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Dimension	Code for the Dimension	Code for the Part of the Dimension	Code for Grade and Item in the List
Science and Engineering Practices	SEP	**AQDP:** **A**sk **Q**uestions and **D**efine **P**roblems **MOD:** Developing and Using **Mod**els **INV:** Planning and Carrying out **Inv**estigations **DATA:** Analyzing **Data** **MATH:** Using **Math**ematics and Computational Thinking **CEDS:** **C**onstructing **E**xplanations and **D**esigning **S**olutions **ARG:** Engaging in **Arg**ument from Evidence **INFO:** Obtaining, Evaluating, and Communicating **Info**rmation	Primary: P1, P2, P3… Elementary: E1, E2, E3… Middle: M1, M2, M3… High: H1, H2, H3…
Disciplinary Core Ideas	DCI	**See additional details on page 3** PS1.A, PS1.B, PS1.C PS2.A, PS2.B, PS2.C PS3.A, PS3.B, PS3.C, PS3.D PS4.A, PS4.B, PS4.C LS1.A, LS1.B, LS1.C, LS1.D LS2.A, LS2.B, LS2.C, LS2.D LS3.A, LS3.B LS4.A, LS4.B, LS4.C, LS4.D ESS1.A, ESS1.B, ESS1.C ESS2.A, ESS2.B, ESS2.C, ESS2.D, ESS2.E ESS3.A, ESS3.B, ESS3.C, ESS3.D ETS1.A, ETS1.B, ETS1.C	Primary: P1, P2, P3… Elementary: E1, E2, E3… Middle: M1, M2, M3… High: H1, H2, H3…
Crosscutting Concepts	CCC	**PAT:** **Pat**terns **CE:** **C**ause and **E**ffect: Mechanism and Explanation **SPQ:** **S**cale, **P**roportion, and **Q**uantity **SYS:** **Sys**tems and Systems Models **EM:** **E**nergy and **M**atter: Flow, Cycles, and Conservation **SF:** **S**tructure and **F**unction **SC:** **S**tability and **C**hange	Primary: P1, P2, P3… Elementary: E1, E2, E3… Middle: M1, M2, M3… High: H1, H2, H3…

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Dimension	Code for the Dimension	Code for the Part of the Dimension	Code for Grade and Item in the List
Connections to Engineering	ENG	**INFLU: Influ**ence of Science, Engineering, and Technology on Society and the Natural World **INTER: Inter**dependence of Science, Engineering, and Technology	Primary: P1, P2, P3… Elementary: E1, E2, E3… Middle: M1, M2, M3… High: H1, H2, H3…
Connections to Nature of Science	NOS	**VOM:** Scientific Investigations Use a **V**ariety **of M**ethods **BEE:** Science Knowledge Is **B**ased on **E**mpirical **E**vidence **OTR:** Scientific Knowledge Is **O**pen **t**o **R**evision in Light of New Evidence **ENP:** Science Models, Laws, Mechanisms, and Theories **E**xplain **N**atural **P**henomena **WOK:** Science Is a **W**ay **of K**nowing **AOC:** Scientific Knowledge **A**ssumes an **O**rder and **C**onsistency in Natural Systems **HE:** Science Is a **H**uman **E**ndeavor **AQAW:** Science **A**ddresses **Q**uestions **A**bout the Natural and Material **W**orld	Primary: P1, P2, P3… Elementary: E1, E2, E3… Middle: M1, M2, M3… High: H1, H2, H3…

Examples*

SEP-MOD-M4: Use and/or develop a model of simple systems with uncertain and less predictable factors.

DCI-PS3.C-E2: Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

CCC-SPQ-H5: Patterns observable at one scale may not be observable or exist at other scales.

ENG-INTER-P1: Science and engineering involve the use of tools to observe and measure things.

NOS-WAK-E2: Science is a way of knowing that is used by many people.

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Disciplinary Core Ideas

Disciplinary Core Ideas in Physical Science

PS1: Matter and Its Interactions

PS1.A:	Structure and Properties of Matter
PS1.B:	Chemical Reactions
PS1.C:	Nuclear Processes

PS2: Motion and Stability: Forces and Interactions

PS2.A:	Forces and Motion
PS2.B:	Types of Interactions
PS2.C	Stability and Instability in Physical Systems

PS3: Energy

PS3.A:	Definitions of Energy
PS3.B:	Conservation of Energy and Energy Transfer
PS3.C:	Relationship Between Energy and Forces
PS3.D:	Energy in Chemical Processes and Everyday Life

PS4: Waves and Their Applications in Technologies for Information Transfer

PS4.A:	Wave Properties
PS4.B:	Electromagnetic Radiation
PS4.C:	Information Technologies and Instrumentation

Disciplinary Core Ideas in Life Science

LS1: From Molecules to Organisms: Structures and Processes

LS1.A:	Structure and Function
LS1.B:	Growth and Development of Organisms
LS1.C:	Organization for Matter and Energy Flow in Organisms
LS1.D:	Information Processing

LS2: Ecosystems: Interactions, Energy, and Dynamics

LS2.A:	Interdependent Relationships in Ecosystems
LS2.B:	Cycles of Matter and Energy Transfer in Ecosystems
LS2.C:	Ecosystem Dynamics, Functioning, and Resilience
LS2.D:	Social Interactions and Group Behavior

LS3: Heredity: Inheritance and Variation of Traits

LS3.A:	Inheritance of Traits
LS3.B:	Variation of Traits

LS4: Biological Evolution: Unity and Diversity

LS4.A:	Evidence of Common Ancestry and Diversity
LS4.B:	Natural Selection
LS4.C:	Adaptation
LS4.D:	Biodiversity and Humans

Disciplinary Core Ideas in Earth and Space Science

ESS1: Earth's Place in the Universe

ESS1.A:	The Universe and Its Stars
ESS1.B:	Earth and the Solar System
ESS1.C:	The History of Planet Earth

ESS2: Earth's Systems

ESS2.A:	Earth Materials and Systems
ESS2.B:	Plate Tectonics and Large-Scale System Interactions
ESS2.C:	The Roles of Water in Earth's Surface Processes
ESS2.D:	Weather and Climate
ESS2.E:	Biogeology

ESS3: Earth and Human Activity

ESS3.A:	Natural Resources
ESS3.B:	Natural Hazards
ESS3.C:	Human Impacts on Earth Systems
ESS3.D:	Global Climate Change

Disciplinary Core Ideas in Engineering, Technology, and Applications of Science

ETS1: Engineering Design

ETS1.A:	Defining and Delimiting an Engineering Problem
ETS1.B:	Developing Possible Solutions
ETS1.C:	Optimizing the Design Solution

How to read the element codes

Element Codes

Topic Code ——

Grade Span ——
- P = Primary (K-2)
- E = Elementary (3-5)
- M = Middle School (6-8)
- H = High School (9-12)

PS1.A-M1

Element Number

Whether it the 1st, 2nd, 3rd, etc. element for the topic in that grade span

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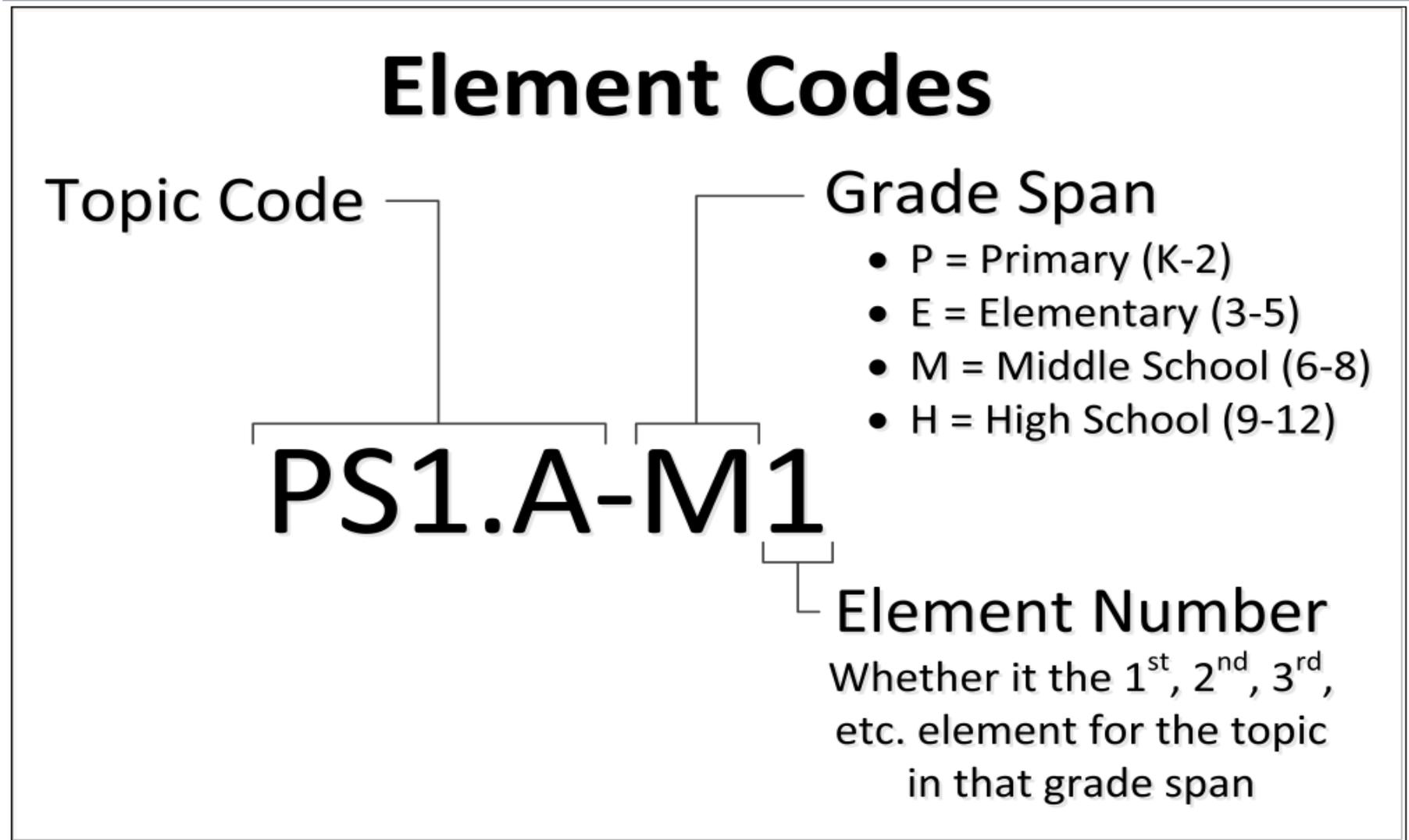
	Primary (K-2)	Elementary (3-5)	Middle School (6-8)	High School (9-12)
AQPD	AQDP-P1, AQDP-P2, AQDP-P3	AQDP-E1, AQDP-E2, AQDP-E3, AQDP-E4, AQDP-E5	AQDP-M1, AQDP-M2, AQDP-M3, AQDP-M4, AQDP-M5, AQDP-M6, AQDP-M7, AQDP-M8	AQDP-H1, AQDP-H2, AQDP-H3, AQDP-H4, AQDP-H5, AQDP-H6, AQDP-H7, AQDP-H8, AQDP-H9
MOD	MOD-P1, MOD-P2, MOD-P3, MOD-P4,	MOD-E1, MOD-E2, MOD-E3, MOD-E4, MOD-E5, MOD-E6	MOD-M1, MOD-M2, MOD-M3, MOD-M4, MOD-M5, MOD-M6, MOD-M7	MOD-H1, MOD-H2, MOD-H3, MOD-H4, MOD-H5, MOD-H6, MOD-H7
INV	INV-P1, INV-P2, INV-P3, INV-P4, INV-P5, INV-P6	INV-E1, INV-E2, INV-E3, INV-E4, INV-E5	INV-M1, INV-M2, INV-M3, INV-M4, INV-M5	INV-H1, INV-H2, INV-H3, INV-H4, INV-H5, INV-H6
DATA	DATA-P1, DATA-P2, DATA-P3, DATA-P4, DATA-P5	DATA-E1, DATA-E2, DATA-E3, DATA-E4, DATA-E5	DATA-M1, DATA-M2, DATA-M3, DATA-M4, DATA-M5, DATA-M6, DATA-M7, DATA-M8	DATA-H1, DATA-H2, DATA-H3, DATA-H4, DATA-H5, DATA-H6
MATH	MATH-P1, MATH-P2, MATH-P3, MATH-P4,	MATH-E1, MATH-E2, MATH-E3, MATH-E4	MATH-M1, MATH-M2, MATH-M3, MATH-M4, MATH-M5	MATH-H1, MATH-H2, MATH-H3, MATH-H4, MATH-H5, MATH-H6
CEDS	CEDS-P1, CEDS-P2, CEDS-P3	CEDS-E1, CEDS-E2, CEDS-E3, CEDS-E4, CEDS-E5	CEDS-M1, CEDS-M2, CEDS-M3, CEDS-M4, CEDS-M5, CEDS-M6, CEDS-M7, CEDS-M8	CEDS-H1, CEDS-H2, CEDS-H3, CEDS-H4, CEDS-H5
ARG	ARG-P1, ARG-P2, ARG-P3, ARG-P4, ARG-P5, ARG-P6, ARG-P7	ARG-E1, ARG-E2, ARG-E3, ARG-E4, ARG-E5, ARG-E6	ARG-M1, ARG-M2, ARG-M3, ARG-M4, ARG-M5	ARG-H1, ARG-H2, ARG-H3, ARG-H4, ARG-H5, ARG-H6

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	Primary (K-2)	Elementary (3-5)	Middle School (6-8)	High School (9-12)
INFO	INFO-P1, INFO-P2, INFO-P3, INFO-P4	INFO-E1, INFO-E2, INFO-E3, INFO-E4, INFO-E5	INFO-M1, INFO-M2, INFO-M3, INFO-M4, INFO-M5	INFO-H1, INFO-H2, INFO-H3, INFO-H4, INFO-H5
PAT	PAT-P1	PAT-E1, PAT-E2, PAT-E3	PAT-M1, PAT-M2, PAT-M3, PAT-M4	PAT-H1, PAT-H2, PAT-H3, PAT-H4, PAT-H5
CE	CE-P1, CE-P2	CE-E1, CE-E2	CE-M1, CE-M2, CE-M3	CE-H1, CE-H2, CE-H3, CE-H4
SPQ	SPQ-P1, SPQ-P2	SPQ-E1, SPQ-E2	SPQ-M1, SPQ-M2, SPQ-M3, SPQ-M4, SPQ-M5	SPQ-H1, SPQ-H2, SPQ-H3, SPQ-H4, SPQ-H5
SYS	SYS-P1, SYS-P2	SYS-E1, SYS-E2	SYS-M1, SYS-M2, SYS-M3	SYS-H1, SYS-H2, SYS-H3, SYS-H4
EM	EM-P1	EM-E1, EM-E2, EM-E3	EM-M1, EM-M2, EM-M3, EM-M4	EM-H1, EM-H2, EM-H3, EM-H4, EM-H5
SF	SF-P1	SF-E1, SF-E2	SF-M1, SF-M2	SF-H1, SF-H2
SC	SC-P1, SC-P2	SC-E1, SC-E2	SC-M1, SC-M2, SC-M3, SC-M4	SC-H1, SC-H2, SC-H3, SC-H4
PS1.A	PS1.A-P1, PS1.A-P2, PS1.A-P3	PS1.A-E1, PS1.A-E2, PS1.A-E3	PS1.A-M1, PS1.A-M2, PS1.A-M3, PS1.A-M4, PS1.A-M5, PS1.A-M6	PS1.A-H1, PS1.A-H2, PS1.A-H3, PS1.A-H4
PS1.B	PS1.B-P1	PS1.B-E1, PS1.B-E2	PS1.B-M1, PS1.B-M2, PS1.B-M3	PS1.B-H1, PS1.B-H2, PS1.B-H3
PS1.C				PS1.C-H1, PS1.C-H2
PS2.A	PS2.A-P1, PS2.A-P2, PS2.A-E1	PS2.A-E2	PS2.A-M1, PS2.A-M2, PS2.A-M3	PS2.A-H1, PS2.A-H2, PS2.A-H3
PS2.B	PS2.B-P1	PS2.B-E1, PS2.B-E2, PS2.B-E3	PS2.B-M1, PS2.B-M2, PS2.B-M3	PS2.B-H1, PS2.B-H2, PS2.B-H3
PS3.A		PS3.A-E1, PS3.A-E2	PS3.A-M1, PS3.A-M2, PS3.A-M3, PS3.A-M4	PS3.A-H1, PS3.A-H2, PS3.A-H3, PS3.A-H4
PS3.B	PS3.B-P1	PS3.B-E1, PS3.B-E2, PS3.B-E3	PS3.B-M1, PS3.B-M2, PS3.B-M3	PS3.B-H1, PS3.B-H2, PS3.B-H3, PS3.B-H4, PS3.B-H5
PS3.C	PS3.C-P1	PS3.C-E1	PS3.C-M1	PS3.C-H1
PS3.D		PS3.D-E1, PS3.D-E2	PS3.D-M1, PS3.D-M2	PS3.D-H1, PS3.D-H2, PS3.D-H3, PS3.D-H4
PS4.A	PS4.A-P1	PS4.A-E1, PS4.A-E2	PS4.A-M1, PS4.A-M2	PS4.A-H1, PS4.A-H2, PS4.A-H3, PS4.A-H4
PS4.B	PS4.B-P1, PS4.B-P2	PS4.B-E1	PS4.B-M1, PS4.B-M2, PS4.B-M3, PS4.B-M4	PS4.B-H1, PS4.B-H2, PS4.B-H3, PS4.B-H4
PS4.C	PS4.C-P1	PS4.C-E1	PS4.C-M1	PS4.C-H1

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LS1.A	LS1.A-P1	LS1.A-E1	LS1.A-M1, LS1.A-M2, LS1.A-M3	LS1.A-H1, LS1.A-H2, LS1.A-H3, LS1.A-H4
LS1.B	LS1.B-P1	LS1.B-E1	LS1.B-M1, LS1.B-M2, LS1.B-M3, LS1.B-M4	LS1.B-H1
LS1.C	LS1.C-P1	LS1.C-E1, LS1.C-E2	LS1.C-M1, LS1.C-M2	LS1.C-H1, LS1.C-H2, LS1.C-H3, LS1.C-H4
LS1.D	LS1.D-P1	LS1.D-E1	LS1.D-M1	
LS2.A	LS2.A-P1, LS2.A-P2	LS2.A-E1	LS2.A-M1, LS2.A-M2, LS2.A-M3, LS2.A-M4	LS2.A-H1
LS2.B		LS2.B-E1	LS2.B-M1	LS2.B-H1, LS2.B-H2, LS2.B-H3
LS2.C		LS2.C-E1	LS2.C-M1, LS2.C-M2	LS2.C-H1, LS2.C-H2
LS2.D		LS2.D-E1		LS2.D-H1
LS3.A	LS3.A-P1	LS3.A-E1, LS3.A-E2	LS3.A-M1, LS3.A-M2	LS3.A-H1
LS3.B	LS3.B-P1	LS3.B-E1, LS3.B-E2	LS3.B-M1, LS3.B-M2	LS3.B-H1, LS3.B-H2
LS4.A		LS4.A-E1, LS4.A-E2	LS4.A-M1, LS4.A-M2, LS4.A-M3	LS4.A-H1
LS4.B		LS4.B-E1	LS4.B-M1, LS4.B-M2	LS4.B-H1, LS4.B-H2
LS4.C		LS4.C-E1	LS4.C-M1	LS4.C-H1, LS4.C-H2, LS4.C-H3, LS4.C-H4, LS4.C-H5
LS4.D	LS4.D-P1	LS4.D-E1	LS4.D-M1	LS4.D-H1, LS4.D-H2
ESS1.A	ESS1.A-P1	ESS1.A-E1	ESS1.A-M1, ESS1.A-M2	ESS1.A-H1, ESS1.A-H2, ESS1.A-H3, ESS1.A-H4
ESS1.B	ESS1.B-P1	ESS1.B-E1	ESS1.B-M1, ESS1.B-M2, ESS1.B-M3	ESS1.B-H1, ESS1.B-H2
ESS1.C	ESS1.C-P1	ESS1.C-E1	ESS1.C-M1, ESS1.C-M2	ESS1.C-H1, ESS1.C-H2
ESS2.A	ESS2.A-P1	ESS2.A-E1, ESS2.A-E2	ESS2.A-M1, ESS2.A-M2	ESS2.A-H1, ESS2.A-H2, ESS2.A-H3
ESS2.B	ESS2.B-P1	ESS2.B-E1	ESS2.B-M1	ESS2.B-H1, ESS2.B-H2, ESS2.B-H3
ESS2.C	ESS2.C-P1	ESS2.C-E1	ESS2.C-M1, ESS2.C-M2, ESS2.C-M3, ESS2.C-M4, ESS2.C-M5	ESS2.C-H1
ESS2.D	ESS2.D-P1	ESS2.D-E1, ESS2.D-E2	ESS2.D-M1, ESS2.D-M2, ESS2.D-M3	ESS2.D-H1, ESS2.D-H2, ESS2.D-H3, ESS2.D-H4
ESS2.E	ESS2.E-P1	ESS2.E-E1		ESS2.E-H1

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ESS3.A	ESS3.A-P1	ESS3.A-E1	ESS3.A-M1	ESS3.A-H1, ESS3.A-H2
ESS3.B	ESS3.B-P1	ESS3.B-E1	ESS3.B-M1	ESS3.B-H1
ESS3.C	ESS3.C-P1	ESS3.C-E1	ESS3.C-M1, ESS3.C-M2	ESS3.C-H1, ESS3.C-H2
ESS3.D			ESS3.D-M1	ESS3.D-H1, ESS3.D-H2
ETS1.A	ETS1.A-P1, ETS1.A-P2, ETS1.A-P3	ETS1.A-E1	ETS1.A-M1	ETS1.A-H1, ETS1.A-H2
ETS1.B	ETS1.B-P1	ETS1.B-E1, ETS1.B-E2, ETS1.B-E3	ETS1.B-M1, ETS1.B-M2, ETS1.B-M3, ETS1.B-M4	ETS1.B-H1, ETS1.B-H2
ETS1.C	ETS1.C-P1	ETS1.C-E1	ETS1.C-M1, ETS1.C-M2	ETS1.C-H1
VOM	VOM-P1, VOM-P2	VOM-E1, VOM-E2	VOM-M1, VOM-M2, VOM-M3, VOM-M4	VOM-H1, VOM-H2, VOM-H3, VOM-H4, VOM-H5
BEE	BEE-P1	BEE-E1, BEE-E2	BEE-M1, BEE-M2	BEE-H1, BEE-H2, BEE-H3, BEE-H4
OTR	OTR-P1	OTR-E1	OTR-M1, OTR-M2, OTR-M3	OTR-H1, OTR-H2, OTR-H3
ENP	ENP-P1, ENP-P2	ENP-E1, ENP-E2	ENP-M1, ENP-M2, ENP-M3, ENP-M4, ENP-M5	ENP-H1, ENP-H2, ENP-H3, ENP-H4, ENP-H5
WOK	WOK-P1	WOK-E1, WOK-E2	WOK-M1, WOK-M2, WOK-M3	WOK-H1, WOK-H2, WOK-H3, WOK-H4
AOC	AOC-P1, AOC-P2	AOC-E1, AOC-E2	AOC-M1, AOC-M2	AOC-H1, AOC-H2
HE	HE-P1, HE-P2	HE-E1, HE-E2, HE-E3, HE-E4	HE-M1, HE-M2, HE-M3, HE-M4	HE-H1, HE-H2, HE-H3, HE-H4, HE-H5
AQAW	AQAW-P1	AQAW-E1	AQAW-M1, AQAW-M2, AQAW-M3	AQAW-H1, AQAW-H2, AQAW-H3, AQAW-H4
INTER	INTER-P1	INTER-E1, INTER-E2, INTER-E3, INTER-E4	INTER-M1, INTER-M2	INTER-H1, INTER-H2
INFLU	INFLU-P1, INFLU-P2, INFLU-P3	INFLU-E1, INFLU-E2, INFLU-E3	INFLU-M1, INFLU-M2, INFLU-M3, INFLU-M4	INFLU-H1, INFLU-H2, INFLU-H3, INFLU-H4

PE Code	PerformanceExpectation
K-PS2-1	Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
K-PS2-2	Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.
K-PS3-1	Make observations to determine the effect of sunlight on Earth's surface.
K-PS3-2	Use tools and materials provided to design and build a structure that will reduce the warming effect of sunlight on an area.
K-LS1-1	Use observations to describe patterns of what plants and animals (including humans) need to survive.
K-ESS2-1	Use and share observations of local weather conditions to describe patterns over time.
K-ESS2-2	Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.
K-ESS3-1	Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.
K-ESS3-2	Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.
K-ESS3-3	Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
1-PS4-1	Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.
1-PS4-2	Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated.
1-PS4-3	Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.
1-PS4-4	Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.
1-LS1-1	Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.
1-LS1-2	Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.
1-LS3-1	Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.
1-ESS1-1	Use observations of the sun, moon, and stars to describe patterns that can be predicted.
1-ESS1-2	Make observations at different times of year to relate the amount of daylight to the time of year.
2-PS1-1	Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

This coding system was developed for the soon to be published NSTA Press Book Mapping the NGSS—An NSTA Atlas by Ted Willard

PE Code	PerformanceExpectation
2-PS1-2	Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
2-PS1-3	Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.
2-PS1-4	Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
2-LS2-1	Plan and conduct an investigation to determine if plants need sunlight and water to grow.
2-LS2-2	Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.
2-LS4-1	Make observations of plants and animals to compare the diversity of life in different habitats.
2-ESS1-1	Use information from several sources to provide evidence that Earth events can occur quickly or slowly.
2-ESS2-1	Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.
2-ESS2-2	Develop a model to represent the shapes and kinds of land and bodies of water in an area.
2-ESS2-3	Obtain information to identify where water is found on Earth and that it can be solid or liquid.
K-2-ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2-ETS1-2	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
K-2-ETS1-3	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
3-PS2-1	Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
3-PS2-2	Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
3-PS2-3	Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
3-PS2-4	Define a simple design problem that can be solved by applying scientific ideas about magnets.
3-LS1-1	Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
3-LS2-1	Construct an argument that some animals form groups that help members survive.
3-LS3-1	Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
3-LS3-2	Use evidence to support the explanation that traits can be influenced by the environment.

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PE Code	PerformanceExpectation
3-LS4-1	Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
3-LS4-2	Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.
3-LS4-3	Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
3-LS4-4	Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
3-ESS2-1	Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
3-ESS2-2	Obtain and combine information to describe climates in different regions of the world.
3-ESS3-1	Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.
4-PS3-1	Use evidence to construct an explanation relating the speed of an object to the energy of that object.
4-PS3-2	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
4-PS3-3	Ask questions and predict outcomes about the changes in energy that occur when objects collide.
4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
4-PS4-1	Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
4-PS4-2	Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
4-PS4-3	Generate and compare multiple solutions that use patterns to transfer information.
4-LS1-1	Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
4-LS1-2	Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.
4-ESS1-1	Identify evidence from patterns in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time.
4-ESS2-1	Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
4-ESS2-2	Analyze and interpret data from maps to describe patterns of Earth's features.
4-ESS3-1	Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

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PE Code	PerformanceExpectation
5-PS1-1	Develop a model to describe that matter is made of particles too small to be seen.
5-PS1-2	Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.
5-PS1-3	Make observations and measurements to identify materials based on their properties.
5-PS1-4	Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
5-PS2-1	Support an argument that the gravitational force exerted by Earth on objects is directed down.
5-PS3-1	Use models to describe that that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.
5-LS1-1	Support an argument that plants get the materials they need for growth chiefly from air and water.
5-LS2-1	Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
5-ESS1-1	Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from the Earth.
5-ESS1-2	Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.
5-ESS2-1	Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
5-ESS2-2	Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
5-ESS3-1	Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-PS1-1	Develop models to describe the atomic composition of simple molecules and extended structures.
MS-PS1-2	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
MS-PS1-3	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
MS-PS1-4	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

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PE Code	PerformanceExpectation
MS-PS1-5	Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
MS-PS1-6	Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
MS-PS2-3	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
MS-PS3-1	Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
MS-PS3-2	Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
MS-PS3-3	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
MS-PS3-4	Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
MS-PS3-5	Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.
MS-PS4-1	Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
MS-PS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
MS-PS4-3	Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.
MS-LS1-1	Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
MS-LS1-2	Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
MS-LS1-3	Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

PE Code	PerformanceExpectation
MS-LS1-4	Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
MS-LS1-5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
MS-LS1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
MS-LS1-7	Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
MS-LS1-8	Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-LS2-5	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
MS-LS3-1	Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
MS-LS3-2	Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
MS-LS4-1	Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.
MS-LS4-2	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
MS-LS4-3	Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.
MS-LS4-4	Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

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PE Code	PerformanceExpectation
MS-LS4-5	Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.
MS-LS4-6	Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.
MS-ESS1-1	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
MS-ESS1-2	Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
MS-ESS1-3	Analyze and interpret data to determine scale properties of objects in the solar system.
MS-ESS1-4	Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.
MS-ESS2-1	Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
MS-ESS2-3	Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.
MS-ESS2-4	Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
MS-ESS2-5	Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
MS-ESS2-6	Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
MS-ESS3-1	Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.
MS-ESS3-2	Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS3-4	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-ESS3-5	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions

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PE Code	PerformanceExpectation
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
HS-PS1-1	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
HS-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
HS-PS1-3	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
HS-PS1-4	Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
HS-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
HS-PS1-6	Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
HS-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
HS-PS2-1	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
HS-PS2-2	Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
HS-PS2-3	Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
HS-PS2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-5	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

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PE Code	PerformanceExpectation
HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
HS-PS3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
HS-PS3-4	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
HS-PS3-5	Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information.
HS-PS4-3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
HS-PS4-4	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
HS-LS1-1	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
HS-LS1-2	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
HS-LS1-3	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
HS-LS1-4	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
HS-LS1-6	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

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PE Code	PerformanceExpectation
HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
HS-LS2-1	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales
HS-LS2-2	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
HS-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
HS-LS2-4	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem
HS-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
HS-LS2-6	Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-LS2-8	Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
HS-LS3-1	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
HS-LS3-2	Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
HS-LS3-3	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
HS-LS4-2	Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
HS-LS4-3	Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

PE Code	PerformanceExpectation
HS-LS4-4	Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
HS-LS4-5	Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
HS-ESS1-1	Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation.
HS-ESS1-2	Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
HS-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements.
HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
HS-ESS1-5	Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
HS-ESS1-6	Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
HS-ESS2-1	Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
HS-ESS2-3	Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
HS-ESS3-3	Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

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PE Code	PerformanceExpectation
HS-ESS3-5	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

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Practice Element Code	Practice Element Text
AQDP-P1	Ask questions based on observations to find more information about the natural and/or designed world(s).
AQDP-P2	Ask and/or identify questions that can be answered by an investigation.
AQDP-P3	Define a simple problem that can be solved through the development of a new or improved object or tool.
AQDP-E1	Ask questions about what would happen if a variable is changed.
AQDP-E2	Identify scientific (testable) and non-scientific (non-testable) questions.
AQDP-E3	Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
AQDP-E4	Use prior knowledge to describe problems that can be solved.
AQDP-E5	Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.
AQDP-M1	Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
AQDP-M2	Ask questions to identify and/or clarify evidence and/or the premise(s) of an argument.
AQDP-M3	Ask questions to determine relationships between independent and dependent variables and relationships in models.
AQDP-M4	Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.
AQDP-M5	Ask questions that require sufficient and appropriate empirical evidence to answer.
AQDP-M6	Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.
AQDP-M7	Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.
AQDP-M8	Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.
AQDP-H1	Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
AQDP-H2	Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
AQDP-H3	Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.
AQDP-H4	Ask questions to clarify and refine a model, an explanation, or an engineering problem.
AQDP-H5	Evaluate a question to determine if it is testable and relevant.

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Practice Element Code	Practice Element Text
AQDP-H6	Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
AQDP-H7	Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of the design.
AQDP-H8	Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations.
AQDP-H9	Analyze complex real-world problems by specifying criteria and constraints for successful solutions.
MOD-P1	Distinguish between a model and the actual object, process, and/or events the model represents.
MOD-P2	Compare models to identify common features and differences.
MOD-P3	Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).
MOD-P4	Develop a simple model based on evidence to represent a proposed object or tool.
MOD-E1	Identify limitations of models.
MOD-E2	Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.
MOD-E3	Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.
MOD-E4	Develop and/or use models to describe and/or predict phenomena.
MOD-E5	Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.
MOD-E6	Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.
MOD-M1	Evaluate limitations of a model for a proposed object or tool.
MOD-M2	Develop or modify a model— based on evidence—to match what happens if a variable or component of a system is changed.
MOD-M3	Use and/or develop a model of simple systems with uncertain and less predictable factors.
MOD-M4	Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.
MOD-M5	Develop and/or use a model to predict and/or describe phenomena.
MOD-M6	Develop a model to describe unobservable mechanisms.
MOD-M7	Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.

Practice Element Code	Practice Element Text
MOD-H1	Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria.
MOD-H2	Design a test of a model to ascertain its reliability.
MOD-H3	Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
MOD-H4	Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.
MOD-H5	Use a model to provide mechanistic accounts of phenomena.
MOD-H6	Develop a complex model that allows for manipulation and testing of a proposed process or system.
MOD-H7	Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
INV-P1	With guidance, plan and conduct an investigation in collaboration with peers.
INV-P2	Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
INV-P3	Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.
INV-P4	Make observations (firsthand or from media) to collect data that can be used to make comparisons.
INV-P5	Make observations (firsthand or from media) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal.
INV-P6	Make predictions based on prior experiences.
INV-E1	Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
INV-E2	Evaluate appropriate methods and/or tools for collecting data.
INV-E3	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
INV-E4	Make predictions about what would happen if a variable changes.
INV-E5	Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.
INV-M1	Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
INV-M2	Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.

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Practice Element Code	Practice Element Text
INV-M3	Evaluate the accuracy of various methods for collecting data.
INV-M4	Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.
INV-M5	Collect data about the performance of a proposed object, tool, process, or system under a range of conditions.
INV-H1	Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible variables or effects and evaluate the confounding investigation's design to ensure variables are controlled.
INV-H2	Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
INV-H3	Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.
INV-H4	Select appropriate tools to collect, record, analyze, and evaluate data.
INV-H5	Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.
INV-H6	Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.
DATA-P1	Record information (observations, thoughts, and ideas).
DATA-P2	Use and share pictures, drawings, and/or writings of observations.
DATA-P3	Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.
DATA-P4	Compare predictions (based on prior experiences) to what occurred (observable events).
DATA-P5	Analyze data from tests of an object or tool to determine if it works as intended.
DATA-E1	Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.
DATA-E2	Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.
DATA-E3	Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
DATA-E4	Analyze data to refine a problem statement or the design of a proposed object, tool, or process.

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Practice Element Code	Practice Element Text
DATA-E5	Use data to evaluate and refine design solutions.
DATA-M1	Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.
DATA-M2	Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.
DATA-M3	Distinguish between causal and correlational relationships in data.
DATA-M4	Analyze and interpret data to provide evidence for phenomena.
DATA-M5	Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible.
DATA-M6	Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).
DATA-M7	Analyze and interpret data to determine similarities and differences in findings.
DATA-M8	Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.
DATA-H1	Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
DATA-H2	Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
DATA-H3	Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.
DATA-H4	Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.
DATA-H5	Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.
DATA-H6	Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.
MATH-P1	Decide when to use qualitative vs. quantitative data.
MATH-P2	Use counting and numbers to identify and describe patterns in the natural and designed world(s).
MATH-P3	Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.
MATH-P4	Use quantitative data to compare two alternative solutions to a problem.
MATH-E1	Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success.

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Practice Element Code	Practice Element Text
MATH-E2	Organize simple data sets to reveal patterns that suggest relationships.
MATH-E3	Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.
MATH-E4	Create and/or use graphs and/or charts generated from simple algorithms to compare alternative solutions to an engineering problem.
MATH-M1	Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends.
MATH-M2	Use mathematical representations to describe and/or support scientific conclusions and design solutions.
MATH-M3	Create algorithms (a series of ordered steps) to solve a problem.
MATH-M4	Apply mathematical concepts and/or processes (such as ratio, rate, percent, basic operations, and simple algebra) to scientific and engineering questions and problems.
MATH-M5	Use digital tools and/or mathematical concepts and arguments to test and compare proposed solutions to an engineering design problem.
MATH-H1	Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.
MATH-H2	Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.
MATH-H3	Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
MATH-H4	Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model "makes sense" by comparing the outcomes with what is known about the real world.
MATH-H5	Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).
MATH-H6	Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.
CEDS-P1	Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.
CEDS-P2	Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.
CEDS-P3	Generate and/or compare multiple solutions to a problem.
CEDS-E1	Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).
CEDS-E2	Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
CEDS-E3	Identify the evidence that supports particular points in an explanation.

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Practice Element Code	Practice Element Text
CEDS-E4	Apply scientific ideas to solve design problems.
CEDS-E5	Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.
CEDS-M1	Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.
CEDS-M2	Construct an explanation using models or representations.
CEDS-M3	Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
CEDS-M4	Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.
CEDS-M5	Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.
CEDS-M6	Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.
CEDS-M7	Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.
CEDS-M8	Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing.
CEDS-H1	Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
CEDS-H2	Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
CEDS-H3	Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
CEDS-H4	Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
CEDS-H5	Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
ARG-P1	Identify arguments that are supported by evidence.
ARG-P2	Distinguish between explanations that account for all gathered evidence and those that do not.
ARG-P3	Analyze why some evidence is relevant to a scientific question and some is not.
ARG-P4	Distinguish between opinions and evidence in one's own explanations.

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Practice Element Code	Practice Element Text
ARG-P5	Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument.
ARG-P6	Construct an argument with evidence to support a claim.
ARG-P7	Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.
ARG-E1	Compare and refine arguments based on an evaluation of the evidence presented.
ARG-E2	Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.
ARG-E3	Respectfully provide and receive critiques from peers about a proposed procedure, explanation or model by citing relevant evidence and posing specific questions.
ARG-E4	Construct and/or support an argument with evidence, data, and/or a model.
ARG-E5	Use data to evaluate claims about cause and effect.
ARG-E6	Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.
ARG-M1	Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts.
ARG-M2	Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.
ARG-M3	Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.
ARG-M4	Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system, based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.
ARG-M5	Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.
ARG-H1	Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.
ARG-H2	Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
ARG-H3	Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence and challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining what additional information is required to resolve contradictions.
ARG-H4	Construct, use, and/or present an oral and written argument or counter- arguments based on data and evidence.
ARG-H5	Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence.

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Practice Element Code	Practice Element Text
ARG-H6	Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).
INFO-P1	Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).
INFO-P2	Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.
INFO-P3	Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.
INFO-P4	Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.
INFO-E1	Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.
INFO-E2	Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.
INFO-E3	Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.
INFO-E4	Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.
INFO-E5	Communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts.
INFO-M1	Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).
INFO-M2	Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings.
INFO-M3	Gather, read, synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.
INFO-M4	Evaluate data, hypotheses, and/or conclusions in scientific and technical texts in light of competing information or accounts.

Practice Element Code	Practice Element Text
INFO-M5	Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.
INFO-H1	Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
INFO-H2	Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.
INFO-H3	Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.
INFO-H4	Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.
INFO-H5	Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

DCI Element Code	DCI Element Text
PS1.A-P1	Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties
PS1.A-P2	Different properties are suited to different purposes.
PS1.A-P3	A great variety of objects can be built up from a small set of pieces.
PS1.A-E1	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 showing 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 and the effects of air on larger particles or objects.
PS1.A-E2	The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.
PS1.A-E3	Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)
PS1.A-M1	Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.
PS1.A-M2	Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.
PS1.A-M3	Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.
PS1.A-M4	In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.
PS1.A-M5	Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).
PS1.A-M6	The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.
PS1.A-H1	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
PS1.A-H2	The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.
PS1.A-H3	The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
PS1.A-H4	Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy, by an amount known as the binding energy, than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.

DCI Element Code	DCI Element Text
PS1.B-P1	Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.
PS1.B-E1	When two or more different substances are mixed, a new substance with different properties may be formed.
PS1.B-E2	No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.)
PS1.B-M1	Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.
PS1.B-M2	The total number of each type of atom is conserved, and thus the mass does not change.
PS1.B-M3	Some chemical reactions release energy, others store energy.
PS1.B-H1	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.
PS1.B-H2	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.
PS1.B-H3	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.
PS1.C-H1	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.
PS1.C-H2	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.
PS2.A-P1	Pushes and pulls can have different strengths and directions.
PS2.A-P2	Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.
PS2.A-E1	Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)
PS2.A-E2	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.)
PS2.A-M1	For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).

DCI Element Code	DCI Element Text
PS2.A-M2	The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.
PS2.A-M3	All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.
PS2.A-H1	Newton's second law accurately predicts changes in the motion of macroscopic objects.
PS2.A-H2	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.
PS2.A-H3	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.
PS2.B-P1	When objects touch or collide, they push on one another and can change motion.
PS2.B-E1	Objects in contact exert forces on each other.
PS2.B-E2	Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.
PS2.B-E3	The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.
PS2.B-M1	Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects..
PS2.B-M2	Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass-e.g., Earth and the Sun.
PS2.B-M3	Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, a magnet, or a ball, respectively).
PS2.B-H1	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.
PS2.B-H2	Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.
PS2.B-H3	Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
PS3.A-E1	The faster a given object is moving, the more energy it possesses.
PS3.A-E2	Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

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DCI Element Code	DCI Element Text
PS3.A-M1	Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.
PS3.A-M2	A system of objects may also contain stored (potential) energy, depending on their relative positions.
PS3.A-M3	The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.
PS3.A-M4	The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material.
PS3.A-H1	Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
PS3.A-H2	At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
PS3.A-H3	"Electrical energy" may mean energy stored in a battery or energy transmitted by electrical currents..
PS3.A-H4	These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.
PS3.B-P1	Sunlight warms Earth's surface.
PS3.B-E1	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.
PS3.B-E2	Light also transfers energy from place to place.
PS3.B-E3	Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

DCI Element Code	DCI Element Text
PS3.B-M1	When the motion energy of an object changes, there is inevitably some other change in energy at the same time.
PS3.B-M2	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.
PS3.B-M3	Energy is spontaneously transferred out of hotter regions or objects and into colder ones.
PS3.B-H1	Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
PS3.B-H2	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
PS3.B-H3	Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
PS3.B-H4	The availability of energy limits what can occur in any system.
PS3.B-H5	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).
PS3.C-P1	A bigger push or pull makes things speed up or slow down more quickly.
PS3.C-E1	When objects collide, the contact forces transfer energy so as to change the objects' motions.
PS3.C-M1	When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.
PS3.C-H1	When two objects interacting through a field change relative position, the energy stored in the field is changed.
PS3.D-E1	The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.
PS3.D-E2	The energy released [from] food was once energy from the Sun that was captured by plants in the chemical process that forms plant matter (from air and water).
PS3.D-M1	The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen.
PS3.D-M2	Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.
PS3.D-H1	Nuclear fusion processes in the center of the Sun release the energy that ultimately reaches Earth as radiation.
PS3.D-H2	The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.
PS3.D-H3	Solar cells are human-made devices that likewise capture the Sun's energy and produce electrical energy.

DCI Element Code	DCI Element Text
PS3.D-H4	Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.
PS4.A-P1	Sound can make matter vibrate, and vibrating matter can make sound.
PS4.A-E1	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; there is no net motion in the direction of the wave except when the water meets a beach.
PS4.A-E2	Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).
PS4.A-M1	A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.
PS4.A-M2	A sound wave needs a medium through which it is transmitted.
PS4.A-H1	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.)
PS4.A-H2	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.
PS4.A-H3	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.
PS4.A-H4	Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.
PS4.B-P1	Objects can be seen only when light is available to illuminate them. Some objects give off their own light.
PS4.B-P2	Some materials allow light to pass through them, others allow only some light through, and still others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.)
PS4.B-E1	An object can be seen when light reflected from its surface enters the eyes.
PS4.B-M1	When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.
PS4.B-M2	The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.
PS4.B-M3	A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media.
PS4.B-M4	However, because light can travel through space, it cannot be a matter wave, like sound or water waves.

DCI Element Code	DCI Element Text
PS4.B-H1	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.
PS4.B-H2	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.
PS4.B-H3	Photovoltaic materials emit electrons when they absorb light of a high-enough frequency.
PS4.B-H4	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.
PS4.C-P1	People use a variety of devices to communicate (send and receive information) over long distances.
PS4.C-E1	Digitized information can be 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.
PS4.C-M1	Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.
PS4.C-H1	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.
LS1.A-P1	All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow.
LS1.A-E1	Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.
LS1.A-M1	All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).
LS1.A-M2	Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.
LS1.A-M3	In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.
LS1.A-H1	Systems of specialized cells within organisms help them perform the essential functions of life.
LS1.A-H2	All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.

DCI Element Code	DCI Element Text
LS1.A-H3	Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.
LS1.A-H4	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.
LS1.B-P1	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.
LS1.B-E1	Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.
LS1.B-M1	Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.
LS1.B-M2	Animals engage in characteristic behaviors that increase the odds of reproduction.
LS1.B-M3	Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.
LS1.B-M4	Genetic factors as well as local conditions affect the growth of the adult plant.
LS1.B-H1	In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism.
LS1.C-P1	All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.
LS1.C-E1	Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
LS1.C-E2	Plants acquire their material for growth chiefly from air and water.
LS1.C-M1	Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.
LS1.C-M2	Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy.
LS1.C-H1	The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.

DCI Element Code	DCI Element Text
LS1.C-H2	The sugar molecules thus formed contain carbon, hydrogen, and oxygen; their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.
LS1.C-H3	As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.
LS1.C-H4	As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.
LS1.D-P1	Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs.
LS1.D-E1	Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.
LS1.D-M1	Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.
LS2.A-P1	Plants depend on water and light to grow.
LS2.A-P2	Plants depend on animals for pollination or to move their seeds around.
LS2.A-E1	The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plant parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.
LS2.A-M1	Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
LS2.A-M2	In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.
LS2.A-M3	Growth of organisms and population increases are limited by access to resources.

DCI Element Code	DCI Element Text
LS2.A-M4	Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.
LS2.A-H1	Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.
LS2.B-E1	Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment and release waste matter (gas, liquid, or solid) back into the environment.
LS2.B-M1	Food webs are models that demonstrate how matter and energy are transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.
LS2.B-H1	Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
LS2.B-H2	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.
LS2.B-H3	Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geologic, and biological processes.
LS2.C-E1	When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.

DCI Element Code	DCI Element Text
LS2.C-M1	Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.
LS2.C-M2	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.
LS2.C-H1	A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
LS2.C-H2	Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
LS2.D-E1	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
LS2.D-H1	Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.
LS3.A-P1	Young animals are very much, but not exactly, like, their parents. Plants also are very much, but not exactly, like their parents.
LS3.A-E1	Many characteristics of organisms are inherited from their parents.
LS3.A-E2	Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.
LS3.A-M1	Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.
LS3.A-M2	Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.
LS3.A-H1	Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.
LS3.B-P1	Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.

This coding system was developed for the soon to be published NSTA Press Book Mapping the NGSS—An NSTA Atlas by Ted Willard

DCI Element Code	DCI Element Text
LS3.B-E1	Different organisms vary in how they look and function because they have different inherited information.
LS3.B-E2	The environment also affects the traits that an organism develops.
LS3.B-M1	In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.
LS3.B-M2	In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.
LS3.B-H1	In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited.
LS3.B-H2	Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus, the variation and distribution of traits observed depends on both genetic and environmental factors.
LS4.A-E1	Some kinds of plants and animals that once lived on Earth are no longer found anywhere.
LS4.A-E2	Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.
LS4.A-M1	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.
LS4.A-M2	Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.
LS4.A-M3	Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully formed anatomy.
LS4.A-H1	Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.
LS4.B-E1	Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.
LS4.B-M1	Natural selection leads to the predominance of certain traits in a population, and the suppression of others.

DCI Element Code	DCI Element Text
LS4.B-M2	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.
LS4.B-H1	Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.
LS4.B-H2	The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.
LS4.C-E1	For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.
LS4.C-M1	Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.
LS4.C-H1	Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment.
LS4.C-H2	Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
LS4.C-H3	Adaptation also means that the distribution of traits in a population can change when conditions change.
LS4.C-H4	Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species.
LS4.C-H5	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.
LS4.D-P1	There are many different kinds of living things in any area, and they exist in different places on land and in water.
LS4.D-E1	Populations live in a variety of habitats, and change in those habitats affects the organisms living there.
LS4.D-M1	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.

DCI Element Code	DCI Element Text
LS4.D-H1	Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
LS4.D-H2	Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
ESS1.A-P1	Patterns of the motion of the Sun, Moon, and stars in the sky can be observed, described, and predicted.
ESS1.A-E1	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.
ESS1.A-M1	Patterns of the apparent motion of the Sun, the Moon, and stars in the sky can be observed, described, predicted, and explained with models.
ESS1.A-M2	Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.
ESS1.A-H1	The star called the Sun is changing and will burn out over a life span of approximately 10 billion years.
ESS1.A-H2	The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
ESS1.A-H3	The big bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and nonstellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.
ESS1.A-H4	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.
ESS1.B-P1	Seasonal patterns of Sunrise and Sunset can be observed, described, and predicted.
ESS1.B-E1	The orbits of Earth around the Sun and of the Moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the Sun, Moon, and stars at different times of the day, month, and year.
ESS1.B-M1	The solar system consists of the Sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the Sun by its gravitational pull on them.
ESS1.B-M2	This model of the solar system can explain eclipses of the Sun and the Moon. Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the Sun. The seasons are a result of that tilt and are caused by the differential intensity of Sunlight on different areas of Earth across the year.
ESS1.B-M3	The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.

DCI Element Code	DCI Element Text
ESS1.B-H1	Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the Sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.
ESS1.B-H2	Cyclical changes in the shape of Earth's orbit around the Sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of Sunlight falling on the Earth. These phenomena cause a cycle of ice ages and other gradual climate changes.
ESS1.C-P1	Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe.
ESS1.C-E1	Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed.
ESS1.C-M1	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.
ESS1.C-M2	Tectonic processes continually generate new ocean seafloor at ridges and destroy old seafloor at trenches.
ESS1.C-H1	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.
ESS1.C-H2	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.
ESS2.A-P1	Wind and water can change the shape of the land.
ESS2.A-E1	Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.
ESS2.A-E2	Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.
ESS2.A-M1	All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the Sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.
ESS2.A-M2	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.

DCI Element Code	DCI Element Text
ESS2.A-H1	Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
ESS2.A-H2	Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, and a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior.
ESS2.A-H3	The geologic 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.
ESS2.B-P1	Maps show where things are located. One can map the shapes and kinds of land and water in any area.
ESS2.B-E1	The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features of Earth.
ESS2.B-M1	Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart.
ESS2.B-H1	The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection.
ESS2.B-H2	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.
ESS2.B-H3	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.C-P1	Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.
ESS2.C-E1	Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.
ESS2.C-M1	Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.
ESS2.C-M2	The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.
ESS2.C-M3	Global movements of water and its changes in form are propelled by Sunlight and gravity.

DCI Element Code	DCI Element Text
ESS2.C-M4	Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.
ESS2.C-M5	Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.
ESS2.C-H1	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.
ESS2.D-P1	Weather is the combination of Sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.
ESS2.D-E1	Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.
ESS2.D-E2	Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.
ESS2.D-M1	Weather and climate are influenced by interactions involving Sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.
ESS2.D-M2	Because these patterns are so complex, weather can only be predicted probabilistically.
ESS2.D-M3	The ocean exerts a major influence on weather and climate by absorbing energy from the Sun, releasing it over time, and globally redistributing it through ocean currents.
ESS2.D-H1	The foundation for Earth's global climate systems is the electromagnetic radiation from the Sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.
ESS2.D-H2	Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
ESS2.D-H3	Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
ESS2.D-H4	Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere.
ESS2.E-P1	Plants and animals can change their environment.
ESS2.E-E1	Living things affect the physical characteristics of their regions.

DCI Element Code	DCI Element Text
ESS2.E-H1	The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.
ESS3.A-P1	Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.
ESS3.A-E1	Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.
ESS3.A-M1	Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.
ESS3.A-H1	Resource availability has guided the development of human society.
ESS3.A-H2	All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.
ESS3.B-P1	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.
ESS3.B-E1	A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts.
ESS3.B-M1	Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces, can help forecast the locations and likelihoods of future events.
ESS3.B-H1	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.
ESS3.C-P1	Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things.
ESS3.C-E1	Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.
ESS3.C-M1	Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
ESS3.C-M2	Typically as human populations and per capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
ESS3.C-H1	The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

DCI Element Code	DCI Element Text
ESS3.C-H2	Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
ESS3.D-M1	Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior, and on applying that knowledge wisely in decisions and activities.
ESS3.D-H1	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.
ESS3.D-H2	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.
ETS1.A-P1	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.
ETS1.A-P2	Asking questions, making observations, and gathering information are helpful in thinking about problems.
ETS1.A-P3	Before beginning to design a solution, it is important to clearly understand the problem.
ETS1.A-E1	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.A-M1	The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions.
ETS1.A-H1	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.
ETS1.A-H2	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.
ETS1.B-P1	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.
ETS1.B-E1	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.

DCI Element Code	DCI Element Text
ETS1.B-E2	Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.
ETS1.B-E3	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.
ETS1.B-M1	A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
ETS1.B-M2	There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem.
ETS1.B-M3	Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.
ETS1.B-M4	Models of all kinds are important for testing solutions.
ETS1.B-H1	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.
ETS1.B-H2	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.
ETS1.C-P1	Because there is always more than one possible solution to a problem, it is useful to compare and test designs.
ETS1.C-E1	Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.
ETS1.C-M1	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.
ETS1.C-M2	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.
ETS1.C-H1	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.

CCC Element Code	CCC Element Text
PAT-P1	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.
PAT-E1	Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products.
PAT-E2	Patterns of change can be used to make predictions.
PAT-E3	Patterns can be used as evidence to support an explanation.
PAT-M1	Macroscopic patterns are related to the nature of microscopic and atomic-level structure.
PAT-M2	Patterns in rates of change and other numerical relationships can provide information about natural systems.
PAT-M3	Patterns can be used to identify cause-and-effect relationships.
PAT-M4	Graphs, charts, and images can be used to identify patterns in data.
PAT-H1	Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
PAT-H2	Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments.
PAT-H3	Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.
PAT-H4	Mathematical representations are needed to identify some patterns.
PAT-H5	Empirical evidence is needed to identify patterns.
CE-P1	Simple tests can be designed to gather evidence to support or refute student ideas about causes.
CE-P2	Events have causes that generate observable patterns.
CE-E1	Cause and effect relationships are routinely identified, tested, and used to explain change.
CE-E2	Events that occur together with regularity might or might not be a cause and effect relationship.
CE-M1	Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
CE-M2	Cause and effect relationships may be used to predict phenomena in natural or designed systems.
CE-M3	Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.
CE-H1	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
CE-H2	Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
CE-H3	Systems can be designed to cause a desired effect.
CE-H4	Changes in systems may have various causes that may not have equal effects.
SPQ-P1	Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower).

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CCC Element Code	CCC Element Text
SPQ-P2	Standard units are used to measure length.
SPQ-E1	Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.
SPQ-E2	Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.
SPQ-M1	Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
SPQ-M2	The observed function of natural and designed systems may change with scale.
SPQ-M3	Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.
SPQ-M4	Scientific relationships can be represented through the use of algebraic expressions and equations.
SPQ-M5	Phenomena that can be observed at one scale may not be observable at another scale.
SPQ-H1	The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
SPQ-H2	Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
SPQ-H3	Patterns observable at one scale may not be observable or exist at other scales.
SPQ-H4	Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.
SPQ-H5	Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
SYS-P1	Objects and organisms can be described in terms of their parts.
SYS-P2	Systems in the natural and designed world have parts that work together.
SYS-E1	A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
SYS-E2	A system can be described in terms of its components and their interactions.
SYS-M1	Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.
SYS-M2	Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.
SYS-M3	Models are limited in that they only represent certain aspects of the system under study.
SYS-H1	Systems can be designed to do specific tasks.
SYS-H2	When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
SYS-H3	Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales.
SYS-H4	Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

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CCC Element Code	CCC Element Text
EM-P1	Objects may break into smaller pieces and be put together into larger pieces, or change shapes.
EM-E1	Matter is made of particles.
EM-E2	Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.
EM-E3	Energy can be transferred in various ways and between objects.
EM-M1	Matter is conserved because atoms are conserved in physical and chemical processes.
EM-M2	Within a natural system, the transfer of energy drives the motion and/or cycling of matter.
EM-M3	Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).
EM-M4	The transfer of energy can be tracked as energy flows through a designed or natural system.
EM-H1	The total amount of energy and matter in closed systems is conserved.
EM-H2	Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
EM-H3	Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.
EM-H4	Energy drives the cycling of matter within and between systems.
EM-H5	In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
SF-P1	The shape and stability of structures of natural and designed objects are related to their function(s).
SF-E1	Different materials have different substructures, which can sometimes be observed.
SF-E2	Substructures have shapes and parts that serve functions.
SF-M1	Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function.
SF-M2	Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.
SF-H1	Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.
SF-H2	The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.
SC-P1	Some things stay the same while other things change.
SC-P2	Things may change slowly or rapidly.

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CCC Element Code	CCC Element Text
SC-E1	Change is measured in terms of differences over time and may occur at different rates.
SC-E2	Some systems appear stable, but over long periods of time will eventually change.
SC-M1	Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.
SC-M2	Small changes in one part of a system might cause large changes in another part.
SC-M3	Stability might be disturbed either by sudden events or gradual changes that accumulate over time.
SC-M4	Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.
SC-H1	Much of science deals with constructing explanations of how things change and how they remain stable.
SC-H2	Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.
SC-H3	Feedback (negative or positive) can stabilize or destabilize a system.
SC-H4	Systems can be designed for greater or lesser stability.

Eng Conn Element Code	Conn to Engineering Element Text
INTER-P1	People encounter questions about the natural world every day.
INTER-P2	Science and engineering involve the use of tools to observe and measure things.
INTER-E1	Science and technology support each other.
INTER-E2	Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.
INTER-E3	Scientific discoveries about the natural world can often lead to new and improved technologies, which are develpped through the engineering design process
INTER-E4	Knowledge of relevant scientific concepts and research findings is important in engineering.
INTER-M1	Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems.
INTER-M2	Science and technology drive each other forward.
INTER-M3	Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.
INTER-H1	Science and engineering complement each other in the cycle known as research and development (R&D).
INTER-H2	Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.
INFLU-P1	Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials.
INFLU-P2	Taking natural materials to make things impacts the environment.
INFLU-P3	People depend on various technologies in their lives; human life would be very different without technology.
INFLU-E1	People's needs and wants change over time, as do their demands for new and improved technologies.
INFLU-E2	Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.
INFLU-E3	When new technologies become available, they can bring about changes in the way people live and interact with one another.
INFLU-M1	All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
INFLU-M2	The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.
INFLU-M3	Technology use varies over time and from region to region.
INFLU-H1	Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications.
INFLU-H2	Engineers continuously modify these systems to increase benefits while decreasing costs and risks.
INFLU-H3	New technologies can have deep impacts on society and the environment, including some that were not anticipated.
INFLU-H4	Analysis of costs and benefits is a critical aspect of decisions about technology.

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NOS Conn Element Code	Conn to Nature of Science Element Text
VOM-P1	Science investigations begin with a question.
VOM-P2	Science uses different ways to study the world.
VOM-E1	Science methods are determined by questions.
VOM-E2	Science investigations use a variety of methods, tools, and techniques.
VOM-M1	Science investigations use a variety of methods and tools to make measurements and observations.
VOM-M2	Science investigations are guided by a set of values to ensure accuracy of measurements, observations, and objectivity of findings.
VOM-M3	Science depends on evaluating proposed explanations.
VOM-M4	Scientific values function as criteria in distinguishing between science and non-science.
VOM-H1	Science investigations use diverse methods and do not always use the same set of procedures to obtain data.
VOM-H2	New technologies advance scientific knowledge.
VOM-H3	Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.
VOM-H4	The discourse practices of science are organized around disciplinary domains that share exemplars for making decisions regarding the values, instruments, methods, models, and evidence to adopt and use.
VOM-H5	Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
BEE-P1	Scientists look for patterns and order when making observations about the world.
BEE-E1	Science findings are based on recognizing patterns.
BEE-E2	Science uses tools and technologies to make accurate measurements and observations.
BEE-M1	Science knowledge is based upon logical and conceptual connections between evidence and explanations.
BEE-M2	Science disciplines share common rules of obtaining and evaluating empirical evidence.
BEE-H1	Science knowledge is based on empirical evidence.
BEE-H2	Science disciplines share common rules of evidence used to evaluate explanations about natural systems.
BEE-H3	Science includes the process of coordinating patterns of evidence with current theory.
BEE-H4	Science arguments are strengthened by multiple lines of evidence supporting a single explanation.
OTR-P1	Science knowledge can change when new information is found.
OTR-E1	Science explanations can change based on new evidence.
OTR-M1	Scientific explanations are subject to revision and improvement in light of new evidence.
OTR-M2	The certainty and durability of science findings varies.
OTR-M3	Science findings are frequently revised and/or reinterpreted based on new evidence.
OTR-H1	Scientific explanations can be probabilistic.

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NOS Conn Element Code	Conn to Nature of Science Element Text
OTR-H2	Most scientific knowledge is quite durable but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.
OTR-H3	Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.
ENP-P1	Science uses drawings, sketches, and models as a way to communicate ideas.
ENP-P2	Science searches for cause and effect relationships to explain natural events.
ENP-E1	Science theories are based on a body of evidence and many tests.
ENP-E2	Science explanations describe the mechanisms for natural events.
ENP-M1	Theories are explanations for observable phenomena.
ENP-M2	Science theories are based on a body of evidence developed over time.
ENP-M3	Laws are regularities or mathematical descriptions of natural phenomena.
ENP-M4	A hypothesis is used by scientists as an idea that may contribute important new knowledge for the evaluation of a scientific theory.
ENP-M5	The term "theory" as used in science is very different from the common use outside of science.
ENP-H1	Theories and laws provide explanations in science, but theories do not with time become laws or facts.
ENP-H2	A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that has been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.
ENP-H3	Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory.
ENP-H4	Laws are statements or descriptions of the relationships among observable phenomena.
ENP-H5	Scientists often use hypotheses to develop and test theories and explanations.
WOK-P1	Science knowledge helps us know about the world.
WOK-E1	Science is both a body of knowledge and processes that add new knowledge.
WOK-E2	Science is a way of knowing that is used by many people.
WOK-M1	Science is both a body of knowledge and the processes and practices used to add to that body of knowledge.
WOK-M2	Science knowledge is cumulative and many people, from many generations and nations, have contributed to science knowledge.
WOK-M3	Science is a way of knowing used by many people, not just scientists.
WOK-H1	Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise, and extend this knowledge.
WOK-H2	Science is a unique way of knowing and there are other ways of knowing.

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NOS Conn Element Code	Conn to Nature of Science Element Text
WOK-H3	Science distinguishes itself from other ways of knowing through use of empirical standards, logical arguments, and skeptical review.
WOK-H4	Science knowledge has a history that includes the refinement of, and changes to, theories, ideas, and beliefs over time.
AOC-P1	Science assumes natural events happen today as they happened in the past.
AOC-P2	Many events are repeated.
AOC-E1	Science assumes consistent patterns in natural systems.
AOC-E2	Basic laws of nature are the same everywhere in the universe.
AOC-M1	Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.
AOC-M2	Science carefully considers and evaluates anomalies in data and evidence.
AOC-H1	Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.
AOC-H2	Science assumes the universe is a vast single system in which basic laws are consistent.
HE-P1	People have practiced science for a long time.
HE-P2	Men and women of diverse backgrounds are scientists and engineers.
HE-E1	Men and women from all cultures and backgrounds choose careers as scientists and engineers.
HE-E2	Most scientists and engineers work in teams.
HE-E3	Science affects everyday life.
HE-E4	Creativity and imagination are important to science.
HE-M1	Men and women from different social, cultural, and ethnic backgrounds work as scientists and engineers.
HE-M2	Scientists and engineers rely on human qualities such as persistence, precision, reasoning, logic, imagination and creativity.
HE-M3	Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism and openness to new ideas.
HE-M4	Advances in technology influence the progress of science and science has influenced advances in technology.
HE-H1	Scientific knowledge is a result of human endeavor, imagination, and creativity.
HE-H2	Individuals and teams from many nations and cultures have contributed to science and to advances in engineering.
HE-H3	Scientists' backgrounds, theoretical commitments, and fields of endeavor influence the nature of their findings.

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NOS Conn Element Code	Conn to Nature of Science Element Text
HE-H4	Technological advances have influenced the progress of science and science has influenced advances in technology.
HE-H5	Science and engineering are influenced by society and society is influenced by science and engineering.
AQAW-P1	Scientists study the natural and material world.
AQAW-E1	Science findings are limited to what can be answered with empirical evidence.
AQAW-M1	Scientific knowledge is constrained by human capacity, technology, and materials.
AQAW-M2	Science limits its explanations to systems that lend themselves to observation and empirical evidence.
AQAW-M3	Science knowledge can describe consequences of actions but is not responsible for society's decisions.
AQAW-H1	Not all questions can be answered by science.
AQAW-H2	Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.
AQAW-H3	Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.
AQAW-H4	Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.