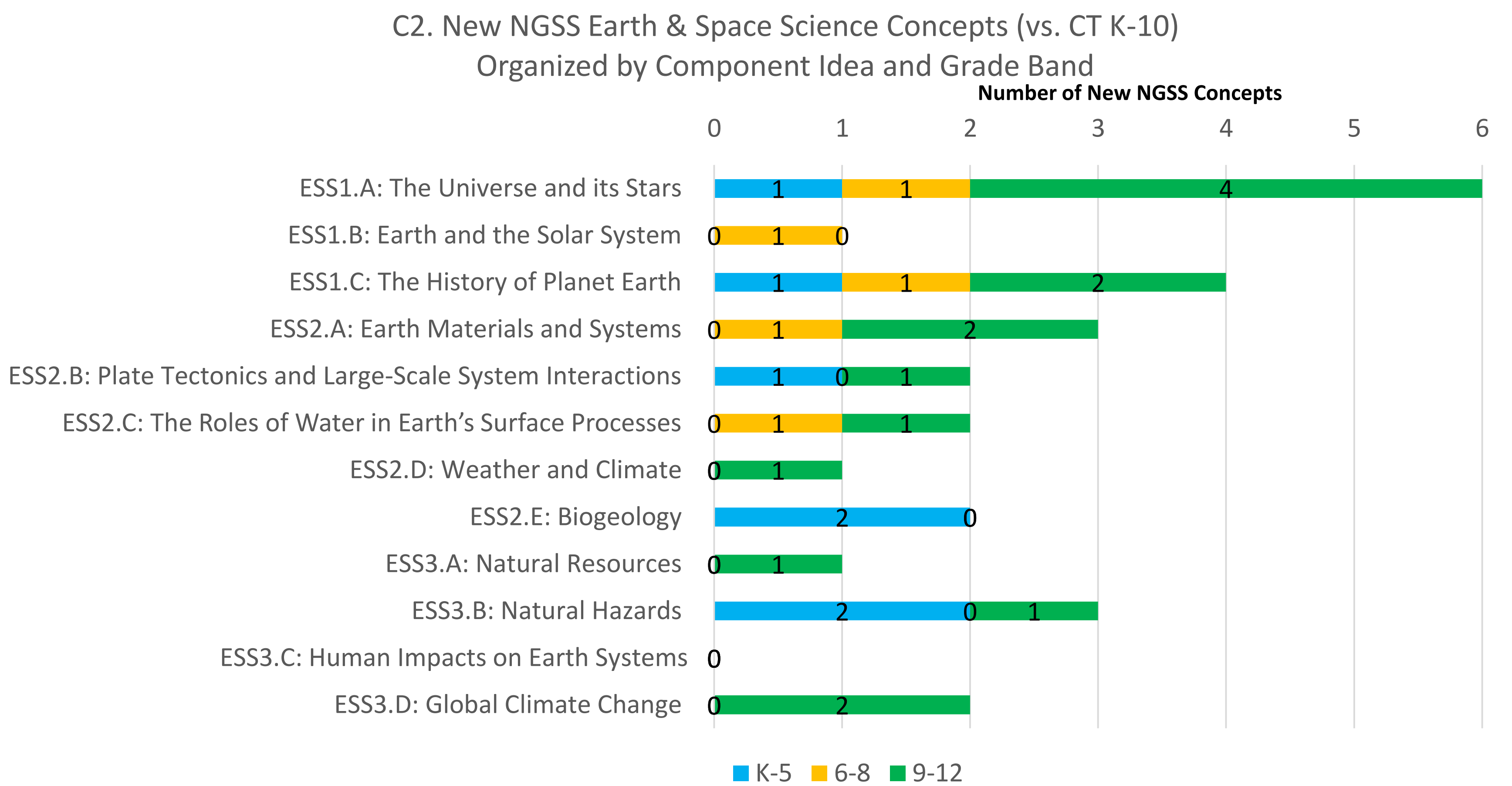
	Alignment(s) found in…		
NGSS Component Idea	**K-5**	**6-8**	**9-12**
ESS1.A: The Universe and its Stars	1.1, 5.3	8.3	
ESS1.B: Earth and the Solar System	1.1, 5.3	8.1, 8.3	
ESS1.C: The History of Planet Earth		7.3	
ESS2.A: Earth Materials and Systems	4.3	6.2, 6.3, 6.4, 7.3	9.7
ESS2.B: Plate Tectonics and Large-Scale System Interactions		7.3	
ESS2.C: The Roles of Water in Earth's Surface Processes	3.1, 4.3	6.3, 6.4, 7.3, 8.3	9.7
ESS2.D: Weather and Climate	K.3	6.3	9.8
ESS2.E: Biogeology			9.7, 10.5, 10.6
ESS3.A: Natural Resources	1.2, 3.2, 3.4		9.3, 9.7, 9.8, 9.9
ESS3.B: Natural Hazards		7.3	
ESS3.C: Human Impacts on Earth Systems	3.4, 4.2	6.2, 6.4	9.8, 9.9, 10.6
ESS3.D: Global Climate Change			9.8, 9.9
LS1.A: Structure and Function	1.2, 3.2	7.2	10.1, 10.4
LS1.B: Growth and Development of Organisms	1.3, 2.2	7.2, 8.2	
LS1.C: Organization for Matter and Energy Flow in Organisms	1.2, 2.2, 4.2	6.2, 7.2	9.5, 10.1
LS1.D: Information Processing	K.1, 5.2		
LS2.A: Interdependent Relationships in Ecosystems	1.2, 2.2, 4.2	6.2	10.6
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems		6.2	9.7, 10.1
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	4.2	6.2	9.8, 9.9, 10.6
LS2.D: Social Interactions and Group Behavior			10.5
LS3.A: Inheritance of Traits	K.2, 3.2	8.2	10.1, 10.4, 10.5
LS3.B: Variation of Traits	K.2	8.2	10.4, 10.5
LS4.A: Evidence of Common Ancestry and Diversity			10.5
LS4.B: Natural Selection	3.2		10.5
LS4.C: Adaptation	3.2, 4.2		10.5
LS4.D: Biodiversity and Humans	K.2, 4.2	6.2	10.6
PS1.A: Structure and Properties of Matter	K.4, 3.1, 3.3	6.1, 6.3	9.4
PS1.B: Chemical Reactions	3.1	6.1	
PS2.A: Forces and Motion	1.1, 4.1, 4.4	8.1, 8.4	
PS2.B: Types of Interactions	1.1, 4.1, 4.4	8.1, 8.3	9.2, 9.4
PS3.A: Definitions of Energy	4.4, 5.1	6.3, 7.1	9.1, 9.2
PS3.B: Conservation of Energy and Energy Transfer	K.3, 4.4	7.1, 8.1, 9.1	
PS3.C: Relationship Between Energy and Forces	4.1		
PS3.D: Energy in Chemical Processes and Everyday Life	4.2	6.2, 7.1	9.1, 9.3, 10.1
PS4.A: Wave Properties	5.1		
PS4.B: Electromagnetic Radiation	5.1, 5.2		
ETS1.A: Defining and Delimiting an Engineering Problem	K.4	8.4	
ETS1.B: Developing Possible Solutions		8.4	
ETS1.C: Optimizing the Design Solution		8.4	



* This graph should not be interpreted to mean that the matches are at the same grade level/band in both standards (some are not).

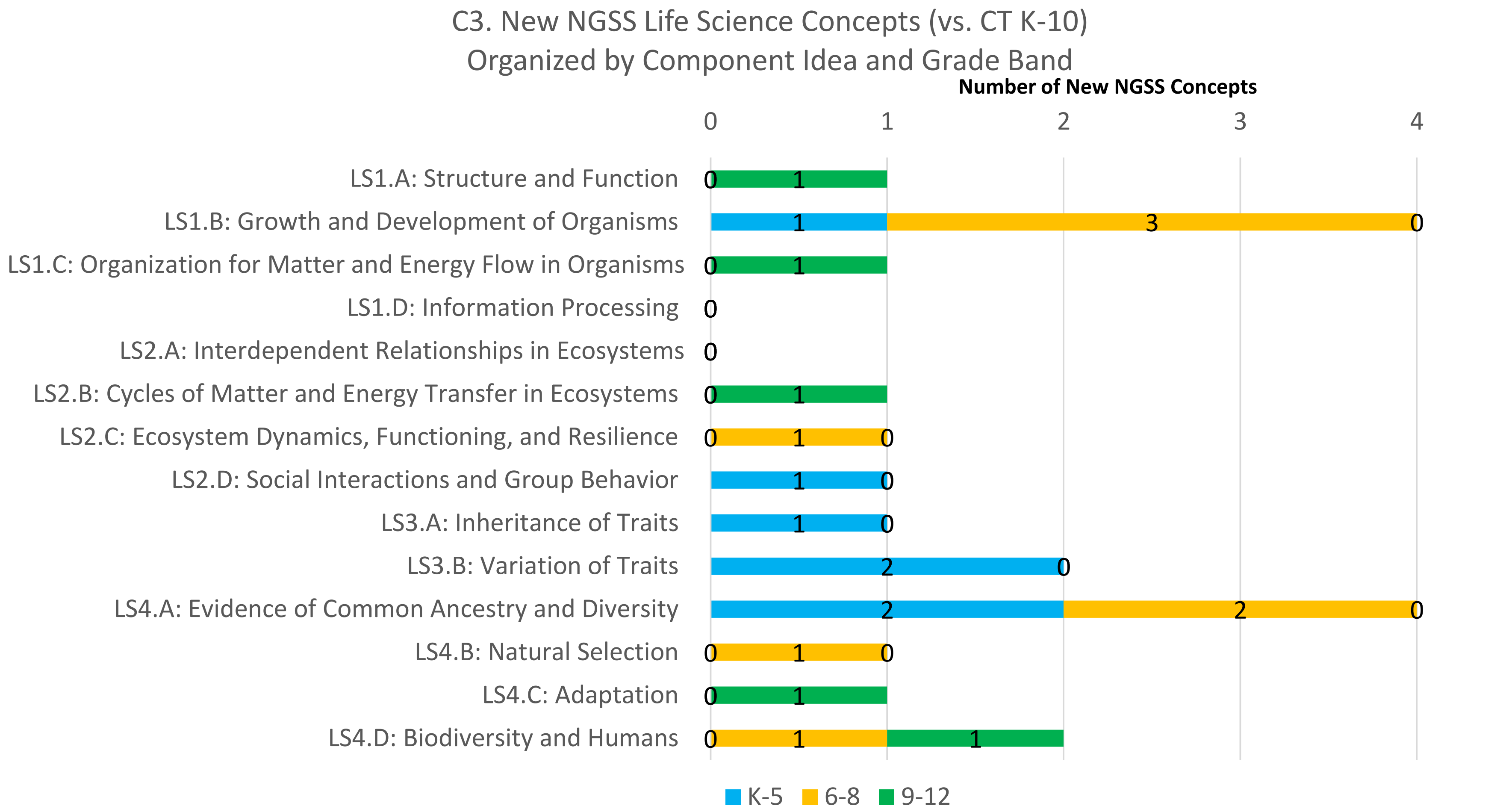
Highlights: The content area with the highest percentage of NGSS concept matches to CT K-10 standards is Life Science, followed by Physical Science and Earth & Space Science. The area with the least percentage of matches is Engineering Design. This is not surprising due to the NGSS commitment to integrating engineering design into the structure of science education.

For a grade band breakdown, see Graph C2.



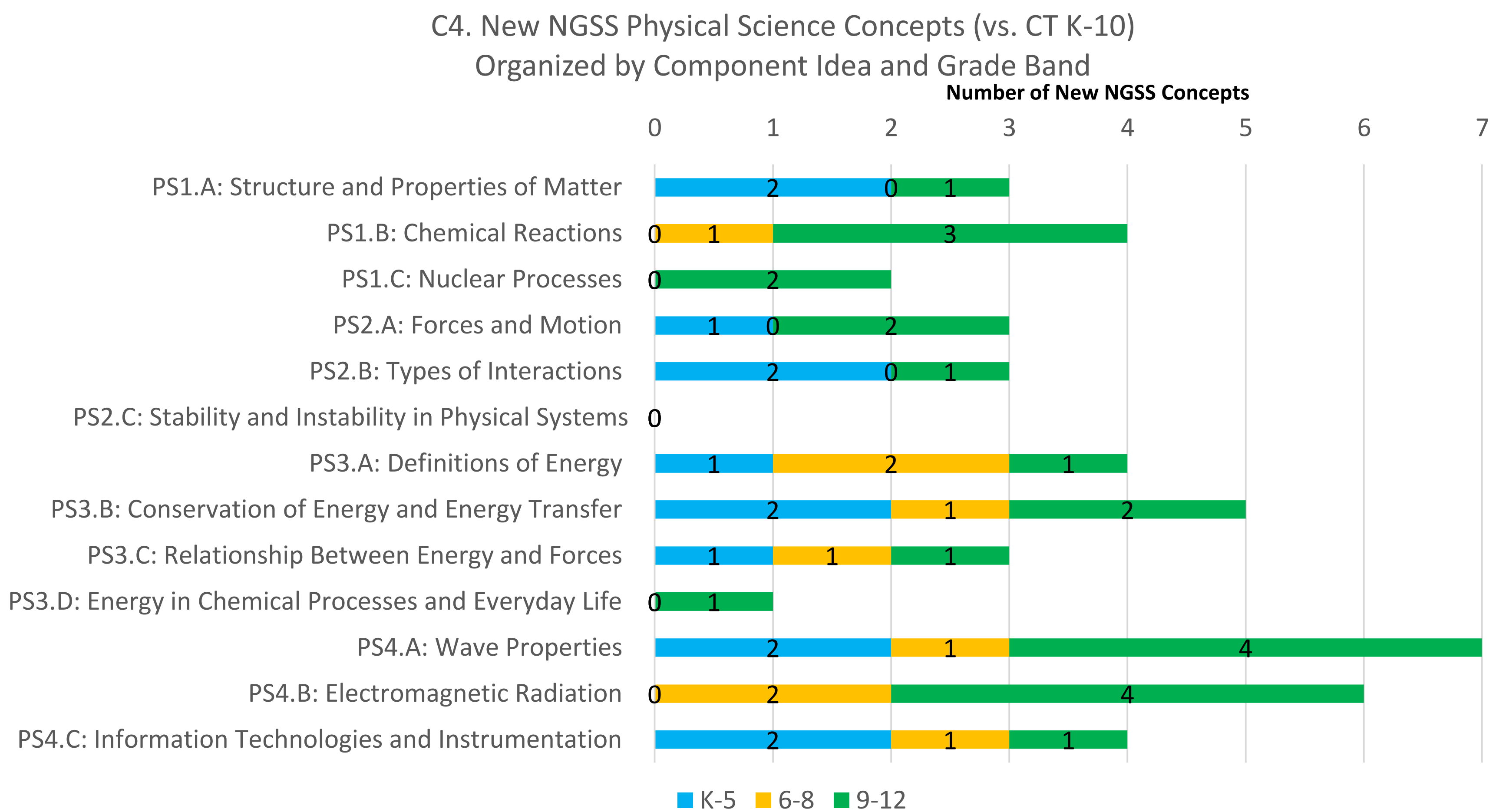
Highlights: There is wide variation in the number of new Earth & Space Science concepts in each Component Idea as well as in what grade or grade band the new concepts would be found if NGSS were adopted. For example, there would be several new concepts related to the Universe and Its Stars, most of them added in Gr. 9-12. By contrast, there would be no entirely new concepts related to Human Impacts on Earth Systems. Low numbers can mean that CT standards already address the concepts and/or that NGSS does not address the concepts at a given grade band.

For a list of the new concepts, see Table C6.



Highlights: There is wide variation in the number of new Life Science concepts in each Component Idea as well as in what grade or grade band the new concepts would be found if NGSS were adopted. For example, there are multiple new concepts in LS1.B and LS4.A; most of them would be added in Gr. 6-8, and none would be added in Gr. 9-12.

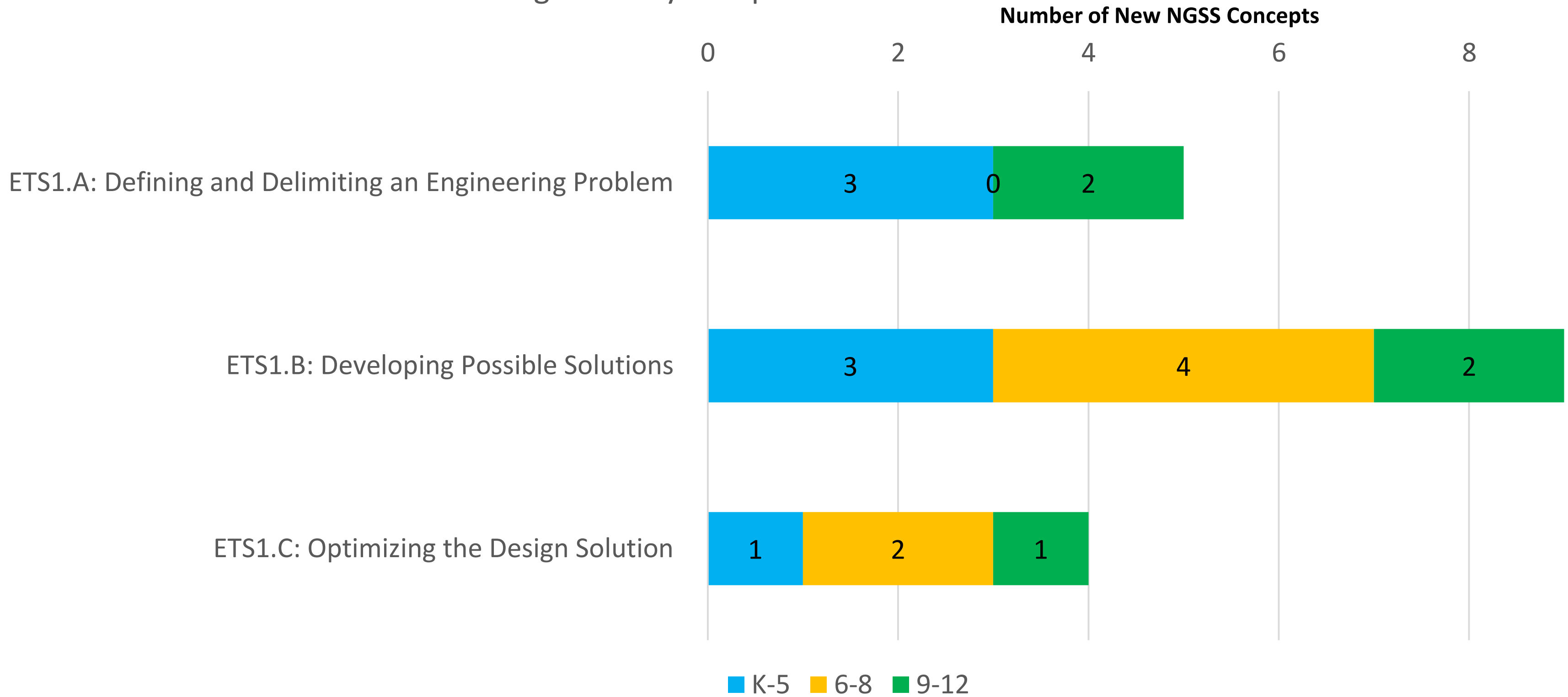
For a list of the new concepts, see Table C6.



Highlights: There is wide variation in the number of new Physical Science concepts in each Component Idea as well as in what grade or grade band the new concepts would be found if NGSS were adopted. The "0" for PS2.C is due to the fact that this Component Idea was eliminated in the final NGSS publication in response to concerns about there being too much content in earlier drafts. Note that Wave Properties (PS4.A) and Electromagnetic Radiation (PS4.B) would be new, especially in Grades 9-12, if NGSS were adopted.

For a list of the new concepts, see Table C6.

C5. New NGSS Engineering Design Concepts (vs. CT K-10)
Organized by Component Idea and Grade Band



Highlights: There is wide variation in the number of new Engineering Design (ETS1) concepts in each Component Idea as well as in what grade or grade band the new concepts would be found if NGSS were adopted. The "0" for ETS1.A Gr. 6-8 indicates that NGSS engineering concepts related to Defining and Delimiting an Engineering Problem were moderately matched in CT standard 8.4. Note, however, that a significant number of new concepts related to Developing Possible Solutions and Optimizing the Design Solution would appear in Gr. 6-8 if NGSS were adopted.

For a list of the new concepts, see Table C6.

C6. NGSS Concepts that Would Be New for CT*
Organized by Content Area then by Grade (K-5)/Grade Band (6-8, 9-12)

* Note that the CT Content Crosswalk did not include CT enrichment standards, so these concepts are new versus the CT K-10 standards.
To see concepts sorted by Grade Band then Content Area, see Table G6.

Highlights: Some of the NGSS Disciplinary Core Ideas (DCIs) and Component Ideas listed may at first seem similar to general topics in current CT standards. However, it is important to look more closely at the specific concepts addressed in both sets of standards. The NGSS concepts listed here are not included in current state standards. Therefore, curriculum learning units would need to be redesigned to reflect the distinct conceptual emphases in NGSS. For example, the new concept associated with NGSS Grade 3 PS2.A "Forces and Motion" differs significantly from anything included in the current CT standard of the same name (CT 4.1).

NGSS DCI (Disciplinary Core Idea)	NGSS Component Idea	New NGSS Concepts for EARTH & SPACE Science, sorted by Component Idea then Grade/Grade Band
ESS1: Earth's place in the universe	ESS1.A: The Universe and its Stars	5-ESS1.A-2: § The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1)
ESS1: Earth's place in the universe	ESS1.A: The Universe and Its Stars	6-8-ESS1.A-1: § Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)
ESS1: Earth's place in the universe	ESS1.A: The Universe and Its Stars	9-12-ESS1.A-1: § Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2),(HS-ESS1-3)
ESS1: Earth's place in the universe	ESS1.A: The Universe and Its Stars	9-12-ESS1.A-2: § The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS-ESS1-2)
ESS1: Earth's place in the universe	ESS1.A: The Universe and Its Stars	9-12-ESS1.A-3: § The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1)
ESS1: Earth's place in the universe	ESS1.A: The Universe and Its Stars	9-12-ESS1.A-4: § The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2),(HS-ESS1-3)
ESS1: Earth's place in the universe	ESS1.B: Earth and the Solar System	6-8-ESS1.B-1: § The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)
ESS1: Earth's place in the universe	ESS1.C: The History of Planet Earth	2-ESS1.C-1: § Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)
ESS1: Earth's place in the universe	ESS1.C: The History of Planet Earth	6-8-ESS1.C-2: § The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)
ESS1: Earth's place in the universe	ESS1.C: The History of Planet Earth	9-12-ESS1.C-1: § Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6)
ESS1: Earth's place in the universe	ESS1.C: The History of Planet Earth	9-12-ESS1.C-2: § Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)
ESS2: Earth's systems	ESS2.A: Earth Materials and Systems	6-8-ESS2.A-2: § The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)
ESS2: Earth's systems	ESS2.A: Earth Materials and Systems	9-12-ESS2.A-1: § Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1),(HS-ESS2-2)
ESS2: Earth's systems	ESS2.A: Earth Materials and Systems	9-12-ESS2.A-3: § The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)
ESS2: Earth's systems	ESS2.B: Plate Tectonics and Large-Scale System Interactions	2-ESS2.B-1: § Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2-2)

ESS2: Earth's systems	ESS2.B: Plate Tectonics and Large-Scale System Interactions	9-12-ESS2.B-1: § Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (ESS2.B Grade 8 GBE) (HS-ESS2-1) (secondary to HS-ESS1-5)
ESS2: Earth's systems	ESS2.C: The Roles of Water in Earth's Surface Processes	6-8-ESS2.C-3: § Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)
ESS2: Earth's systems	ESS2.C: The Roles of Water in Earth's Surface Processes	9-12-ESS2.C-1: § The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)
ESS2: Earth's systems	ESS2.D: Weather and Climate	9-12-ESS2.D-3: § Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7)
ESS2: Earth's systems	ESS2.E: Biogeology	K-ESS2.E-1: § Plants and animals can change their environment. (K-ESS2-2)
ESS2: Earth's systems	ESS2.E: Biogeology	4-ESS2.E-2: § Living things affect the physical characteristics of their regions. (4-ESS2-1)
ESS3: Earth and human activity	ESS3.A: Natural Resources	9-12-ESS3.B-1: § Resource availability has guided the development of human society. (HS-ESS3-1)
ESS3: Earth and human activity	ESS3.B: Natural Hazards	K-ESS3.B-1: § Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (K-ESS3-2)
ESS3: Earth and human activity	ESS3.B: Natural Hazards	3, 4-ESS3.B-2: § A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.) (3-ESS3-1) (Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)
ESS3: Earth and human activity	ESS3.B: Natural Hazards	9-12-ESS3.B-2: § Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)
ESS3: Earth and human activity	ESS3.D: Global Climate Change	9-12-ESS3.D-1: § Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)
ESS3: Earth and human activity	ESS3.D: Global Climate Change	9-12-ESS3.D-2: § Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

NGSS DCI (Disciplinary Core Idea)	NGSS Component Idea	New NGSS Concepts for LIFE Science, sorted by Component Idea then Grade Band
LS1: From molecules to organisms: Structures and processes	LS1.A: Structure and Function	9-12-LS1.A-2: § Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)
LS1: From molecules to organisms: Structures and processes	LS1.B: Growth and Development of Organisms	1-LS1.B-1: § Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)
LS1: From molecules to organisms: Structures and processes	LS1.B: Growth and Development of Organisms	6-8-LS1.B-1: § Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)
LS1: From molecules to organisms: Structures and processes	LS1.B: Growth and Development of Organisms	6-8-LS1.B-2: § Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)
LS1: From molecules to organisms: Structures and processes	LS1.B: Growth and Development of Organisms	6-8-LS1.B-4: § Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
LS1: From molecules to organisms: Structures and processes	LS1.C: Organization for Matter and Energy Flow in Organisms	9-12-LS1.C-2: § As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7)
LS2: Ecosystems: Interactions, energy, and dynamics	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	9-12-LS2.B-3: § Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)
LS2: Ecosystems: Interactions, energy, and dynamics	LS2.C: Ecosystem Dynamics, Functioning, and Resilience	6-8-LS2.C-1: § Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)
LS2: Ecosystems: Interactions, energy, and dynamics	LS2.D: Social Interactions and Group Behavior	3-LS2.D-1: § Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size (Note: Moved from K-2). (3-LS2-1)
LS3: Heredity: Inheritance and variation of traits	LS3.A: Inheritance of Traits	3-LS3.A-3: § Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2)
LS3: Heredity: Inheritance and variation of traits	LS3.B: Variation of Traits	3-LS3.B-2: § Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1)
LS3: Heredity: Inheritance and variation of traits	LS3.B: Variation of Traits	3-LS3.B-3: § The environment also affects the traits that an organism develops. (3-LS3-2)
LS4: Biological evolution: Unity and diversity	LS4.A: Evidence of Common Ancestry and Diversity	3-LS4.A-1: § Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1)
LS4: Biological evolution: Unity and diversity	LS4.A: Evidence of Common Ancestry and Diversity	3-LS4.A-2: § Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (Note: moved from K-2) (3-LS4-1)
LS4: Biological evolution: Unity and diversity	LS4.A: Evidence of Common Ancestry and Diversity	6-8-LS4.A-2: § Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)
LS4: Biological evolution: Unity and diversity	LS4.A: Evidence of Common Ancestry and Diversity	6-8-LS4.A-3: § The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1)

LS4: Biological evolution: Unity and diversity	LS4.B: Natural Selection	6-8-LS4.B-1: § In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5)
LS4: Biological evolution: Unity and diversity	LS4.C: Adaptation	9-12-LS4.C-5: § Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)
LS4: Biological evolution: Unity and diversity	LS4.D: Biodiversity and Humans	6-8-LS4.D-1: § Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (MS-LS2-5)
LS4: Biological evolution: Unity and diversity	LS4.D: Biodiversity and Humans	9-12-LS4.D-1: § Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)

NGSS DCI (Disciplinary Core Idea)	NGSS Component Idea	New NGSS Concepts for PHYSICAL Science, sorted by Component Idea then Grade Band
PS1: Matter and its interactions	PS1.A: Structure and Properties of Matter	2-PS1.A-1: § A great variety of objects can be built up from a small set of pieces. (2-PS1-3)
PS1: Matter and its interactions	PS1.A: Structure and Properties of Matter	5-PS1.A-4: § Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model shows that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects. (5-PS1-1)
PS1: Matter and its interactions	PS1.A: Structure and Properties of Matter	9-12-PS1.A-2: § Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)
PS1: Matter and its interactions	PS1.B: Chemical Reactions	6-8-PS1.B-1: § Some chemical reactions release energy, others store energy. (MS-PS1-6)
PS1: Matter and its interactions	PS1.B: Chemical Reactions	9-12-PS1.B-1: § Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4),(HS-PS1-5)
PS1: Matter and its interactions	PS1.B: Chemical Reactions	9-12-PS1.B-2: § In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)
PS1: Matter and its interactions	PS1.B: Chemical Reactions	9-12-PS1.B-3: § The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2),(HS-PS1-7)
PS1: Matter and its interactions	PS1.C: Nuclear Processes	9-12-PS1.C-1: § Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8)
PS1: Matter and its interactions	PS1.C: Nuclear Processes	9-12-PS1.C-2: § Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary to HS-ESS1-5),(secondary to HS-ESS1-6)
PS2: Motion and stability: Forces and interactions	PS2.A: Forces and Motion	3-PS2.A-4: § The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2)
PS2: Motion and stability: Forces and interactions	PS2.A: Forces and Motion	9-12-PS2.A-1: § If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2),(HS-PS2-3)
PS2: Motion and stability: Forces and interactions	PS2.A: Forces and Motion	9-12-PS2.A-2: § Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved. (HS-PS2-2)
PS2: Motion and stability: Forces and interactions	PS2.B: Types of Interactions	3-PS2.B-3: § Objects in contact exert forces on each other. (3-PS2-1)
PS2: Motion and stability: Forces and interactions	PS2.B: Types of Interactions	5-PS2.B-4: § The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)
PS2: Motion and stability: Forces and interactions	PS2.B: Types of Interactions	9-12-PS2.B-3: § Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)
PS3: Energy	PS3.A: Definitions of Energy	4-PS3.A-2: § The faster a given object is moving, the more energy it possesses. (4-PS3-1)
PS3: Energy	PS3.A: Definitions of Energy	6-8-PS3.A-3: § Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)
PS3: Energy	PS3.A: Definitions of Energy	6-8-PS3.A-4: § Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (secondary to MS-PS1-4)

PS3: Energy	PS3.A: Definitions of Energy	9-12-PS3.A-4: § These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as either motions of particles or energy stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)
PS3: Energy	PS3.B: Conservation of Energy and Energy Transfer	4-PS3.B-3: § Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2),(4-PS3-3)
PS3: Energy	PS3.B: Conservation of Energy and Energy Transfer	4-PS3.B-4: § Light also transfers energy from place to place. (4-PS3-2)
PS3: Energy	PS3.B: Conservation of Energy and Energy Transfer	6-8-PS3.B-2: § The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4)
PS3: Energy	PS3.B: Conservation of Energy and Energy Transfer	9-12-PS3.B-4: § The availability of energy limits what can occur in any system. (HS-PS3-1)
PS3: Energy	PS3.B: Conservation of Energy and Energy Transfer	9-12-PS3.B-5: § Uncontrolled systems always evolve toward more stable states–that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)
PS3: Energy	PS3.C: Relationship Between Energy and Forces	4-PS3.C-2: § When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3)
PS3: Energy	PS3.C: Relationship Between Energy and Forces	6-8-PS3.C-1: § When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)
PS3: Energy	PS3.C: Relationship Between Energy and Forces	9-12-PS3.C-1: § When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)
PS3: Energy	PS3.D: Energy in Chemical Processes and Everyday Life	9-12-PS3.D-2: § Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary to HS-ESS1-1)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	4-PS4.A-2: § Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	4-PS4.A-3: § Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; it does not move in the direction of the wave except when the water meets the beach. (Note: This grade band endpoint was moved from K-2). (4-PS4-1)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	6-8-PS4.A-1: § A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	9-12-PS4.A-1: § [From the 3-5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) (HS-PS4-3)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	9-12-PS4.A-2: § Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to HS-ESS2-3)
PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	9-12-PS4.A-3: § Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2),(HS-PS4-5)

PS4: Waves and their applications in technologies for information transfer	PS4.A: Wave Properties	9-12-PS4.A-4: § The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	6-8-PS4.B-1: § A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	6-8-PS4.B-2: § However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	9-12-PS4.B-1: § Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (secondary to HS-ESS1-2)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	9-12-PS4.B-2: § Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	9-12-PS4.B-3: § Photovoltaic materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)
PS4: Waves and their applications in technologies for information transfer	PS4.B: Electromagnetic Radiation	9-12-PS4.B-4: § When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4)
PS4: Waves and their applications in technologies for information transfer	PS4.C: Information Technologies and Instrumentation	1-PS4.C-1: § People also use a variety of devices to communicate (send and receive information) over long distances. (1-PS4-4)
PS4: Waves and their applications in technologies for information transfer	PS4.C: Information Technologies and Instrumentation	4-PS4.C-2: § Digitized information transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information–convert it from digitized form to voice–and vice versa. (4-PS4-3)
PS4: Waves and their applications in technologies for information transfer	PS4.C: Information Technologies and Instrumentation	6-8-PS4.C-1: § Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)
PS4: Waves and their applications in technologies for information transfer	PS4.C: Information Technologies and Instrumentation	9-12-PS4.C-1: § Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)

NGSS DCI (Disciplinary Core Idea)	NGSS Component Idea	New NGSS Concepts for ENGINEERING DESIGN, sorted by Component Idea then Grade Band
ETS1: Engineering design	ETS1.A: Defining and Delimiting an Engineering Problem	K,2-ETS1.A-1: § A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (secondary to K-PS2-2) (K-2-ETS1-1)
ETS1: Engineering design	ETS1.A: Defining and Delimiting an Engineering Problem	K,2-ETS1.A-2: § Asking questions, making observations, and gathering information are helpful in thinking about problems. (secondary to K-ESS3-2) (K-2-ETS1-1)
ETS1: Engineering design	ETS1.A: Defining and Delimiting an Engineering Problem	2-ETS1.A-3: § Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)
ETS1: Engineering design	ETS1.A: Defining and Delimiting an Engineering Problem	9-12-ETS1.A-6: § Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary to HS-PS2-3) (secondary to HS-PS3-3) (HS-ETS1-1)
ETS1: Engineering design	ETS1.A: Defining and Delimiting an Engineering Problem	9-12-ETS1.A-7: § Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	K,2-ETS1.B-1: § Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to 2-LS2-2) (secondary to K-ESS3-3) (K-2-ETS1-2)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	5-ETS1.B-3: § At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	5-ETS1.B-4: § Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	6-8-ETS1.B-6: § A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (secondary to MS-PS1-6) (secondary to MS-PS3-3) (MS-ETS1-4)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	6-8-ETS1.B-7: § Models of all kinds are important for testing solutions. (MS-ETS1-4)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	6-8-ETS1.B-8: § Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	6-8-ETS1.B-9: § There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5) (secondary to MS-PS3-3) (MS-ETS1-2) (MS-ETS1-3)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	9-12-ETS1.B-10: § Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (secondary to HS-LS4-6) (HS-ETS1-4)
ETS1: Engineering design	ETS1.B: Developing Possible Solutions	9-12-ETS1.B-11: § When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (secondary to HS-LS2-7) (secondary to HS-LS4-6) (secondary to HS-ESS3-2) (secondary to HS-ESS3-4) (HS-ETS1-3)
ETS1: Engineering design	ETS1.C: Optimizing the Design Solution	4, 5-ETS1.C-2: § Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)
ETS1: Engineering design	ETS1.C: Optimizing the Design Solution	6-8-ETS1.C-3: § Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process–that is, some of the characteristics may be incorporated into the new design. (secondary to MS-PS1-6) (MS-ETS1-3)
ETS1: Engineering design	ETS1.C: Optimizing the Design Solution	6-8-ETS1.C-4: § The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (secondary to MS-PS1-6) (MS-ETS1-4)
ETS1: Engineering design	ETS1.C: Optimizing the Design Solution	9-12-ETS1.C-5: § Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6) (secondary to HS-PS2-3) (HS-ETS1-2)

Appendix A

NGSS-CT Concept Crosswalk Workshop

AGENDA

April 30, 2013

TIME	TASK	FACILITATOR	MATERIALS
8:00-8:30	Refreshments, sign-in		
8:30-8:35	Introductions		
8:35-9:00	**Content Crosswalk: Step 1 of the Adoption Implications Study** • Why we are here; • Adoption Implications Study Timeline • Purpose of the Content Crosswalk – what questions can be answered? • Why are we crosswalking? What questions will our crosswalk answer? GOAL is to find out what is DIFFERENT; not to "stretch" to make it seem as though "we are already doing all this". • What are we crosswalking? • Why we are not crosswalking Practices, Crosscutting Concepts, and PEs • What adoption implications can the crosswalk reveal? Outcomes of today's session.	Liz	
9:00 – 9:15	**Overview of the Crosswalk process** **Crosswalk Process Instructions** a. Explanation of match strength categories: Concepts and Grade level b. Using the SurveyMonkey form to record matches. c. Getting on-line: www.surveymonkey.com/s/ctngsscrosswalk. d. Walk-thru the fields of the form; general explanations of what goes in each field.	Liz Nick and Josiah	
9:15 – 9:45	**Crosswalking Think Alouds** • Elementary example • Middle school example • Clarifying questions	Liz- Life Sci Nick-Earth Sci	K-8 Standards with GLCs

9:45 – 10:00	BREAK and move to Team Room	Red Team- Theater Blue Team- Collaboration Rm.	
10:00-12:00	**Crosswalking** Monitoring and adjusting: matches and pace. Make individual course corrections, or if there's a trend in both rooms, make whole group announcements.	Josiah	
12:00-12:30	LUNCH		
12:30-2:00	**Crosswalking - continued**		
2:00-3:00	Debrief, next steps, adjourn		

Thank you for dedicating your expertise to this

CSDE NGSS initiative!

Appendix B: NGSS-CT Concept Crosswalk Instructions

How to Use the Crosswalk Form:

1. Choose your DCI / Grade Band (you'll keep picking the same one each time you go through the survey).

2. Choose the NGSS DCI concept you are currently searching for in the CT Framework. You have a printed checklist to help keep track of which ones you have done.

3. Look through the Content Standards, Supportive Concepts, and either the Grade-Level Concepts (GLCs) for K-8 or the Expected Performances for 9-10. You may need to look at multiple grades above and below. However, we will <u>not</u> be looking through the Enrichment Standards today.

When searching in K-8, look here:

Structure and Function — How are organisms structured to ensure efficiency and survival? GRADE 1			
	1.2 — Living things have different structures and behaviors that allow them to meet their basic needs.		
Core Science Curriculum Framework	Grade-Level Concepts *Students should understand that…*	Grade-Level Expectations *Students should be able to…*	Assessment
1.2.a. Animals need air, water and food to survive. **1.2.b.** Plants need air, water and sunlight to survive.	GRADE-LEVEL CONCEPT 1.2.a. 1. All living things (organisms) need air, water and food to stay alive and grow; they meet these needs in different ways. 2. Most animals move from place to place to find food and water. Some animals have two legs, four legs, six legs or more for moving. Other animals move using fins, wings or by slithering. 3. Animals get air in different ways. For example, humans breathe with lungs, while fish breathe with gills. 4. Animals get food in different ways. Some animals eat parts of plants and others catch and eat other animals. 5. Animals get water in different ways. Some animals have special body parts, such as noses, tongues or beaks that help them get water. 6. Fictional animals and plants can have structures and behaviors that are different than real animals and plants. GRADE-LEVEL CONCEPT 1.2.b. 1. Plants absorb sunlight and air through their leaves and water through their roots. 2. Plants use sunlight to make food from the air and water they absorb. 3. Plants have various leaf shapes and sizes that help them absorb sunlight and air. 4. Plant roots grow toward a source of water. 5. Plant stems grow toward sunlight.	1. Infer from direct observation and print or electronic information that most animals and plants need water, food and air to stay alive. 2. Identify structures and behaviors used by mammals, birds, amphibians, reptiles, fish and insects to move around, breathe and obtain food and water (e.g., legs/wings/fins, gills/lungs, claws/fingers, etc.) 3. Sort and classify plants (or plant parts) by observable characteristics (e.g., leaf shape/size, stem or trunk covering, flower or fruit). 4. Use senses and simple measuring tools to measure the effects of water and sunlight on plant growth. 5. Compare and contrast information about animals and plants found in fiction	**A12.** Describe the different ways that animals, including humans, obtain water and food. **A13.** Describe the different structures plants have for obtaining water and sunlight. **A14.** Describe the structures that animals, including humans, use to move around.

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When searching in 9-10, look here:

Grade 9 Core Themes, Content Standards and Expected Performances Strand II: Chemical Structures and Properties	
Content Standards	**Expected Performances**
Properties of Matter – How does the structure of matter affect the properties and uses of materials? **9.4 - Atoms react with one another to form new molecules.** • Atoms have a positively charged nucleus surrounded by negatively charged electrons. • The configuration of atoms and molecules determines the properties of the materials.	**D 10.** Describe the general structure of the atom, and explain how the properties of the first 20 elements in the Periodic Table are related to their atomic structures. **D 11.** Describe how atoms combine to form new substances by transferring electrons (ionic bonding) or sharing electrons (covalent bonding). **D 12.** Explain the chemical composition of acids and bases, and explain the change of pH in neutralization reactions.

4. Identify if there is a strong match (captures the essence), moderate match (somewhat captures it / captures a piece), or no match (also use this for minimal/tangential matches).

The survey branches at this point based on your previous response.

5.
   a. Strong Match (Q24): List the one standard (and just the standard) that is the strongest match.

   b. Moderate Match (Q25): List the one or two standards (and just the standards) that are moderate matches. If there are more than two, just choose the best two.

   c. No/Minimal Match: You will be sent back to the beginning of the survey. Begin again for the next NGSS DCI concept. *Please be sure to go through the first three questions even when there is no match – it will help us to track and analyze the data. Your printout may help you to keep track of your progress.*

Applicable for strong and moderate matches:

6. (Q26) Identify where you found evidence of the alignment. Use GLCs for K-8 and expected performances for 9-10. If you only found evidence in the Content Standard or Supportive Concept and not in the GLCs or Expected Performances, leave this item blank.

   For matches in K-8, see the sample below:

1	1.2.a.5
2	1.2.b.4
3	

Enter no more than one per box.

If there are more than three, pick the best three.

GRADE-LEVEL CONCEPT 1.2.a.

1. All living things (organisms) need air, water and food to stay alive and grow; they meet these needs in different ways.
2. Most animals move from place to place to find food and water. Some animals have two legs, four legs, six legs or more for moving. Other animals move using fins, wings or by slithering.
3. Animals get air in different ways. For example, humans breathe with lungs, while fish breathe with gills.
4. Animals get food in different ways. Some animals eat parts of plants and others catch and eat other animals.
5. Animals get water in different ways. Some animals have special body parts, such as noses, tongues or beaks that help them get water.
6. Fictional animals and plants can have structures and behaviors that are different than real animals and plants.

GRADE-LEVEL CONCEPT 1.2.b.

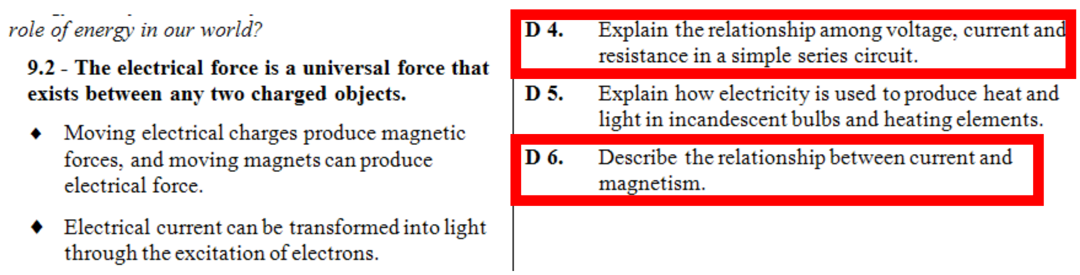
1. Plants absorb sunlight and air through their leaves and water through their roots.
2. Plants use sunlight to make food from the air and water they absorb.
3. Plants have various leaf shapes and sizes that help them absorb sunlight and air.
4. Plant roots grow toward a source of water.
5. Plant stems grow toward sunlight.

For matches in 9-10, see the sample below:

1 D4
2 D6
3

Enter no more than one per box.

If there are more than three, pick the best three.



role of energy in our world?

9.2 - The electrical force is a universal force that exists between any two charged objects.

- Moving electrical charges produce magnetic forces, and moving magnets can produce electrical force.
- Electrical current can be transformed into light through the excitation of electrons.

D 4. Explain the relationship among voltage, current and resistance in a simple series circuit.

D 5. Explain how electricity is used to produce heat and light in incandescent bulbs and heating elements.

D 6. Describe the relationship between current and magnetism.

7. (Q27) Identify if/how there is a grade level (K-8) or grade band (MS/HS) shift in the CT Framework versus the NGSS. Examples:
    a. The NGSS DCI concept is in grade 4. You find a match in grade 5 in CT. Choose (CT is) “at a higher grade/grade band than NGSS.”
    b. The NGSS DCI concept is in the Middle School grade band. You find a match in grade 4 in CT. Choose (CT is) “at a lower grade/grade band than NGSS.”
    c. The NGSS DCI concept is in the High School grade band. You find a match in grade 9 in CT. Choose (CT is) “at the same grade/grade band as NGSS.”
    d. The NGSS DCI concept is in grade 5. You find matches in grades 3 and 7 in CT. Choose (CT is) “at grades/grade bands both above and below NGSS.”

After clicking “Done,” you will be sent back to the beginning of the survey.
Begin again for the next NGSS DCI concept. Your printout may help you to keep track of your progress.

Please notify us after you have submitted two survey responses so we can verify that they have been entered successfully.

Thank you!